Waste Management of North America, Inc.
Carolinas/Tennessee District
110 Berry Shoals Road • P.O. Box 338
Duncan, South Carolina 29334
803/439-8426

January 25, 1989

Mr. Jim Coffey
Solid Waste Branch
NC Dept. of Human Resources
Division of Health Services
P.O. Box 2091
Raleigh, NC 27602-2091

RE: LEACHATE COLLECTION DESIGN DOCUMENTS FOR THE PIEDMONT SANITARY LANDFILL; KERNERSVILLE, NC

Dear Jim:

Mike and I appreciated you and Gary meeting with us this past Tuesday and hope we were able to shed some light on how we designed the leachate collection system. Enclosed you will find the results of the **HELP** model used for this landfill. Let me explain some of the major points of this model.

This model contains a great deal of default information such as that shown on Table 3 and also local precipitation data that occurred between 1974 and 1978. Notice for the use of this model we were only concerned with the infiltration through Layers 1 and 2, (the topsoil and final cover). This percolation would represent the leachate collected in our system. As you can then see from the Leachate Head Analysis we desired **h max = 1 ft**, the head of the leachate upon the liner. The **h max** is dependent upon a number of factors in which base grade slopes **S**, and length between collection pipes, **L**, are two factors. As stated to you before, there are some areas of the total landfill that exceed this 1 ft of head but the majority of the Piedmont Sanitary Landfill has been designed such that 1 foot or less of leachate head will be upon the liner.

You questioned at what point we would begin pumping the leachate, and we are willing to commit to pumping the leachate once levels are at or below 1 foot above the lip of the sump. Of course this would mean that an asbuilt of each sump would be required to insure we know where this level is.

We hope this has satisfied your questions concerning this matter. We are enclosing three (3) sets of the latest revised engineering plans for your use. If there is anything else you need, please give Mike or I a call.

Sincerely,

Edward L. Gibson, P.E.
Environmental Engineer

/ELG:adb 205

attachments

cc: Hank Ludwig
Mike Adams
Clarke Lundell

HELP MODEL INPUT DATA SUMMARY

Site Name: Piedmont Prepared by: CML Date: 10/28/87

Landfilled Area: 3,100,000 SF SCS Runoff CN Default

State: North Carolina City: Kernersville (Greensboro)

Vegetative Cover Description: Fair grass

Vegetative Cover Number (1) 4

Evaporative Zone Depth 6 Inches (Less or equal to thickness of layer number 1)

Recommended: 4-in. for Bareground; 10-in. for Fair Grass; 18-in. for Excellent Grass

Layer Number	Thickness (inches)	Type (2)	Texture (3)	Compaction (Y/N) (4)	Layer Description
1	6	1	11	N	Topsoil
2	36	3	17	Y	Barrier (3' of 1×10^{-6})
3	1080	4	19		Waste
4	24	1	9	N	Protective cover (SM)
5	0.20	2	22		Geonet (specify prop.) 200' 2%
6	6	5	20		Liner (fraction = 0.001)

NOTES:

(1) See Table 1

(2) See Table 2 - If lateral drainage layer type is selected (Type 2) include drainage length (25 ft. to 200 ft.) and bottom of layer slope (0% to 10%) in the layer description. If barrier soil layer with an impermeable liner (Type 5) is selected, include membrane leachate fraction (between 0 and 1) to reduce the effective hydraulic conductivity of the layer.

(3) See Table 3 - Default values 1 through 21. Use 22 or 23 for manual soil characteristics for which additional information is needed as described in Table 4.

(4) Needed for layer textures 1 through 18. If the answer is YES, the hydraulic conductivity is reduced by a factor of 20, porosity and plant available water capacity is reduced by 25 percent and the evaporation coefficient is reduced to 3.1 $(mm/day)^{0.5}$. If the answer is NO, data from Table 3 are used. Compaction is already considered for barrier soil layers (soil texture 4 or 5 from Table 2).

TABLE 1

VEGETATIVE COVER NUMBERS

1. FOR BARE GROUND
2. FOR EXCELLENT GRASS
3. FOR GOOD GRASS
4. FOR FAIR GRASS
5. FOR POOR GRASS
6. FOR GOOD ROW CROPS
7. FOR FAIR ROW CROPS

TABLE 2

LAYER TYPE SELECTION

1. FOR A VERTICAL PERCOLATION LAYER
2. FOR A LATERAL DRAINAGE LAYER
3. FOR A BARRIER SOIL LAYER
4. FOR A WASTE LAYER
5. FOR A BARRIER SOIL LAYER WITH AN IMPERMEABLE LINER

TABLE 4

MANUAL SOIL CHARACTERISTICS FOR LAYER NUMBER ______

POROSITY	0.80	(VOL/VOL)
FIELD CAPACITY	0.05	(VOL/VOL)
WILTING POINT	0.03	(VOL/VOL)
HYDRAULIC CONDUCTIVITY	1400	INCH/HOUR
EVAPORATION COEFFICIENT	3.0	$(MM/DAY)^{0.5}$

$T = 5 \times 10^{-4}$ m²/sec

K = 10 cm/sec

NOTE: POROSITY HAS TO BE GREATER THAN FIELD CAPACITY. FIELD CAPACITY HAS TO BE GREATER THAN WILTING POINT.

TABLE 3 DEFAULT SOIL CHARACTERISTICS

Soil Texture Class HELP[a]	USDA[b]	USCS[c]	MIR[d] In/hr	Porosity Vol/Vol	Field Capacity Vol/Vol	Wilting Point Vol/Vol	Hydraulic Conductivity in/hr	CON[e] [illegible]/day$^{0.5}$	K cm/sec.
1	CoS	GS	0.500	0.351	0.174	0.107	11.95	3.3	8.43×10^{-3}
2	CoSL	GP	0.450	0.376	0.218	0.131	7.090	3.3	5.00×10^{-3}
3	S	SW	0.400	0.389	0.199	0.066	6.620	3.3	4.67×10^{-3}
4	FS	SM	0.390	0.371	0.172	0.050	5.400	3.3	3.31×10^{-3}
5	LS	SM	0.380	0.430	0.16	0.060	2.780	3.4	1.96×10^{-3}
6	LFS	SM	0.340	0.401	0.129	0.075	1.000	3.3	7.06×10^{-4}
7	LVFS	SM	0.320	0.421	0.176	0.090	0.910	3.4	6.42×10^{-4}
8	SL	SM	0.300	0.442	0.256	0.133	0.670	3.8	4.73×10^{-4}
9	FSL	SM	0.250	0.458	0.223	0.092	0.550	4.5	3.88×10^{-4}
10	VFSL	MH	0.250	0.511	0.301	0.184	0.330	5.0	233×10^{-4}
11	L	ML	0.200	0.521	0.377	0.221	0.210	4.5	1.48×10^{-4}
12	SIL	ML	0.170	0.535	0.421	0.222	0.110	5.0	776×10^{-5}
13	SCL	SC	0.110	0.453	0.319	0.200	0.084	4.7	5.93×10^{-5}
14	CL	CL	0.090	0.582	0.452	0.325	0.065	3.9	4.59×10^{-5}
15	SICL	CL	0.070	0.588	0.504	0.355	0.041	4.2	2.89×10^{-5}
16	SC	CH	0.060	0.572	0.456	0.378	0.065	3.6	4.59×10^{-5}
17	SIC	CH	0.020	0.592	0.501	0.378	0.033	3.8	233×10^{-5}
18	C	CH	0.010	0.680	0.607	0.492	0.022	3.5	1.55×10^{-5}
19	Waste		0.230	0.520	0.320	0.190	0.283	3.3	2.00×10^{-4}
20	Barrier Soil		0.002	0.520	0.450	0.360	0.000142	3.1	1.00×10^{-7}
21	Barrier Soil		0.001	0.520	0.480	0.400	0.0000142	3.1	1.00×10^{-8}

[a] Soil classification system used in the HELP model (see discussion in text).

[b] Soil classification system used by the U.S. Department of Agriculture.

[c] The Unified Soil Classification System.

[d] MIR = Minimum Infiltration Rate.

[e] CON = Evaporation Coefficient (Transmissivity).

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     TO STOP THE PROGRAM, AND
     TO RUN THE SIMULATION AND OBTAIN ONLY SUMMARY OUTPUT.


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1.1 HOW MANY YEARS OF OUTPUT DO YOU WANT?
(BETWEEN 2 AND 20 YEARS MAY BE USED.)

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PIEDMONT LANDFILL WITH FINAL COVER
KERNERSVILLE, NC
OCTOBER 28, 1987

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                                   FAIR GRASS


                                    LAYER 1          TOPSOIL
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          VERTICAL PERCOLATION LAYER
          THICKNESS                              =       6.00 INCHES
          EVAPORATION COEFFICIENT                =       4.500 MM/DAY**0.5
          POROSITY                               =        .5210 VOL/VOL
          FIELD CAPACITY                         =        .3770 VOL/VOL
          WILTING POINT                          =        .2210 VOL/VOL
          EFFECTIVE HYDRAULIC CONDUCTIVITY       =        .63000000 INCHES/HR


                                    LAYER 2
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B.S. LAYER 2 FINAL COVER

BARRIER SOIL LAYER

THICKNESS	=	36.00 INCHES
EVAPORATION COEFFICIENT	=	3.100 MM/DAY**0.5
POROSITY	=	.5385 VOL/VOL
FIELD CAPACITY	=	.4702 VOL/VOL
WILTING POINT	=	.3790 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	.00145000 INCHES/HR

1x10-6

LAYER 3

WASTE

WASTE LAYER

THICKNESS	=	1080.00 INCHES
EVAPORATION COEFFICIENT	=	3.300 MM/DAY**0.5
POROSITY	=	.5200 VOL/VOL
FIELD CAPACITY	=	.3200 VOL/VOL
WILTING POINT	=	.1900 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	.28300000 INCHES/HR

2x10-4

LAYER 4

PROTECTIVE + DRAINAGE

VERTICAL PERCOLATION LAYER

THICKNESS	=	24.00 INCHES
EVAPORATION COEFFICIENT	=	4.500 MM/DAY**0.5
POROSITY	=	.4580 VOL/VOL
FIELD CAPACITY	=	.2230 VOL/VOL
WILTING POINT	=	.0920 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	.55000000 INCHES/HR

1x10-4

4x10-4

LAYER 5

GEONET

LATERAL DRAINAGE LAYER

SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	200.0 FEET
THICKNESS	=	.20 INCHES
EVAPORATION COEFFICIENT	=	3.000 MM/DAY**0.5
POROSITY	=	.8000 VOL/VOL
FIELD CAPACITY	=	.0500 VOL/VOL
WILTING POINT	=	.0300 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	1400.00000000 INCHES/HR

LAYER 6

LINER

BARRIER SOIL LAYER WITH LINER

THICKNESS	=	6.00 INCHES
EVAPORATION COEFFICIENT	=	3.100 MM/DAY**0.5
POROSITY	=	.5200 VOL/VOL
FIELD CAPACITY	=	.4500 VOL/VOL
WILTING POINT	=	.3600 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	.00014200 INCHES/HR

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	79.43
TOTAL AREA OF COVER	=	3100000. SQ. FT 71.2 Ac.
EVAPORATIVE ZONE DEPTH	=	6.00 INCHES
LINER LEAKAGE FRACTION	=	.001000
EFFECTIVE EVAPORATION COEFFICIENT	=	4.500 MM/DAY**0.5
UPPER LIMIT VEG. STORAGE	=	3.1260 INCHES
INITIAL VEG. STORAGE	=	1.7940 INCHES

CLIMATOLOGIC DATA FOR GREENSBORO NORTH CAROLINA

MONTHLY MEAN TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
38.16	40.53	47.61	57.50	67.55	75.07
73.04	75.67	68.59	58.70	48.65	41.13

MONTHLY MEANS SOLAR RADIATION, LANGLEYS PER DAY

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
213.78	272.26	360.30	454.31	529.11	564.64
551.39	492.91	404.87	310.85	236.06	200.53

LEAF AREA INDEX TABLE

DATE	LAI
1	.00
98	.00
119	.61
139	.99
160	.99
180	.99
201	.99
222	.99
242	.89
263	.65
283	.32
304	.17
366	.00

FAIR GRASS

WINTER COVER FACTOR = .60

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AVERAGE MONTHLY TOTALS FOR 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	4.43	1.99	4.38	2.21	4.14	2.73
	5.32	4.79	5.44	3.60	2.36	3.98
RUNOFF (INCHES)	1.532	.214	.753	.224	.403	.002
	1.739	1.119	1.731	.819	.001	.675
EVAPOTRANSPIRATION (INCHES)	1.751	1.622	2.691	1.940	3.386	2.632
	3.182	3.092	2.747	1.978	1.548	1.633
PERCOLATION FROM BASE OF COVER (INCHES)	1.2419	.7568	.7825	.3647	.4898	.1909
	.3904	.4766	.7629	.6110	.6700	1.1553
PERCOLATION FROM BASE OF LANDFILL (INCHES)	.0005	.0001	.0001	.0001	.0001	.0001
	.0001	.0001	.0001	.0001	.0001	.0001
DRAINAGE FROM BASE OF COVER (INCHES)	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000	.000
DRAINAGE FROM BASE OF LANDFILL (INCHES)	.908	.935	.877	.707	.533	.397
	.314	.406	.527	.640	.602	.814

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AVERAGE ANNUAL TOTALS FOR 74 THROUGH 78

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	45.37	11720580.	100.00

RUNOFF	9.211	2379460.	[illegible]
EVAPOTRANSPIRATION	28.202	7285399.	62.16
PERCOLATION FROM BASE OF COVER	7.8927	2038954.	17.40
PERCOLATION FROM BASE OF LANDFILL	.0016	421.	.00
DRAINAGE FROM BASE OF COVER	.000	0.	.00
DRAINAGE FROM BASE OF LANDFILL	7.659	1978660.	16.88

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PEAK DAILY VALUES FOR 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	4.73	1221917.0
RUNOFF	3.271	844957.8
PERCOLATION FROM BASE OF COVER	.1009	26056.9
PERCOLATION FROM BASE OF LANDFILL	.0016	424.9
DRAINAGE FROM BASE OF COVER	.000	.0
DRAINAGE FROM BASE OF LANDFILL	.049	12580.2
HEAD ON BASE OF COVER	6.0	
HEAD ON BASE OF LANDFILL	.1	
SNOW WATER	.00	.0

MAXIMUM VEG. SOIL WATER (VOL/VOL)	.5210
MINIMUM VEG. SOIL WATER (VOL/VOL)	.2198

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Waste Management, Inc. Environmental Engineering Group	PROJECT Piedmont No. D-014	SHEET 1 OF 2	PAGE
SUBJECT: Leachate Head Analysis	PREPARED BY CMG 12/11/87	CHECKED BY AEM 1/28/88	REVISED BY / /

Assumptions:

Annual infiltration is 7.9 inches
Drainage blanket permeability is 1×10^{-3} cm/sec or 1×10^{-2} cm/sec
Use EPA-SW 869 Equation
por. → $n = 0.35$

4:1

Calculation:

$$e = 7.9''/\text{year}\left(\frac{\text{year}}{365\text{ days}}\right)\left(\frac{\text{day}}{86400\text{ sec}}\right)\left(\frac{2.54\text{ cm}}{\text{in}}\right) = 6.4\times10^{-7}\text{ cm/sec}$$

For $L = 600'$ $K = 1\times10^{-3}$ cm/sec
$s = 2\%$

4.8

$$h_{max} = \frac{600}{2(0.35)}\left[\left(\frac{6.4\times10^{-7}}{1\times10^{-3}} + (0.02)^2\right)^{1/2} - 0.02\right] = 10.5'$$

For $L = 300'$ $h_{max} = 5.25'$
$L = 57'$ $h_{max} = 1.0'$ 25% ↓ e L = 72. ↑25%

$\frac{L}{h} = \frac{L}{h}$

For $L = 600'$ $K = 1\times10^{-3}$ cm/sec
$s = 4.5\%$

$$h_{max} = \frac{600}{2(0.35)}\left[\left(\frac{6.4\times10^{-7}}{1\times10^{-3}} + (0.045)^2\right)^{1/2} - 0.045\right] = 5.7'$$

For $L = 300'$ $h_{max} = 2.8'$

$L = 105$ $h_{max} = 1.0'$

Waste Management, Inc.
Environmental Engineering Group

PROJECT	Piedmont	SHEET	PAGE
No.	D-014	2 OF 2	

SUBJECT:	PREPARED BY	CHECKED BY	REVISED BY
Leachate Head Analysis	CMK	AEM	
	12/11/87	1/28/88	/ /

For $L = 600'$ $K = 1\times10^{-2}$ cm/sec
$S = 2\%$

$$h_{max} = \frac{600}{2(0.35)}\left[\left(\frac{6.4\times10^{-7}}{1\times10^{-2}} + (0.02)^2\right)^{1/2} - 0.02\right] = 1.3'$$

For $L = 300'$ $h_{max} = 0.66'$

For $L = 600'$ $K = 1\times10^{-2}$ cm/sec
$S = 4.5\%$

$$h_{max} = \frac{600}{2(0.35)}\left[\left(\frac{6.4\times10^{-7}}{1\times10^{-2}} + (0.045)^2\right)^{1/2} - 0.045\right] = 0.6'$$

For $L = 300'$ $h_{max} = 0.3'$