Weyerhaeuser

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94-01 5/9/12

Construction Plan Application For On-site Industrial Waste Landfill No. 3

Weyerhaeuser Company
Plymouth, North Carolina

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APPROVED
DIVISION OF SOLID WASTE MANAGEMENT
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Volume II

Appendix E
Slope Stability Analysis

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Attachment E1
Slope Stability Findings

Slope Stability Findings

A slope stability analysis of the proposed solid waste facility was conducted using Geotechnical Analysis for Review of Dike Stability (GARDS) developed by the University of Cincinnati for USEPA.

This analysis was based on the following assumptions and input parameters:

- The soil borings encountered *in-situ* soils that are representative of the site conditions.
- The RMT slope stability analysis evaluated two sections of the proposed landfill: a west section and an east section, both based on geological cross-section C-C' (refer to Drawing No. 510101-C06). Cross-section C-C' encompasses the general stratigraphy of the site under the most critical loading condition of the proposed landfill. The west subsurface section is based on borings MW-6, MW-6A, SB-9, OW-3, and HA-9. The east subsurface section is based on borings OW-3, HA-9, OW-1, and MW-7.
- Laboratory shear strength results are representative of site conditions. Physical properties of the proposed waste materials and the *in-situ* soils used in the analyses were derived from laboratory test data by Law Engineering, Kiber Environmental Services, Inc., and RMT's past experience with similar materials.
- The groundwater table used in the analyses was based on the April 2, 1993, water table surface. It is considered the high groundwater table and it exists approximately 4 feet below the natural ground surface, based on water level readings from site monitoring and observation wells.
- The bottom of the landfill was modeled to be at least 4 feet above groundwater table surface and follows the general topography of the site. The bottom of the landfill will range in elevation from 12 to 44 feet.
- The liner will consist of a GCL, and a 60-mil HDPE-textured geomembrane, overlying 1 foot of compacted subgrade soil.
- The cap will consist of 12 inches of select ash; a GCL; a 40-mil VFPE textured geomembrane; a geocomposite drainage layer; 12 inches of general fill (vegetation support layer); and 6 inches of topsoil.
- The perimeter dikes will consist of compacted general fill.
- The waste in the center of the landfill will be approximately 185 feet thick. The landfill's southwest side will be constructed to a maximum height of 214 feet above the existing ground surface elevation at the southwest perimeter berm. The top 14 feet of the landfill will slope away from the center of the landfill at an average slope of approximately 6 percent. The exterior side slope of the landfill will be constructed with a 3 horizontal to 1 vertical side slope that benches inward 15 feet for every 20 feet of height. RMT's analysis

was conducted using a 3 horizontal to 1 vertical side slope without the terraces. This was a more conservative approach than modeling the proposed construction geometry.

- Stability was evaluated for CU conditions (short-term condition immediately following construction) and CD conditions (long-term condition sometime after construction).
- The analyses were also conducted under seismic loading conditions for the drained case. A seismic coefficient of 0.07 gravity (g) and a design earthquake magnitude of 5.25 were used in these analyses on the basis of site seismicity location according to GARDS' recommendations.
- A peizometric surface was modeled after the groundwater table since the leachate collection system will be designed to allow for more than 1 foot of head above the liner on the bottom of the landfill.
- Landfill waste will predominately consist of ash with some dewatered 30-year-old wastewater solids dredged from Weyerhaeuser's wastewater treatment ponds.

The input parameters used in the analyses are as follows:

MEASUREMENT	DENSE SP/SM	MEDIUM DENSE SP/SM	LOOSE SP/SM	LOOSE SM	FIRM CL/ML/SC	SOFT CL/ML/SC	ASH	DEWATERED WASTEWATER SOLIDS
C_{CU} (psf)	0	0	0	0	350	140	0	855
ϕ_{CU} (degrees)	35	30	25	25	28	15	28	21
C'_{CD} (psf)	0	0	0	0	350	140	0	820
ϕ'_{CD} (degrees)	35	30	25	25	28	15	41	19
Total Unit Weight (pcf)	140	130	115	125	130	130	70	70

Slope Stability Findings and Conclusions

For the conditions described above, the slope stability analyses resulted in the following minimum factors of safety:

SECTION	WASTE MATERIAL	FACTORS OF SAFETY		
		CU WITHOUT PORE PRESSURE MEASUREMENTS	CU WITH PORE PRESSURE MEASUREMENTS	CU WITH PORE PRESSURE MEASUREMENTS UNDER SEISMIC LOADING CONDITIONS
East C-C'	Ash	1.61	> 2.50	2.01
West C-C'	Ash	1.61	> 2.50	1.85
East C-C'	Dewatered Wastewater Solids	2.14	1.98	1.60
West C-C'	Dewatered Wastewater Solids	2.05	1.98	1.61

These results met or exceeded GARDS' minimum recommended Factor of Safety of 1.50. GARDS output and graphical results of the slope stability analysis are attached.

Based on the slope stability analysis, the construction of the proposed facility described herein is feasible. Parameters used in the Slope Stability Analysis Model are valid for the proposed facility at the proposed site for the following reasons:

- Soil parameters were obtained by testing samples from the proposed site.
- Waste parameters were obtained by testing actual samples of ash from Weyerhaeuser's existing landfill and dewatered wastewater solids dredged from Weyerhaeuser's wastewater treatment ponds. No significant change in waste material or landfill operations are expected for the new landfill.
- The highest recorded groundwater readings from the actual site were used to account for a seasonally high fluctuation in groundwater.
- The proposed geometry was based on Weyerhaeuser's needs, but limited by regulatory constraints and the seasonal high groundwater level.

However, the slope stability analysis revealed that the potential for slope failure at this site increases under the following conditions:

- A rise in the groundwater table
- Steeper slopes
- Waste materials placed much looser or wetter than in the existing landfill or that which was tested
- Actual shear strength parameters significantly less than those used in the RMT analysis
- Subgrade or subsurface soils destabilized due to poor drainage or construction equipment traffic
- Any leachate generated that is not able to adequately drain
- Soil not compacted as recommended

Design feature and operating procedure described in this application have been developed to minimize the potential for slope failures. Recommendations to construct this facility are discussed below and in Section 4.

Slope Stability Recommendations

The following recommendations are based on the subsurface exploration data obtained, the laboratory test results, and RMT's past experience with similar projects:

- Immediately prior to construction of the liner, the subgrade soils should be observed by a qualified geotechnical engineer to confirm that the subgrades are suitable for construction of the landfill.

- Placement and compaction of all controlled fill soil used to construct the landfill and sediment basins should be monitored and tested by qualified geotechnical personnel to verify that the recommended compaction has been attained.
- Careful control of the equipment traffic and drainage should be exercised throughout construction (especially during rainy weather) to prevent destabilization of the subgrade soils.
- Soil used in construction of the perimeter dikes or grading of the site should be placed in 8-inch thick (loose) lifts and compacted to at least 95 percent of the Standard Proctor (ASTM D 698) maximum dry density at ±3 percent of the optimum moisture content.
- Dewater all dredged wastewater solids by plate and frame press immediately prior to placement in landfill.
- Place and compact the waste material in lifts no more than 3 feet thick. Waste material placed in the facility should be compacted by repeated passes of the bulldozer until firm.
- Keep all waste material well drained by sloping the surface of the waste material to allow for stormwater drainage.
- In the event dewatered wastewater solids are subjected to precipitation prior to placement, blend it with ash to improve its shear strength and compaction. The shear strength of a 60/40 dewatered wastewater solids to ash blend is significantly higher than for dewatered wastewater solids alone.
- Conduct additional testing and slope stability analyses if there is a change in the waste material placed or the quality of waste material placed in the landfill.
- Waste placement operations should be such that adequate drainage of any leachate generated should be maintained at all times. RMT recommends that no more than 1 foot of head be allowed to build up within the solid waste facility.
- The side slopes should not exceed 3 horizontal to 1 vertical and the maximum height of the landfill should not exceed 214 feet. The exterior side slope should bench inward 15 feet for every 20 feet rise in height.

The findings of the slope stability analyses were based on laboratory test results from samples that are assumed to be representative. During operations, actual average properties of the ash, dewatered wastewater solids, and fill material may vary. Therefore, RMT recommends that additional laboratory testing be conducted on samples obtained during operations if significant changes are made to the waste generation processes.

Attachment E2
GARDS Computer Modeling for Ash and Wastewater solids – 4 Runs Total

```
*********************************************************************
*                                                                   *
*                      G A R D S   S U M M A R Y                    *
*                                                                   *
*    Project:  WEYERHAEUSER PLYMOUTH/EAST/C-C'/H=186'/3H:1V/ASH     *
*       File:  WPCC_E_A                                             *
*                                                                   *
*                         GARDS  Version 2.00                       *
*                            developed by                           *
*          Department of Civil and Environmental Engineering        *
*                      University of Cincinnati                     *
*                          under contract to                        *
*                 U.S. Environmental Protection Agency              *
*                   Land Pollution Control Division                 *
*            Hazardous Waste Engineering Research Laboratory        *
*                                                                   *
*********************************************************************
```

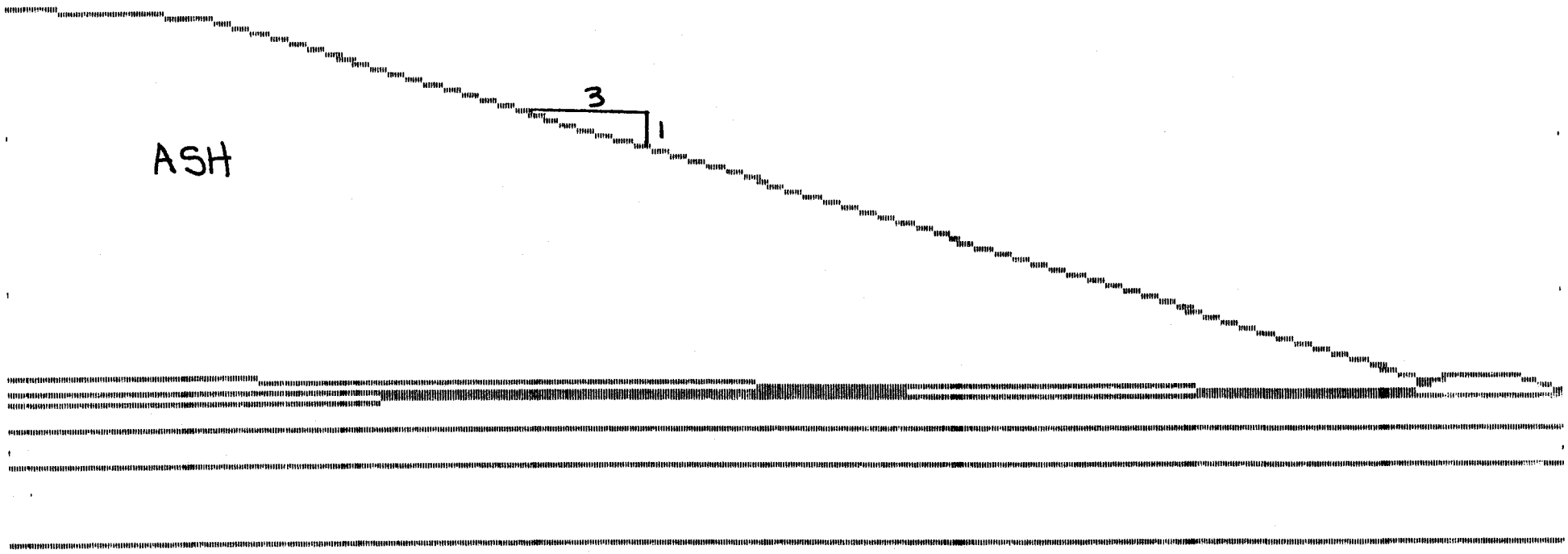
```
*********************************************************************
*                        Site Characteristics                       *
*********************************************************************
*                                                                   *
*      The seismic coefficient is. . . . . . . . . . . . . . 0.07   *
*                                                                   *
*      The design earthquake magnitude is. . . . . . . . . . 5.25   *
*                                                                   *
*      The maximum flood elevation in this case is . . . . .    0   *
*                                                                   *
*      The elevation of the seasonal high ground water is. .    0   *
*                                                                   *
*      The design waste elevation in the cell is . . . . . .    0   *
*                                                                   *
*      The soil number representing the clay liner is. . . .    0   *
*                                                                   *
*********************************************************************
```

The number of soil boundary lines for this section is 7

Line	Point	X	Y
1	1	0	0
	2	2000	0
2	1	0	38
	2	2000	38
3	1	0	55
	2	2000	56
4	1	0	65
	2	230	69
	3	500	70
	4	1180	70
5	1	0	73
	2	210	72
	3	550	73
	4	630	76
6	1	0	82
	2	630	76
	3	809	74
	4	827	80
7	1	0	264
	2	119	264
	3	291	252
	4	807	80
	5	817	77
	6	827	80
	7	852	80
	8	870	74
	9	930	72
	10	1140	72
	11	1180	70
	12	1220	62
	13	1250	62
	14	1320	72
	15	2000	76

WEYERHAUSER PLYMOUTH/EAST/C-C'/H=186'/3H:1V/ASH File: WPCC_EA

Hydraulic Condition 7: User Defined



(206 ,107) SCALE : 1 inch = 75 feet

Soil 1 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	0	0	(lb/sq.ft)
Phi Angle	0	35	35	(degrees)

Unit Weight	140.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 2 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	350	350	(lb/sq.ft)
Phi Angle	0	28	28	(degrees)

Unit Weight	130.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

```
*********************************************************************
*                        Soil  3 Properties                         *
*********************************************************************
*                                                                   *
*            Unconsolidated  Consolidated  Consolidated             *
*                Undrained     Undrained      Drained               *
*               ------------  ------------  ------------            *
*   Cohesion          0             0             0       (lb/sq.ft) *
*   Phi Angle         0            30            30        (degrees) *
*-------------------------------------------------------------------*
*                                                                   *
*        Unit Weight . . . . . . . . . . 130.000   (lb/cu.ft)       *
*        Clay Content  . . . . . . . . .   0.000   (%)              *
*        Overconsolidation Ratio . . . .   0.000                    *
*        Initial Void Ratio  . . . . . .   0.000                    *
*        Compression Index . . . . . . .   0.000                    *
*        Recompression Index . . . . . .   0.000                    *
*        Permeability  . . . . . . . .     0.000   (ft/yr)          *
*        Median Grain Size . . . . . . .   0.000   (mm)             *
*        Plasticity Index  . . . . . . .   0.000   (%)              *
*        Liquid Limit  . . . . . . . . .   0.000   (%)              *
*        Standard Penetration Number . .   0.000   (blows/ft)       *
*********************************************************************
```

```
*********************************************************************
*                        Soil  4 Properties                         *
*********************************************************************
*                                                                   *
*            Unconsolidated  Consolidated  Consolidated             *
*                Undrained     Undrained      Drained               *
*               ------------  ------------  ------------            *
*   Cohesion          0           350           350       (lb/sq.ft) *
*   Phi Angle         0            28            28        (degrees) *
*-------------------------------------------------------------------*
*                                                                   *
*        Unit Weight . . . . . . . . . . 130.000   (lb/cu.ft)       *
*        Clay Content  . . . . . . . . .   0.000   (%)              *
*        Overconsolidation Ratio . . . .   0.000                    *
*        Initial Void Ratio  . . . . . .   0.000                    *
*        Compression Index . . . . . . .   0.000                    *
*        Recompression Index . . . . . .   0.000                    *
*        Permeability  . . . . . . . .     0.000   (ft/yr)          *
*        Median Grain Size . . . . . . .   0.000   (mm)             *
*        Plasticity Index  . . . . . . .   0.000   (%)              *
*        Liquid Limit  . . . . . . . . .   0.000   (%)              *
*        Standard Penetration Number . .   0.000   (blows/ft)       *
*********************************************************************
```

```
*********************************************************************
*                        Soil  5 Properties                         *
*********************************************************************
*                                                                   *
*            Unconsolidated  Consolidated  Consolidated             *
*                Undrained     Undrained      Drained               *
*              ------------  ------------  ------------             *
*   Cohesion          0           140           140       (lb/sq.ft) *
*   Phi Angle         0            15            15        (degrees) *
*-------------------------------------------------------------------*
*                                                                   *
*        Unit Weight . . . . . . . . . . . 130.000   (lb/cu.ft)     *
*        Clay Content  . . . . . . . . . .   0.000   (%)            *
*        Overconsolidation Ratio . . . .     0.000                  *
*        Initial Void Ratio  . . . . . .     0.000                  *
*        Compression Index . . . . . . .     0.000                  *
*        Recompression Index . . . . . .     0.000                  *
*        Permeability  . . . . . . . .       0.000   (ft/yr)        *
*        Median Grain Size . . . . . . .     0.000   (mm)           *
*        Plasticity Index  . . . . . . .     0.000   (%)            *
*        Liquid Limit  . . . . . . . . .     0.000   (%)            *
*        Standard Penetration Number . .     0.000   (blows/ft)     *
*********************************************************************
```

```
*********************************************************************
*                        Soil  6 Properties                         *
*********************************************************************
*                                                                   *
*            Unconsolidated  Consolidated  Consolidated             *
*                Undrained     Undrained      Drained               *
*              ------------  ------------  ------------             *
*   Cohesion          0             0             0       (lb/sq.ft) *
*   Phi Angle         0            28            41        (degrees) *
*-------------------------------------------------------------------*
*                                                                   *
*        Unit Weight . . . . . . . . . . .  70.000   (lb/cu.ft)     *
*        Clay Content  . . . . . . . . . .   0.000   (%)            *
*        Overconsolidation Ratio . . . .     0.000                  *
*        Initial Void Ratio  . . . . . .     0.000                  *
*        Compression Index . . . . . . .     0.000                  *
*        Recompression Index . . . . . .     0.000                  *
*        Permeability  . . . . . . . .       0.000   (ft/yr)        *
*        Median Grain Size . . . . . . .     0.000   (mm)           *
*        Plasticity Index  . . . . . . .     0.000   (%)            *
*        Liquid Limit  . . . . . . . . .     0.000   (%)            *
*        Standard Penetration Number . .     0.000   (blows/ft)     *
*********************************************************************
```

```
*************************************************************************
*                        Hydraulics Results                             *
*************************************************************************
*                                                                       *
*        Seepage In  . . . . . . . .        0.000   (cu.ft/yr)         *
*                                                                       *
*        Seepage Out . . . . . . . .        0.000   (cu.ft/yr)         *
*                                                                       *
*        Critical Exit Gradient  . . .      0.000                      *
*                                                                       *
*        For this hydraulic condition there is no liner uplift.         *
*                                                                       *
*************************************************************************
```

```
*************************************************************************
*                          User Defined                                 *
*             Piezometric Surface for Hydraulic Condition               *
*             7: User Defined                                           *
*************************************************************************
*                                                                       *
*                  Point          X            Y                       *
*                 ------       ------       ------                     *
*                    1            0           72                       *
*                    2          215           71                       *
*                    3          809           70                       *
*                    4         1220           61                       *
*                    5         2000           61                       *
*************************************************************************
```

```
*************************************************************************
*                                                                       *
*        R O T A T I O N A L   F A I L U R E   R E S U L T S            *
*                                                                       *
*                     User defined Grid Search                          *
*                                                                       *
*     The slopes were analyzed for failure arcs having centers in       *
*     areas defined by the following parallelograms:                    *
*************************************************************************
*                                                                       *
*                              Slope  1                                 *
*                                                                       *
*    Co-ord.       Point 1       Point 2       Point 3       Point 4    *
*    -------       -------       -------       -------       -------    *
*       X            291           1220          1410          481      *
*       Y            300            110           442          632      *
*-----------------------------------------------------------------------*
*                                                                       *
*        The number of divisions between points 1 and 2 were  8         *
*        The number of divisions between points 2 and 3 were  8         *
*        The X-increment used in the search was  . . . . . . 20         *
*        The Y-increment used in the search was  . . . . . . 20         *
*                                                                       *
*************************************************************************
```

ROTATIONAL FAILURE RESULTS

Hydraulic Condition 7: User Defined

Consolidated Undrained (CU) Case

Safety Factor	Failure Radius	X-Co-ord	Y-Co-ord
1.61	1628.6	1049.4	1700.8
1.61	1633.4	1049.4	1705.8
1.61	1647.8	1049.4	1720.8
1.61	1666.9	1049.4	1740.8
1.61	1686.1	1049.4	1760.8
1.61	1627.3	1044.4	1700.8
1.61	1661.7	1029.4	1740.8
1.61	1642.5	1029.4	1720.8
1.61	1623.4	1029.4	1700.8
1.61	1623.4	1029.4	1700.8
1.61	1604.2	1029.4	1680.8
1.61	1599.0	1009.4	1680.8
1.61	1579.8	1009.4	1660.8
1.61	1560.7	1009.4	1640.8
1.61	1541.5	1009.4	1620.8
1.61	1522.4	1009.4	1600.8
1.61	1503.2	1009.4	1580.8
1.61	1484.1	1009.4	1560.8
1.61	1464.9	1009.4	1540.8
1.61	1445.8	1009.4	1520.8
1.61	1426.7	1009.4	1500.8
1.61	1407.5	1009.4	1480.8
1.61	1388.4	1009.4	1460.8
1.61	1383.1	989.4	1460.8
1.61	1377.8	969.4	1460.8
1.61	1372.6	949.4	1460.8
1.61	1353.4	949.4	1440.8
1.61	1334.3	949.4	1420.8
1.61	1315.1	949.4	1400.8
1.61	1296.0	949.4	1380.8
1.61	1276.8	949.4	1360.8
1.61	1257.7	949.4	1340.8
1.61	1238.5	949.4	1320.8
1.61	1219.4	949.4	1300.8
1.61	1200.3	949.4	1280.8
1.61	1181.1	949.4	1260.8
1.61	1162.0	949.4	1240.8
1.61	1142.8	949.4	1220.8
1.61	1123.7	949.4	1200.8
1.62	1118.4	929.4	1200.8
1.62	1113.1	909.4	1200.8
1.62	1107.9	889.4	1200.8
1.62	1088.7	889.4	1180.8
1.62	1069.6	889.4	1160.8
1.62	1050.4	889.4	1140.8
1.62	1031.3	889.4	1120.8
1.62	1012.1	889.4	1100.8
1.62	993.0	889.4	1080.8
1.62	973.9	889.4	1060.8
1.62	954.7	889.4	1040.8
1.62	935.6	889.4	1020.8
1.62	916.4	889.4	1000.8
1.62	897.3	889.4	980.8
1.62	878.1	889.4	960.8
1.62	859.0	889.4	940.8
1.62	839.8	889.4	920.8
1.62	820.7	889.4	900.8

*	1.63	804.9	829.4	900.8	*
*	1.63	785.7	829.4	880.8	*
*	1.63	766.6	829.4	860.8	*
*	1.63	747.4	829.4	840.8	*
*	1.63	728.3	829.4	820.8	*
*	1.63	709.2	829.4	800.8	*
*	1.63	690.0	829.4	780.8	*
*	1.63	670.9	829.4	760.8	*
*	1.63	651.7	829.4	740.8	*
*	1.64	632.6	829.4	720.8	*
*	1.64	613.4	829.4	700.8	*
*	1.64	594.3	829.4	680.8	*
*	1.64	575.1	829.4	660.8	*
*	1.64	556.0	829.4	640.8	*
*	1.64	536.9	829.4	620.8	*
*	1.64	517.7	829.4	600.8	*
*	1.64	498.6	829.4	580.8	*
*	1.64	479.4	829.4	560.8	*
*	1.64	479.4	829.4	560.8	*
*	1.65	474.2	809.4	560.8	*
*	1.65	433.4	805.6	519.2	*
*	1.66	387.3	781.9	477.6	*
*	1.66	471.6	713.3	584.5	*
*	1.68	425.5	689.5	542.9	*
*	1.68	341.3	758.1	436.1	*
*	1.69	463.7	597.1	608.3	*
*	1.69	379.5	665.8	501.4	*
*	1.69	295.2	734.4	394.5	*
*	1.70	417.6	573.4	566.7	*
*	1.71	333.4	642.0	459.8	*
*	1.72	371.6	549.6	525.1	*
*	1.72	249.2	710.6	352.9	*
*	1.73	287.4	618.3	418.3	*
*	1.74	325.6	525.9	483.6	*
*	1.74	165.0	779.3	246.1	*
*	1.76	203.2	686.9	311.4	*
*	1.76	241.3	594.5	376.7	*
*	1.77	279.5	502.1	442.0	*
*	1.82	233.5	478.4	400.4	*
*	1.82	195.3	570.8	335.1	*
*	1.82	157.1	663.1	269.8	*
*	1.82	118.9	755.5	204.5	*
*	1.88	187.4	454.6	358.9	*
*	1.90	149.2	547.0	293.6	*
*	1.91	451.4	481.0	632.0	*
*	1.93	111.1	639.4	228.3	*
*	1.96	405.0	457.3	590.4	*
*	2.01	141.4	430.9	317.3	*
*	2.02	358.7	433.5	548.9	*
*	2.03	862.7	829.4	920.8	*
*	2.08	103.2	523.3	252.0	*
*	2.11	312.6	409.8	507.3	*
*	2.15	1164.5	889.4	1220.8	*
*	2.22	266.6	386.0	465.8	*
*	2.28	95.3	407.1	275.8	*
*	2.39	220.9	362.3	424.2	*
*	2.41	1427.3	949.4	1480.8	*
*	2.47	499.9	849.4	560.8	*

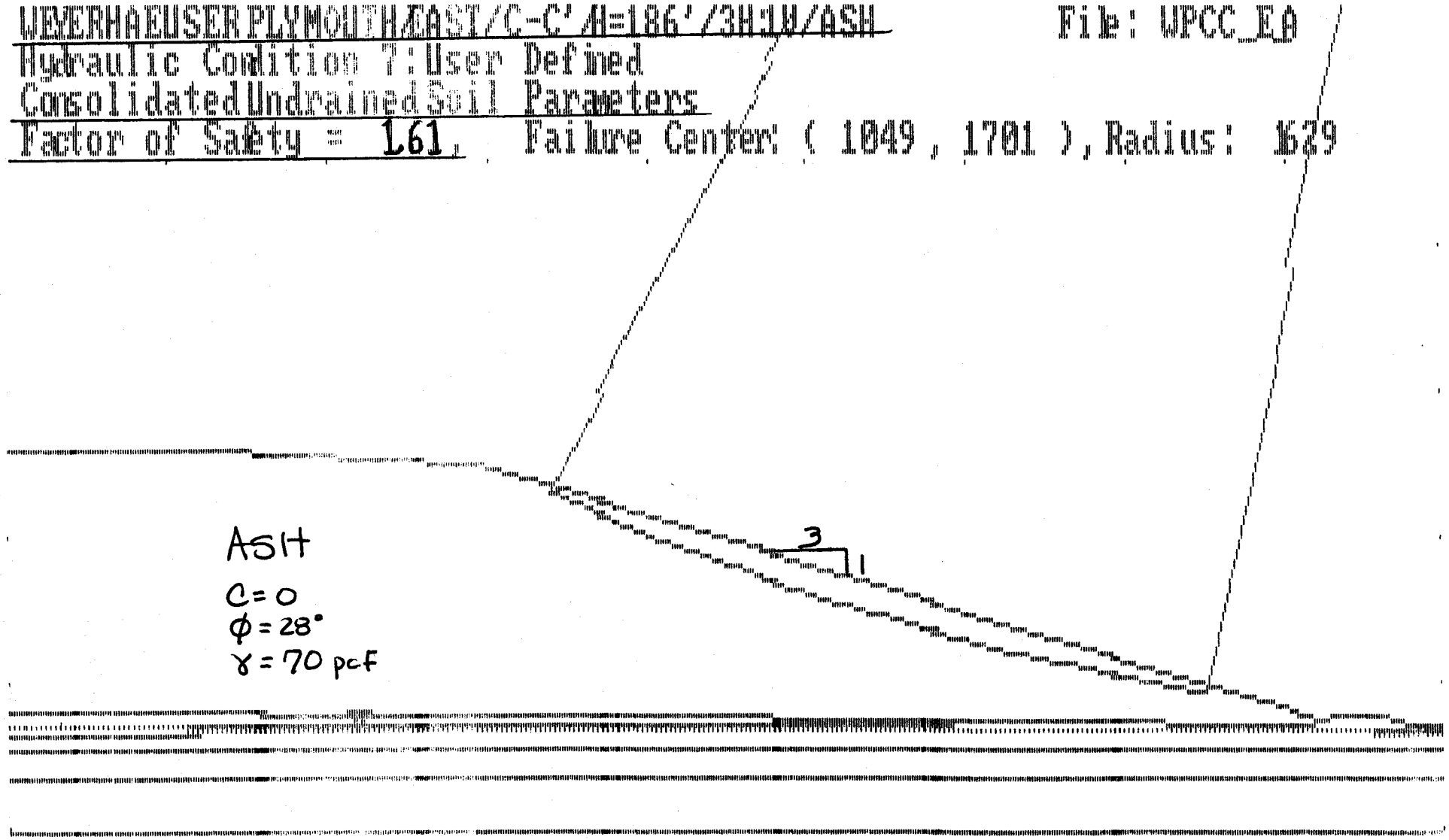
****

WEYERHAEUSER PLYMOUTH/ASI/C-C' H=186'/3H:1V/ASH File: WPCC_E8

Hydraulic Condition 7: User Defined

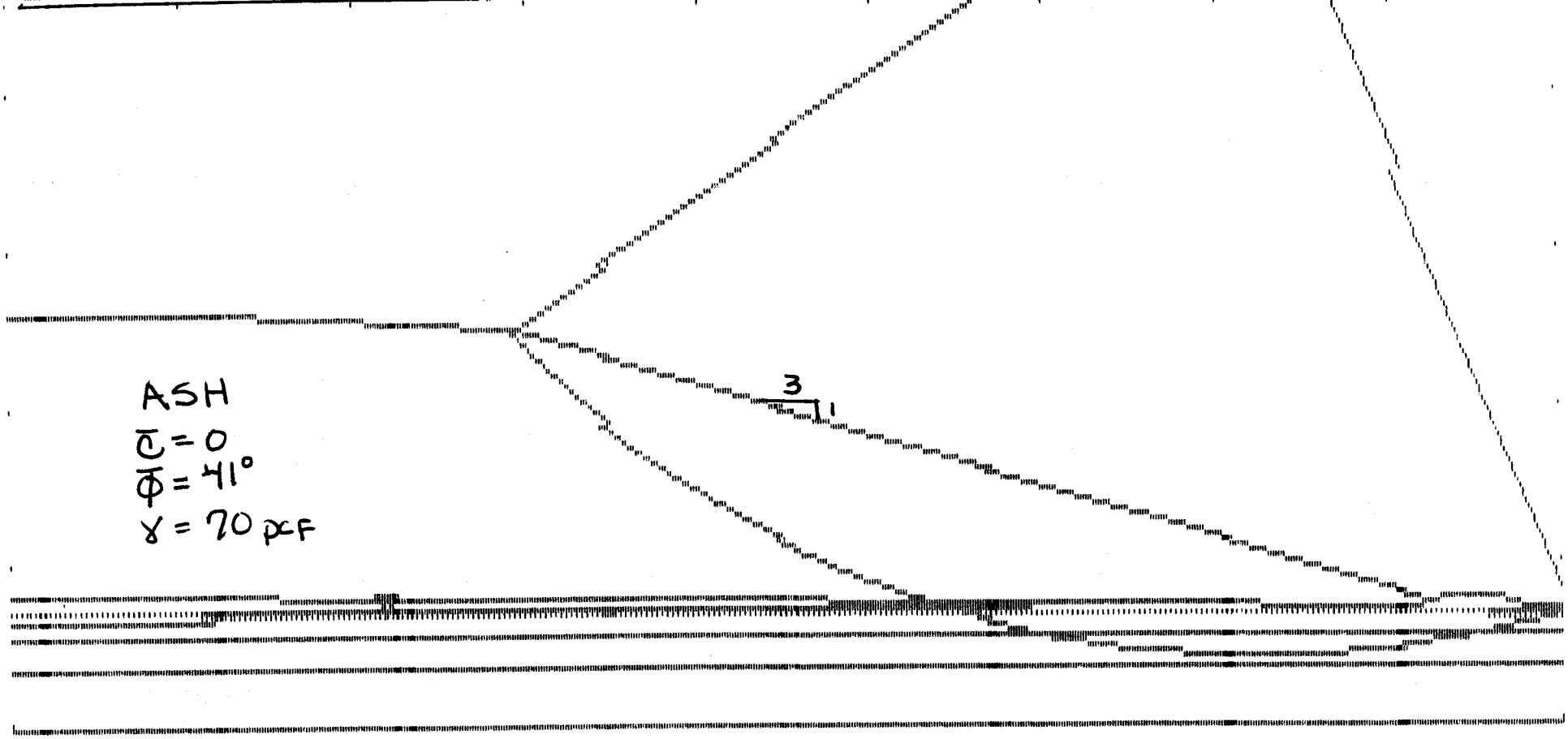
Consolidated Undrained Soil Parameters

Factor of Safety = 1.61, Failure Center (1049 , 1701), Radius: 1629



(0 , -100) SCALE : 1 inch = 100 feet

WEYERHAEUSER PLYMOUTH/EAST/C-C/H=186'/3H:1V/ASH File: WPCC_E0
Hydraulic Condition 7: User Defined
Consolidated Drained Soil Parameters with Seismic
Factor of Safety = 2.01, Failure Center: (718 , -590), Radius: 545



(0 , -100) SCALE : 1 inch = 100 feet

R O T A T I O N A L F A I L U R E R E S U L T S

Hydraulic Condition 7: User Defined

Consolidated Drained (CD) Case
Seismic Coefficient = 0.07

Safety Factor	Failure Radius	X-Co-ord	Y-Co-ord
2.01	544.8	718.3	589.5
2.01	545.3	723.3	589.5
2.01	539.8	718.3	584.5
2.02	549.7	718.3	594.5
2.02	540.4	723.3	584.5
2.02	539.3	713.3	584.5
2.02	539.3	713.3	584.5
2.02	544.2	713.3	589.5
2.02	519.7	713.3	564.5
2.02	559.0	713.3	604.5
2.02	541.4	733.3	584.5
2.03	496.0	689.5	542.9
2.03	537.2	693.3	584.5
2.03	452.6	665.8	501.4
2.07	409.3	642.0	459.8
2.09	354.8	734.4	394.5
2.11	398.2	758.1	436.1
2.12	311.4	710.6	352.9
2.13	268.1	686.9	311.4
2.14	423.5	781.9	477.6
2.15	365.9	618.3	418.3
2.20	467.7	805.6	519.2
2.22	550.4	597.1	608.3
2.27	322.5	594.5	376.7
2.29	512.0	829.4	560.8
2.29	224.7	663.1	269.8
2.29	507.1	573.4	566.7
2.31	165.0	779.3	246.1
2.36	136.1	755.5	204.5
2.38	463.7	549.6	525.1
2.41	233.5	478.4	400.4
2.43	226.3	803.0	287.6
2.43	271.5	826.8	329.2
2.44	279.2	570.8	335.1
2.47	451.4	481.0	632.0
2.48	452.0	525.9	483.6

RECOMMENDED MINIMUM FACTOR OF SAFETY FOR SLOPE STABILITY

Shear Strength Parameter	Confidence of Strength Measurement	Recommended Minimum F.S.
UU (end of construction, no waste or pool containment)	low	1.40
	high	1.20
CU	low	1.50
	high	1.30
CU (drawdown pool condition)	low	1.40
	high	1.20
CD (long-term, no seismic effects)	low	1.60
	high	1.40
CD (long-term with seismic effects)	low	1.50
	high	1.30

If the dike > 30 feet in height, add 0.10 to the F.S. in each case.

```
*********************************************************************
*                                                                   *
*                      G A R D S   S U M M A R Y                    *
*                                                                   *
*    File:  WPCC_E_A            Date: 06-10-1999    Time: 10:36:07  *
*    Project:  WEYERHAEUSER PLYMOUTH/EAST/C-C'/H=186'/3H:1V/ASH     *
*    Hydraulic Condition 7: User Defined                            *
*                                                                   *
*-------------------------------------------------------------------*
*            Rotational Failure Analysis Safety Factor              *
*-------------------------------------------------------------------*
*       Unconsolidated Undrained Case . . . . . . . . . Not Run     *
*       Consolidated Undrained Case . . . . . . . . . . . 1.61      *
*       Consolidated Drained Case . . . . . . . . . . . . 2.01      *
*-------------------------------------------------------------------*
*            Translational Failure Analysis. . . . . . Not Run      *
*-------------------------------------------------------------------*
*            Settlement Analysis . . . . . . . . . . . Not Run      *
*-------------------------------------------------------------------*
*            Liquefaction Analysis . . . . . . . . . . Not Run      *
*********************************************************************
```

```
*********************************************************************
*                                                                   *
*                      G A R D S   S U M M A R Y                    *
*                                                                   *
*    Project:  WEYERHAEUSER PLYMOUTH/EAST/C-C'/H=186'/3H:1V/SLUDGE  *
*       File:  WPCC_E_S                                             *
*                                                                   *
*                          GARDS  Version 2.00                      *
*                             developed by                          *
*          Department of Civil and Environmental Engineering        *
*                        University of Cincinnati                   *
*                            under contract to                      *
*                 U.S. Environmental Protection Agency              *
*                   Land Pollution Control Division                 *
*            Hazardous Waste Engineering Research Laboratory        *
*                                                                   *
*********************************************************************
```

```
*********************************************************************
*                        Site Characteristics                       *
*********************************************************************
*                                                                   *
*      The seismic coefficient is. . . . . . . . . . . . . . 0.07   *
*                                                                   *
*      The design earthquake magnitude is. . . . . . . . . . 5.25   *
*                                                                   *
*      The maximum flood elevation in this case is . . . . .    0   *
*                                                                   *
*      The elevation of the seasonal high ground water is. .    0   *
*                                                                   *
*      The design waste elevation in the cell is . . . . . .    0   *
*                                                                   *
*      The soil number representing the clay liner is. . . .    0   *
*                                                                   *
*********************************************************************
```

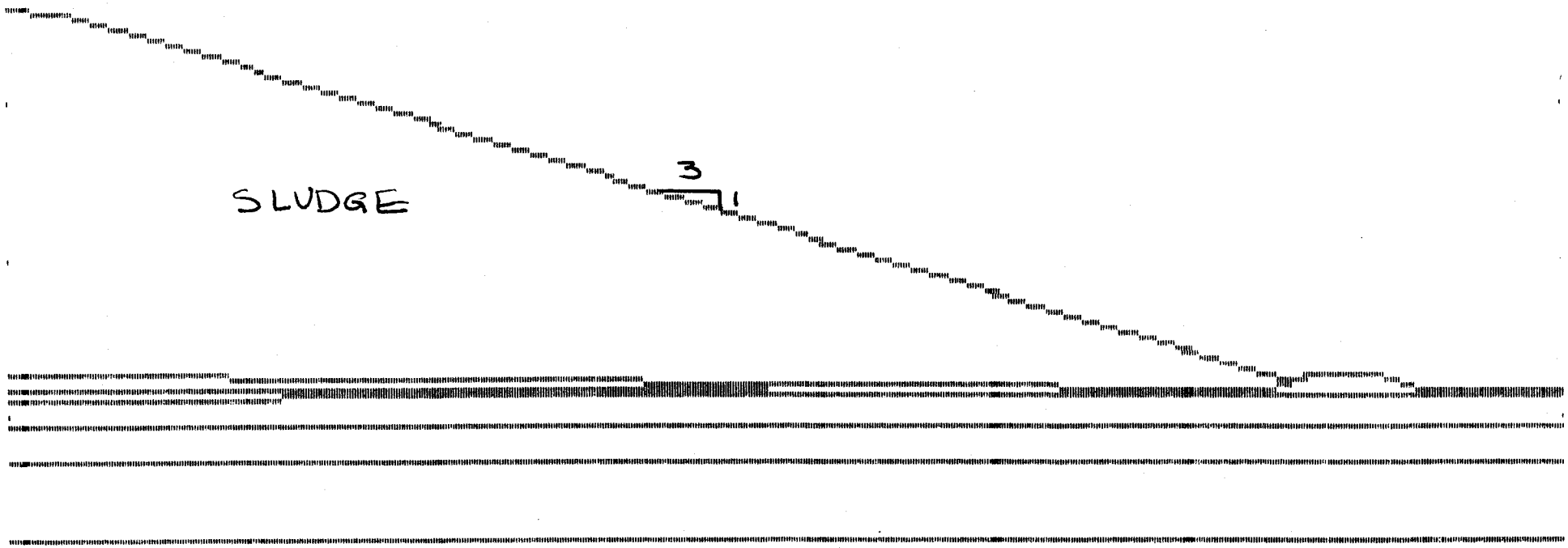
Section Geometry

The number of soil boundary lines for this section is 7

Line	Point	X	Y
1	1	0	0
	2	2000	0
2	1	0	38
	2	2000	38
3	1	0	55
	2	2000	56
4	1	0	65
	2	230	69
	3	500	70
	4	1180	70
5	1	0	73
	2	210	72
	3	550	73
	4	630	76
6	1	0	82
	2	630	76
	3	809	74
	4	827	80
7	1	0	264
	2	119	264
	3	291	252
	4	807	80
	5	817	77
	6	827	80
	7	852	80
	8	870	74
	9	930	72
	10	1140	72
	11	1180	70
	12	1220	62
	13	1250	62
	14	1320	72
	15	2000	76

WEYERHAEUSER PLYMOUTH EAST/C-C/H=186'/3H:1V/SLUDGE File: WPCC_E_S

Hydraulic Condition 7: User Defined



(266 ,-92) SCALE : 1 inch = 75 feet

Soil 1 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	0	0	(lb/sq.ft)
Phi Angle	0	35	35	(degrees)

Unit Weight	140.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 2 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	350	350	(lb/sq.ft)
Phi Angle	0	28	28	(degrees)

Unit Weight	130.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 3 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	0	0	(lb/sq.ft)
Phi Angle	0	30	30	(degrees)

Unit Weight	130.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 4 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	350	350	(lb/sq.ft)
Phi Angle	0	28	28	(degrees)

Unit Weight	130.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 5 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	140	140	(lb/sq.ft)
Phi Angle	0	15	15	(degrees)

Unit Weight	130.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 6 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	855	820	(lb/sq.ft)
Phi Angle	0	21	19	(degrees)

Unit Weight	70.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

User Defined
Piezometric Surface for Hydraulic Condition
7: User Defined

Point	X	Y
1	0	72
2	215	71
3	809	70
4	1220	61
5	2000	61

Hydraulics Results

Seepage In . . . . . 0.000 (cu.ft/yr)

Seepage Out . . . . . 0.000 (cu.ft/yr)

Critical Exit Gradient . . . 0.000

For this hydraulic condition there is no liner uplift.

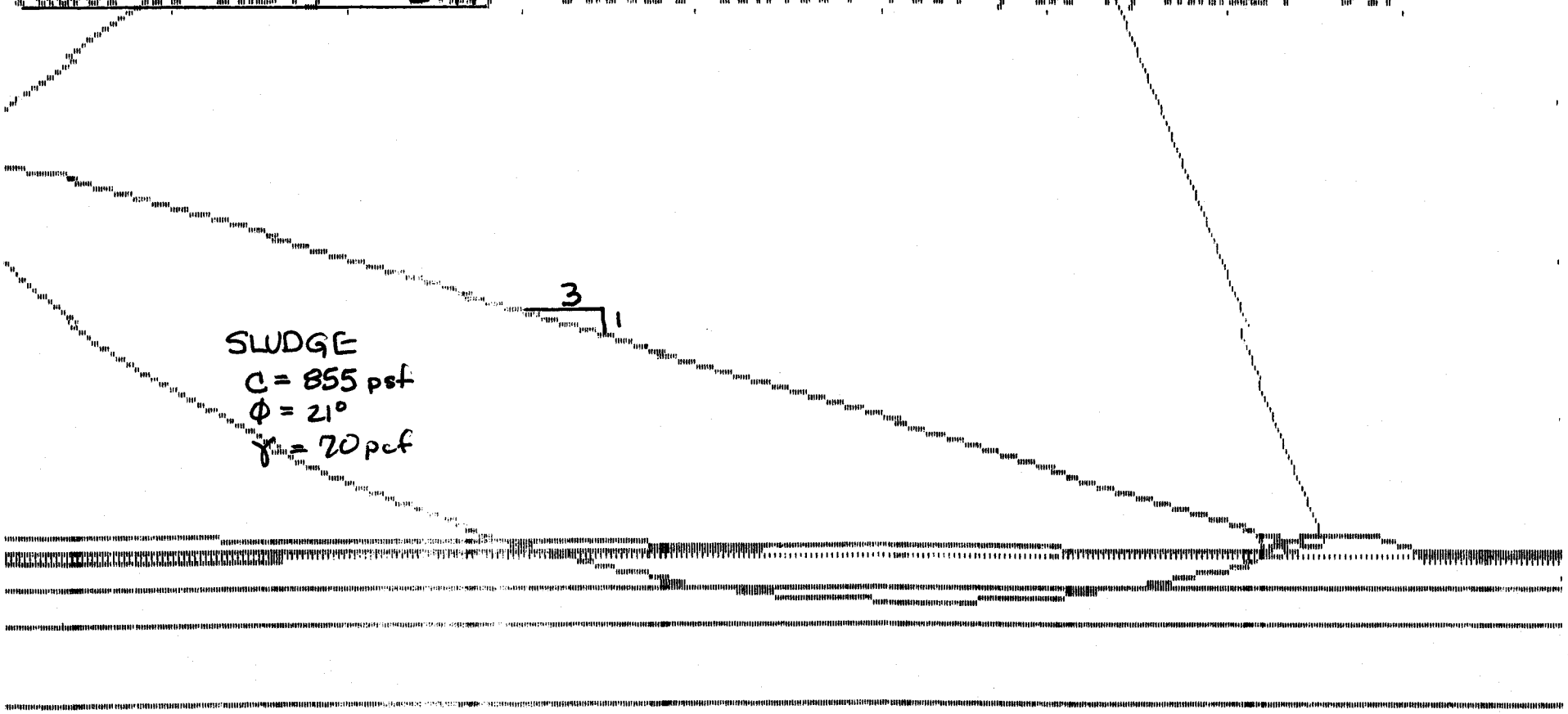
```
*********************************************************************
*                                                                   *
*        R O T A T I O N A L   F A I L U R E   R E S U L T S        *
*                                                                   *
*                    User defined Grid Search                       *
*                                                                   *
*     The slopes were analyzed for failure arcs having centers in   *
*     areas defined by the following parallelograms:                *
*********************************************************************
*                                                                   *
*                              Slope  1                             *
*                                                                   *
*    Co-ord.       Point 1       Point 2       Point 3       Point 4 *
*    -------       -------       -------       -------       ------- *
*       X            291           1220          1410           481  *
*       Y            300            110           442           632  *
*-------------------------------------------------------------------*
*                                                                   *
*        The number of divisions between points 1 and 2 were  8     *
*        The number of divisions between points 2 and 3 were  8     *
*        The X-increment used in the search was  . . . . . . 20     *
*        The Y-increment used in the search was  . . . . . . 20     *
*                                                                   *
*********************************************************************
```

WEYERHAEUSER PLYMOUTH/EAST/C-C'/H=186'/3H:1V/SLUDGE File: WPCC_E_S

Hydraulic Condition 1: User Defined

Consolidated Undrained Soil Parameters

Factor of Safety = 2.14 Failure Center: (657 , 58), Radius: 547



(36 , -92) SCALE : 1 inch = 75 feet

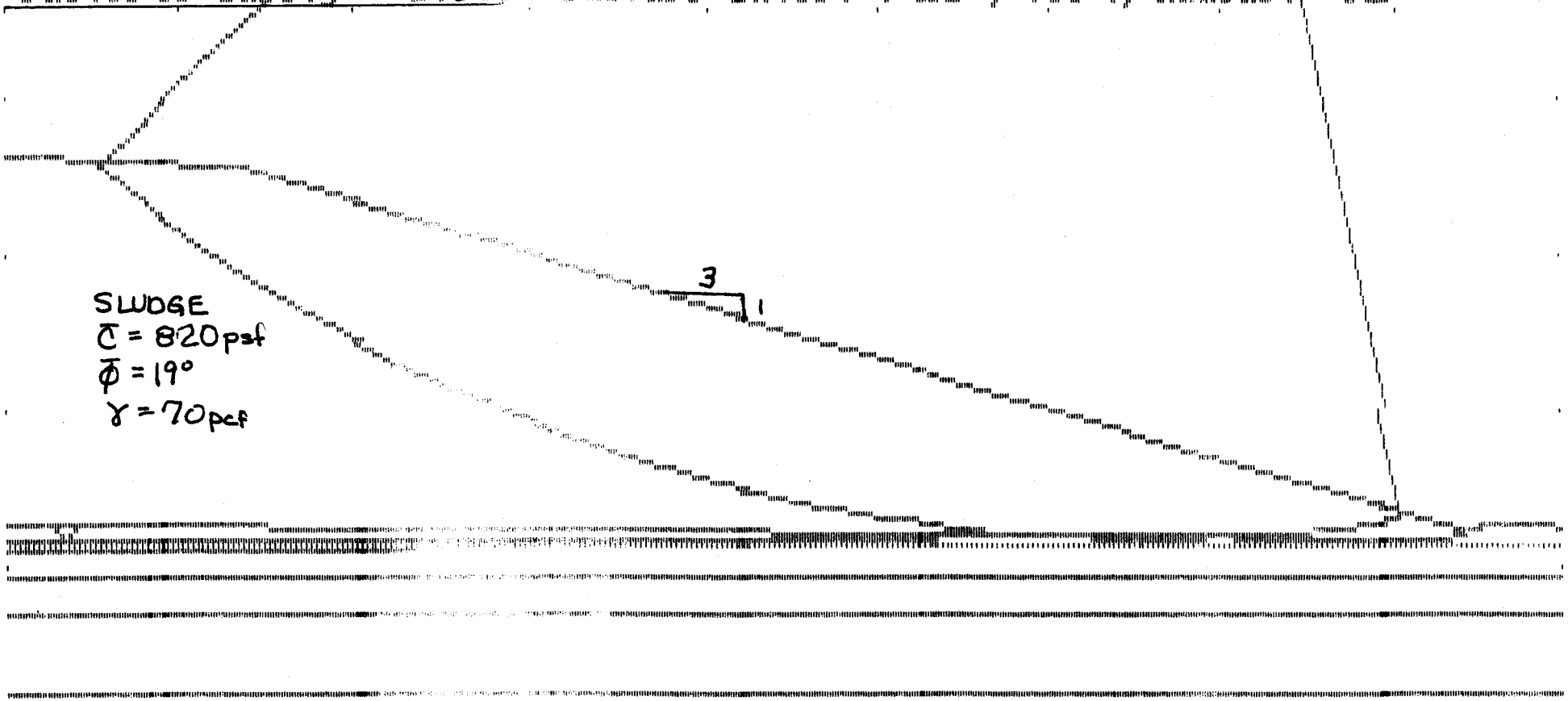
R O T A T I O N A L F A I L U R E R E S U L T S

Hydraulic Condition 7: User Defined

Consolidated Undrained (CU) Case

Safety Factor	Failure Radius	X-Co-ord	Y-Co-ord
2.14	546.9	657.1	598.3
2.14	551.8	657.1	603.3
2.14	556.7	657.1	608.3
2.14	561.7	657.1	613.3
2.14	556.2	652.1	608.3
2.14	542.0	657.1	593.3
2.14	576.4	657.1	628.3
2.14	546.4	652.1	598.3
2.14	557.3	662.1	608.3
2.14	537.1	657.1	588.3
2.14	547.4	662.1	598.3
2.16	527.8	637.1	608.3
2.16	558.9	677.1	608.3
2.17	524.7	617.1	608.3
2.20	521.5	597.1	608.3
2.20	521.5	597.1	608.3
2.20	452.6	665.8	501.4
2.21	516.7	713.3	584.5
2.22	496.0	689.5	542.9
2.22	477.3	573.4	566.7
2.25	409.3	642.0	459.8
2.26	433.0	549.6	525.1
2.31	339.7	618.3	418.3
2.32	388.8	525.9	483.6
2.38	295.5	594.5	376.7
2.46	290.7	710.6	352.9
2.47	334.9	734.4	394.5
2.48	251.2	570.8	335.1
2.49	312.0	502.1	442.0

WEYERHAEUSER PLYMOUTH/DASIC-C/H=186'/3H:1V/SLUDGE File: WPCC_ES
Hydraulic Condition 7: User Defined
Consolidated Drained Soil Parameters with Seismic Loading
Factor of Safety = 1.60 Failure Center: (82 , 738), Radius: 68



(191 ,-92) SCALE : 1 inch = 75 feet

ROTATIONAL FAILURE RESULTS

Hydraulic Condition 7: User Defined

Consolidated Drained (CD) Case
Seismic Coefficient = 0.07

Safety Factor	Failure Radius	X-Co-ord	Y-Co-ord
1.60	661.6	682.1	738.3
1.60	656.7	682.1	733.3
1.60	666.5	682.1	743.3
1.60	651.9	682.1	728.3
1.60	651.1	677.1	728.3
1.60	646.2	677.1	723.3
1.60	656.0	677.1	733.3
1.61	662.4	687.1	738.3
1.61	641.3	677.1	718.3
1.61	660.8	677.1	738.3
1.61	640.5	672.1	718.3
1.61	635.7	672.1	713.3
1.61	645.4	672.1	723.3
1.61	630.8	672.1	708.3
1.61	631.6	677.1	708.3
1.61	642.1	682.1	718.3
1.61	630.0	667.1	708.3
1.61	625.1	667.1	703.3
1.61	634.9	667.1	713.3
1.61	620.3	667.1	698.3
1.61	615.4	667.1	693.3
1.61	652.7	687.1	728.3
1.61	610.5	667.1	688.3
1.61	609.7	662.1	688.3
1.61	608.9	657.1	688.3
1.61	628.4	657.1	708.3
1.61	589.5	657.1	668.3
1.61	611.3	672.1	688.3
1.61	612.1	677.1	688.3
1.61	570.0	657.1	648.3
1.61	566.8	637.1	648.3
1.61	586.3	637.1	668.3
1.61	547.3	637.1	628.3
1.61	605.8	637.1	688.3
1.62	527.8	637.1	608.3

*	1.62	524.7	617.1	608.3	*
*	1.62	531.0	657.1	608.3	*
*	1.63	573.1	677.1	648.3	*
*	1.63	521.5	597.1	608.3	*
*	1.63	521.5	597.1	608.3	*
*	1.65	477.3	573.4	566.7	*
*	1.68	433.0	549.6	525.1	*
*	1.70	452.6	665.8	501.4	*
*	1.70	539.3	713.3	584.5	*
*	1.70	496.0	689.5	542.9	*
*	1.72	384.0	642.0	459.8	*
*	1.74	339.7	618.3	418.3	*
*	1.79	295.5	594.5	376.7	*
*	1.80	543.9	481.0	632.0	*
*	1.84	357.2	525.9	483.6	*
*	1.86	499.1	457.3	590.4	*
*	1.87	251.2	570.8	335.1	*
*	1.87	312.0	502.1	442.0	*
*	1.90	334.9	734.4	394.5	*
*	1.91	379.2	758.1	436.1	*
*	1.91	290.7	710.6	352.9	*
*	1.93	266.9	478.4	400.4	*
*	1.93	454.7	433.5	548.9	*
*	1.95	268.1	686.9	311.4	*
*	1.96	423.5	781.9	477.6	*
*	2.01	221.7	454.6	358.9	*
*	2.01	411.0	409.8	507.3	*
*	2.04	467.7	805.6	519.2	*
*	2.11	224.7	663.1	269.8	*
*	2.13	368.0	386.0	465.8	*
*	2.15	512.0	829.4	560.8	*
*	2.16	176.6	430.9	317.3	*
*	2.18	178.1	547.0	293.6	*
*	2.29	326.0	362.3	424.2	*
*	2.36	157.9	639.4	228.3	*
*	2.42	203.6	407.1	275.8	*
*	2.42	133.0	523.3	252.0	*
*	2.43	197.4	779.3	246.1	*
*	2.44	241.7	803.0	287.6	*

****

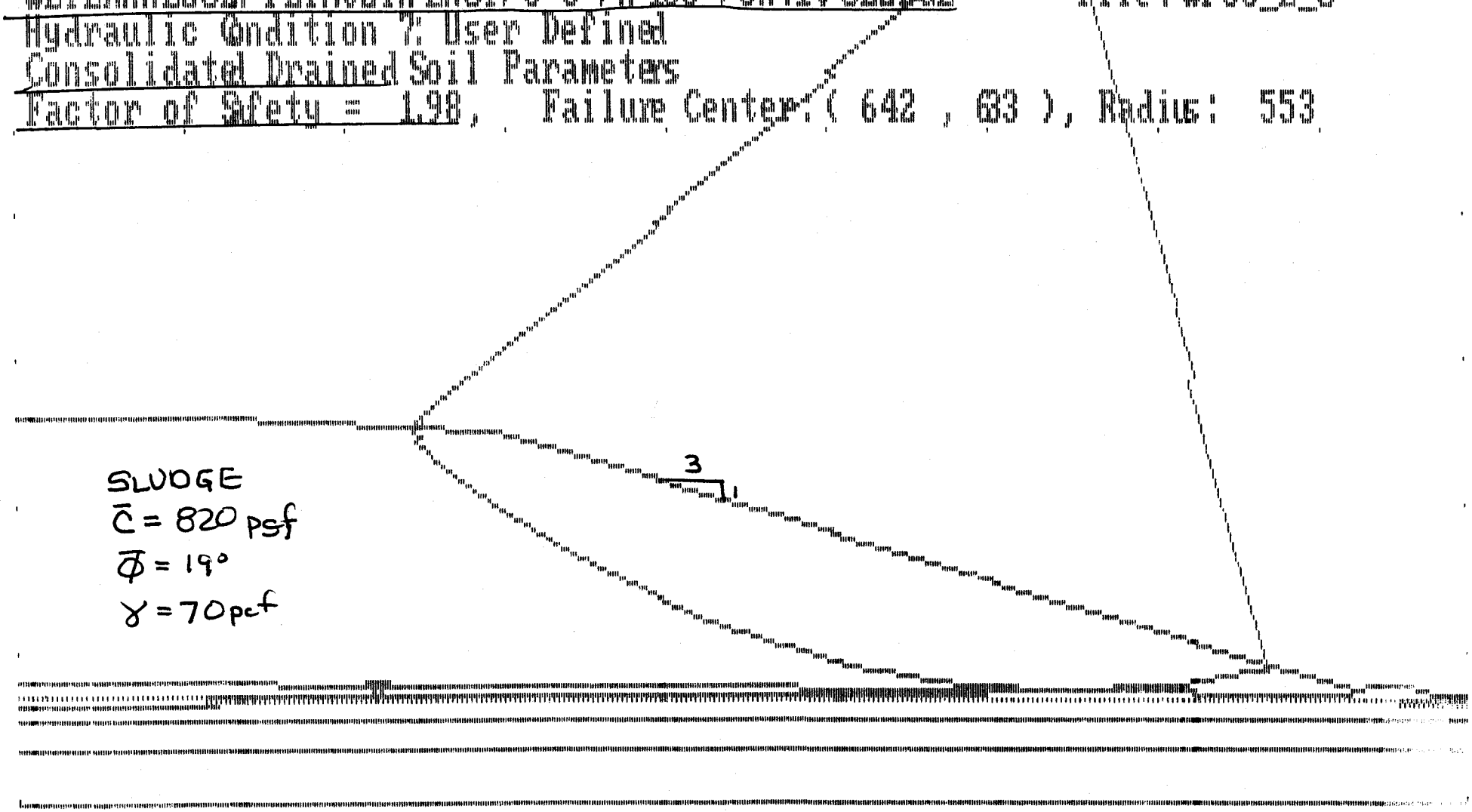
RECOMMENDED MINIMUM FACTOR OF SAFETY FOR SLOPE STABILITY

Shear Strength Parameter	Confidence of Strength Measurement	Recommended Minimum F.S.
UU (end of construction, no waste or pool containment)	low	1.40
	high	1.20
CU	low	1.50
	high	1.30
CU (drawdown pool condition)	low	1.40
	high	1.20
CD (long-term, no seismic effects)	low	1.60
	high	1.40
CD (long-term with seismic effects)	low	1.50
	high	1.30

If the dike > 30 feet in height, add 0.10 to the F.S. in each case.

```
*                                                                    *
*                    G A R D S   S U M M A R Y                       *
*                                                                    *
*    File:  WPCC_E_S            Date: 06-10-1999    Time: 10:47:33   *
*    Project:  WEYERHAEUSER PLYMOUTH/EAST/C-C'/H=186'/3H:1V/SLUDGE   *
*    Hydraulic Condition 7: User Defined                             *
*                                                                    *
*--------------------------------------------------------------------*
*            Rotational Failure Analysis Safety Factor               *
*--------------------------------------------------------------------*
*       Unconsolidated Undrained Case . . . . . . . . . . Not Run    *
*       Consolidated Undrained Case . . . . . . . . . . . . 2.14     *
*       Consolidated Drained Case . . . . . . . . . . . . . 1.60     *
*--------------------------------------------------------------------*
*            Translational Failure Analysis. . . . . . Not Run       *
*--------------------------------------------------------------------*
*            Settlement Analysis . . . . . . . . . . . Not Run       *
*--------------------------------------------------------------------*
*            Liquefaction Analysis . . . . . . . . . . Not Run       *
**********************************************************************
```

WEYERHAEUSR PLYMOUTH/EAST/C-C'/H=86'/3H:1V/SLUDGE File: WPCC_E_S
Hydraulic Condition 7: User Defined
Consolidated Drained Soil Parameters
Factor of Safety = 1.98, Failure Center: (642 , 63), Radius: 553



(0 , -100) SCALE: 1 inch = 100 feet

```
*********************************************************************
*                                                                   *
*                      G A R D S   S U M M A R Y                    *
*                                                                   *
*    Project:  WEYERHAEUSER PLYMOUTH/WEST/C-C'/H=200'/3H:1V/SLUDGE  *
*       File:  WPCC_W_S                                             *
*                                                                   *
*                         GARDS  Version 2.00                       *
*                            developed by                           *
*          Department of Civil and Environmental Engineering        *
*                      University of Cincinnati                     *
*                          under contract to                        *
*                 U.S. Environmental Protection Agency              *
*                   Land Pollution Control Division                 *
*            Hazardous Waste Engineering Research Laboratory        *
*                                                                   *
*********************************************************************
```

```
*********************************************************************
*                       Site Characteristics                        *
*********************************************************************
*                                                                   *
*      The seismic coefficient is. . . . . . . . . . . . . . 0.07   *
*                                                                   *
*      The design earthquake magnitude is. . . . . . . . . . 5.25   *
*                                                                   *
*      The maximum flood elevation in this case is . . . . .    0   *
*                                                                   *
*      The elevation of the seasonal high ground water is. .    0   *
*                                                                   *
*      The design waste elevation in the cell is . . . . . .    0   *
*                                                                   *
*      The soil number representing the clay liner is. . . .    0   *
*                                                                   *
*********************************************************************
```

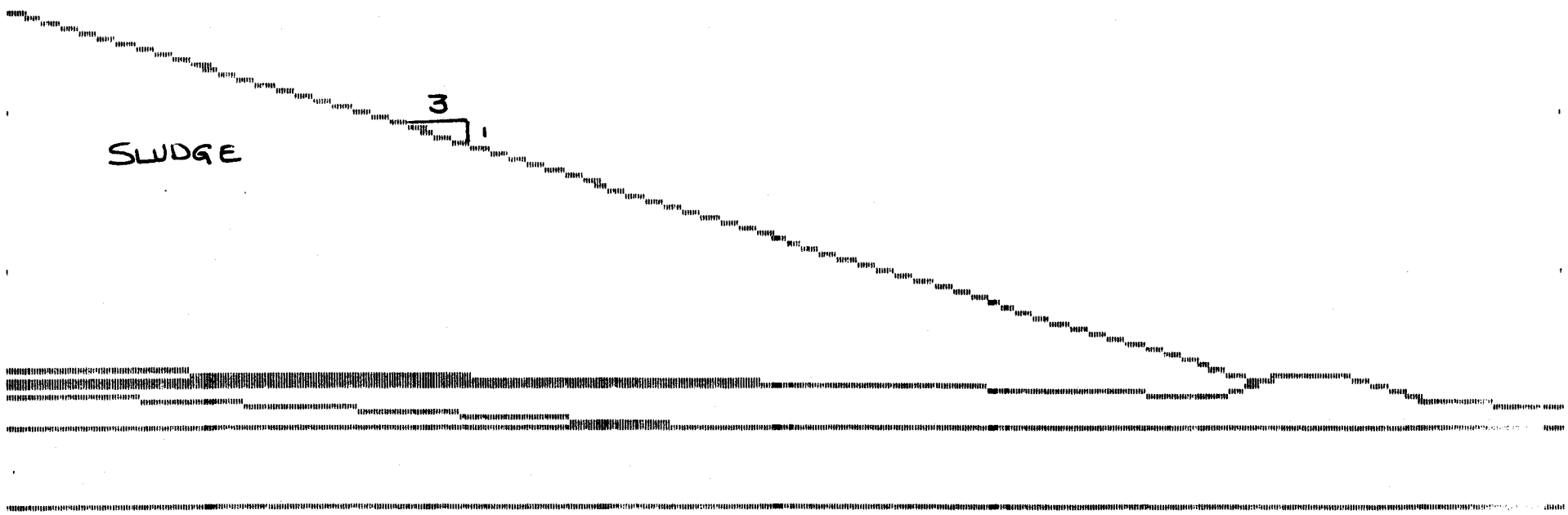
Section Geometry

The number of soil boundary lines for this section is 9

Line	Point	X	Y
1	1	0	0
	2	1800	0
2	1	0	38
	2	870	38
3	1	0	55
	2	580	55
	3	870	38
	4	1800	38
4	1	0	60
	2	950	60
5	1	300	62
	2	820	63
6	1	0	65
	2	150	61
	3	300	62
	4	560	69
7	1	0	77
	2	280	75
8	1	0	82
	2	280	75
	3	560	69
	4	820	63
	5	950	60
	6	1098	56
	7	1125	65
9	1	0	264
	2	316	264
	3	550	250
	4	1105	65
	5	1115	62
	6	1125	65
	7	1150	65
	8	1189	52
	9	1300	50
	10	1800	50

WEYERHAEUSER PLYMOUTHWEST/C-C/H=200'/3H:1V/SLUDGE File: WPCC_W_S

Hydraulic Condition 7. User Defined



(539 ,-13) SCALE : 1 inch = 80 feet

Soil 1 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	0	0	(lb/sq.ft)
Phi Angle	0	35	35	(degrees)

Unit Weight	140.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 2 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	350	350	(lb/sq.ft)
Phi Angle	0	28	28	(degrees)

Unit Weight	130.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 3 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	0	0	(lb/sq.ft)
Phi Angle	0	30	30	(degrees)

Unit Weight	130.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 4 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	350	350	(lb/sq.ft)
Phi Angle	0	28	28	(degrees)

Unit Weight	130.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number	0.000	(blows/ft)

Soil 5 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	0	0	(lb/sq.ft)
Phi Angle	0	25	25	(degrees)

Unit Weight	115.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 6 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	140	140	(lb/sq.ft)
Phi Angle	0	15	15	(degrees)

Unit Weight	130.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 7 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	0	0	(lb/sq.ft)
Phi Angle	0	25	25	(degrees)

Unit Weight	115.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 8 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	855	820	(lb/sq.ft)
Phi Angle	0	21	19	(degrees)

Unit Weight	70.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

User Defined
Piezometric Surface for Hydraulic Condition
7: User Defined

Point	X	Y
1	0	72
2	280	71
3	1115	49
4	1290	46
5	1800	45

Hydraulics Results

Seepage In	0.000	(cu.ft/yr)
Seepage Out	0.000	(cu.ft/yr)
Critical Exit Gradient . . .	0.000	

For this hydraulic condition there is no liner uplift.

```
*********************************************************************
*                                                                   *
*        R O T A T I O N A L   F A I L U R E   R E S U L T S        *
*                                                                   *
*                     User defined Grid Search                      *
*                                                                   *
*     The slopes were analyzed for failure arcs having centers in   *
*     areas defined by the following parallelograms:                *
*********************************************************************
*                                                                   *
*                              Slope  1                             *
*                                                                   *
*    Co-ord.        Point 1        Point 2        Point 3        Point 4   *
*    -------        -------        -------        -------        -------   *
*       X             550            1189           1387            748     *
*       Y             300             102            448            646     *
*-------------------------------------------------------------------*
*                                                                   *
*        The number of divisions between points 1 and 2 were  8     *
*        The number of divisions between points 2 and 3 were  8     *
*        The X-increment used in the search was  . . . . . . 20     *
*        The Y-increment used in the search was  . . . . . . 20     *
*                                                                   *
*********************************************************************
```

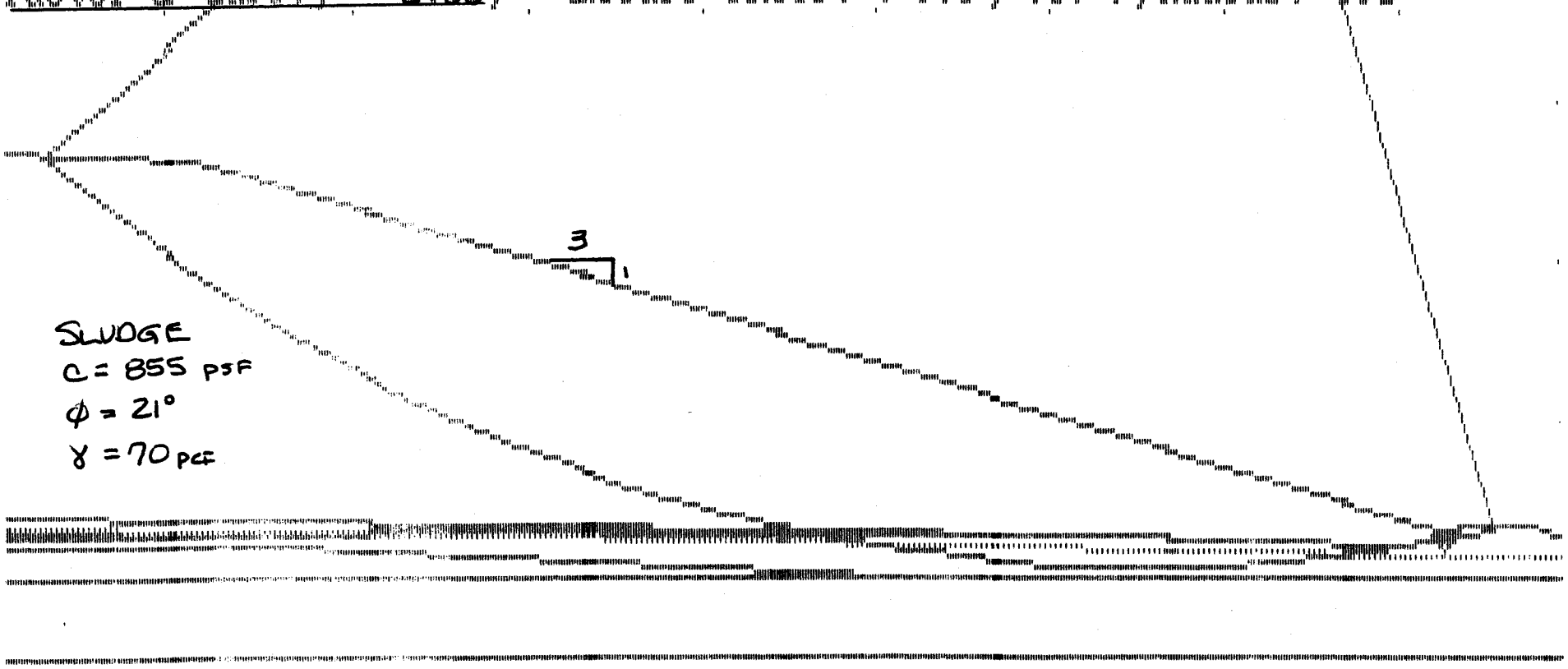
ROTATIONAL FAILURE RESULTS

Hydraulic Condition 7: User Defined

Consolidated Undrained (CU) Case

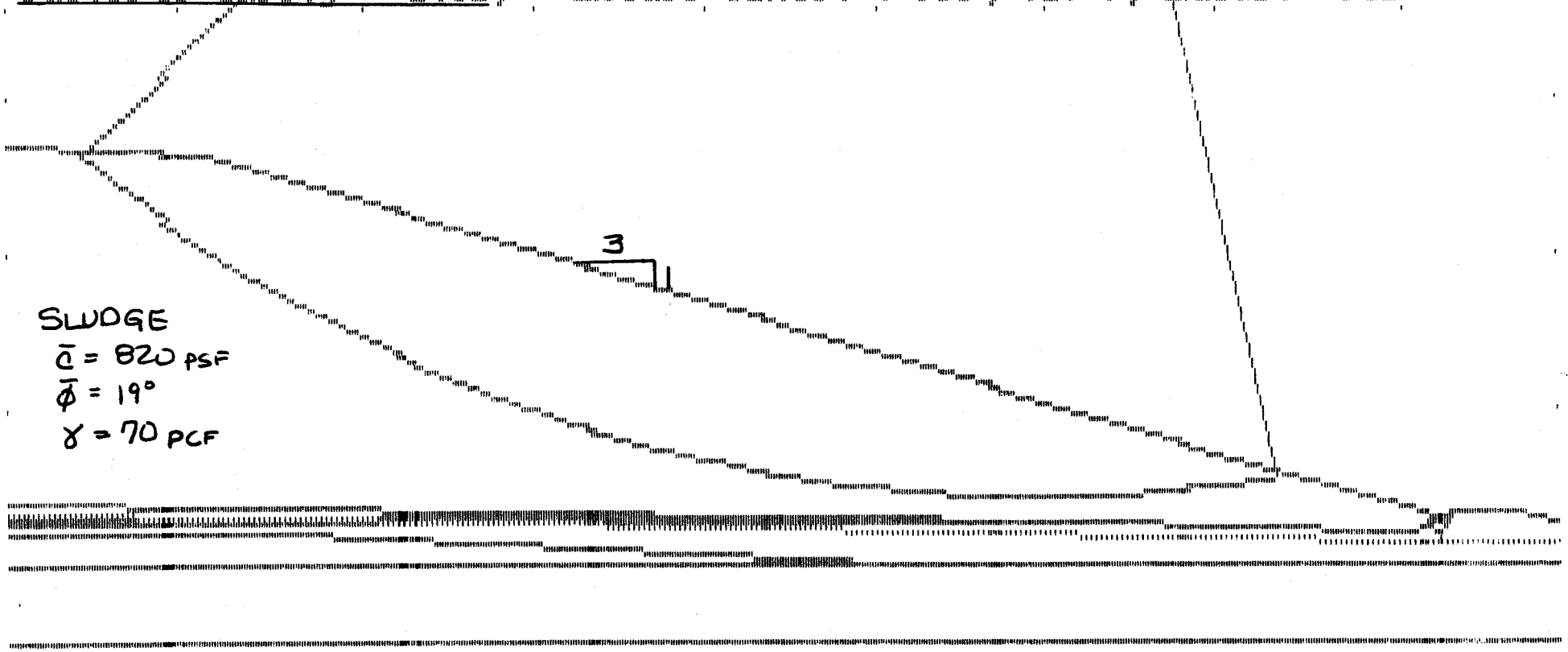
Safety Factor	Failure Radius	X-Co-ord	Y-Co-ord
2.05	690.2	977.6	736.8
2.05	695.1	977.6	741.8
2.05	685.3	977.6	731.8
2.05	700.0	977.6	746.8
2.05	704.9	977.6	751.8
2.05	709.8	977.6	756.8
2.05	714.7	977.6	761.8
2.05	719.7	977.6	766.8
2.05	724.6	977.6	771.8
2.05	729.5	977.6	776.8
2.06	689.6	972.6	736.8
2.06	690.7	982.6	736.8
2.06	725.1	982.6	771.8
2.06	725.6	987.6	771.8
2.06	706.0	987.6	751.8
2.07	745.3	987.6	791.8
2.07	686.3	987.6	731.8
2.07	726.1	992.6	771.8
2.07	666.6	987.6	711.8
2.08	647.0	987.6	691.8
2.09	627.3	987.6	671.8
2.09	723.5	967.6	771.8
2.09	724.0	972.6	771.8
2.09	727.7	1007.6	771.8
2.09	607.7	987.6	651.8
2.10	588.0	987.6	631.8
2.11	568.4	987.6	611.8
2.13	548.7	987.6	591.8
2.14	529.0	987.6	571.8
2.14	529.0	987.6	571.8
2.15	526.9	967.6	571.8
2.16	544.9	907.8	596.5
2.18	473.1	883.0	553.2
2.19	483.9	962.9	528.4
2.21	531.2	1007.6	571.8
2.21	426.9	858.3	509.9
2.24	438.7	938.1	485.1
2.25	380.8	833.5	466.6
2.26	530.7	827.9	621.3
2.29	377.6	993.3	417.1
2.29	393.5	913.4	441.8
2.30	484.5	803.1	577.9
2.30	334.7	808.8	423.3
2.33	450.1	1042.8	503.7
2.35	470.5	778.4	534.6
2.36	323.2	888.6	398.5
2.38	404.0	1018.0	460.4
2.39	332.4	968.5	373.8
2.39	288.6	784.0	379.9
2.42	392.3	753.6	491.3
2.43	277.1	863.9	355.2
2.45	496.2	1067.5	547.0

WEYERHAUSER PLYMOUTH/WEST/CC'/H=200'/3H:1V/SLUDGE File: WPCCW_S
Hydraulic Condition 7: User Defined
Consolidated Undrained Soil Parameters
Factor of Safety = 2.05, Failure Center: (978 , 737), Radius: 690



(459 , -123) SCALE : 1 inch = 80 feet

WEYERHAUSER PLYMOUTH/WEST/C-C'/H=200'/3H:1V/SLUDGE File: UPCC_W_S
Hydraulic Condition 7: User Defined
Consolidated Drained Soil Parameters with Seismic Loading
Factor of Safety = 1.61, Failure Center: (933 , 717), Radius: 640



(459 ,-123) SCALE : 1 inch = 80 feet

R O T A T I O N A L F A I L U R E R E S U L T S

Hydraulic Condition 7: User Defined

Consolidated Drained (CD) Case
Seismic Coefficient = 0.07

Safety Factor	Failure Radius	X-Co-ord	Y-Co-ord
1.61	640.0	932.8	716.5
1.61	640.8	937.8	716.5
1.61	644.9	932.8	721.5
1.61	635.2	932.8	711.5
1.61	630.3	932.8	706.5
1.61	629.5	927.8	706.5
1.61	634.4	927.8	711.5
1.61	624.6	927.8	701.5
1.61	639.3	927.8	716.5
1.61	619.8	927.8	696.5
1.61	619.0	922.8	696.5
1.61	623.9	922.8	701.5
1.61	614.1	922.8	691.5
1.61	609.2	922.8	686.5
1.61	608.4	917.8	686.5
1.61	613.3	917.8	691.5
1.61	603.6	917.8	681.5
1.61	598.7	917.8	676.5
1.61	620.6	932.8	696.5
1.61	631.1	937.8	706.5
1.61	610.0	927.8	686.5
1.61	599.5	922.8	676.5
1.61	597.9	912.8	676.5
1.61	597.1	907.8	676.5
1.61	577.6	907.8	656.5
1.61	600.3	927.8	676.5
1.61	616.6	907.8	696.5
1.62	558.1	907.8	636.5
1.62	555.0	887.8	636.5
1.62	574.5	887.8	656.5
1.62	535.5	887.8	616.5
1.62	594.0	887.8	676.5
1.62	516.0	887.8	596.5
1.63	561.3	927.8	636.5
1.63	519.2	907.8	596.5
1.63	519.2	907.8	596.5
1.63	512.9	867.8	596.5
1.64	473.1	883.0	553.2
1.64	522.3	927.8	596.5
1.65	529.0	987.6	571.8
1.66	426.9	858.3	509.9
1.66	530.7	827.9	621.3
1.68	380.8	833.5	466.6
1.69	484.5	803.1	577.9
1.69	483.9	962.9	528.4
1.70	470.5	778.4	534.6
1.73	334.7	808.8	423.3
1.73	415.5	938.1	485.1
1.74	369.3	913.4	441.8
1.76	425.3	753.6	491.3
1.77	377.6	993.3	417.1
1.78	323.2	888.6	398.5
1.78	576.8	748.0	646.0
1.79	450.1	1042.8	503.7
1.80	288.6	784.0	379.9
1.83	404.0	1018.0	460.4
1.83	277.1	863.9	355.2
1.83	531.6	923.3	602.7
1.84	346.2	728.9	448.0
1.86	332.4	968.5	373.8

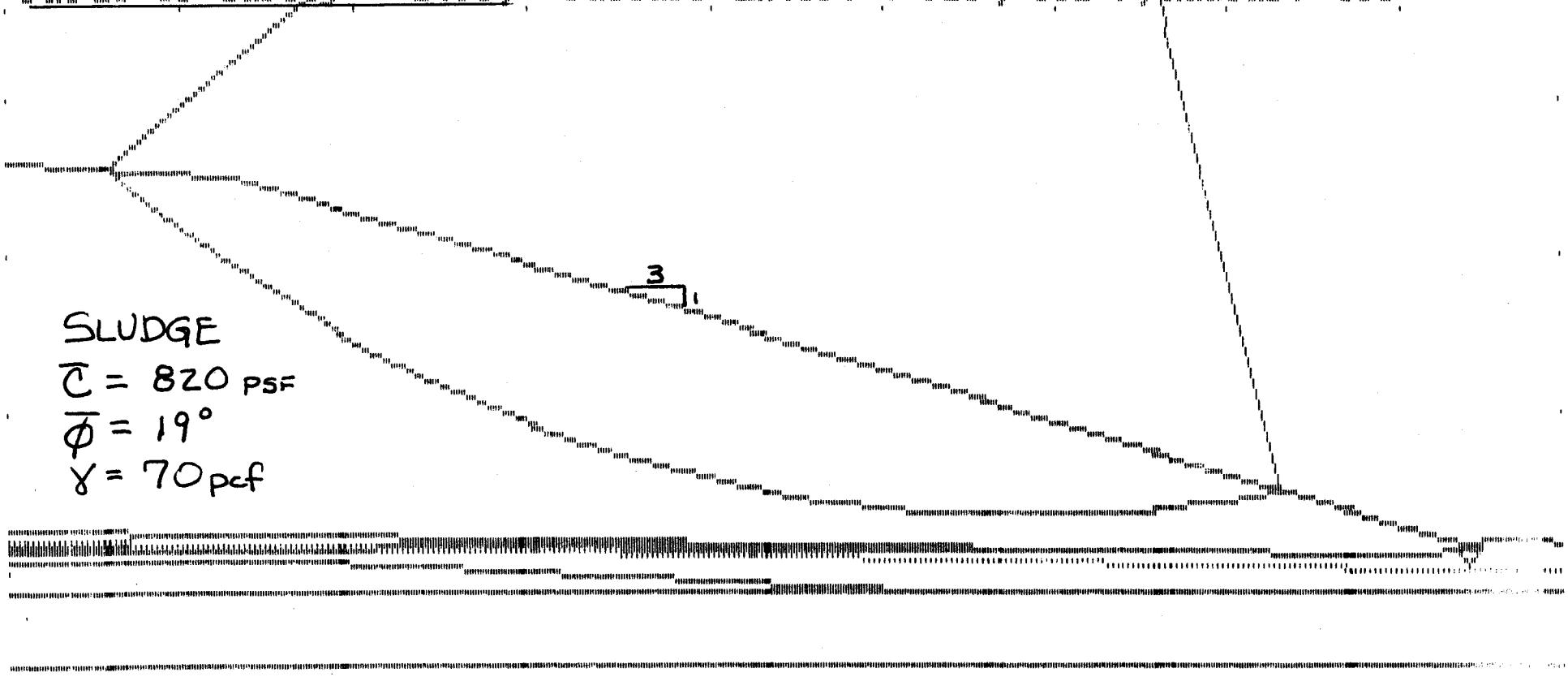
*	1.86	552.4	968.5	575.8	*
*	1.87	496.2	1067.5	547.0	*
*	1.91	242.5	759.3	336.6	*
*	1.91	486.4	698.5	559.4	*
*	1.91	265.6	943.8	330.4	*
*	1.93	231.0	839.1	311.9	*
*	1.94	300.1	704.1	404.7	*
*	1.98	300.3	1048.4	349.0	*
*	2.00	219.5	919.0	287.1	*
*	2.00	441.2	673.8	516.1	*
*	2.03	254.1	1023.6	305.7	*
*	2.05	56.0	1189.0	101.5	*
*	2.09	346.4	1073.1	392.3	*
*	2.09	228.7	734.5	293.3	*
*	2.11	218.2	679.4	361.4	*
*	2.11	184.9	814.4	268.6	*
*	2.11	208.0	998.9	262.4	*
*	2.12	396.0	649.0	472.8	*
*	2.13	392.5	1097.9	435.6	*
*	2.14	438.6	1122.6	478.9	*
*	2.16	173.4	894.3	243.8	*
*	2.26	484.7	1147.4	522.3	*
*	2.26	161.9	974.1	219.1	*
*	2.28	350.9	624.3	429.4	*
*	2.29	150.4	1054.0	194.3	*
*	2.30	171.1	654.6	318.1	*
*	2.45	242.7	1103.5	280.9	*
*	2.47	150.3	709.8	250.0	*
*	2.48	138.8	789.6	225.3	*
*	2.49	182.9	1078.8	237.6	*

****

```
*************************************************************************
*                                                                       *
*                      G A R D S   S U M M A R Y                        *
*    File:  WPCC W S              Date: 06-10-1999    Time: 11:51:04    *
*    Project:  WEYERHAEUSER PLYMOUTH/WEST/C-C'/H=200'/3H:1V/SLUDGE      *
*    Hydraulic Condition 7: User Defined                                *
*                                                                       *
*-----------------------------------------------------------------------*
*             Rotational Failure Analysis Safety Factor                 *
*-----------------------------------------------------------------------*
*       Unconsolidated Undrained Case . . . . . . . . . . Not Run       *
*       Consolidated Undrained Case . . . . . . . . . . . .  2.05      *
*       Consolidated Drained Case . . . . . . . . . . . . .  1.61      *
*-----------------------------------------------------------------------*
*             Translational Failure Analysis. . . . . . Not Run         *
*-----------------------------------------------------------------------*
*             Settlement Analysis . . . . . . . . . . . Not Run         *
*-----------------------------------------------------------------------*
*             Liquefaction Analysis . . . . . . . . . . Not Run         *
*************************************************************************
```

```
*************************************************************************
*       RECOMMENDED MINIMUM FACTOR OF SAFETY FOR SLOPE STABILITY        *
*************************************************************************
*  Shear Strength                Confidence of            Recommended   *
*    Parameter                 Strength Measurement        Minimum F.S.  *
*-----------------------------------------------------------------------*
*  UU (end of construction, no          low                    1.40     *
*      waste or pool containment)       high                   1.20     *
*                                                                       *
*  CU                                   low                    1.50     *
*                                       high                   1.30     *
*                                                                       *
*  CU (drawdown pool condition)         low                    1.40     *
*                                       high                   1.20     *
*                                                                       *
*  CD (long-term, no seismic            low                    1.60     *
*      effects)                         high                   1.40     *
*                                                                       *
*  CD (long-term with seismic           low                    1.50     *
*      effects)                         high                   1.30     *
*                                                                       *
*  If the dike > 30 feet in height, add 0.10 to the F.S. in each case.  *
*************************************************************************
```

WEYERHAEUSER PLYMOUTH/WES/C-C'/H=200/3H:1V/SLUDGE File: WPCCW_S
Hydraulic Condition A: User Defined
Consolidated Drained Soil Parameters
Factor of Safety = 1.98, Failure Center: (913 , 662), Radius: 583



(40 , -113) SCALE : 1 inch = 79.99999 feet

```
*********************************************************************
*                                                                   *
*                      G A R D S   S U M M A R Y                    *
*                                                                   *
*    Project:  WEYERHAEUSER PLYMOUTH/WEST/C-C'/H=200'/3H:1V/ASH     *
*       File:  WPCC_W_A                                             *
*                                                                   *
*                         GARDS  Version 2.00                       *
*                            developed by                           *
*          Department of Civil and Environmental Engineering        *
*                      University of Cincinnati                     *
*                          under contract to                        *
*                 U.S. Environmental Protection Agency              *
*                   Land Pollution Control Division                 *
*            Hazardous Waste Engineering Research Laboratory        *
*                                                                   *
*********************************************************************
```

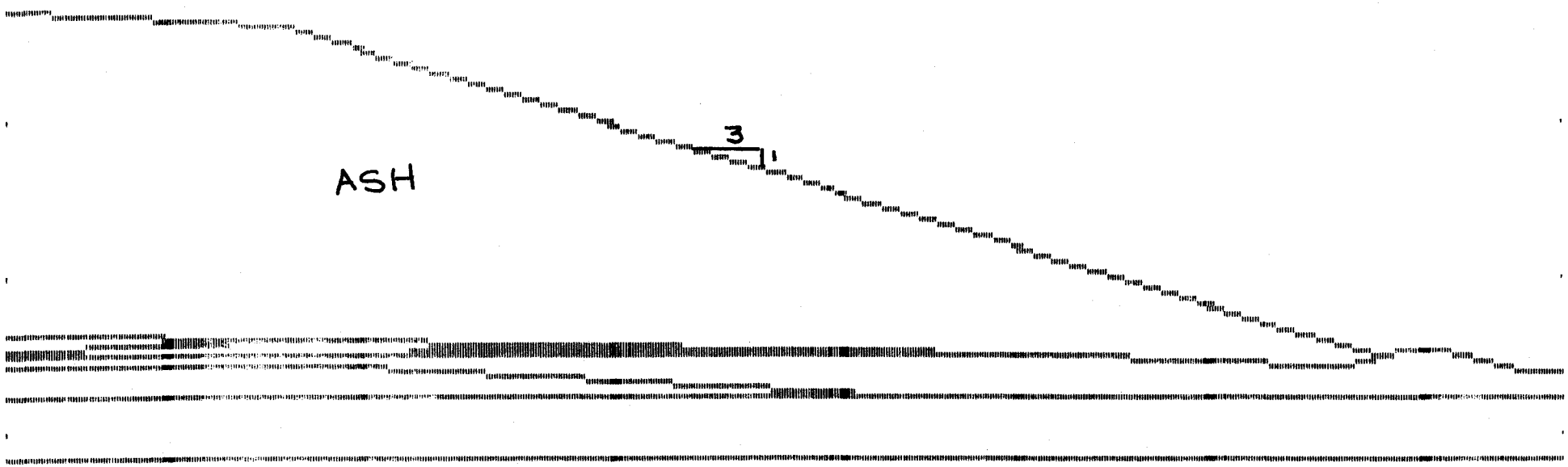
```
*********************************************************************
*                         Site Characteristics                      *
*********************************************************************
*                                                                   *
*      The seismic coefficient is. . . . . . . . . . . . . . 0.07   *
*                                                                   *
*      The design earthquake magnitude is. . . . . . . . . . 5.25   *
*                                                                   *
*      The maximum flood elevation in this case is . . . . .    0   *
*                                                                   *
*      The elevation of the seasonal high ground water is. .    0   *
*                                                                   *
*      The design waste elevation in the cell is . . . . . .    0   *
*                                                                   *
*      The soil number representing the clay liner is. . . .    0   *
*                                                                   *
*********************************************************************
```

The number of soil boundary lines for this section is 9

Line	Point	X	Y
1	1	0	0
	2	1800	0
2	1	0	38
	2	870	38
3	1	0	55
	2	580	55
	3	870	38
	4	1800	38
4	1	0	60
	2	950	60
5	1	300	62
	2	820	63
6	1	0	65
	2	150	61
	3	300	62
	4	560	69
7	1	0	77
	2	280	75
8	1	0	82
	2	280	75
	3	560	69
	4	820	63
	5	950	60
	6	1098	56
	7	1125	65
9	1	0	264
	2	316	264
	3	550	250
	4	1105	65
	5	1115	62
	6	1125	65
	7	1150	65
	8	1189	52
	9	1300	50
	10	1800	50

WEYERHAEUSER PLYMOUTH/WEST/C-C/H=200'/3H1V/ASH File: WPCC_W_A

Hydraulic Condition 7: User Defined



(409 ,-167) SCALE : 1 inch = 90.0001 feet

Soil 1 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	0	0	(lb/sq.ft)
Phi Angle	0	35	35	(degrees)

Unit Weight	140.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 2 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	350	350	(lb/sq.ft)
Phi Angle	0	28	28	(degrees)

Unit Weight	130.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 3 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	0	0	(lb/sq.ft)
Phi Angle	0	30	30	(degrees)

Unit Weight	130.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number	0.000	(blows/ft)

Soil 4 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	350	350	(lb/sq.ft)
Phi Angle	0	28	28	(degrees)

Unit Weight	130.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 5 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	0	0	(lb/sq.ft)
Phi Angle	0	25	25	(degrees)

Unit Weight	115.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 6 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	140	140	(lb/sq.ft)
Phi Angle	0	15	15	(degrees)

Unit Weight	130.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 7 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	0	0	(lb/sq.ft)
Phi Angle	0	25	25	(degrees)

Unit Weight	115.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

Soil 8 Properties

	Unconsolidated Undrained	Consolidated Undrained	Consolidated Drained	
Cohesion	0	0	0	(lb/sq.ft)
Phi Angle	0	28	41	(degrees)

Unit Weight	70.000	(lb/cu.ft)
Clay Content	0.000	(%)
Overconsolidation Ratio	0.000	
Initial Void Ratio	0.000	
Compression Index	0.000	
Recompression Index	0.000	
Permeability	0.000	(ft/yr)
Median Grain Size	0.000	(mm)
Plasticity Index	0.000	(%)
Liquid Limit	0.000	(%)
Standard Penetration Number . .	0.000	(blows/ft)

```
*************************************************************************
*                        Hydraulics Results                             *
*************************************************************************
*                                                                       *
*       Seepage In  . . . . . . . .        0.000   (cu.ft/yr)          *
*                                                                       *
*       Seepage Out . . . . . . . .        0.000   (cu.ft/yr)          *
*                                                                       *
*       Critical Exit Gradient  . . .      0.000                       *
*                                                                       *
*       For this hydraulic condition there is no liner uplift.          *
*                                                                       *
*************************************************************************
```

```
*************************************************************************
*                          User Defined                                 *
*             Piezometric Surface for Hydraulic Condition               *
*             7: User Defined                                           *
*************************************************************************
*                                                                       *
*                  Point          X            Y                       *
*                 ------       ------       ------                     *
*                    1            0           72                       *
*                    2          280           71                       *
*                    3         1115           49                       *
*                    4         1290           46                       *
*                    5         1800           45                       *
*************************************************************************
```

```
*************************************************************************
*                                                                       *
*        R O T A T I O N A L   F A I L U R E   R E S U L T S            *
*                                                                       *
*                    User defined Grid Search                           *
*                                                                       *
*     The slopes were analyzed for failure arcs having centers in       *
*     areas defined by the following parallelograms:                    *
*************************************************************************
*                                                                       *
*                              Slope  1                                 *
*                                                                       *
*    Co-ord.        Point 1       Point 2       Point 3       Point 4   *
*                                                                       *
*      X             550           1189          1387           748     *
*      Y             300            102           448           646     *
*-----------------------------------------------------------------------*
*                                                                       *
*        The number of divisions between points 1 and 2 were  8         *
*        The number of divisions between points 2 and 3 were  8         *
*        The X-increment used in the search was  . . . . . . 20         *
*        The Y-increment used in the search was  . . . . . . 20         *
*                                                                       *
*************************************************************************
```

```
*            1.61        1231.9
*************************************************************************
*                                                                       *
*           Hydraulic Condition: 7: User Defined                        *
*                                                                       *
*                   Consolidated Undrained (CU) Case                    *
*-----------------------------------------------------------------------*
*          Safety        Failure        X-           Y-                *
*          Factor        Radius        Co-ord       Co-ord             *
*         --------      --------      --------     --------            *
*            1.61        1257.1        1297.6       1313.9             *
```

Press RETURN to continue...

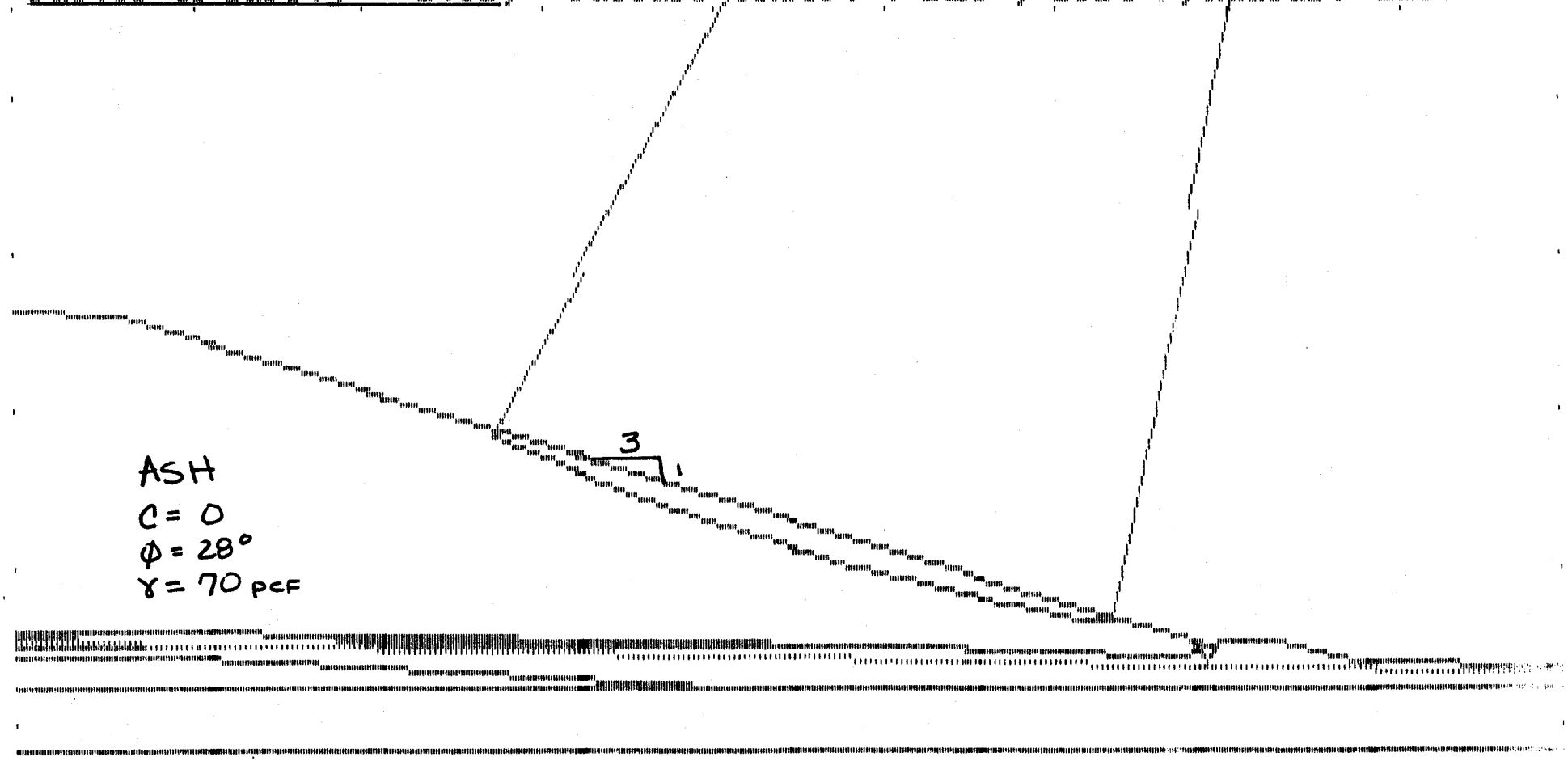
```
*            2.09         871.2        1222.6        918.9             *
*            2.13          78.5         869.5        200.5             *
*            2.14        1072.8        1262.6       1118.9             *
*            2.15         329.0         673.8        516.1             *
*            2.16         650.3        1182.6        698.9             *
*            2.18        1173.6        1282.6       1218.9             *
*            2.21        1053.5        1262.6       1098.9             *
*            2.23          81.1         789.6        225.3             *
*            2.24        1244.3        1297.6       1288.9             *
*            2.24        1100.6        1242.6       1138.9             *
*            2.25         472.2        1147.4        522.3             *
*            2.25        1269.5        1302.6       1313.9             *
*            2.28         281.0         649.0        472.8             *
*            2.29        1141.2        1252.6       1178.9             *
*            2.32          83.8         709.8        250.0             *
*            2.33        1186.6        1262.6       1223.9             *
*            2.35         429.4        1142.6        478.9             *
*            2.38         265.1        1128.3        324.3             *
*            2.38        1257.2        1277.6       1293.9             *
*            2.43          86.4         629.9        274.8             *
*            2.45         233.0         624.3        429.4             *
*************************************************************************
```

Press RETURN to continue...

```
*************************************************************************
*                                                                       *
*           Hydraulic Condition: 7: User Defined                        *
*                                                                       *
*                   Consolidated Drained (CD) Case                      *
*                   Seismic Coefficient = 0.07                          *
*-----------------------------------------------------------------------*
*          Safety        Failure        X-           Y-                *
*          Factor        Radius        Co-ord       Co-ord             *
*         --------      --------      --------     --------            *
*            1.85          43.8        1179.0         91.5             *
```

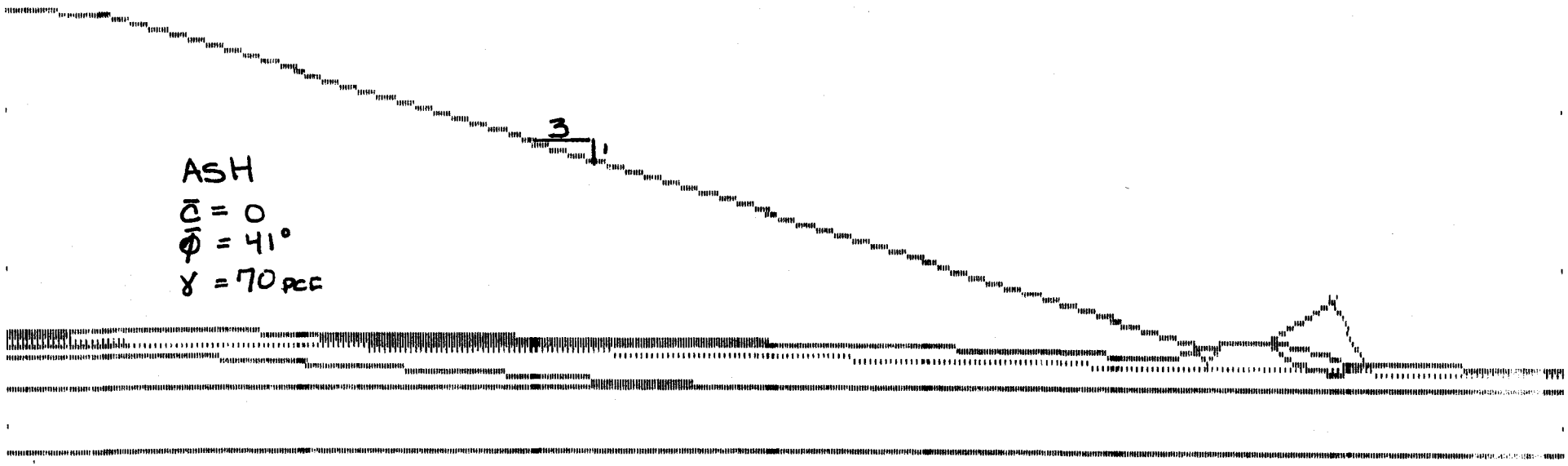
Press RETURN to continue...

WEYERHAEUSER PLYMOUTH/WEST/CC'/H=200'/3H:1V/ASH File: WPCCW_A
Hydraulic Condition 7: User Defined
Consolidated Undrained Soil Parameters
Factor of Safety = 1.61, Failure Center: (128 , 1314), Radius: 1257



(499 , -7) SCALE : 1 inch = 90.0001 feet

WEYERHAEUSER ELYMOUTH/WEST/C-C'/H=200'/3H:1V/ASH File: WPC_W_A
Hydraulic Condition 7: User Defined
Consolidated Drained Soil Parameters with Seismic Loading
Factor of Safety = 1.85, Failure Center: (179 , 92), Radius: 44



(49 , -167) SCALE : 1 inch = 90.0001 feet

*	2.27	226.1	998.9	262.4 *
*	2.27	169.2	1078.8	237.6 *
*	2.27	422.3	803.1	577.9 *
*	2.28	484.7	1147.4	522.3 *
*	2.29	323.7	833.5	466.6 *
*	2.30	526.5	883.0	553.2 *
*	2.30	374.3	778.4	534.6 *
*	2.33	275.7	808.8	423.3 *
*	2.34	326.3	753.6	491.3 *
*	2.35	348.3	888.6	398.5 *
*	2.36	121.2	1054.0	194.3 *
*	2.39	227.7	784.0	379.9 *
*	2.39	278.3	728.9	448.0 *
*	2.40	242.7	1103.5	280.9 *
*	2.43	181.0	974.1	219.1 *
*	2.43	177.1	839.1	311.9 *
*	2.44	242.1	919.0	287.1 *
*	2.46	230.4	704.1	404.7 *
*	2.47	288.8	1128.3	324.3 *
*	2.48	179.7	759.3	336.6 *
*	2.50	472.9	748.0	646.0 *

Press RETURN to continue...

RECOMMENDED MINIMUM FACTOR OF SAFETY FOR SLOPE STABILITY

Shear Strength Parameter	Confidence of Strength Measurement	Recommended Minimum F.S.
UU (end of construction, no waste or pool containment)	low	1.40
	high	1.20
CU	low	1.50
	high	1.30
CU (drawdown pool condition)	low	1.40
	high	1.20
CD (long-term, no seismic effects)	low	1.60
	high	1.40
CD (long-term with seismic effects)	low	1.50
	high	1.30

If the dike > 30 feet in height, add 0.10 to the F.S. in each case.

Press RETURN to continue...

```
*                    G A R D S   S U M M A R Y                          *
*                                                                       *
*    File:  WPCC_W_A            Date: 06-10-1999    Time: 11:09:05     *
*    Project:  WEYERHAEUSER PLYMOUTH/WEST/C-C'/H=200'/3H:1V/ASH         *
*    Hydraulic Condition 7: User Defined                                *
*                                                                       *
*-----------------------------------------------------------------------*
*             Rotational Failure Analysis Safety Factor                 *
*-----------------------------------------------------------------------*
*       Unconsolidated Undrained Case . . . . . . . . . . Not Run       *
*       Consolidated Undrained Case . . . . . . . . . . . 1.61          *
*       Consolidated Drained Case . . . . . . . . . . . . 1.85          *

Press RETURN to continue...

*-----------------------------------------------------------------------*
*            Translational Failure Analysis . . . . . . Not Run         *
*-----------------------------------------------------------------------*
*             Settlement Analysis . . . . . . . . . . . Not Run         *
*-----------------------------------------------------------------------*
*       Liquefaction Analysis . . . . . . . . . . . . . Not Run         *
*************************************************************************

Press RETURN to continue...
```

Attachment E3
Interface Friction Analysis

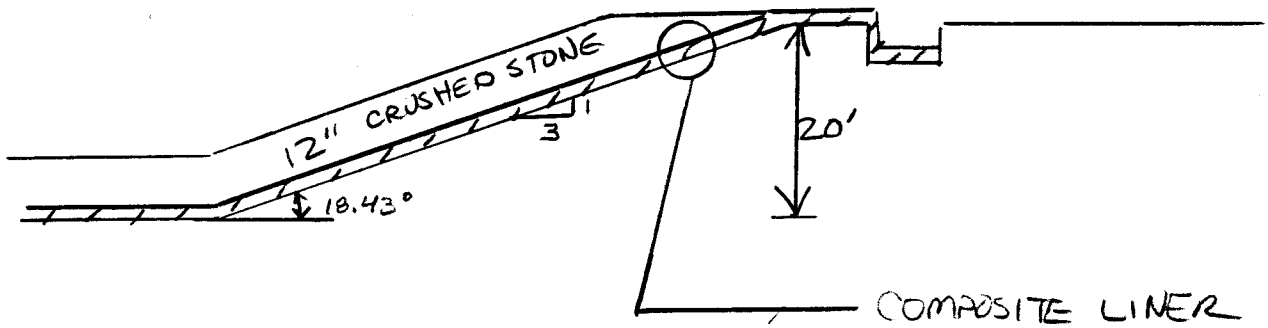
DESIGN SHEET

SHEET 1 OF

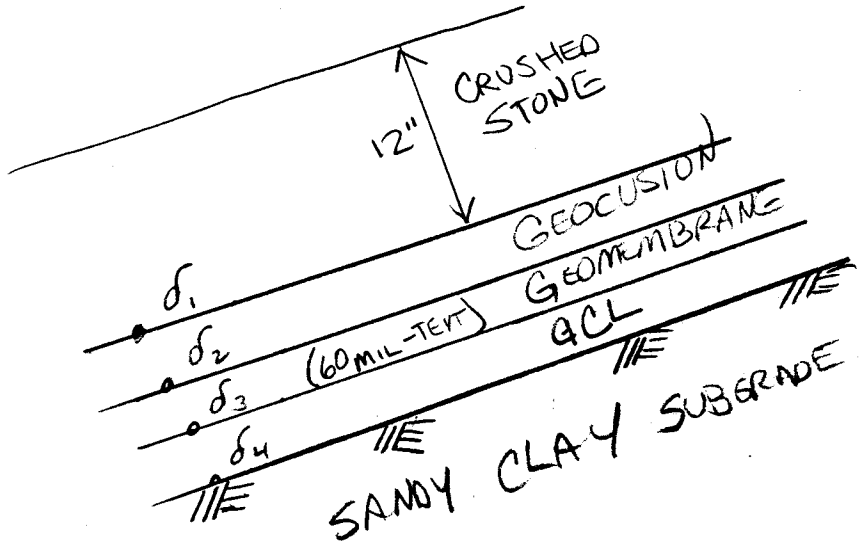
RMT®
100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER PLYMOUTH	SYK	9/3/99	[illegible]	9/14/99	05101.01

INTERFACE FRICTION ANALYSES, SIDE SLOPE AGGREGATE & DOZER SUPPORT ANALYSES + ANCHOR TRENCH DESIGN



NOTE: 6 INCH SAND & 12 INCH SELECT ASH LAYER WILL BE PLACED JUST PRIOR TO WASTE PLACEMENT



DESIGN SHEET

SHEET 2 OF

RMT®
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PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER-PLYMOUTH	SYK	9/3/99	EWJ	9/14/99	05101.01

DESIGN PARAMETERS TO BE USED IN ANALYSIS:

Ref #	Interface Description	Interface Friction Angle	SOURCE
δ_0	SOIL : GEOCUSHION	23°	ASSUMED VALUE
δ_1	Stone : GEOCUSHION	23°	ASSUMED VALUE
δ_2	GEOCUSHION: TEXT GEOMEMBRANE	36°	*
δ_3	TEXT GEOMEMBRANE : GCL	26°	TEST RESULT
δ_4	GCL: SANDY CLAY	25°	TEST RESULT

* ASSUMED BASED ON TREVIRA TECHNICAL NOTE
** GCL GEOTEXTILE IS WOVEN.

MATERIAL SPECIFICATIONS:

γ_{STONE} = 125 PCF

GEOCUSHION = 32 oz/SY

$\gamma_{COVER\ SOIL}$ = 110 PCF

GEOMEMBRANE = 0.95 gm/cm²

γ_{GCL} = 0.95 lb/SF

BULLDOZER = 22,500 lb
(18" x 88" TRACKS)

GEOMEMBRANE = 0.06 INCHES THICK.

NOTE

DESIGN PARAMETERS NEED TO BE CONFIRMED VIA INTERFACE FRICTION TESTING OF ACTUAL MATERIALS TO BE USED.

DESIGN SHEET

SHEET 3 OF

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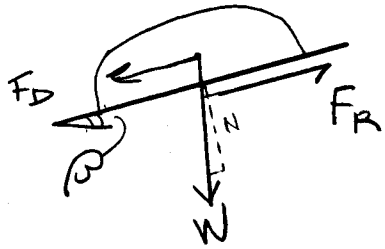
PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER PLYMOUTH	SYK	9/3/99	ewj	9/14/99	05101.01

CHECK INTERFACE BETWEEN STONE AND GEOCUSHION TO SEE IF SLIDING COULD BE A PROBLEM.



$\sin\beta = \frac{F_D}{W}$

$\cos\beta = \frac{N}{W}$

$F_R = N \tan\delta$

$T_R = F_D(FS) - F_R$

$0 = F_D(FS) - F_R$

$F_R = F_D(FS)$

$\cancel{W_T} \cos\beta \tan\delta = \cancel{W_T}(\sin\beta)(FS)$

$FS = \cos\beta \tan\delta / \sin\beta$

$F_D = W_T \sin\beta$

$F_R = W_T \cos\beta \tan\delta$

LET: $T_R = 0$

$\beta = 18.43°$

$\delta = 23°$

$FS = \cos 18.43° \tan 23° / \sin 18.43°$

$FS = 1.27 \gg 1.0$ STONE SHOULD NOT SLIDE ALONG THE GEOCUSHION : STONE INTERFACE

DESIGN SHEET

RMT®
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PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER PLYMOUTH	SYK	9/3/99	EWJ	9/14/99	05101.01

CHECK THE STRESS IN EACH LINER COMPONENT DUE TO ITS WEIGHT AND THE LOADING CONDITIONS ABOVE IT VERSES ITS LOWEST YEILD TENSION TO SEE THAT ITS NOT OVERSTRESSED.

$$T_R \leq T_{YEILD} \text{ OR } T_{ULT}$$

WHERE: T_R = NET DRIVING FORCE = $F_D - F_F$

WEIGHT OF EACH COMPONENT PER 1-FOOT WIDTH OF THE SECTION SHOWN ON SHEET 1

GEOCUSHION:

$$W_{T_{CUSH}} = \left[\frac{32\text{ oz}}{\text{SQ. YD.}} \middle| \frac{1\text{ lb}}{16\text{ oz}} \middle| \frac{1\text{ SQ YD}}{9\text{ SQ FT}}\right]\left[\frac{20\text{ ft}}{\cos 18.43^\circ}\right]\left[1\text{ ft width}\right]$$

$$W_{T_{CUSH}} = 14.06 \text{ lbs}$$

GEOMEMBRANE:

$$W_{T_{FML}} = \left[\frac{0.95\text{ gm}}{\text{cm}^3} \middle| \frac{1\text{ lb}}{454\text{ gm}} \middle| \frac{(2.54\text{ cm})^3}{(1\text{ in})^3} \middle| 0.06\text{ in} \middle| \frac{144\text{ in}^2}{1\text{ ft}^2}\right]\left[\frac{20\text{ ft}}{\cos 18.43^\circ}\right]\left[1\text{ ft width}\right]$$

$$W_{T_{FML}} = 18.74 \text{ lbs}$$

STONE:

$$W_{T_{STONE}} = \left[125\text{ pcf} \middle| 1\text{ ft} \middle| \frac{20\text{ ft}}{\cos 18.43^\circ}\right]\left[1\text{ ft width}\right]$$

$$W_{T_{STONE}} = 7907.74 \text{ lb}$$

DESIGN SHEET

SHEET 5 OF

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PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER PLYMOUTH	DJK	9/3/99	[illegible]	9/14/99	0501.01

GEOSYNTHETIC CLAY LINER (GCL)

$\gamma_{GCL} = 0.95 \text{ lb/ft}^2$

$W_{T_{GCL}} =$ 0.95 | 20 ft | 1 ft
| sin 18.43° |

$W_{T_{GCL}} = 60.10 \text{ lbs}$

DESIGN SHEET

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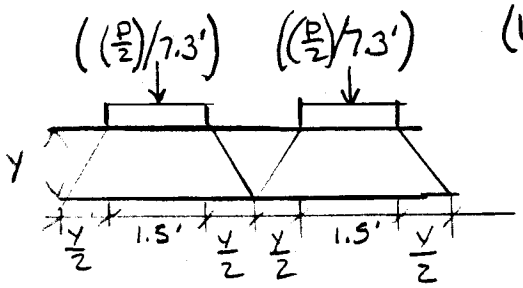
PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER PLYMOUTH	AYK	9/3/99	BWD	9/14/99	05101.01

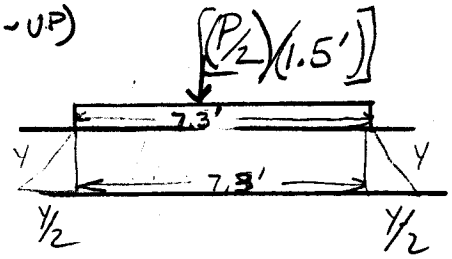
BULLDOZER DH 4 SERIES II (STRAIGHT BLADE)

TOTAL WT = 22,500 lb = P
BLADE CAPACITY = 2.5 cy = 67 ft³
TRACK WIDTH = 1.5 ft BLADE HT = 38 in =
TRACK LENGTH = 7.3 ft BLADE WIDTH = 8' 6"

(S~SIDE WAYS)



(U~UP)

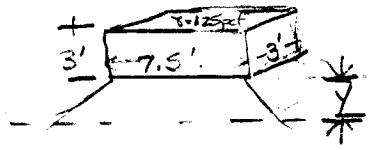


DETERMINE THE MAXIMUM TEMPORARY WEIGHT OF THE BULLDOZER IMPOSED ON THE UNDER

$$W_{BD}^{(S)} = \left[\left(\frac{P}{2}\right)/(7.3')\right]2 = 3082.19/\text{ft width}$$

$$W_{BD}^{(U)} = \left(\frac{P}{2}\right)/(1.5') = 7500.00/\text{ft width}$$

TEMPORARY STOCKPILE: (ASSUMED SIZE OF STOCKPILE MOVED BY DOZER)



$$W_{TSP}^{(U)} = \frac{(3')(3')(7.5')(125\,pcf)}{7.5\,ft} = 1125\,\#/\text{ft width}$$

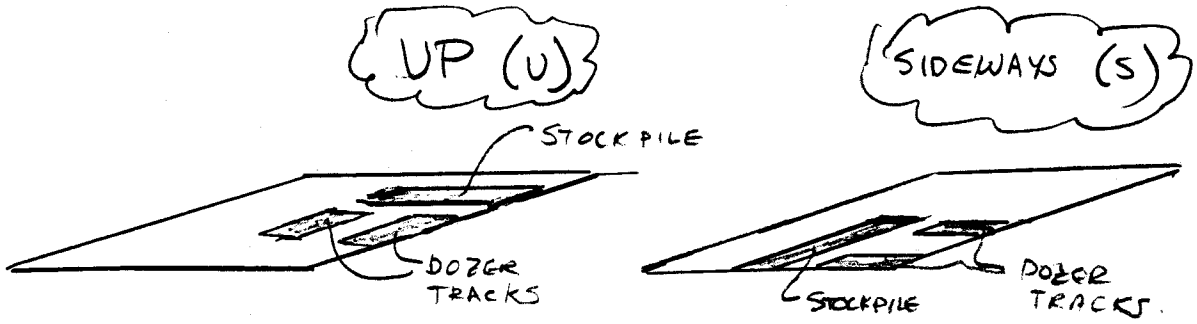
$$W_{TSP}^{(S)} = \frac{(3')(3')(7.5')(125\,pcf)}{3'\text{ width}} = 2813\ \frac{lb}{ft\ width}$$

DESIGN SHEET

RMT® 100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

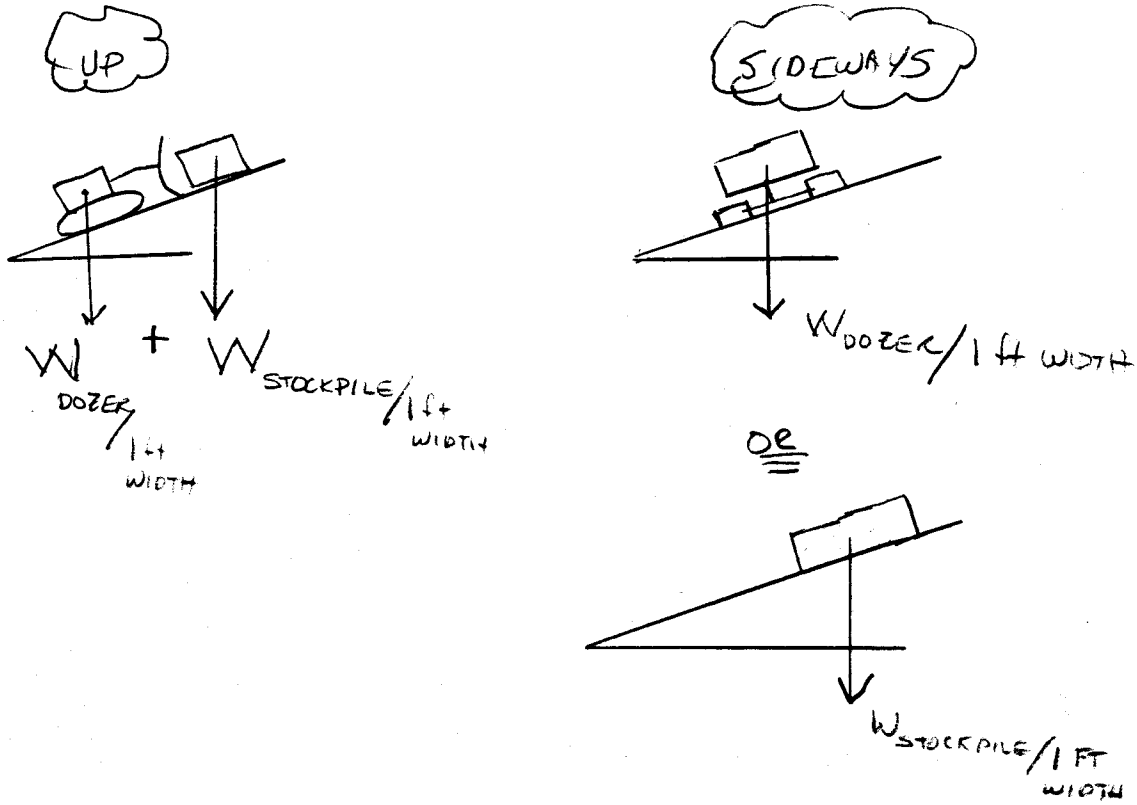
PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	9/3/99	EWD	9/14/99	05101.01

TEMPORARY LOADING SENARIOS



MAXIMUM TEMPORARY WEIGHT ON 1-FOOT WIDE SECTION

W_{TEMP} (U) = 7500# + 1125# = 8625# W_{TEMP} (S) = 3082 #



DESIGN SHEET

RMT®
100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER PLYMOUTH	SYK	9/3/99	EWZ	9/14/99	05101.01

COMPONENT	COMPONENT WT. / 1-FT. WIDTH (lbs)	WT CUMMULATIVE NET WT. / 1-FT. WIDTH (lbs)	δ (degree)	F_D ($W_T \sin\beta$)	F_R ($W_T \cos\beta \cdot \tan\delta$)	T_R $\frac{(F_D - F_R)}{FS}$	T_Y	COMPONENT
TEMP. STOCKPILE	1125		-					
BULLDOZER	7500		-					
STONE	7908		23°					
GEOCUSHION	14	16,547	36°	5,231	11,405	-6174* / 2.18	100	GEOCUSHION
GEOMEMBRANE(T)	19	16,566	26°	5237	7,665	-2428* / 1.46	1800	GEOMEMBRAN
GCL	60	16,626	25°	5256	7355	-2099* / 1.40	420	GCL
SANDY CLAY	—							

*NO TENSILE STRESS IN GEOSYNTHETIC COMPONENTS, COMPONENTS HELD ON SLOPE VIA FRICTION FORCES

$F_D = W_T \sin\beta$

$F_R = W_T \cos\beta \tan\delta$

where: $\beta = 18.43°$

T_Y = Tensile Yeild Strength of Component (from mfr's specifications)

T_R = Tensile Force Required in Component

$T_R = F_D - F_R$

DESIGN SHEET

RMT®

SHEET 9 OF

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	9/9/99	CWJ	9/14/99	05101.01

DESIGN ANCHOR TENCH TO RESIST $T_{ALLOWABLE}$ OF THE GEOCUSHION: $T_{ALL} = (T_y / FS) = (100 \text{ lbs} / 1.3)$

$T_{ALL} = 77$ lbs

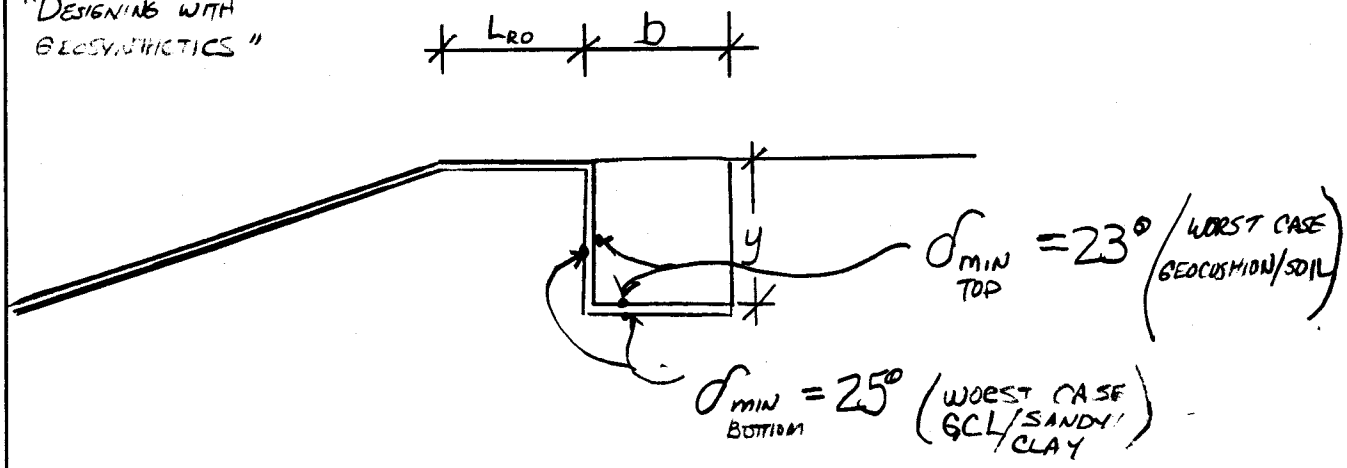
ASSUME ALL GEOSYNTHETIC LAYERS GO INTO THE SAME ANCHOR TRENCH

AND USE $\delta_0 = 23°$ (GEOCUSHION TO SOIL) AS TOP FRICTION ANGLE

AND USE $\delta_4 = 25°$ (GCL TO CLAY/SAND) AS BOTTOM FRICTION ANGLE

KOERNER (1990)

"DESIGNING WITH GEOSYNTHETICS"



$$T_R = F_{U\,LRO} + F_{L\,LRO} + F_{U\,ATS} + F_{L\,ATS} + F_{U\,ATB} + F_{L\,ATB}$$

$$F_{U\,LRO} = [d_c \gamma_{cs} L_{RO} \tan \delta_u]$$ ~ assumed negligible

$$F_{L\,LRO} = [d_c \gamma_{cs} L_{RO} \tan \delta_L]$$

$$F_{ATS} = y K_0 \gamma_{cs} (d_c + 0.5y) \tan \delta_{G/S}$$

$$F_{ATB} = (d_c \gamma_{cs} + y \gamma_c) b \tan \delta_{G/S}$$

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where:

T_R = required tensile strength $= T_{ALL}$

$F_{U_{LRO}}$ = horizontal friction force above geosynthetic, along runout length

$F_{L_{LRO}}$ = " " " below " " " "

F_{ATS} = frictional force along side of anchor trench

F_{ATB} = " " " bottom " " "

$\delta_{G/S}$ = interface friction angle between soil & geosynthetic

b = width of anchor trench.

y = depth of anchor trench.

L_{RO} = runout length (3 ft min)

d_c = depth of cover soil

δ = interface friction angle

K_o = lateral earth pressure coefficient $\cong (1 - \sin\phi)$

ϕ = angle of shear resistance of backfill

The following parameters are used in this analysis

$T_R = 77$ lbs/1-ft width

$\gamma_{CS} = 110$ pcf

$\delta_u = 23°$

$\delta_L = 25°$

$\phi = 30°$

$K_o = (1 - \sin 30°) = 0.5$

$L_{RO} = 3$ ft

$d_c = 0$, since cover soil on top of anchor trench and dike will not likely be placed immediately after geomembrane installation (because of QA/QC reqmts), thus, it is not considered in determining the anchor trench pull out resistance.

DESIGN SHEET

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$$T_R = \cancel{F_{U_{LRO}}}^{0} + \cancel{F_{L_{LRO}}}^{0} + F_{U_{ATS}} + F_{L_{ATS}} + F_{U_{ATB}} + F_{L_{ATB}}$$

$$T_R = y K_o \gamma_{cs}(0.5y)[\tan\delta_u + \tan\delta_L] + y\gamma_{cs} b(\tan\delta_u + \tan\delta_L)$$

$$77 = y(0.5)(110)(0.5)(y)[\tan 23^\circ + \tan 23^\circ] + y(110)(b)(\tan 23^\circ + \tan 23^\circ)$$

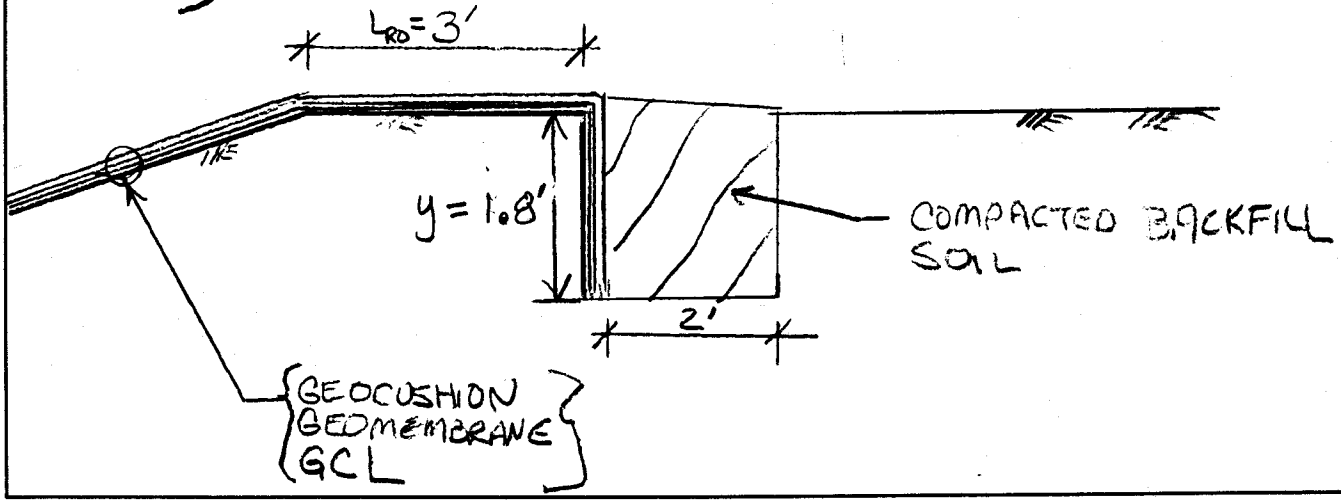
$$77 = y^2(24.5) + y(98.0)(b)$$

$$b = \frac{77 - (24.5)y^2}{y(98.0)}$$

let "y" equal (feet)	solve for "b" (feet)
0.5'	1.44'
1.0'	0.54'
0.67	1.00'

ASSUME WIDTH OF ANCHOR TRENCH IS NEGLIGIBLE (b = 0) — THE GEOSYNTHETICS ARE INSTALLED ONLY ALONG THE SIDEWALL OF THE ANCHOR TRENCH

$$y = (77/24.5)^{1/2} = 1.77 \text{ ft} \simeq 22 \text{ INCHES}.$$



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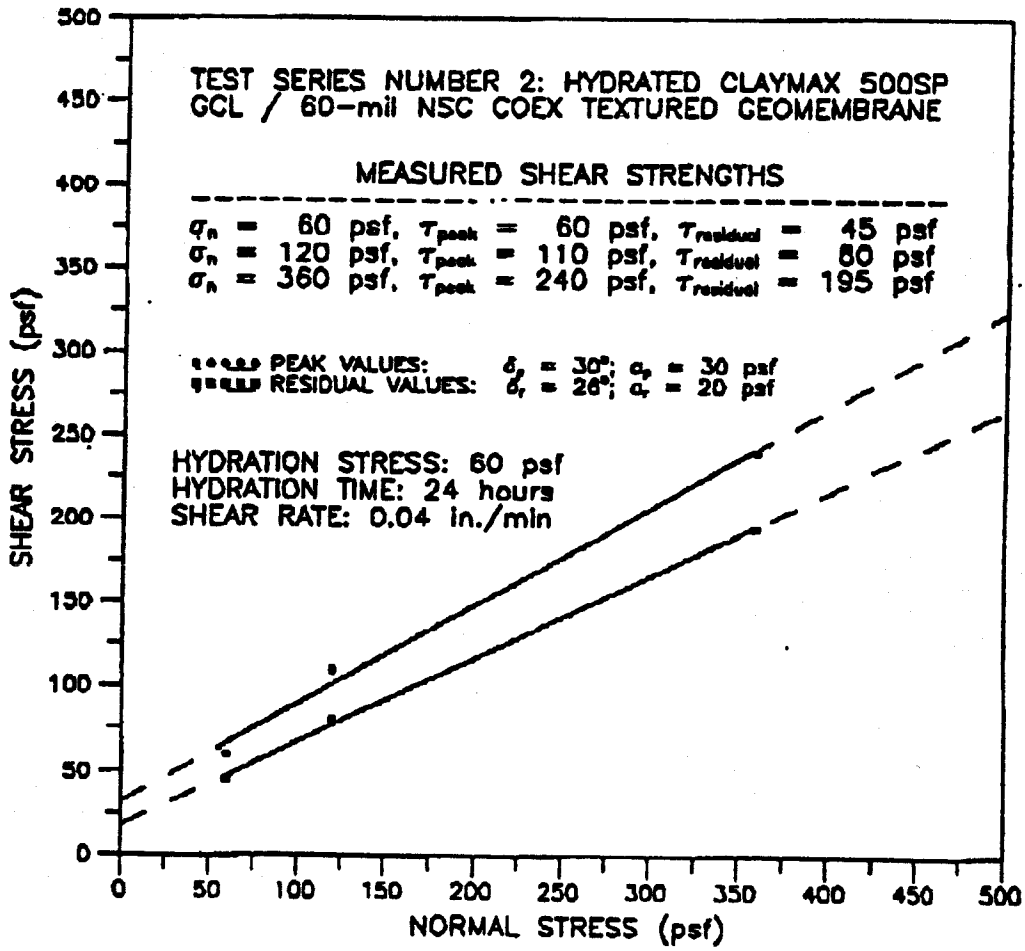
RMT, INC.
INTERFACE DIRECT SHEAR TESTING



NOTE: The reported value of adhesion may not be the true adhesion of the interface, and caution should be exercised in using this adhesion value for applications involving normal stresses outside the range of stresses covered by the test.

DATE TESTED: 7 JULY 1993

GEOSYNTEC CONSULTANTS
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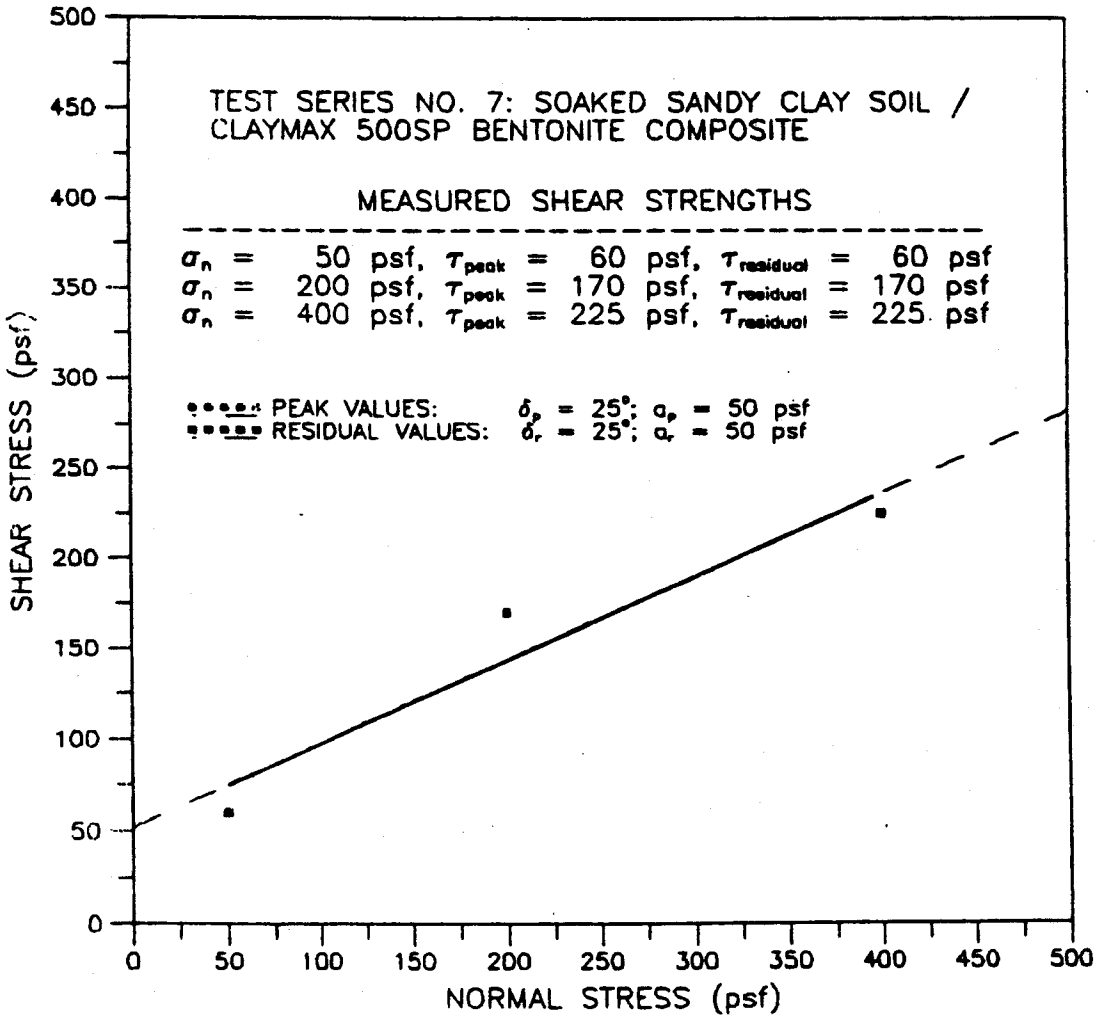
FIGURE NO.	A-4
PROJECT NO.	GL3410
DOCUMENT NO.	
PAGE NO.	

JAMES CLEM CORPORATION
INTERFACE DIRECT SHEAR TESTING



NOTE: The reported value of adhesion may not be the true adhesion of the interface, and caution should be exercised in using this adhesion value for applications involving normal stresses outside the range of stresses covered by the test.

DATE TESTED: NOVEMBER 1992

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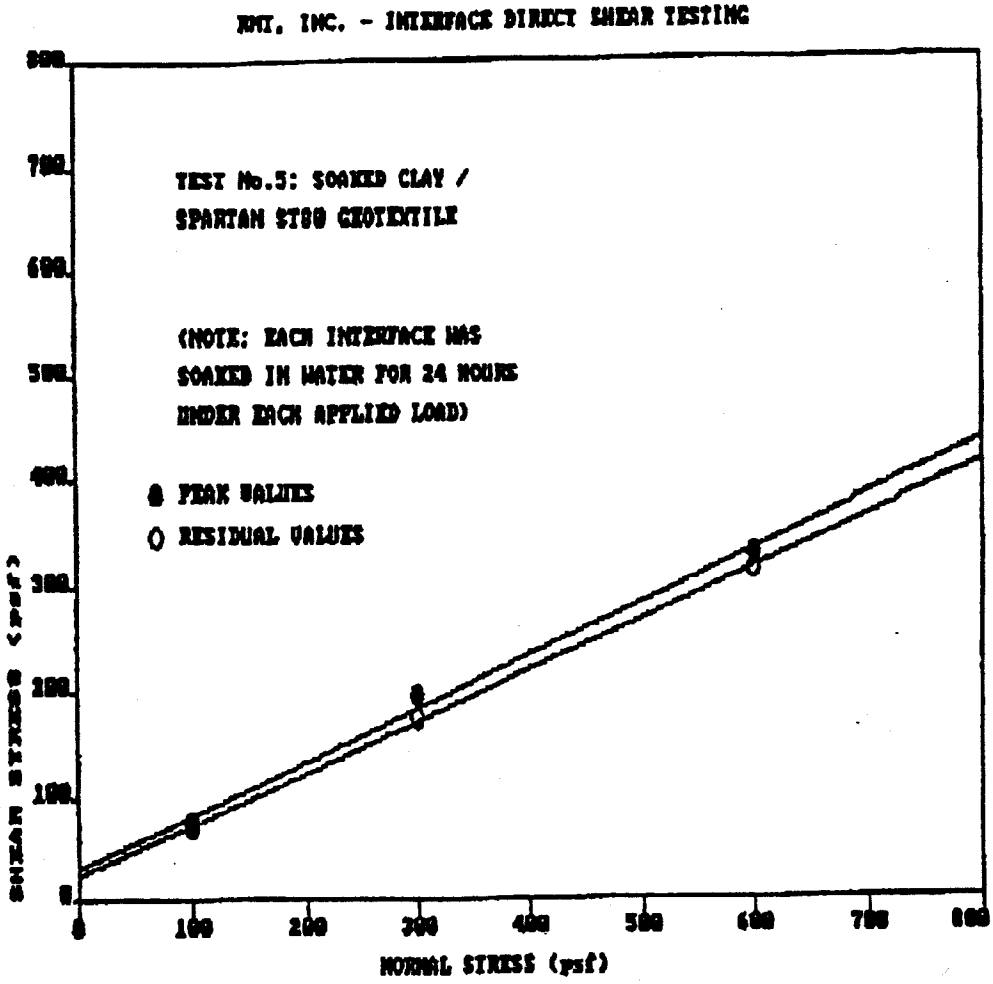
FIGURE NO.	B-13
PROJECT NO.	GL3160
DOCUMENT NO.	GFI92211
PAGE NO.	



THE REGRESSION POLYNOMIAL OF LINE 7 - PEAK VALUES

(3.158E+01) + (5.053E-01)*X
THE VARIANCE - 7.105E+01

$a = 30$ PSF $\delta = 27°$

THE REGRESSION POLYNOMIAL OF LINE 8 - RESIDUAL VALUES

(2.395E+01) + (4.882E-01)*X
THE VARIANCE - 1.075E+01

$a = 25$ PSF $\delta = 26°$

TREVIRA® SPUNBOND

TECH NOTE

Hoechst Celanese Corporation
P.O. Box 5650 Spartanburg, SC 29304-5650

Soil/Geosynthetic Interface Friction By Direct Shear

Test Procedure: The coefficient of friction between a geosynthetic and soil (see Table 1) or between any combination of geosynthetics selected by the user is determined by placing the geosynthetic and one or more contact surfaces within a 12" x 12" direct shear box. A constant, normal compressive stress is applied to the specimen and a tangential (shear) force is applied to the apparatus so that one section of the box moves in relation to the other section. The shear force is recorded as a function of the deflection of the moving section of the shear box. The test is performed for a minimum of three different, normal stresses selected by the user (100, 200, and 250 psf were used here) to model appropriate field conditions. The peak (or residual) shear stresses recorded are plotted against the applied, normal compressive stresses used for testing. The test data generally forms a straight line whose slope is the coefficient of friction, μ, between the two materials where the shearing occurred. The y-intercept of the plot is the adhesion, a. The equivalent friction angle, δ, is calculated as: $\delta = \tan(\mu)$.

Related Test: Interlock Friction by Pullout is a related test used primarily with geogrids. Generally, for geotextiles, the direct shear test provides more conservative (lower) results than the pullout test.

Results of Tests Performed by Georgia Institute of Technology

SLIDING SURFACE	μ	δ (deg.)	a (psf)
Ottowa Sand/TREVIRA® 011/140	0.51	27	68
Ottowa Sand/Trevira 011/550	0.68	34	21
Glatial Till/Trevira 011/140	0.76	37	32
Glatial Till/Trevira 011/550	0.75	37	10
Gulf Coast Clay/Trevira 011/140	0.96	43	62
Gulf Coast Clay/Trevira 011/550	1.26	52	45
MDPE Geonet*/Trevira 011/140	0.46	25	29
HDPE Geonet*/Trevira 011/140	0.32	18	39
HDPE Geomembrane/Trevira 011/550	0.17	10	0
Embossed HDPE Geomembrane/Trevira 011/550	0.72	36	18
Trevira®011/550 / Trevira®011/550**	0.33	18	13
Typar 3401/Typar 3401**	0.19	11	44
Mirafi 600X/Mirafi 600X**	0.29	16	60

* Avg. of 3 different confining soils. ** Glatial Till used as confining soil.

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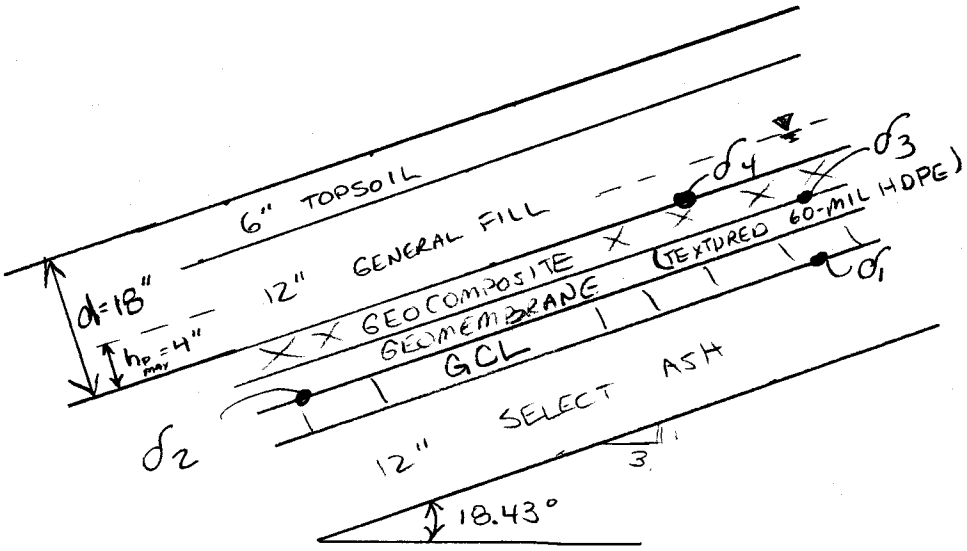
INTERFACE FRICTION ANALYSIS OF PROPOSED CAP



INTERFACE COMPONENT	INTERFACE FRICTION	SOURCE
SELECT ASH (GRANULAR) / GCL	$\delta_1 = 33°$	*
GCL / TEXTURED GEOMEMBRANE	$\delta_2 = 26°$	TEST RESULT
TEXTURED GEOMEMBRANE / GEOCOMPOSITE	$\delta_3 = 36°$	*
GEOCOMPOSITE / GENERAL FILL (SANDY)	$\delta_4 = 34°$	*

* ESTIMATED BASED ON LITERATURE

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WEYERHAEUSER - PLYMOUTH	SYK	6/23/99	RKN	7/8/99	05101.01

GENERAL EQUATION:

$$FS_{MIN} = \frac{\tan \delta_{min}}{\tan \beta}\left[1 - \left(\frac{\gamma_w h_p}{\gamma \cdot d}\right)\cdot\left(\frac{1}{\cos^2 \beta}\right)\right]$$

where: $\gamma_w = 62.4$ pcf
$d = 1.5$ ft
$\delta_{min} = 26°$
$\beta = 18.43°$ (3H:1V SIDE SLOPE

FS = factor of safety

assume: $h_p \leq 4$ inches
$\gamma = 110$ pcf

$$FS_{MIN} = \frac{\tan 26°}{\tan 18.43°}\left[1 - \frac{(62.4)(0.333')}{(110)(1.500')}\cdot\frac{1}{\cos^2(18.43)}\right]$$

$FS_{MIN} = 1.25 \geq 1.20$ OK

Appendix F
Groundwater Flow Model for Liner Design

RMT®
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P.O. Box 16778 29606-6778
Greenville, SC
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GROUNDWATER FLOW MODEL FOR LINER DESIGN

WEYERHAEUSER COMPANY
PLYMOUTH, NORTH CAROLINA

PREPARED BY RMT, INC., NORTH CAROLINA

September 1999

NORTH CAROLINA PROFESSIONAL SEAL No. 17543 ENGINEER R. KENT NILSSON

R. Kent Nilsson, P.E.
Project Manager

Jon A. Freitag
Groundwater Scientist

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Certification

The hydrogeology work for the Weyerhaeuser Company, Plymouth, North Carolina, site was performed by an RMT, Inc. Consulting Hydrogeologist in support of RMT, Inc., North Carolina.

Dan O. Madison, Jr., P.G.
Consulting Hydrogeologist
RMT, Inc.

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Section 1
Introduction

Groundwater modeling was performed to aid in the design of proposed Landfill No. 3, at the Weyerhaeuser Company's (Weyerhaeuser's) Facility located in Plymouth, North Carolina. Drainage restoration along the southeast side of proposed Landfill No. 3 was conducted during the spring of 1999 in an attempt to lower the water table in the vicinity of the drainage ditch. Groundwater modeling was used to assess the long-term configuration of the water table resulting from the drainage restoration. Steady state simulations were run since the rate of change was not important for this evaluation. Results from the predictive groundwater simulations were used in conjunction with historical water levels to design the liner of the proposed landfill. Using the model results for the design basis allows for a lowering of landfill base grades, while complying with applicable regulatory requirements. Optimized base grades will increase the landfill capacity and reduce fill requirements for construction.

Groundwater modeling was conducted using MODFLOW (McDonald and Harbaugh, 1988), which is a three-dimensional finite difference numerical model. The model setup was completed using Visual MODLFOW (version 2.8), by Waterloo Hydrogeologic, which is a pre-processor and post-processor for MODFLOW.

Section 2
Model Setup

2.1 Grid Layout

The modeled area extends from Welch Creek in the west to Little Mill Creek in the north and east, and approximately 300 feet south of the proposed Landfill No. 3 footprint. The model grid encompasses an area of 5,500 feet in the X - direction and 6,000 feet in the Y - direction. Grid spacing ranges from 25 to 100 feet with 58 rows and 85 columns. A finer grid spacing (25 feet) was used in the vicinity of the drainage enhancements and increased by a factor of 1.5 to the maximum spacing (100 feet). The refined grid spacing allowed the assignment of drain nodes consistent with the dimensions of the drainage ditch and more resolution in model-calculated hydraulic heads near drainage enhancements, where steeper gradients would be imposed on the hydrogeologic system. The model grid also includes five layers, which comprise the shallow, unconfined aquifer, with uniform layer thicknesses ranging from 10 to 15 feet and a total thickness of 65 feet. The layout of the model grid in map view is illustrated in Figure 1. A cross-sectional schematic of the model grid layers is illustrated in Figure 2.

2.2 Groundwater Flow Calibration

Following the initial assignment of hydraulic parameters and boundary conditions, numerous simulations were run during the calibration process. Hydraulic conductivity values, zonation, and boundary conditions were adjusted iteratively until model calibration was achieved. The types of boundary condition assignments, and specific parameters within a given boundary condition were also changed during the calibration process. The final calibrated groundwater model demonstrated a good match between modeled and observed hydraulic heads for water level measurements taken in April 1993. The April 1993 water level data were used for the model calibration, because it represents the highest water levels measured at the site to date. The resulting calibrated model will therefore be conservative with respect to the water level elevations.

Model calibration was performed with the assistance of WinPEST, an automated parameter estimation package. WinPEST, developed by Watermark Numerical Computing, was run within Visual MODFLOW to optimize parameter values using nonlinear parameter estimation techniques. Groundwater flow models are inherently nonlinear problems due to the heterogeneity and anisotropy of most hydrogeologic systems. Parameter estimation for

nonlinear problems is performed by linearizing the relationship between model parameters and model-generated observations. The problem is linearized by calculating derivatives of all observations with respect to all of the model parameters. The linearized problem is then solved for better parameter set by running the model again, while reducing the difference between model-calculated observations and field-measured observations.

WinPEST was used to optimize the hydraulic conductivity values for each of the zones defined in the model layers. Aquifer recharge resulting from the direct infiltration of precipitation is generally more homogeneous than hydraulic conductivity values, and is easier to estimate based on precipitation data. Therefore, WinPEST was not used to optimize recharge estimates. No constraints were placed on the range of hydraulic conductivity values generated by WinPEST during optimization runs. This approach provided an indication of how reasonable the assignment of parameter zonations and boundary conditions were. If an optimization run resulted in hydraulic conductivity values beyond the expected range of a given material, the boundary conditions and parameter zonations were reevaluated. WinPEST allowed model calibration to be completed more efficiently and with greater accuracy than most likely could have been achieved manually.

The difference between observed hydraulic heads and model-generated hydraulic heads, residuals, range from 0.65 feet to 2.52 feet. The maximum and minimum residuals are 10 percent and 2.5 percent, respectively, of the range of water levels measured at the site in April 1993. This indicates that the variability between the response of the modeled hydrogeologic system and the actual hydrogeologic system is relatively small. Table 1 summarizes the calculated and observed hydraulic heads, and the residuals for each of the 13 monitoring wells, which had water levels measured during April 1993. The distribution of residuals is illustrated in Figure 3. The areas with the largest residuals are centered around LF0-04 and MW-5, which are both in the vicinity of large hydraulic gradients. These two areas are also outside of the landfill footprint, where precise modeled water levels are not as important. Figure 4 illustrates contours of model-calculated hydraulic heads and observed hydraulic heads from April 1993, at the locations of existing monitoring wells used in the model calibration. The two sets of contours overlay each other very closely. The similarity between the two sets of contours indicates, qualitatively, that the calibrated model produces a hydraulic head distribution similar to the observed hydraulic head distribution.

The model calibration was also evaluated quantitatively. Figure 5 illustrates a scatter plot of model-calculated hydraulic heads and observed heads. A linear trendline was fit to the hydraulic head data with a correlation coefficient of 0.98. The fit of the trendline to the hydraulic head data is indicative of the excellent match between calculated and observed

hydraulic heads. The following three statistics were also calculated to evaluate the model calibration in a quantitative manner: 1) mean error, 2) mean absolute error, and 3) root mean squared. These statistics are defined below:

Mean Error $$ME = \frac{1}{n}\sum_{i=1}^{n}(h_o - h_c)$$

Mean Absolute Error $$MAE = \frac{1}{n}\sum_{i=1}^{n}|(h_o - h_c)_i|$$

Root Mean Squared $$RMS = \left[\frac{1}{n}\sum_{i=1}^{n}(h_o - h_c)_i^2\right]^{1/2}$$

The mean error describes the average residual (in this case, the average residual hydraulic head) throughout the model. It tends to characterize error on the low side since positive and negative residuals negate each other. The mean absolute error provides a more accurate indication of the average magnitude of error, by averaging the absolute value of each residual. The root mean squared, also known as the standard deviation, is the average of the squared differences in observed and model-calculated hydraulic heads.

The calibration statistics are summarized in Table 1. These statistics range from 0.4 percent to 6.6 percent of the observed range in water levels at the site. Each of the methods of evaluating the model calibration indicate that the current configuration of boundary conditions and hydraulic parameters result in a response from the model that closely resembles the observed groundwater flow system at the site. The modeled water table configuration from the calibrated groundwater model is illustrated in Figure 6. This configuration is based on model-calculated hydraulic heads at each node throughout the modeled area.

2.3 Parameter Assignments

Hydraulic parameters were assigned to the active cells within the modeled area. The hydraulic parameters include hydraulic conductivity zones, which varied between each layer and within individual layers. Initial assignments were made based on hydraulic conductivity estimates from single well response tests and the general configuration of the water table surface as mapped in April 1993. Hydraulic conductivity values and zonation were changed during the calibration process until a good match between modeled and observed hydraulic heads was achieved. The final hydraulic conductivity zonation and associated hydraulic conductivity values for each layer are illustrated in Figures 7, 8, and 9.

2.4 Boundary Conditions

Six types of boundary conditions were used in the setup of the groundwater flow model: 1) no flow, 2) general head, 3) constant head, 4) rivers 5) drains, and 6) recharge. These boundary conditions were used to simulate a range of hydrogeologic conditions, such as surface water/groundwater interactions, regional groundwater flow, and groundwater streamlines. The boundary condition assignments are illustrated in Figures 10, 11, 12, and 13.

General head boundary conditions were used to simulate regional groundwater flow into and out of the modeled area. General head boundary conditions were used along the southern boundary to simulate regional groundwater flow into the site, and along the east boundary to simulate groundwater flow out of the modeled area. Groundwater underflow beneath the two creeks was also represented using a general head boundary condition. The conductance values assigned to general head boundary nodes range from 42 to 500 ft^2/day. Values assigned to the general head boundaries are summarized in Table 2.

Constant head boundary conditions were used to simulate regional groundwater flow into the modeled area along the southeastern corner of the model. The use of a constant head boundary condition also provides the model a reference elevation for the calculation of hydraulic heads for steady state simulations. The exclusive use of general head boundary conditions in steady state simulations may result in a non-unique solution because both the groundwater flow equations and boundary conditions would be written as differences in hydraulic heads. Constant head boundary assignments ranged from 35 feet to 27.5 feet.

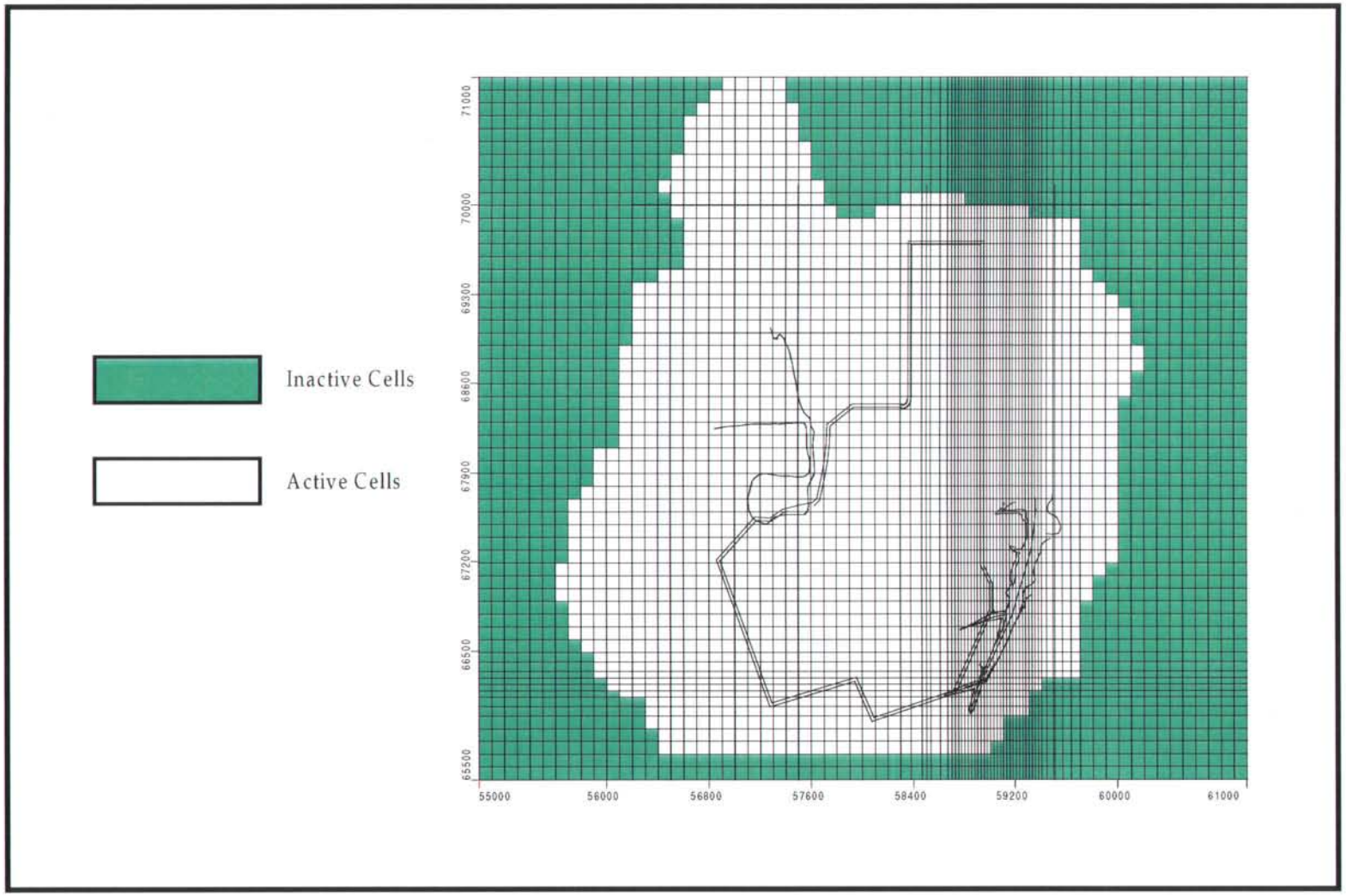
River boundary conditions were used to represent groundwater interactions with Welch Creek, which borders the site to the west, and Little Mill Creek, which borders the site to the north and northeast. Both of these creeks appear to be discharge points for groundwater based on groundwater elevations near the creeks that are greater than the adjacent creek stage. Values assigned to the river stage at nodes representing Welch creek ranged from 4 feet in the southwest to 2 feet at the confluence with Little Mill Creek. Values assigned to the river stage at nodes representing Little Mill Creek ranged from 5 feet in the east to 2 feet at the confluence with Welch Creek. The creek stage assignments were based on staff gauge measurements and supplemented with the water table configuration as mapped in April 1993. The creek sediment thickness was assumed to be a uniform 2 feet along the entire length of each creek, and the conductance at each node ranged from 125 to 342 ft^2/day. Values assigned to river nodes are summarized in Table 3.

Drain boundary conditions were used to represent groundwater discharge into low-lying areas and ditches where seepage faces would be expected based on the water table configuration at the site. Drain nodes were incorporated into the model in Layer 1 and Layer 2 in the north central part of the modeled area, where an elongated depression is observed in the water table configuration as mapped in April 1993. The topography in this portion of the site indicates a ditch or low-lying area where groundwater most likely discharges during periods of elevated groundwater levels. Drain conductances were uniformly assigned a value of 1,000 ft^2/day. Values for drain elevation and conductance assignments are summarized in Table 4.

No flow boundary conditions were used to represent groundwater streamlines and impermeable contacts. Streamlines run parallel to the direction of groundwater flow, and by definition are oriented perpendicular to equipotential lines. Streamlines therefore represent no flow boundaries, which were assigned along relatively short sections of the perimeter of the modeled area in the southeast and southwest, based on the water table configuration. The base of Layer 5 is also a no flow boundary, representing the contact with a clay unit situated beneath the materials comprising the water table aquifer.

A recharge boundary condition was used to represent the infiltration of precipitation at the site. Recharge enters the modeled area through the highest active cells, which are typically in Layer 1. Recharge was uniformly assigned as 7.5 inches per year over the entire modeled area. The 7.5 inches per year represent precipitation to the modeled area, which infiltrates down to the water table. The recharge to the site is lower than the total precipitation due to runoff and evapotranspiration.

Figure 1
Weyerhaeuser - Plymouth, NC



Model Grid and Base Map

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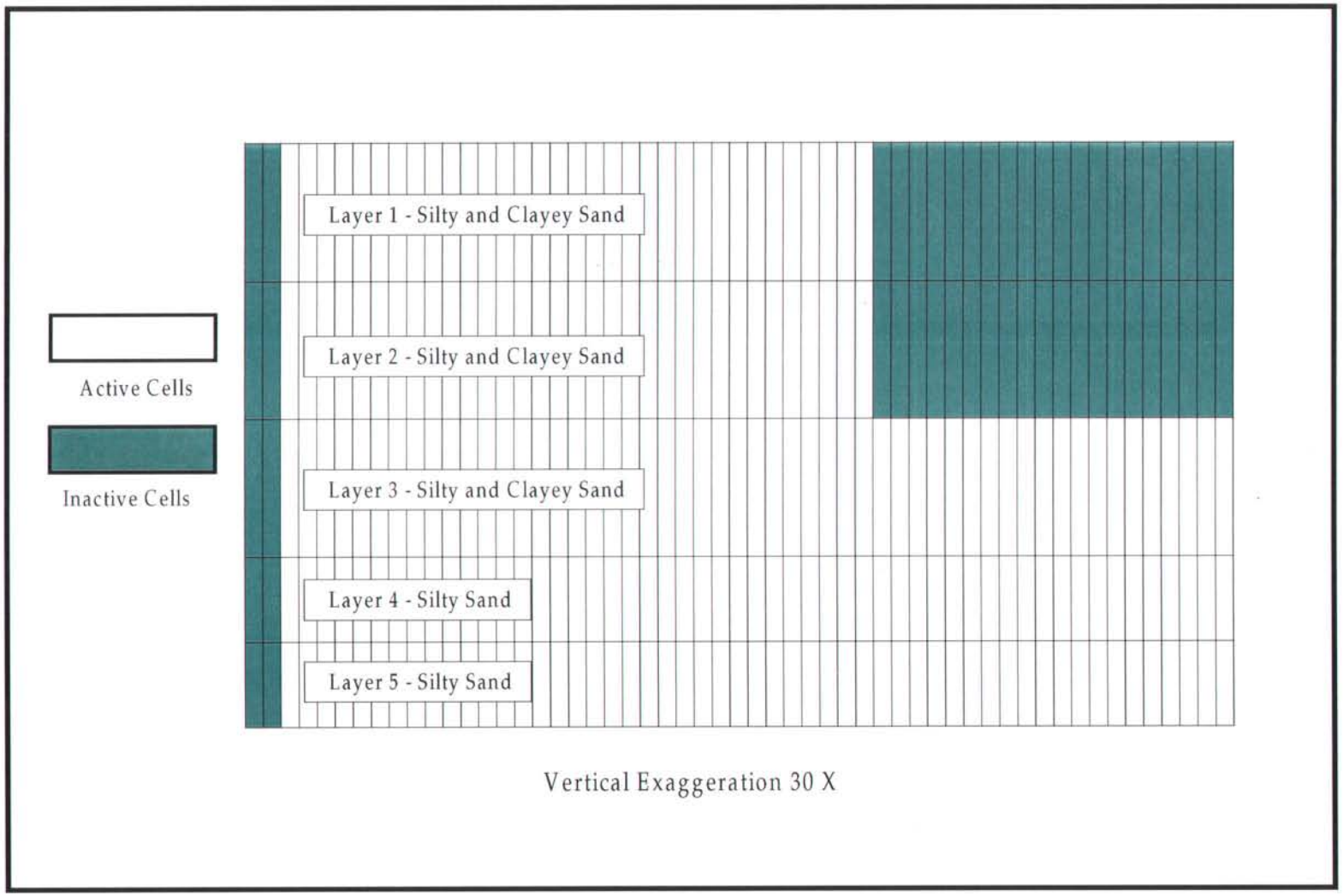
Figure 2
Weyerhaeuser - Plymouth, NC



Model Layers

RMT

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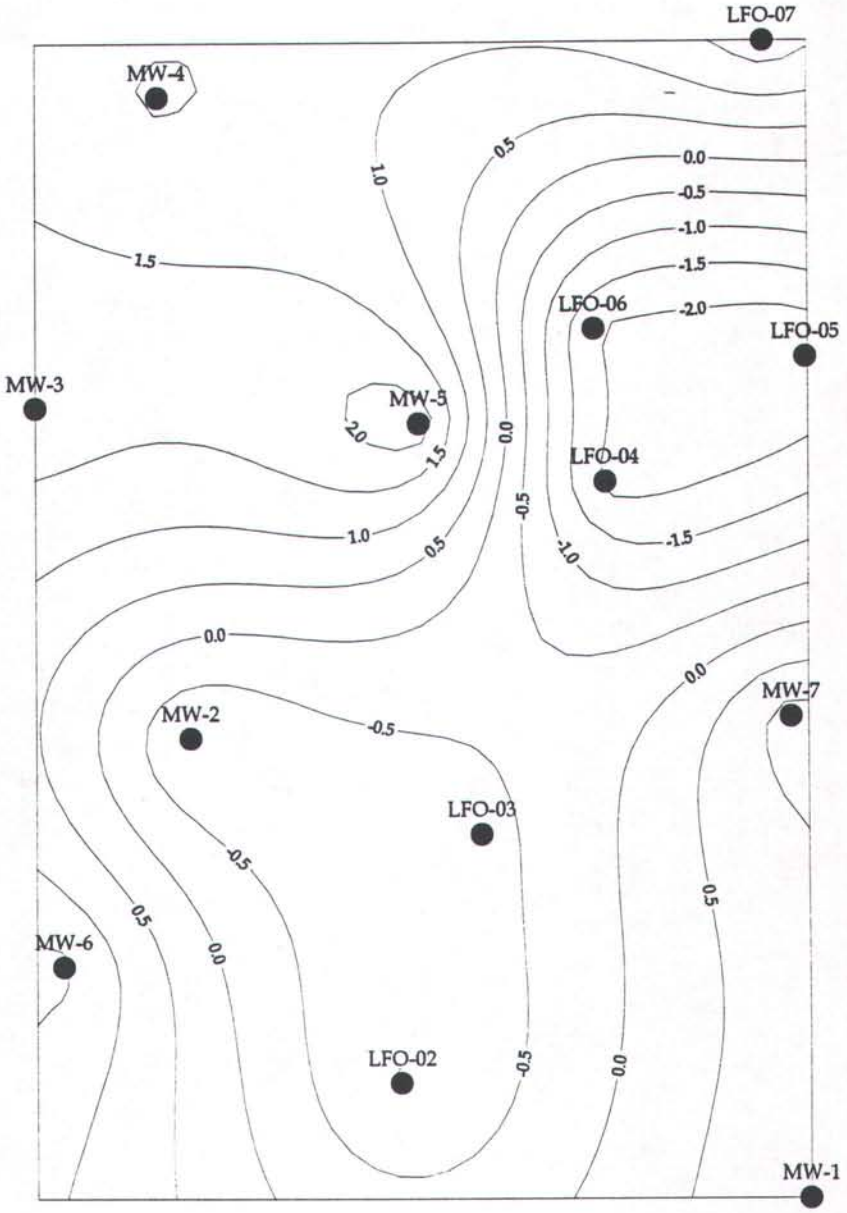
Figure 3
Weyerhaeuser - Plymouth, North Carolina



Modeled Water Level Residuals (feet)

RMT

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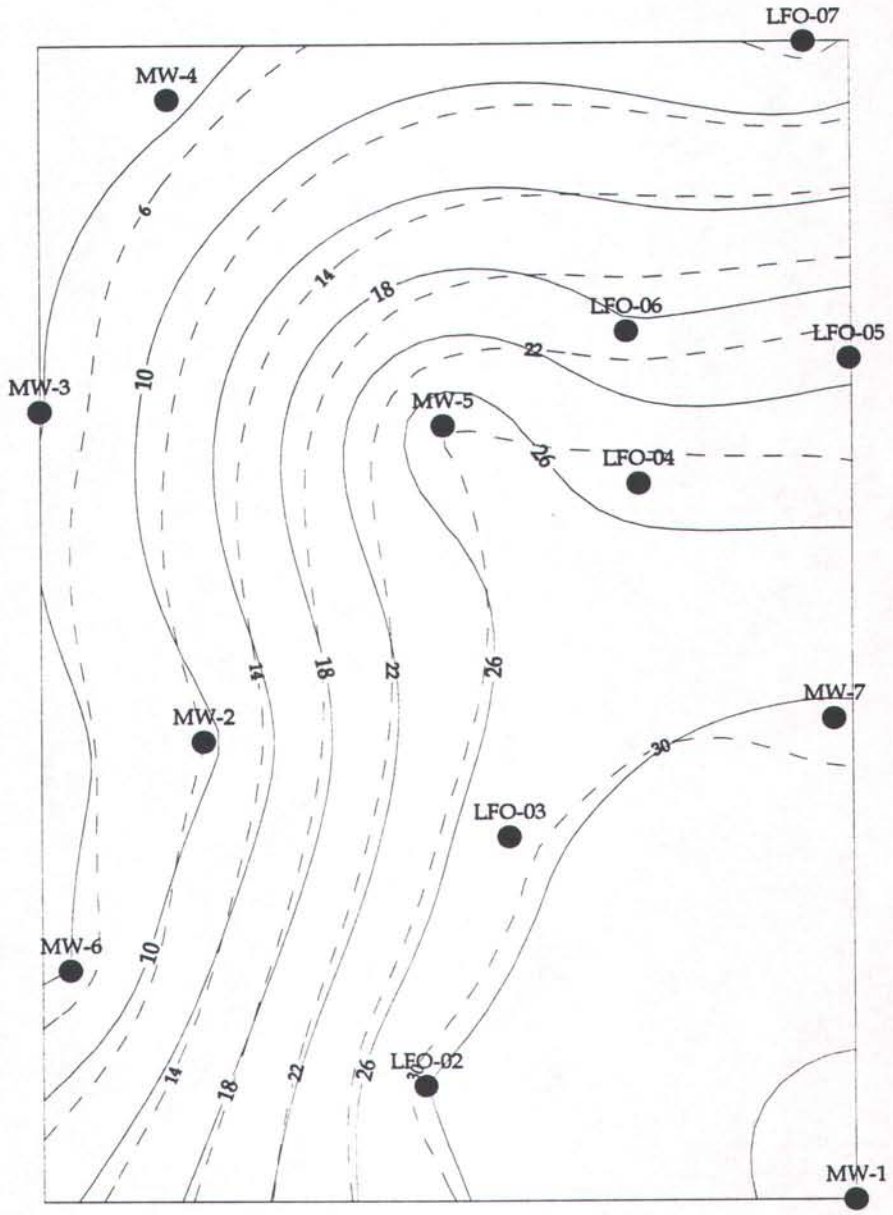
Figure 4
Weyerhaeuser - Plymouth, North Carolina



Qualitative Calibration Evaluation

Modeled Water Levels

Observed Water Levels - April 1993

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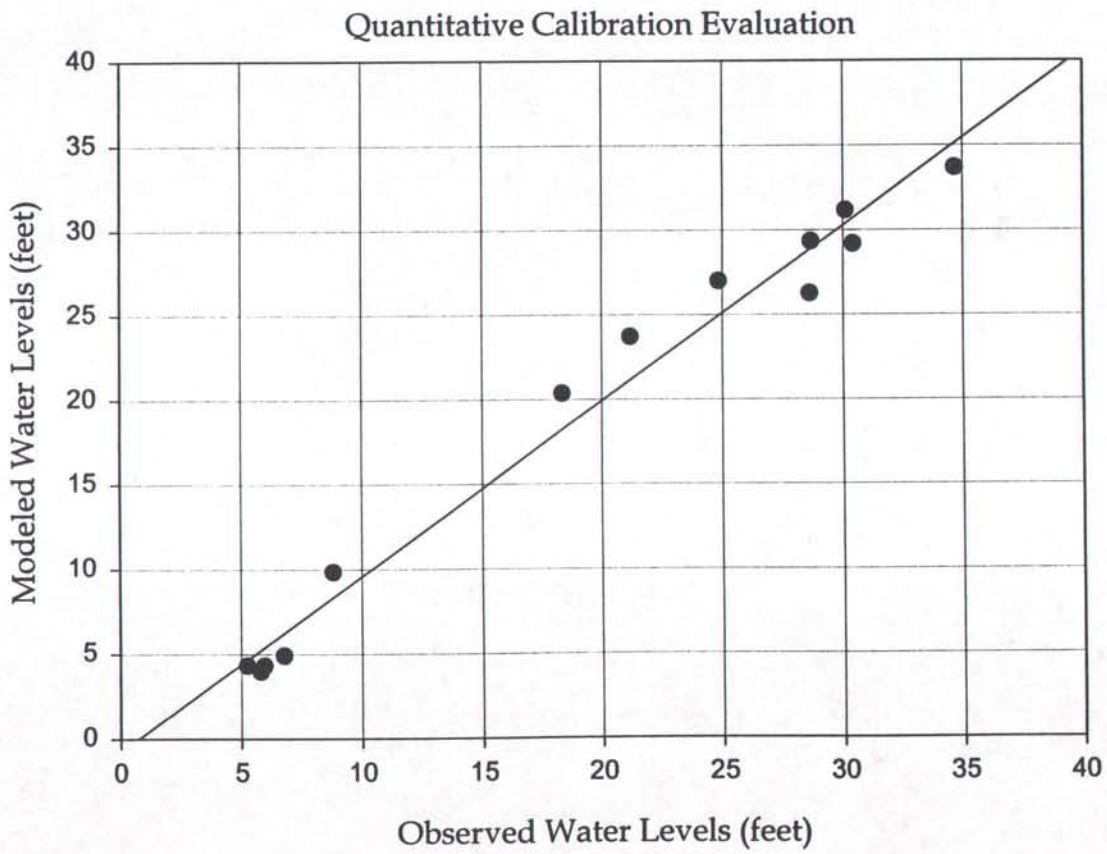
Figure 5
Weyerhaeuser - Plymouth, NC

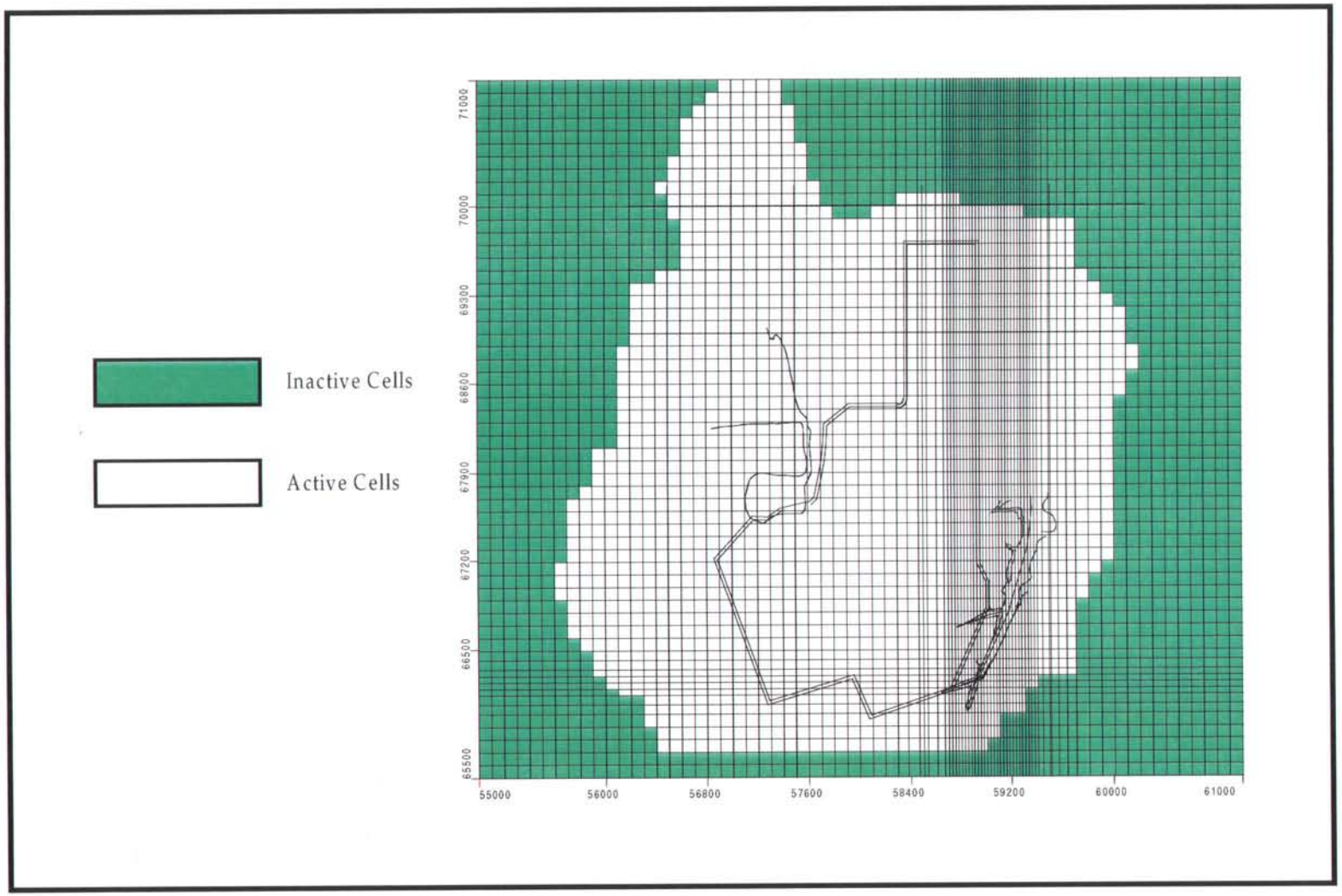


Correlation Coefficient 0.98
Mean Error 0.11 (ft)
Mean Absolute Error 1.56 (ft)
Root Mean Squared 1.66 (ft)

RMI

G:\Data\Hydro\5101\model\doc\calbr.jnb

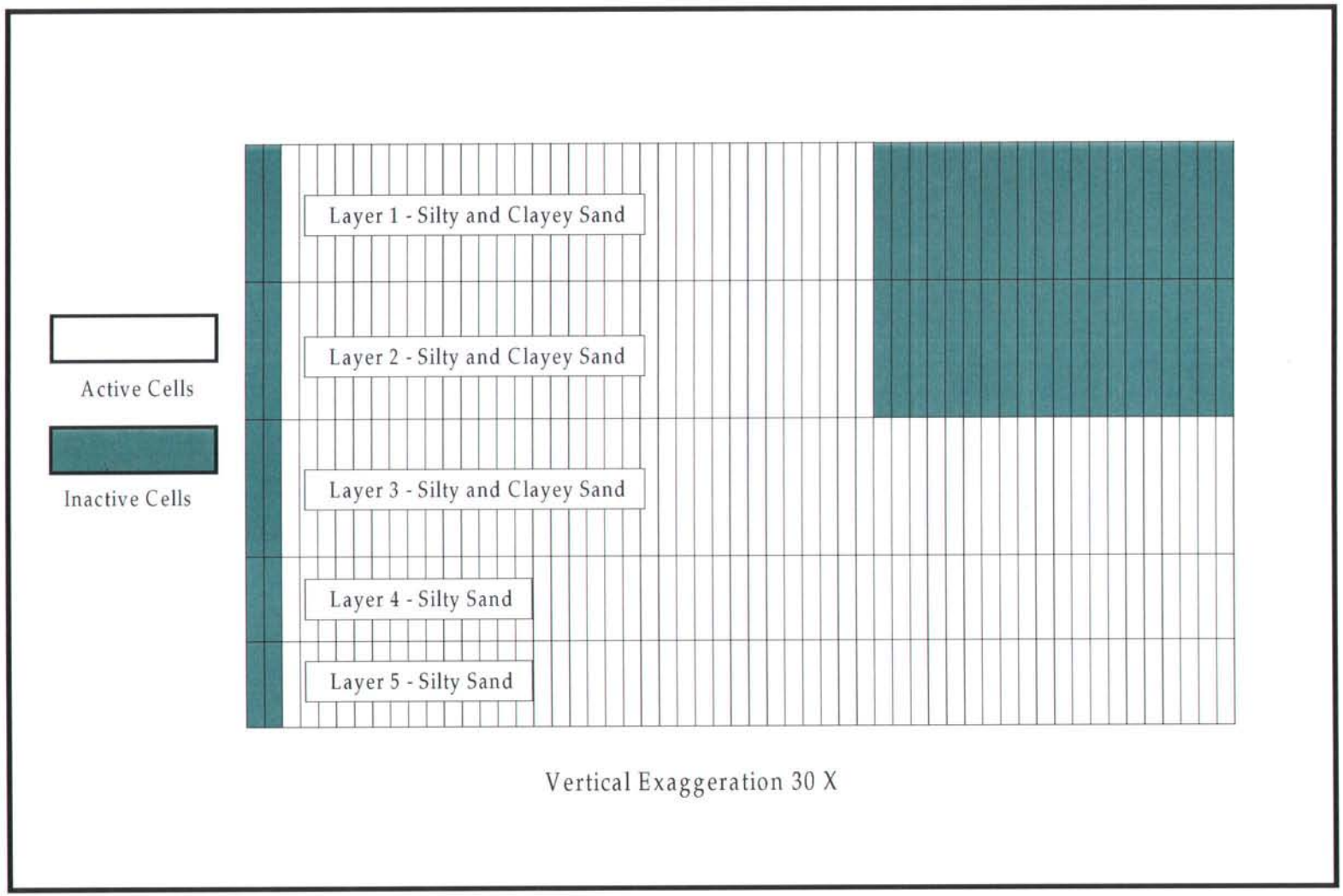
Figure 1
Weyerhaeuser - Plymouth, NC



Model Grid and Base Map

G:data:hydro:5101:model:doc:grid2.srf

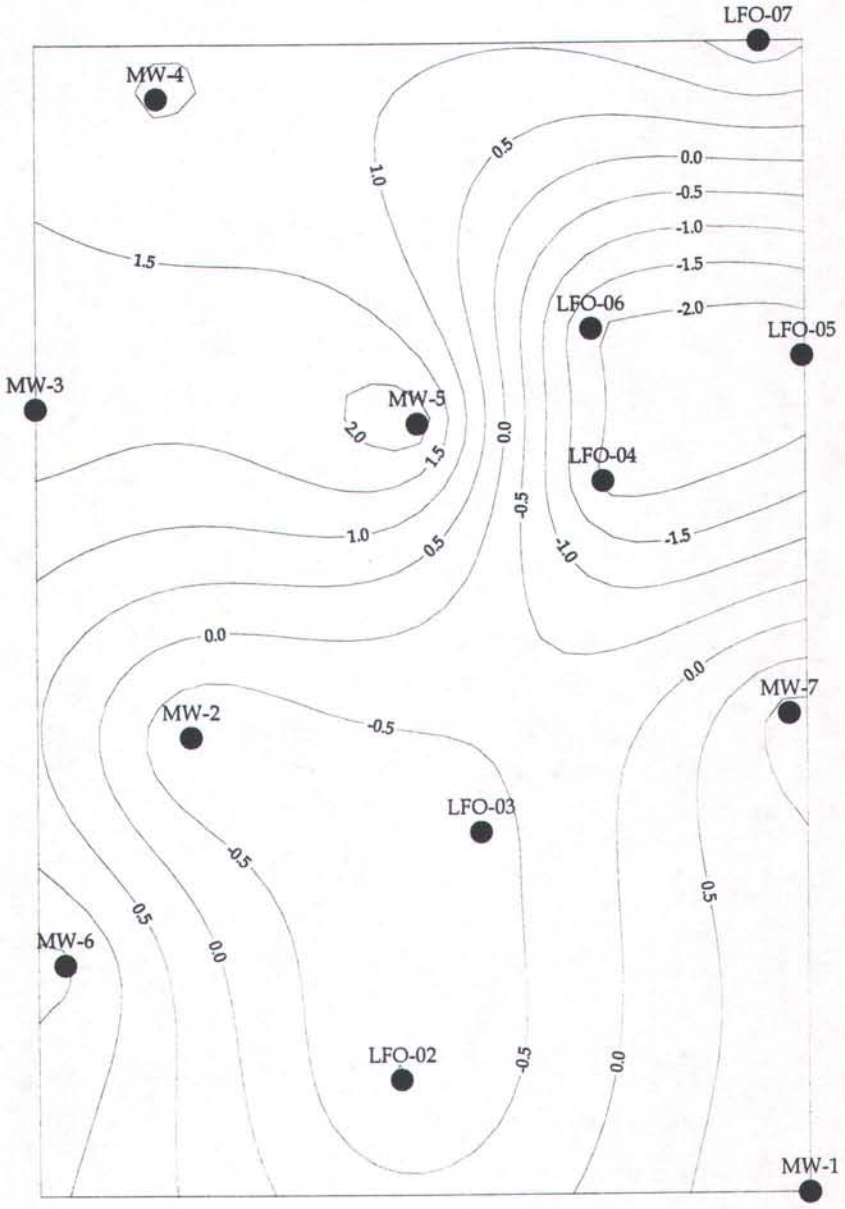
Figure 2
Weyerhaeuser - Plymouth, NC



Model Layers

G:data:hydro:5101:model:doc:cross1.srf

Figure 3
Weyerhaeuser - Plymouth, North Carolina

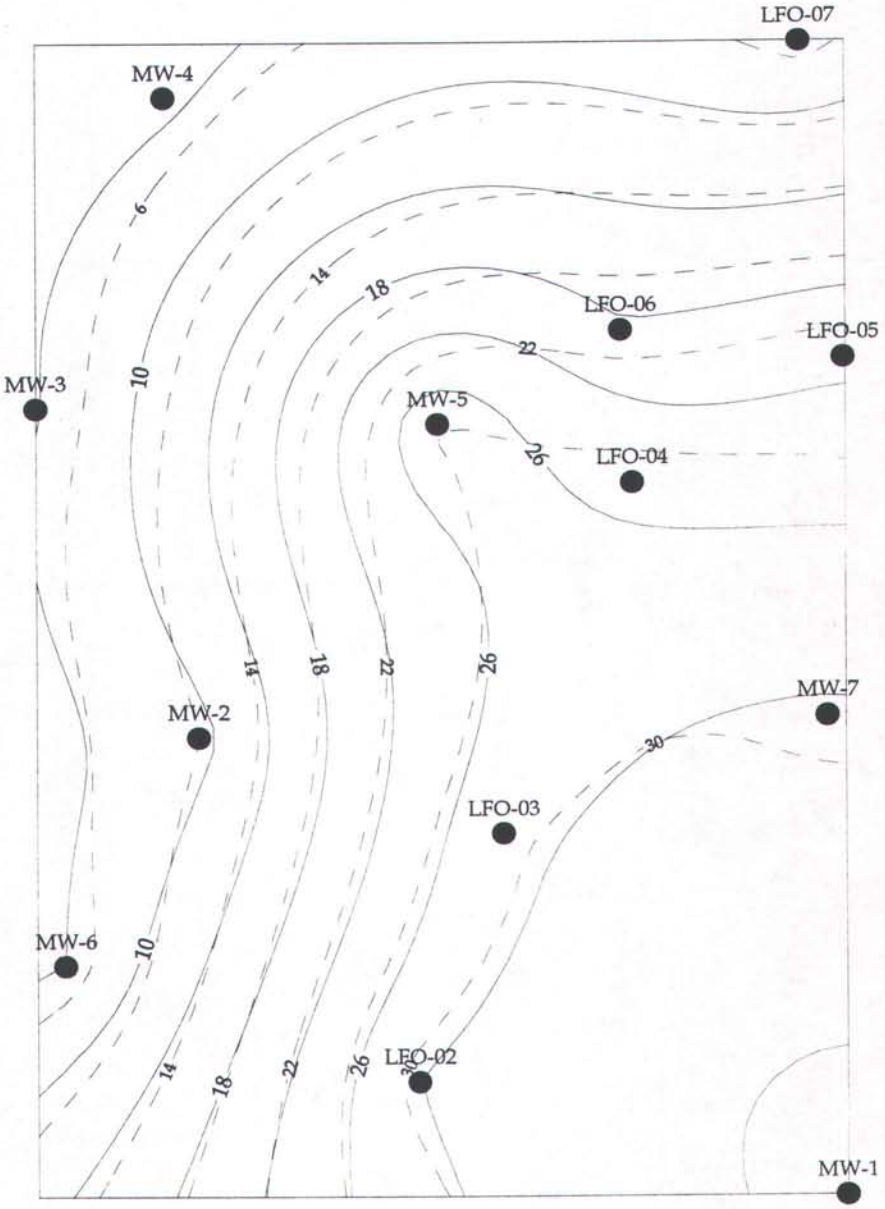


Modeled Water Level Residuals (feet)

RMT®

G:data:hydro:5101:model:doc:resid.srf

Figure 4
Weyerhaeuser - Plymouth, North Carolina



Qualitative Calibration Evaluation

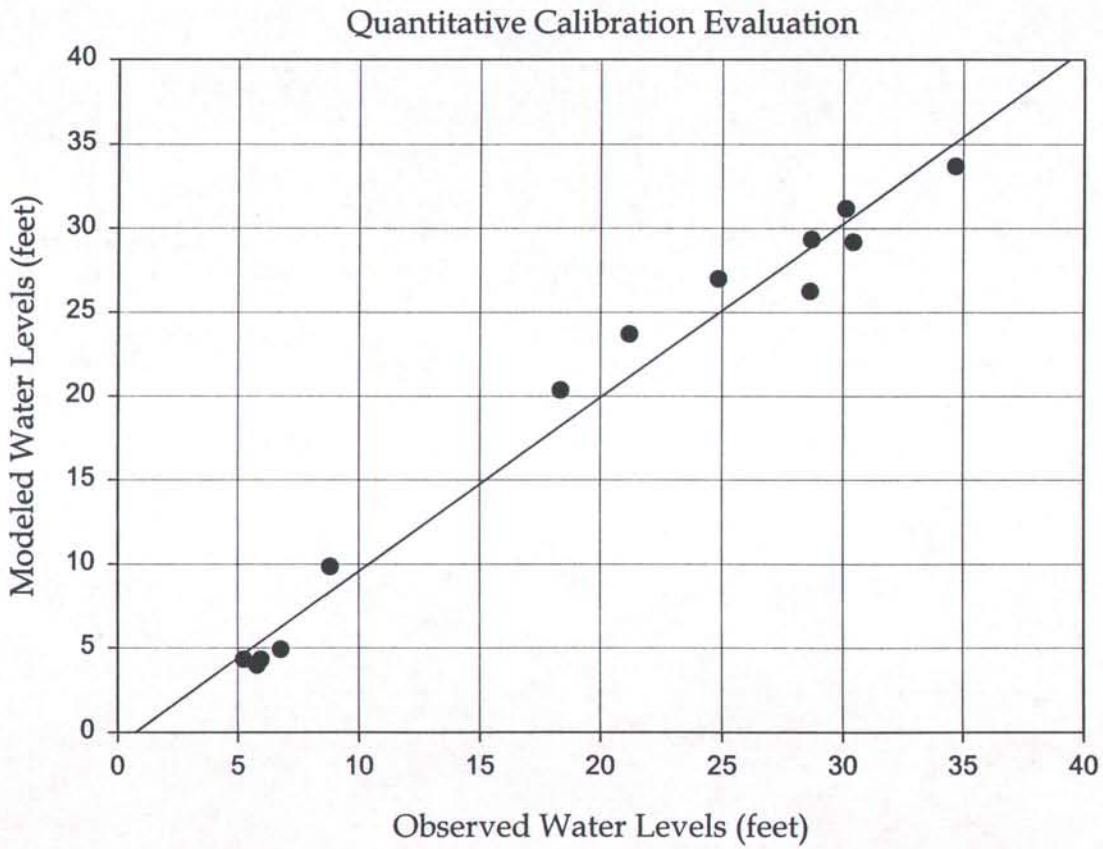
Modeled Water Levels

Observed Water Levels - April 1993

RMT®

G:data:hydro:5101:model:doc:comp.srf

Figure 5
Weyerhaeuser - Plymouth, NC



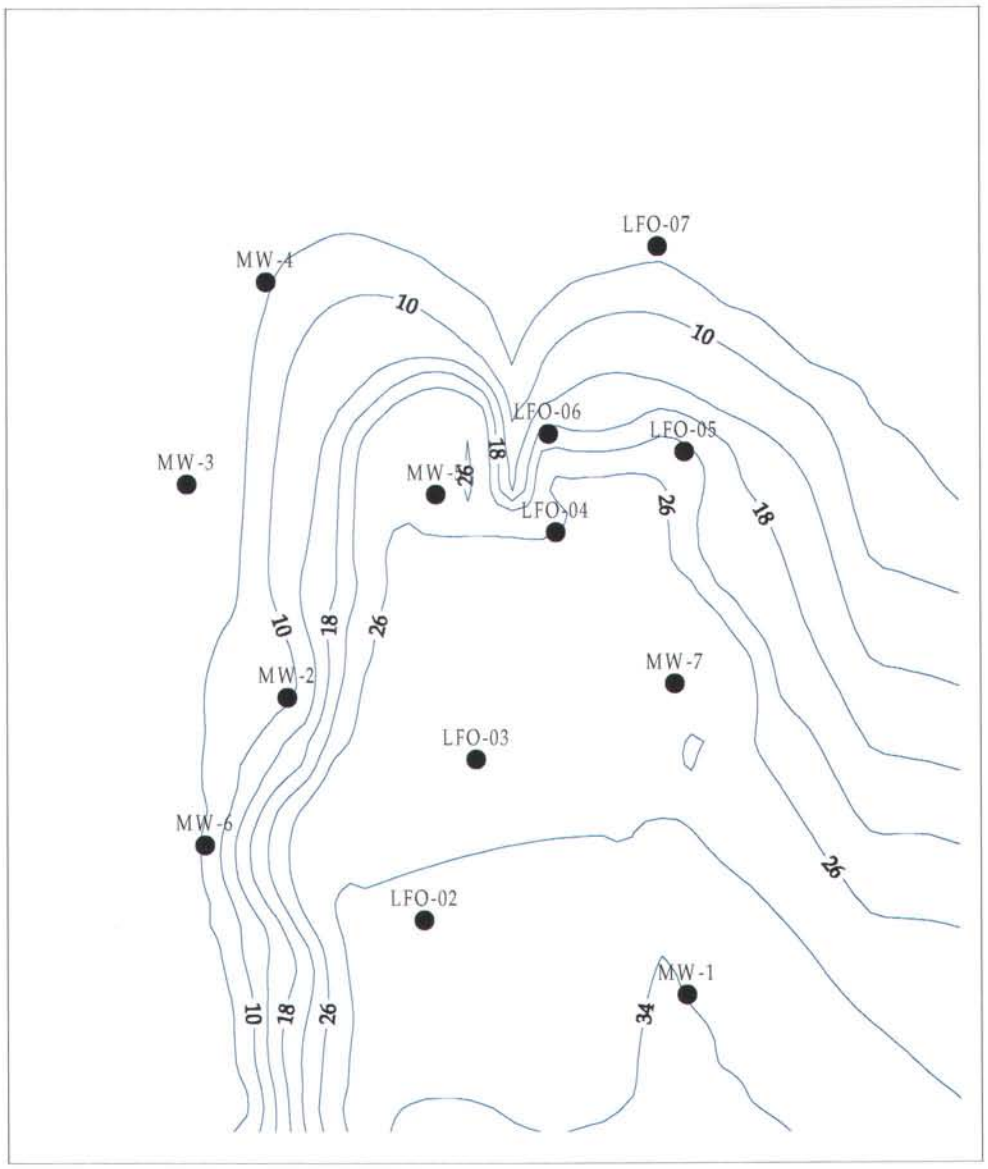
Correlation Coefficient 0.98
Mean Error 0.11 (ft)
Mean Absolute Error 1.56 (ft)
Root Mean Squared 1.66 (ft)

Table 1
Summary of Observed and Calculated Hydraulic Head

Well Number	Observed Head(1)	Calculated Head(1)	Residual(1)
LFO-2	30.1	31.15	-1.05
LFO-3	28.67	29.32	-0.65
LFO-4	24.83	26.99	-2.16
LFO-5	21.18	23.7	-2.52
LFO-6	18.35	20.35	-2
LFO-7	6.76	4.9	1.86
MW-1	34.67	33.66	1.01
MW-2	8.8	9.84	-1.04
MW-3	5.78	3.96	1.82
MW-4	5.24	4.31	0.93
MW-5	28.62	26.24	2.38
MW-6	5.94	4.32	1.62
MW-7	30.41	29.18	1.23
Minimum(1)			0.65
Maximum(1)			2.52
ME(1)			0.11
MAE(1)			1.56
RMS(1)			1.66

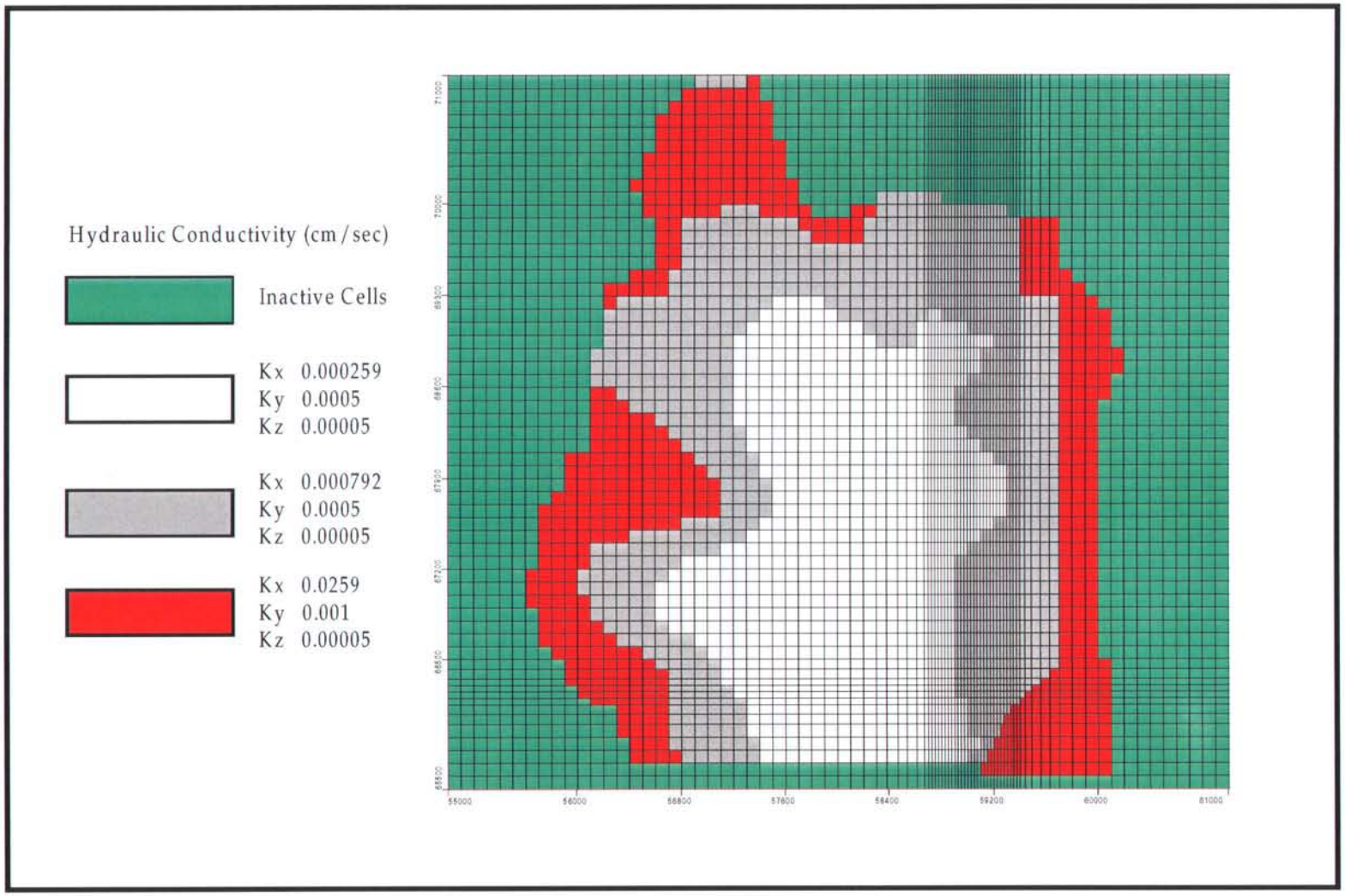
(1) measurement in feet

Figure 6
Weyerhaeuser - Plymouth, North Carolina



Modeled Water Table Configuration April 1993

Figure 7
Weyerhaeuser - Plymouth, NC

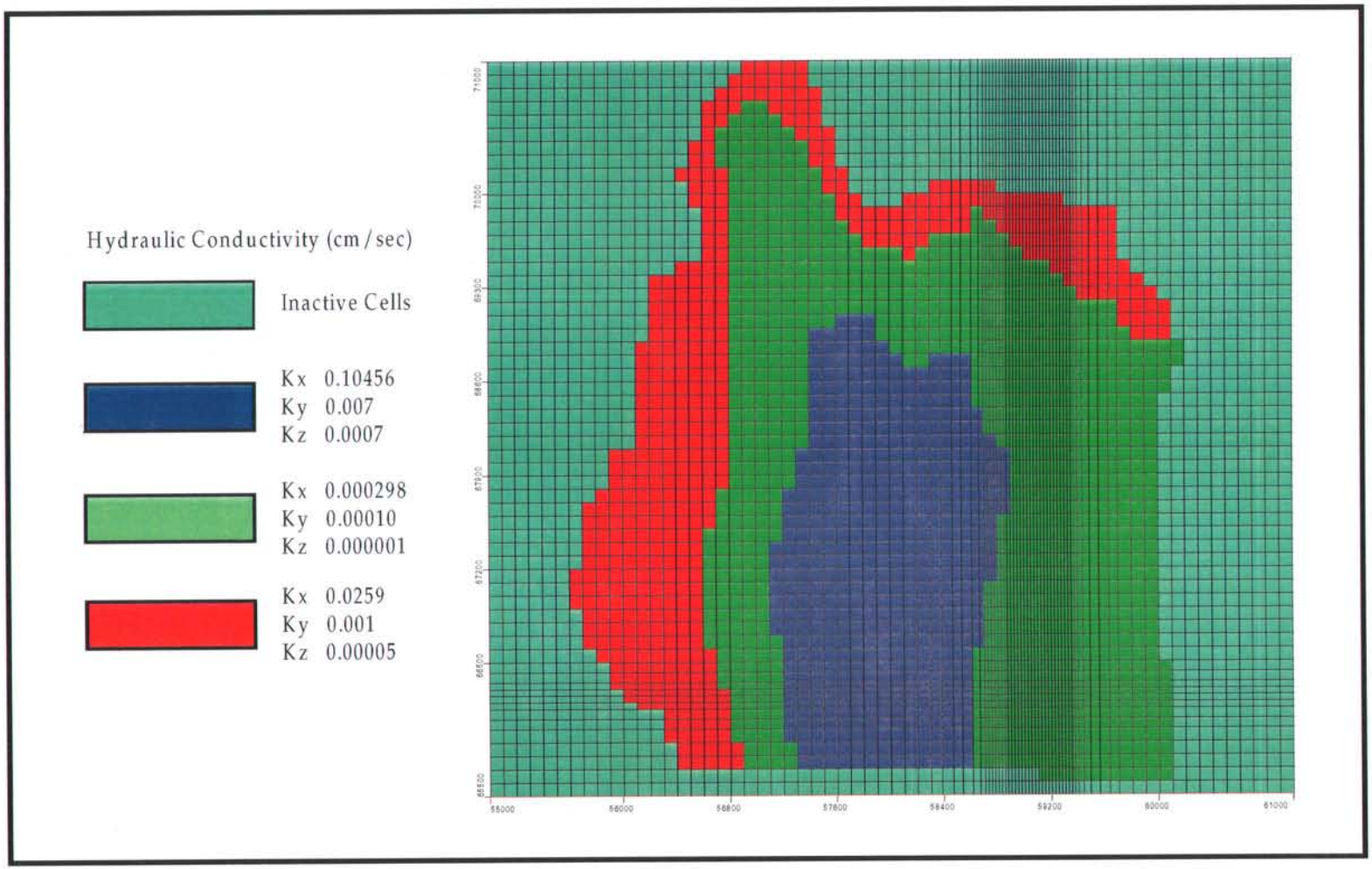


Hydraulic Conductivity Distribution
Layers 1to 3 (Silty and Clayey Sand)

RMT

G:data:hydro:5101:model:doc:hdrcon3a.srf

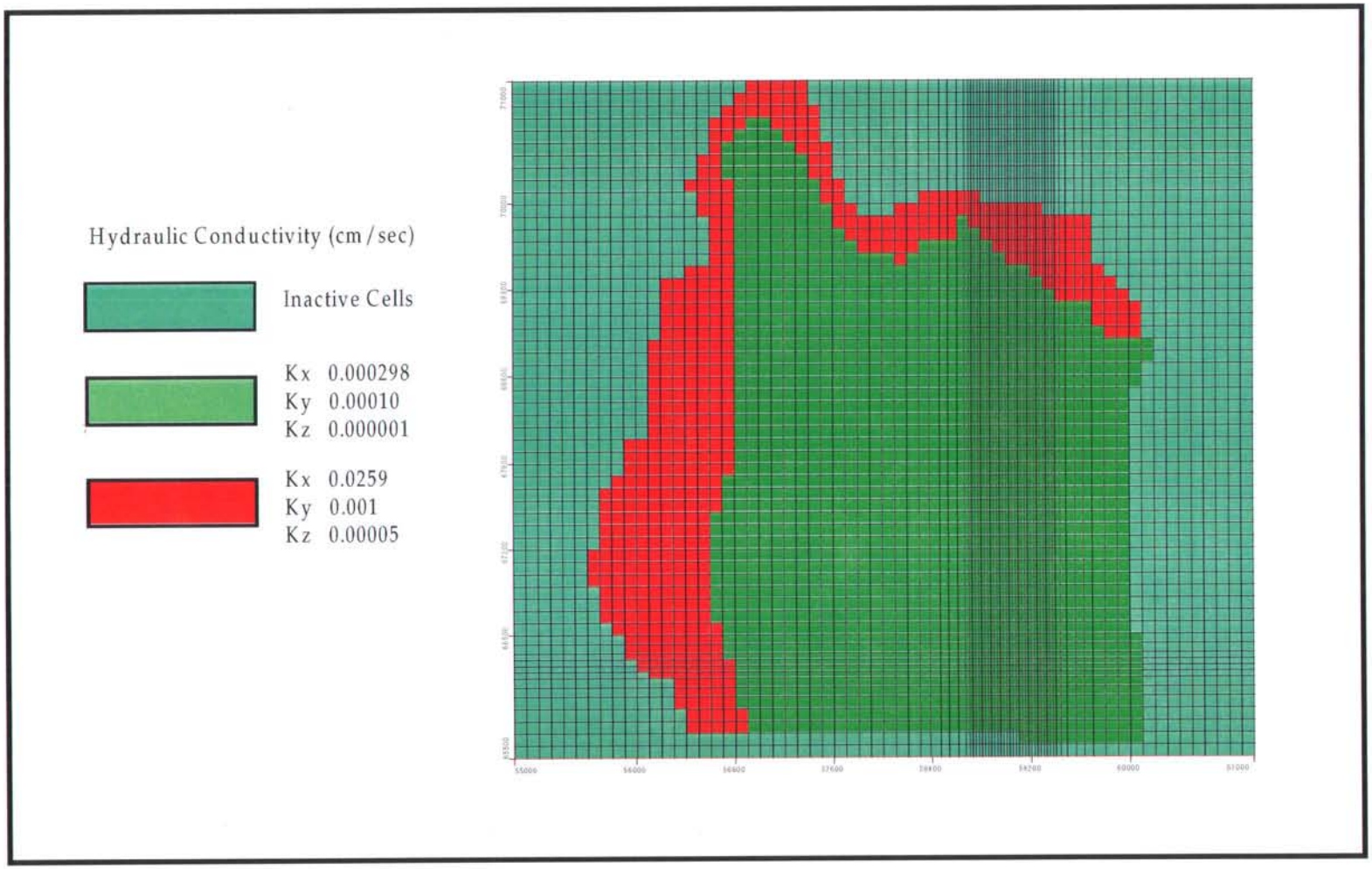
Figure 8
Weyerhaeuser - Plymouth, NC



Hydraulic Conductivity Distribution
Layer 4 (Silty Sand)

G:data:hydro:5101:model:doc:hdrcon4.srf

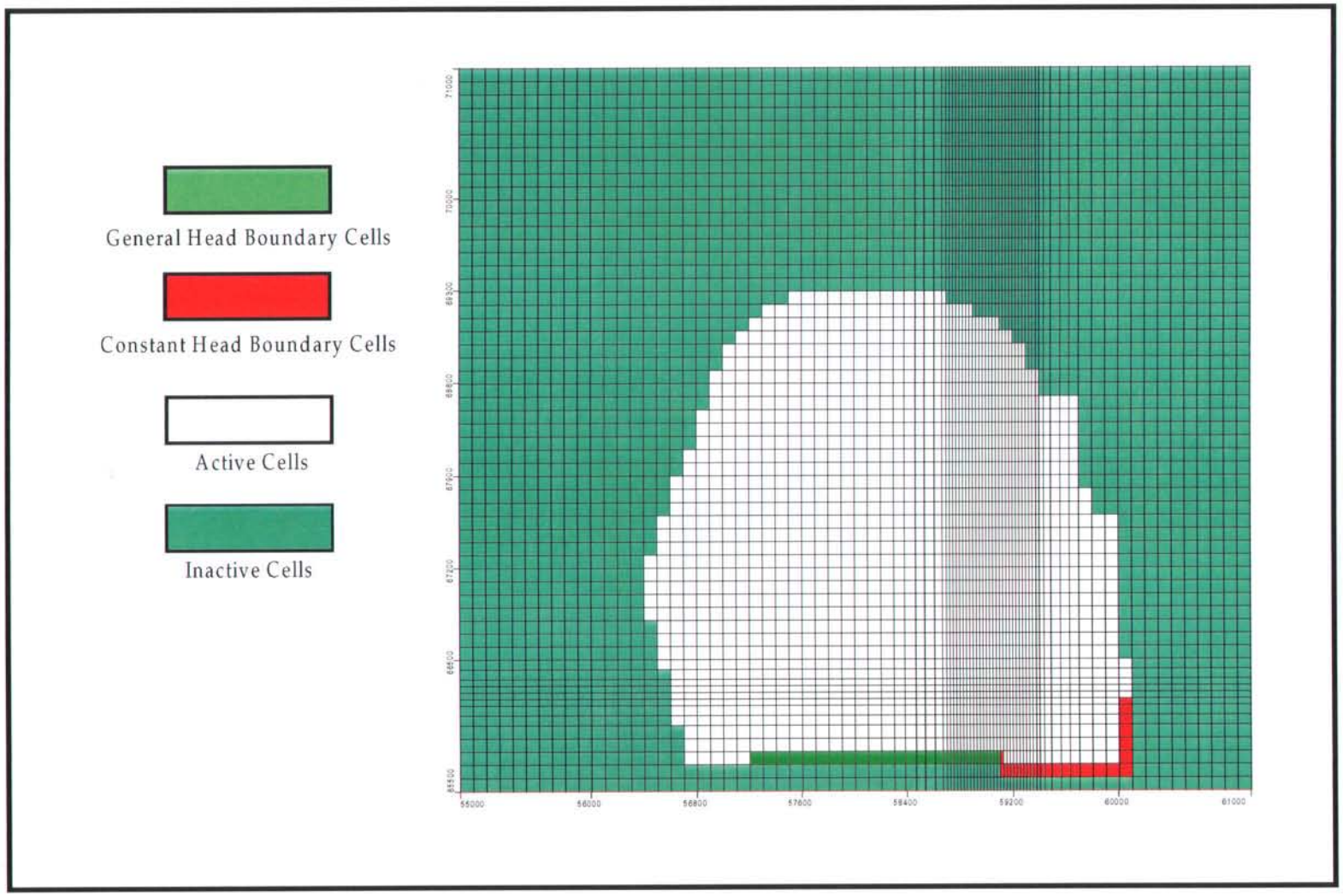
Figure 9
Weyerhaeuser - Plymouth, NC



Hydraulic Conductivity Distribution
Layer 5 (Silty Sand)

G:data:hydro:5101:model:doc:hdrcon5.srf

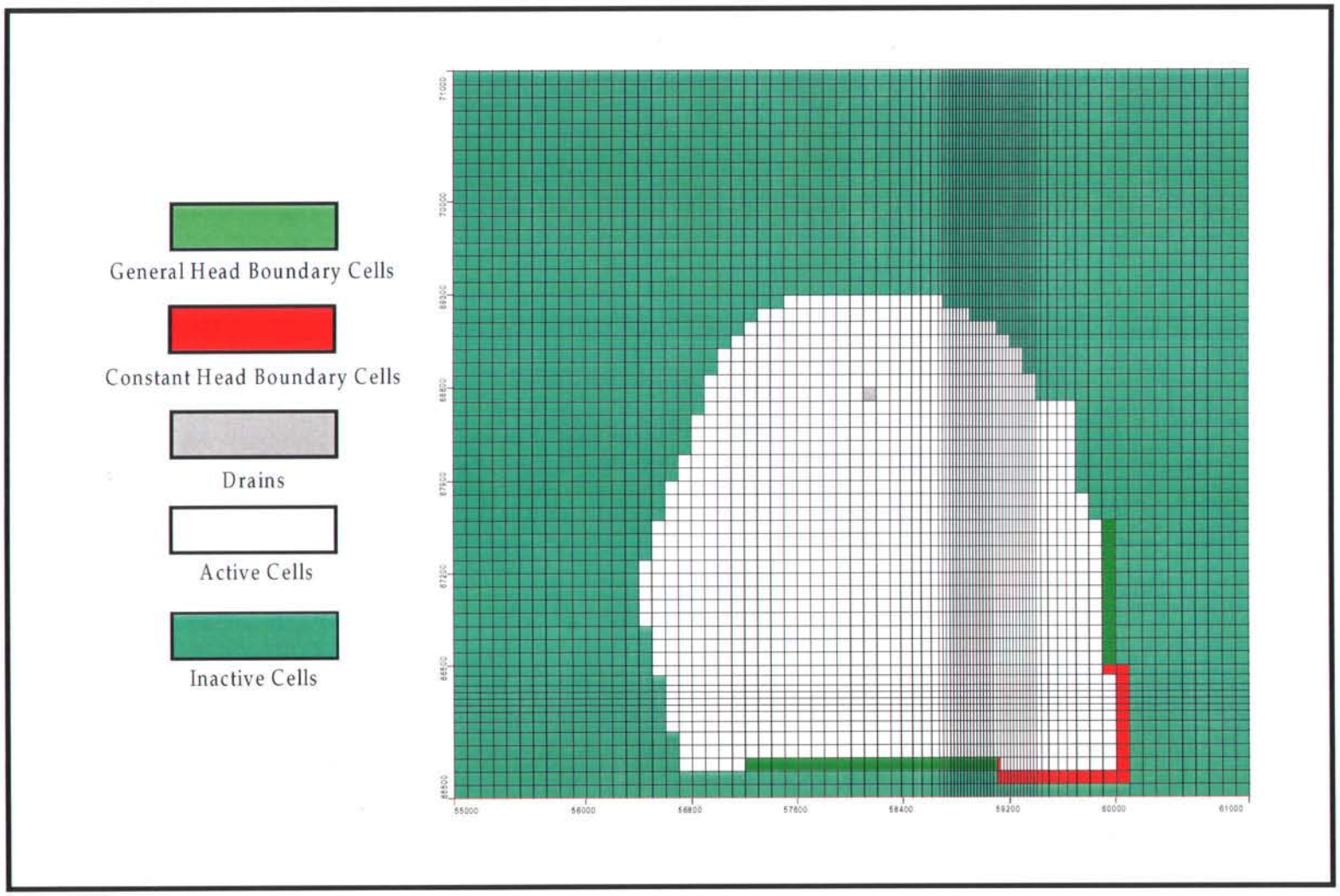
Figure 10
Weyerhaeuser - Plymouth, NC



Boundary Conditions
Layer 1

G:data:hydro:5101:model:doc:bdry1.srf

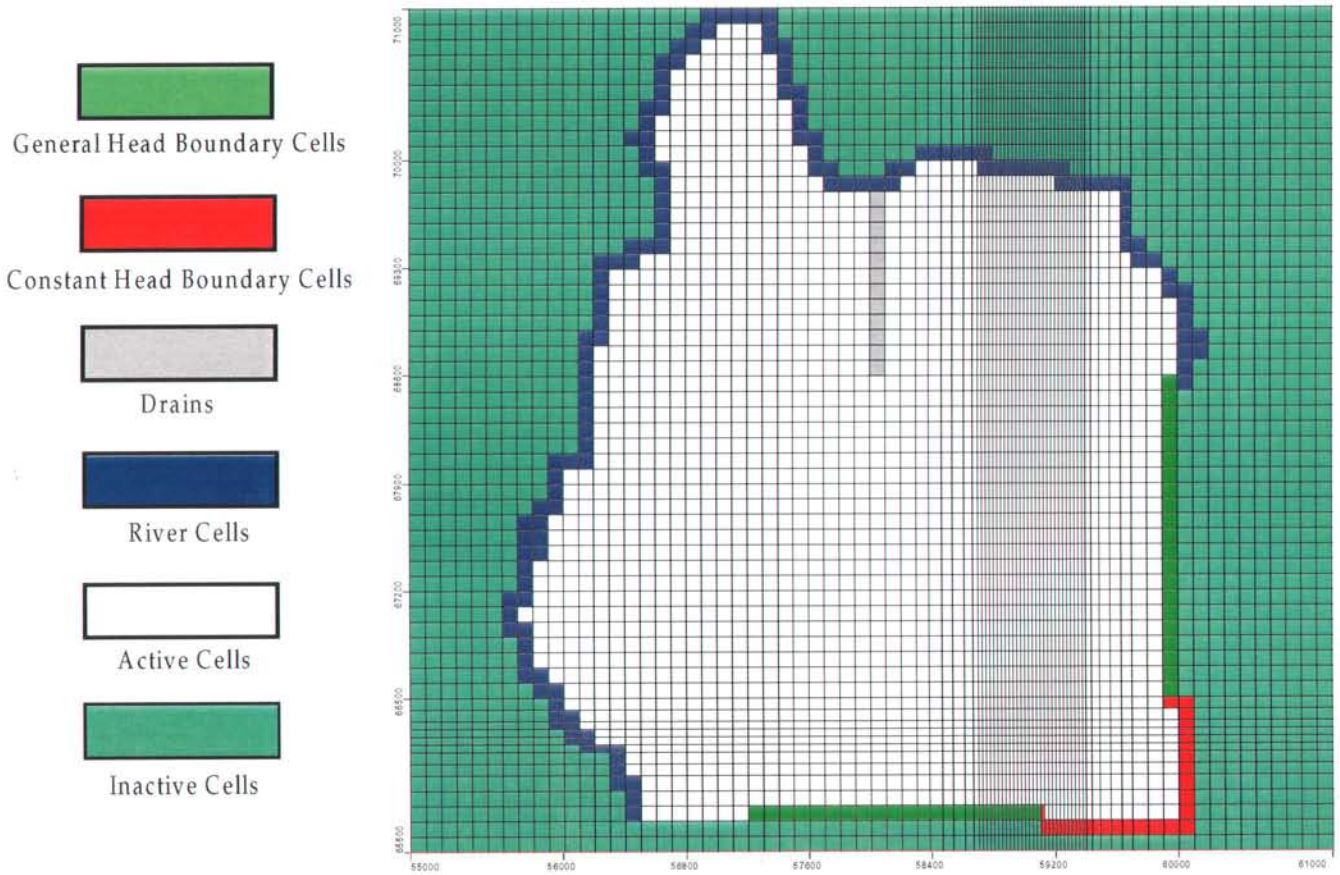
Figure 11
Weyerhaeuser - Plymouth, NC



Boundary Conditions
Layer 2

G:data:hydro:5101:model:doc:bdry2.srf

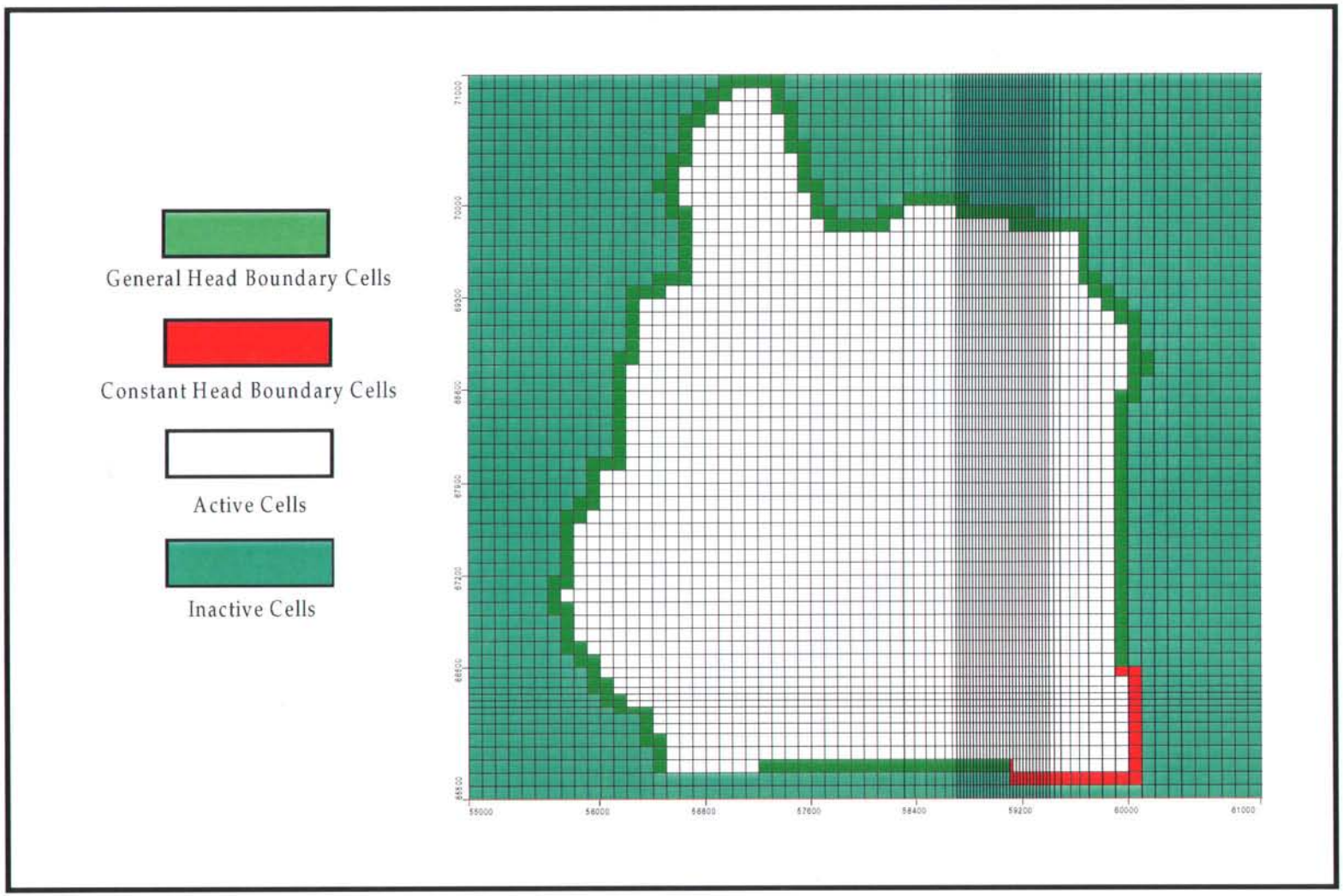
Figure 12
Weyerhaeuser - Plymouth, NC



Boundary Conditions
Layer 3

G:data:hydro:5101:model:doc:bdry3.srf

Figure 13
Weyerhaeuser - Plymouth, NC



Boundary Conditions
Layers 4 and 5

G:data:hydro:5101:model:doc:bdry5.srf

Table 2
Summary of General Head Boundary Conditions

Layer #	Description of Area	General Head feet		Conductance feet^2 per day
		Maximum	Minimum	
1	South	35	35	10
		35	35	22
		40	35	42
2	South	35	35	10
		35	35	22
		40	35	42
	East	26	16	42
3	South	35	35	10
		35	35	30
		40	35	42
	East	13	3	75
		24	24	42
		3	3	143

Table 2
Summary of General Head Boundary Conditions

Layer #	Description of Area	General Head feet		Conductance feet² per day
		Maximum	Minimum	
4	South	40	35	42
		35	35	30
		35	35	10
	East	27	15	42
		8	5	75
	Northeast	5	4	75
		3	3	115
		3	3	143
	North	4	3	75
	Northwest	3	3	134
		3	3	225
	West	3	3	500
	Southwest	3	3	500
5	South	40	35	42
		35	35	31
		35	35	10
	East	8	5	75
		7	15	42
	Northeast	5	4	75
		3	3	115
		3	3	143
	North	4	3	75
	Northwest	3	3	134
		3	3	225
	West	3	3	500
	Southwest	3	3	500

Table 3
Summary of River Boundary Conditions

Layer #	Description of Area	River Stage Elevation feet		River Bottom feet		Conductance feet² per day
		Maximum	Minimum	Maximum	Minimum	
3	Southwest	4	3.5	1	0.5	300
	West	3.5	3	0.5	-0.1	300
	Northwest	3	3	-0.1	-0.5	300
		3	3	-0.1	-0.2	200
		3	3	-0.4	-0.6	142
		2.5	2	-0.5	-0.1	342
		3.5	3	0.3	0	125
	North	3	4	0.4	1	125
	Northeast	5	4	2	1	125
		4	4	0.9	0.8	200

Table 4
Summary of Drain Boundary Conditions

Layer #	Description of Area	Drain Elevation feet		Conductance feet² per day
		Maximum	Minimum	
2	North	18	18	1000
3	North	10	2	1000

Section 3
Predictive Simulations

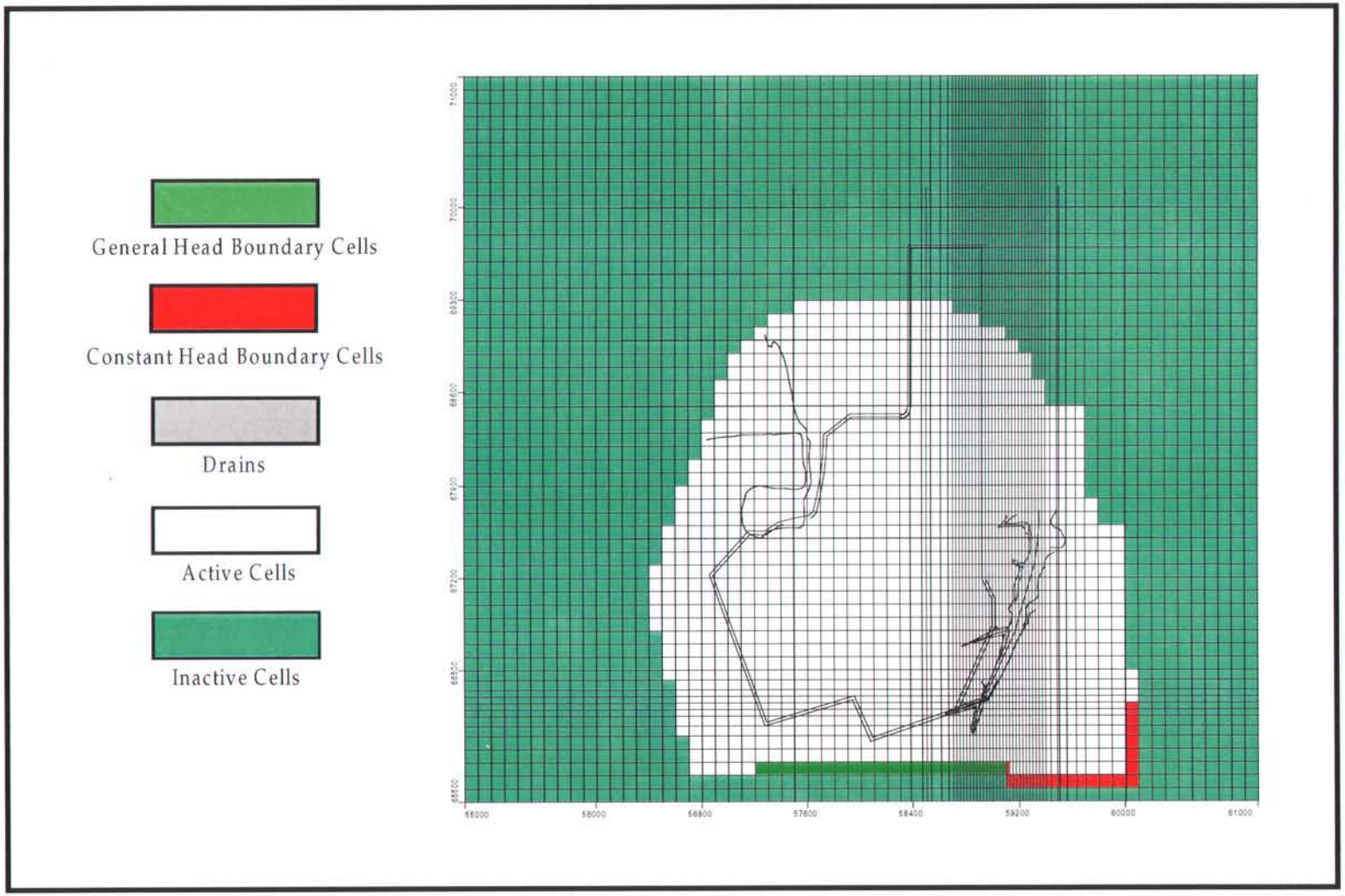
Following the calibration step in the modeling process, modifications to the model setup were made to reflect future site conditions. Future site conditions in the vicinity of proposed Landfill No. 3 consist of drainage restoration along the southeast side of the proposed landfill.

The drainage restoration conducted in the spring of 1999 was represented in the model using drain boundary conditions. This type of boundary allows groundwater to be removed from the model when water levels in the adjacent model cells are greater than the drain bottom elevation. This boundary condition assignment does not allow water to move from drain cells back into adjacent model cells under any circumstance. The drain bottom elevations assigned in the model range from 34 feet to 22 feet, based on the actual construction details of the drainage ditch. The conductance values assigned to the drain cells range from 35 ft^2/day to 142 ft^2/day depending on the size of the given cell. The drain conductance was assigned based on the following assumptions: 1) groundwater enters the ditch over a 10-foot wide surface area across the ditch; 2) the thickness of drain materials is a uniform 2 feet over the length of the ditch; and 3) the hydraulic conductivity of drain materials is 1×10^{-4} cm/sec. The drain boundary conditions for Layer 1 and Layer 2 are illustrated in Figures 14 and 15.

The results from the predictive groundwater simulations demonstrate that the long-term water table configuration will be lowered up to 6 feet in the immediate vicinity of the drainage enhancements. The long-term configuration of the water table will also exhibit a 0.5-foot depression over 1,000 feet wide and over 1,900 feet long based on the groundwater modeling. The decrease in modeled water levels resulting from the drainage enhancements is illustrated in Figure 16. The modeled water table configuration, resulting from drainage enhancements, is illustrated in Figure 17. Figure 18 illustrates the modeled water table configuration before and after drainage enhancements, as a three-dimensional surface.

Based on the current model setup, the long-term water table configuration resulting from drainage restoration can be significantly lowered along the southeast side of proposed Landfill No 3. By lowering the water table, the design capacity of the landfill can be increased and fill requirements can be reduced.

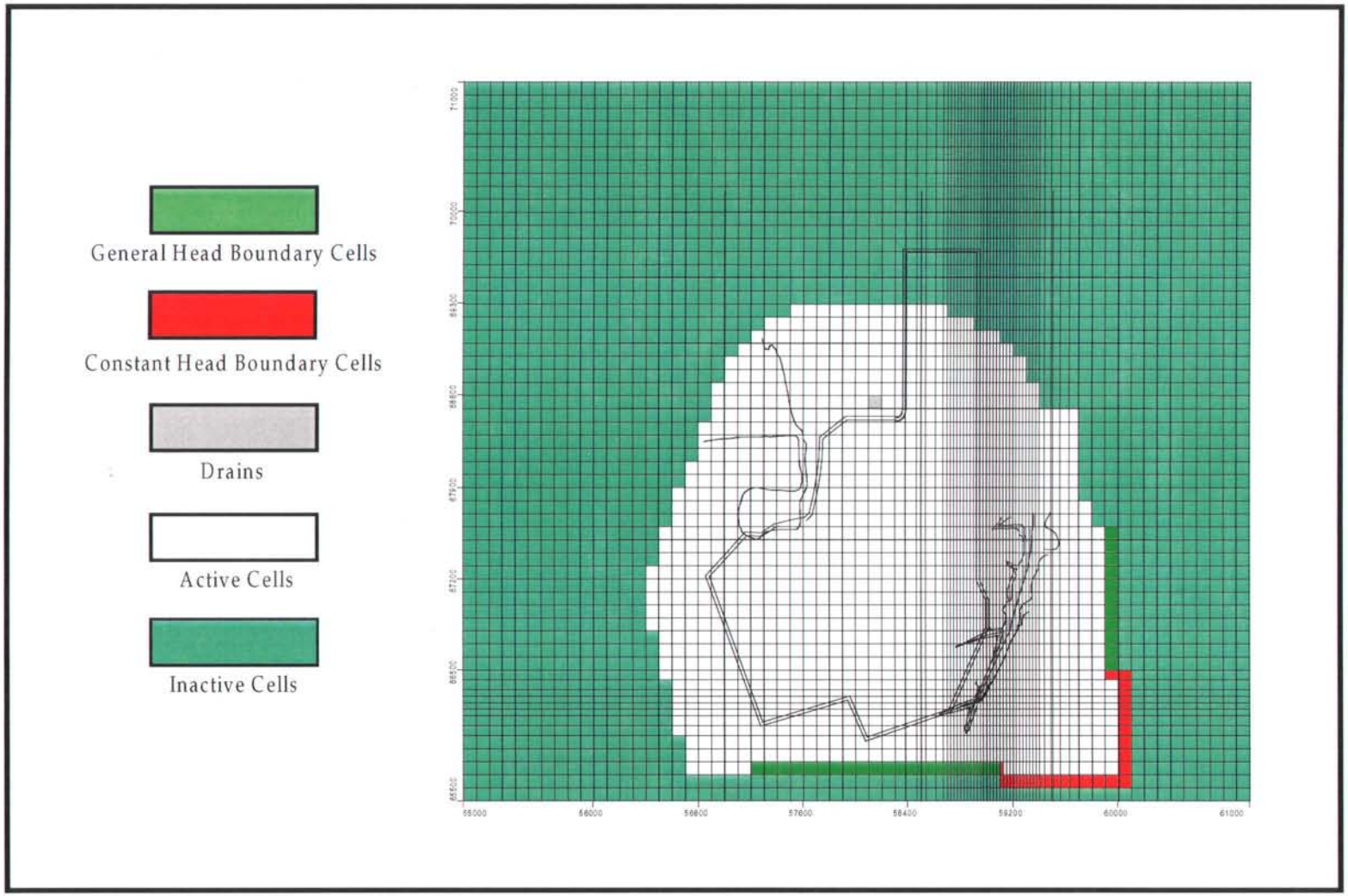
Figure 14
Weyerhaeuser - Plymouth, NC



Drainage Enhancements
Layer 1

G:data:hydro:5101:model:doc:drn1.srf

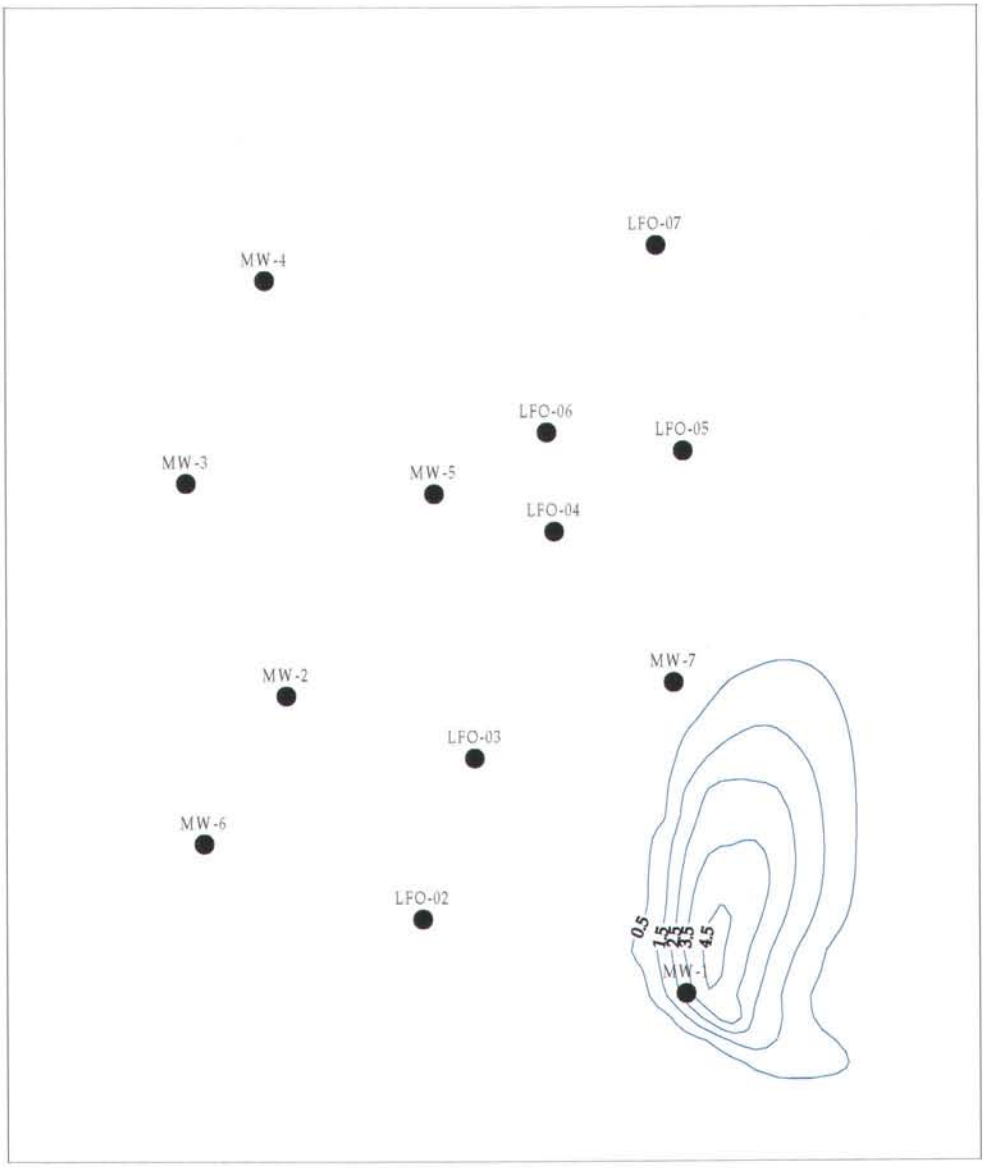
Figure 15
Weyerhaeuser - Plymouth, NC



Drainage Enhancements
Layer 2

G:data:hydro:5101:model:doc:drn2.srf

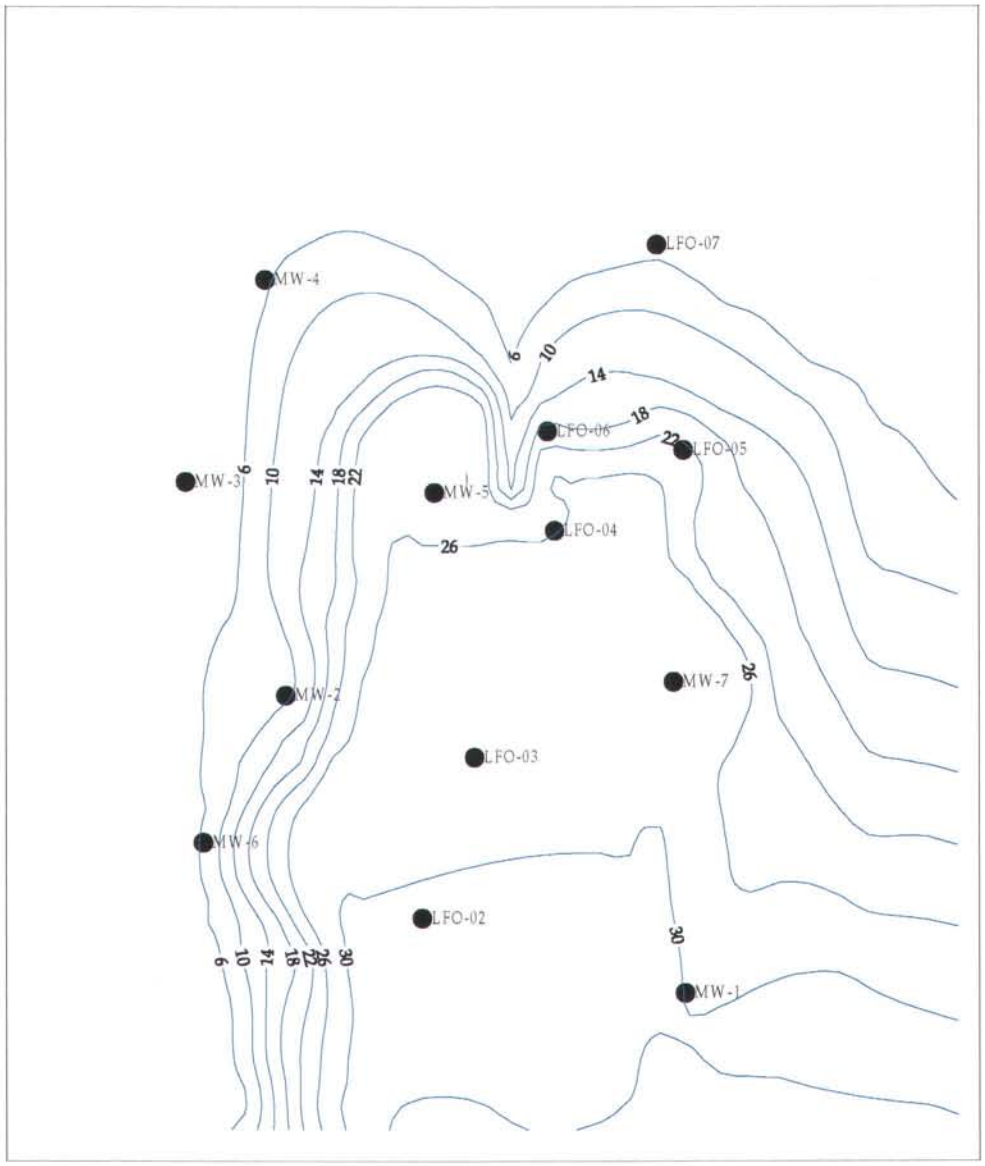
Figure 16
Weyerhaeuser - Plymouth, North Carolina



Drawdown Resulting From Drainage Enhancements

G:data:hydro:5101:model:doc:drwdn.srf

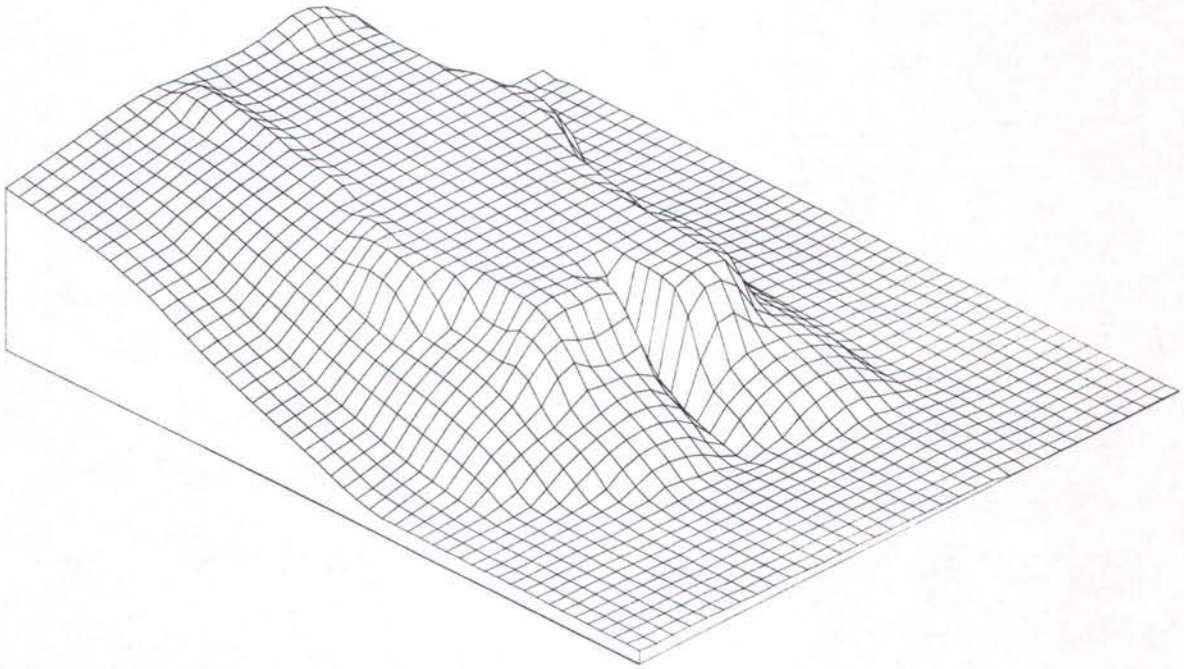
Figure 17
Weyerhaeuser - Plymouth, North Carolina



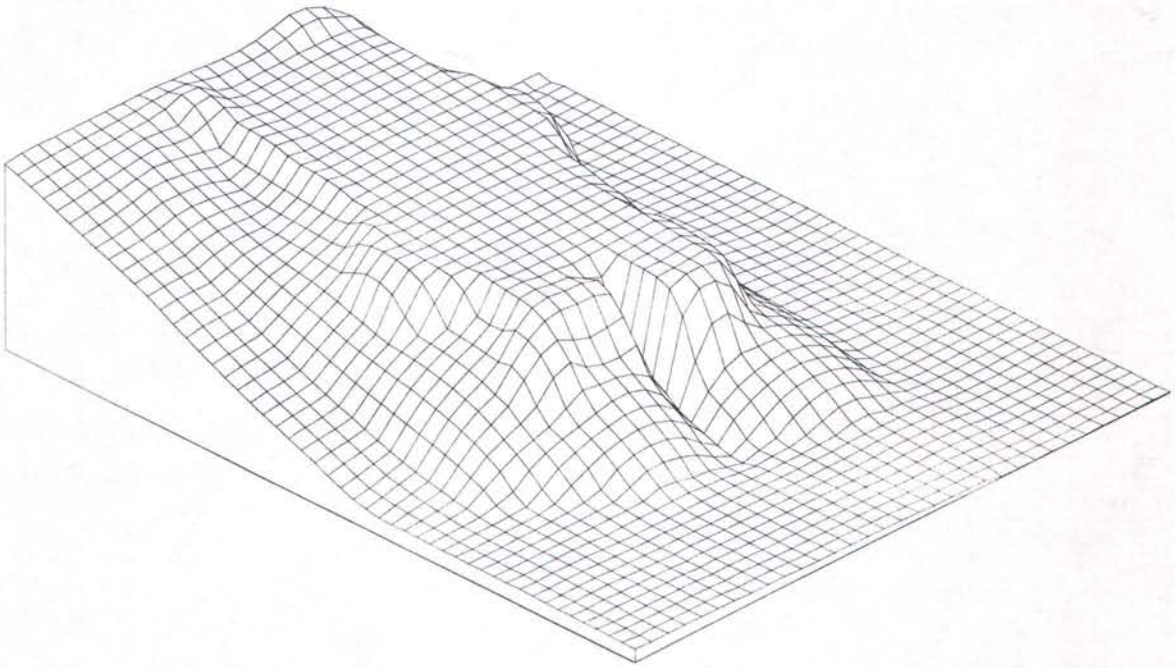
Predictive Water Table Configuration With Drainage Enhancements

G:data:hydro:5101:model:doc:pred1ml.srf

Figure 18
Weyerhaeuser - Plymouth, North Carolina



Modeled Water Table Configuration



Modeled Water Table Configuration With Drainage Enhancements)

RMT®

Appendix G
Water and Mass Balance Calculations

Attachment G1	**Landfill Cover and Liner Design Evaluation**
Attachment G2	**HELP Model Data**
Attachment G3	**Projected Leachate Generation Rates**
Attachment G4	**Mass Balance Calculations for Liner Design of Landfill No. 3 Technical Memorandum dated September 27, 1999 (including Responses to NC DENR letter dated April 29, 1999)**

Attachment G1
Water Balance Calculations

Landfill Cover and Liner Design Evaluation

Introduction

The purpose of this report is to evaluate the cover and liner design in combination with site-specific climatological information to estimate the following average annual quantities:

- Precipitation
- Runoff
- Evapotranspiration
- Percolation
- Lateral drainage
- Head on the liner
- Percolation through the liner

Methods

To evaluate the design, the HELP model was used. The HELP model was developed by the US Army Engineer Waterways Experiment Station in Vicksburg, Mississippi (Schroeder, *et al.*, 1989, Volume 3) to estimate the surface runoff, subsurface drainage, and leachate from various solid waste disposal facility designs. These calculated amounts are simulated by interpreting the combined effects of precipitation, surface storage, runoff, infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage.

The HELP model contains a number of inherent assumptions, which need to be considered when interpreting the calculated values for runoff, drainage, and infiltration for a landfill design. These include the following:

1. Four types of layers can be used: a vertical percolation layer, a lateral drainage layer, a barrier soil layer, and a barrier soil with a geomembrane layer.
2. The top layer may not be a geomembrane liner.
3. Lateral drainage is not permitted from a vertical percolation layer. The maximum drainage slope is 10 percent.
4. The profile can contain no more than a total of five barrier soil liners and geomembrane liners.
5. Both vertical and lateral drainage are permitted from a lateral drainage layer.
6. The top layer of the cover cannot be a barrier soil (compacted clay).

7. A barrier soil layer may not be placed adjacent to another barrier soil layer, and a geomembrane may not be placed adjacent to another geomembrane.
8. A geomembrane may not be placed directly between two barrier soil liners, and a barrier soil liner may not be placed directly between two geomembranes.
9. When a barrier soil layer or geomembrane liner is not placed directly below the lowest drainage layer, all drainage layers below the lowest liner are treated as vertical percolation layers. Thus, no lateral drainage is computed for the bottom section of the landfill.
10. Only a barrier soil or another lateral drainage layer may be placed directly below a lateral drainage layer.
11. Cover runoff is computed by using the Soil Conservation Service Runoff Curve Number method. Unless this number is manually input, the model does not consider surface slope and roughness of infiltration into the computation.
12. Percolation is modeled using Darcy's Law for saturated flow. Lateral drainage is modeled using a linearized Boussinesq equation. Evapotranspiration is modeled using a modification of the Penman method (Schroeder *et al.*, 1981).

Climatologic data can be entered using one of the following three options:

- A default precipitation option
- A manual precipitation option
- A synthetic precipitation option, with a user input option

The program can generate a synthetic daily precipitation and temperature record for 1 to 20 years for any of 139 cities. The synthetic precipitation and temperature data will have approximately the same statistical characteristics as the historical data at the selected location. For this analysis, historical data for Norfolk, Virginia, were combined with 29 years (1951 to 1980) of monthly mean precipitation and temperatures for Plymouth, North Carolina, using the synthetic option with user input override to generate data. Norfolk, Virginia, is also in a coastal plain and has a climate similar to Plymouth, North Carolina.

Daily solar radiation data were also generated based on historical data from Norfolk, Virginia, and the latitude for Plymouth, North Carolina. The climatological data for Plymouth, North Carolina, is attached.

The user must enter a maximum value of leaf area index for the vegetative cover. Leaf area index is defined as the dimensionless ratio of the leaf area of actively transpiring vegetation to the nominal surface area of the land on which the vegetation is growing. For this analysis, a maximum leaf area index of zero was used for the open landfill analysis and a maximum leaf area index of two was used for post-closure. Two is a typical value provided by the program for a fair stand of grass in the Norfolk, Virginia, area.

The closed facility will consist of nine distinct layers:

1. Vegetative layer
2. Geocomposite Drainage Layer
3. Textured 40-mil VFPE Geomembrane
4. GCL
5. Waste Material
6. Graded granular filter (6 inches of sand)
7. Lateral drainage layer (12 inches of crushed stone overlying a geocushion)
8. Textured 60-mil HDPE Geomembrane
9. GCL

The open facility will consist of five distinct layers:

1. Waste Material
2. Graded granular filter (6 inches of sand)
3. Lateral drainage layer (12 inches of crushed stone overlying a geocushion)
4. Textured 60-mil HDPE Geomembrane
5. GCL

The user must also specify an evaporative zone depth. This is the maximum depth from which water may be removed from the soil by evapotranspiration. Where surface vegetation is present (post-closure conditions), the evaporative depth should at least equal the expected average depth of root penetration. Although an evaporative depth of 22 inches is recommended for a fair stand of grass in the Norfolk area, the evaporative depth was limited to 18 inches since the depth to the top of the barrier layer is 18 inches. Where surface vegetation is not present (open landfill), the evaporative depth of 8 to 18 inches is recommended for silt size soil. Therefore, an evaporative depth of 13 inches was used for the open landfill conditions.

The program allows the characteristics of each layer in the design to be entered in one of two ways. The user can choose to select default characteristic values by assigning a soil texture class number to each layer. When this method is chosen, the program provides values for each layer for porosity, wilting point, field capacity, and hydraulic conductivity. Default characteristic values were used for the various cap and liner components since no testing was performed to determine the specific values. See Table 4 from the HELP Model User's Guide for specific Default Soil, Waste, and Geosynthetic Characteristic values. The following characteristic numbers were selected to represent various components of the liner and cap.

COMPONENT	HELP DEFAULT CHARACTERISTIC #
Vegetative Layer	4
Geocomposite Drainage Layer	20
Geomembrane	35
GCL	17
Graded Granular Filter (sand)	2
Lateral Drainage Layer (crushed stone)	21

"Soil" characteristic data for the waste was entered manually when a waste layer was considered. The porosity, hydraulic conductivity, and initial moisture content were based on RMT test data, and the wilting point and field capacity were estimated.

The geomembrane was modeled with 8 pinholes per acre of installation defects and 1 pinhole per acre of manufacturing defects per NC DENR recommendations per correspondence dated April 29, 1999 (Appendix F). The open landfill was modeled for the maximum percolation/leakage rate through the liner by not allowing for any runoff. This is a conservative assumption, since the waste material will be sloped to drain according recommendations to the operation plan. The open landfill was modeled with 2 feet, 4 feet, 41 feet, 81 feet, and 181 feet of waste. The cap of the closed landfill with vegetative cover over 181 feet of waste was modeled along the side and on top of the landfill.

The majority of the waste will consist of relatively dry ash. Based on Weyerhaeuser's experience with this material at their existing facility, significant pore water release is not anticipated. Therefore, it was not included in the projected leachate generation rates. Temporary stormwater controls recommended in the Operating Plan will also limit the quantity of leachate generated.

Conclusions

The HELP Model evaluation indicates that the cover and liner design in combination with site-specific climatological data will produce the following quantities for the top and side of the landfill.

Average Annual Totals of Closed Landfill in Inches per Acre

DESCRIPTION	TOP OF LANDFILL	SIDE OF LANDFILL
Precipitation	52.35	52.35
Runoff	0.189	0.189
Evapotranspiration	7.205	7.668
Lateral drainage through the geonet	44.955	44.491
Percolation through the cover	0	0
Lateral drainage through the granular drainage layer	0	0
Percolation through the liner	0	0

The HELP Model evaluation indicates that the liner design in combination with site-specific climatological data will produce the following quantities for various waste thickness.

Average Annual Totals of Open Landfill in Inches per Acre

DESCRIPTION	2' WASTE	4' WASTE	41'WASTE	81' WASTE	181' WASTE
Precipitation	52.35	52.35	52.35	52.35	52.35
Runoff	0	0	0	0	0
Evapotranspiration	31.46	31.46	31.46	31.46	31.46
Lateral drainage through the granular drainage layer	20.58	20.60	20.32	19.34	16.75
Percolation through the liner	0.00006	0.00005	0.00005	0.00004	0.00003

Attachment G2
HELP Model Data

The following parameters were input in to the HELP model for the Open Landfill condition with only two feet of waste in the landfill:

Description	Parameter Used:
AREA OF LANDFILL	1 acre
LANDFILL CONDITION	open
PERCENTAGE OF AREA WHERE RUNOFF IS POSSIBLE	0 percent (conservative assumption)
EVAPORATIVE ZONE DEPTH	13 inches (recommended by HELP for silt size particles without vegetation)
MAXIMUM LEAF AREA INDEX FOR VEGETATIVE COVER	0 (bare ground)
START OF GROWING SEASON (JULIAN DATE)	94 (user input for Plymouth, NC)
END OF GROWING SEASON (JULIAN DATE)	311 (user input for Plymouth, NC)
NUMBER OF YEARS FOR SYNTHETIC DATA GENERATION	20 years
PRECIPITATION INPUT	Synthetic---data entered manually for Plymouth, North Carolina
TEMPERATURE INPUT	Synthetic---data entered manually for Plymouth, North Carolina
SOLAR RADIATION INPUT	Synthetic---data entered manually for Plymouth, North Carolina
NEAREST CITY FOR DEFAULT INPUT	Norfolk, VA
DEPTH OF WASTE	2 feet (minimum thickness of waste placed – conservative assumption)
LEACHATE COLLECTION SYSTEM (LCS) BELOW WASTE	6 inches of sand 12 inches of crushed stone
FIRST LAYER OF COMPOSITE LINER	60-mil high density polyethylene (HDPE)
SECOND LAYER OF COMPOSITE LINER	geosynthetic clay liner (GCL)
SCS RUNOFF CURVE NUMBER	93 (newly graded area)

The following soil parameter data was input for this HELP model for the Open Landfill condition.

MATERIAL	THICK-NESS (inches)	SOIL TEXTURE	POROSITY	FIELD CAPACITY	WILTING POINT	INITIAL SOIL WATER CONTENT	EFFECTIVE SATURATED HYDRAULIC CONDUCT. (cm/sec)	SLOPE (%)	DRAIN LENGTH (feet)	FML PINHOLE DENSITY (holes/ac)	FML INSTALLA-TION DEFECTS (holes/ac)	FML PLACE-MENT QUALITY
WASTE	12	---	0.7630	0.2440	0.1360	0.2365	1.0E-05	---	---	---	---	---
WASTE	12	---	0.7630	0.2440	0.1360	0.6648	1.0E-05	---	---	---	---	---
LCS	6	2	0.4370	0.0620	0.0240	0.1752	5.8E-03	---	---	---	---	---
LCS	12	21	0.3970	0.0320	0.0130	0.0569	3.0E-01	2	100	---	---	---
FML	0.06	35	0	0	0	0	2.0E-13	---	---	1	8	3 – good
GCL	0.24	17	0.7500	0.7470	0.4000	0.7500	3.0E-09	---	---	---	---	---

This HELP model resulted in an average annual percolation or leakage rate through the bottom of the landfill of 0.205 cubic feet /acre/year. This was used in the mass balance calculations for the liner design.

CLIMATOGRAPHY OF THE UNITED STATES NO. 20

PLYMOUTH, NC

PERIOD: 1951-80
ELEVATION: 21 FT

CLIMATOLOGICAL SUMMARY

	TEMPERATURE (F)															PRECIPITATION TOTALS (INCHES)											
	MEANS			EXTREMES						MEAN NUMBER OF DAYS				DEGREE DAYS		*	*					SNOW			MEAN NUMBER OF DAYS		
										MAX		MIN															
	* DAILY MAXIMUM	* DAILY MINIMUM	* MONTHLY	RECORD HIGHEST	YEAR	DAY	RECORD LOWEST	YEAR	DAY	90 AND ABOVE	32 AND BELOW	32 AND BELOW	0 AND BELOW	* HEATING BASE 65	* COOLING BASE 65	MEAN	GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	DAY	MEAN	MAXIMUM MONTHLY	YEAR	.10 OR MORE	.50 OR MORE	1.00 OR MORE
JAN	53.5	30.7	42.1	80+	52	27	1+	62	13	0	1	18	0	710	0	4.17	9.02	60	5.10	60	31	1.6	7.5	65	7	3	1
FEB	55.7	32.1	43.9	84+	62	28	4+	79	10	0	0	16	0	591	0	3.98	6.80	61	2.36	71	23	1.9	11.5	80	7	3	1
MAR	63.3	38.5	50.9	89+	74	8	16+	80	4	0	0	10	0	445	8	4.18	6.63	80	2.45	68	13	1.1	15.0	80	7	3	1
APR	73.9	46.6	60.3	95+	60	26	25+	73	12	1	0	2	0	156	15	3.14	5.60	59	2.86	75	15	.0	.0		6	2	1
MAY	80.2	55.2	67.7	95+	64	20	31+	54	11	3	0	0	0	34	118	4.66	11.12	66	4.05	77	24	.0	.0		8	3	1
JUN	86.1	62.5	74.3	102+	54	27	42+	65	5	10	0	0	0	0	279	4.53	13.07	62	4.17	62	30	.0	.0		7	3	1
JUL	89.1	66.9	78.0	102+	52	22	47+	72	8	15	0	0	0	0	403	6.30	14.95	65	4.22	65	05	.0	.0		9	4	2
AUG	88.2	66.4	77.3	100+	80	6	39	65	31	13	0	0	0	0	381	5.85	13.42	55	5.04	55	12	.0	0		7	4	2
SEP	83.2	60.8	72.0	98+	80	7	36	51	30	5	0	0	0	7	217	4.62	11.97	55	5.20	55	19	.0	0		6	3	1
OCT	73.6	49.4	61.5	95	54	6	21+	62	26	0	0	2	0	147	39	3.35	11.52	71	4.20	64	05	.0	0		5	2	1
NOV	65.0	39.7	52.4	87+	74	3	14	51	21	0	0	8	0	378	0	3.10	6.64	77	4.17	69	03	.0	5	55	5	2	1
DEC	56.5	32.7	44.6	82+	78	9	5+	58	16	0	0	17	0	632	0	3.32	7.81	73	3.12	64	27	.6	12.0	58	6	3	1
YEAR	72.4	48.5	60.4	102	JUL 52	22	1	JAN 62	13	47	1	73	0	3100	1460	51.20	14.95	JUL 65	5.20	SEP 55	19	5.2	15.0	MAR 80	80	35	14

*FROM 1951-80 NORMALS

ESTIMATED VALUE BASED ON DATA FROM SURROUNDING STATIONS

+ ALSO ON EARLIER DATES.

DEGREE DAYS TO SELECTED BASE TEMPERATURES (F)

BASE	HEATING DEGREE DAYS												
BELOW	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
65	710	591	445	156	34	0	0	0	7	147	378	632	3100
60	562	459	305	61	6	0	0	0	0	64	240	486	2183
57	475	381	232	25	0	0	0	0	0	29	167	400	1709
55	419	332	190	12	0	0	0	0	0	17	127	345	1442
50	290	222	107	0	0	0	0	0	0	0	51	226	896

BASE	COOLING DEGREE DAYS												
ABOVE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
55	19	21	63	171	394	579	713	691	510	218	49	23	3451
57	13	14	43	124	332	519	651	629	450	169	29	15	2988
60	7	8	23	70	244	429	558	536	360	110	12	8	2365
65	0	0	8	15	118	279	403	381	217	39	0	0	1460
70	0	0	0	0	38	145	248	226	100	9	0	0	766

DERIVED FROM THE 1951-80 MONTHLY NORMALS

PROBABILITY THAT THE MONTHLY PRECIPITATION WILL BE EQUAL TO OR LESS THAN THE INDICATED PRECIPITATION AMOUNT

MONTHLY PRECIPITATION (INCHES)

PROBABILITY LEVELS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
.05	1.40	1.56	1.99	1.25	1.26	1.29	2.04	1.07	1.19	.50	.69	1.12
.10	1.80	1.92	2.35	1.54	1.70	1.72	2.64	1.59	1.63	.78	.98	1.43
.20	2.37	2.45	2.84	1.95	2.38	2.37	3.52	2.45	2.30	1.26	1.43	1.89
.30	2.86	2.89	3.25	2.29	2.97	2.94	4.27	3.24	2.89	1.73	1.84	2.28
.40	3.33	3.30	3.62	2.62	3.55	3.49	5.00	4.05	3.47	2.21	2.25	2.65
.50	3.82	3.72	3.99	2.94	4.15	4.06	5.75	4.93	4.09	2.74	2.68	3.04
.60	4.35	4.17	4.39	3.29	4.82	4.70	6.57	5.92	4.77	3.35	3.17	3.46
.70	4.97	4.70	4.84	3.70	5.62	5.45	7.53	7.13	5.58	4.09	3.76	3.95
.80	5.76	5.36	5.41	4.22	6.66	6.43	8.76	8.73	6.64	5.09	4.53	4.58
.90	7.00	6.39	6.26	5.01	8.28	7.96	10.68	11.31	8.31	6.73	5.75	5.56
.95	8.13	7.32	7.03	5.73	9.81	9.38	12.46	13.77	9.87	8.29	6.90	6.46

THESE VALUES WERE DETERMINED FROM THE INCOMPLETE GAMMA DISTRIBUTION.

316853 PLYMOUTH, NC

LAT: DEG MIN 35 52N LONG: DEG MIN 76 39W

PERIOD: 1951-80

FREEZE DATA

PROBABILITY OF LATER DATE IN SPRING (THRU JULY 31) THAN INDICATED(*)

SPRING FREEZE DATES (MO/DAY)

TEMP (F)	90	80	70	60	50	40	30	20	10
36	4/11	4/17	4/21	4/24	4/28	5/01	5/05	5/09	5/15
32	3/30	4/04	4/08	4/11	4/14	4/17	4/20	4/24	4/29
28	3/12	3/18	3/22	3/26	3/29	4/01	4/05	4/09	4/14
24	2/17	2/24	3/01	3/06	3/10	3/14	3/19	3/24	3/31
20	1/27	2/03	2/09	2/13	2/17	2/21	2/26	3/03	3/10
16	12/26	1/10	1/19	1/25	1/31	2/06	2/12	2/19	2/28

PROBABILITY OF EARLIER DATE IN FALL (BEGINNING AUG 1) THAN INDICATED(*)

FALL FREEZE DATES (MO/DAY)

TEMP (F)	10	20	30	40	50	60	70	80	90
36	10/04	10/09	10/12	10/15	10/17	10/20	10/22	10/25	10/30
32	10/11	10/16	10/19	10/22	10/25	10/28	10/31	11/03	11/08
28	10/24	10/29	11/02	11/06	11/09	11/12	11/15	11/19	11/24
24	10/30	11/05	11/09	11/13	11/17	11/20	11/24	11/29	12/05
20	11/17	11/23	11/28	12/01	12/05	12/08	12/12	12/17	12/23
16	12/01	12/10	12/17	12/23	12/29	1/03	1/10	1/18	2/02

PROBABILITY OF LONGER THAN INDICATED FREEZE FREE PERIOD (DAYS)

FREEZE FREE PERIOD

TEMP (F)	10	20	30	40	50	60	70	80	90
36	193	186	180	176	172	167	163	157	150
32	212	206	201	197	193	189	185	180	174
28	249	241	234	229	224	219	214	208	199
24	280	270	263	257	251	245	239	232	222
20	318	309	302	296	290	284	278	271	261
16	>365	>365	349	336	328	320	313	305	294

(*)PROBABILITY OF OBSERVING A TEMPERATURE AS COLD, OR COLDER, LATER IN THE SPRING OR EARLIER IN THE FALL THAN THE INDICATED DATE. 0/00 INDICATES THAT THE PROBABILITY OF OCCURRENCE OF THRESHOLD TEMPERATURE IS LESS THAN INDICATED PROBABILITY.

GROWING DEGREE UNITS TO SELECTED BASE TEMPERATURES (F)

BASE		GROWING DEGREE UNITS												
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
40	M	167	179	358	614	867	1036	1187	1165	968	677	385	208	7811
	S	167	346	704	1318	2185	3221	4408	5573	6541	7218	7603	7811	
45	M	93	102	231	465	712	886	1032	1010	818	523	256	120	6248
	S	93	195	426	891	1603	2489	3521	4531	5349	5872	6128	6248	
50	M	45	51	134	324	557	736	877	855	668	374	150	62	4833
	S	45	96	230	554	1111	1847	2724	3579	4247	4621	4771	4833	
55	M	18	21	68	204	404	586	722	700	518	239	75	26	3581
	S	18	39	107	311	715	1301	2023	2723	3241	3480	3555	3581	
60	M	5	7	28	112	260	436	567	545	369	129	31	8	2497
	S	5	12	40	152	412	848	1415	1960	2329	2458	2489	2497	

M = MONTHLY DATA S = SUM OF MONTHLY DATA

		GROWING DEGREE UNITS FOR CORN												
CORN	M	113	121	232	401	569	700	817	803	655	435	250	138	5234
	S	113	234	466	867	1436	2136	2953	3756	4411	4846	5096	5234	

NOTE: FOR CORN THE BASE IS 50, AND THE DEGREE UNITS ARE ADJUSTED FOR TEMPERATURES BELOW 50 AND ABOVE 86

OTHER CLIMATOLOGICAL DATA ARE AVAILABLE IN A VARIETY OF SUMMARIES AND FORMATS, SUCH AS THE CLIMATOGRAPHY OF THE UNITED STATES: NO. 60 - CLIMATE OF STATES; NO. 81 - MONTHLY NORMALS (AND SUPPLEMENTS: ANNUAL DEGREE DAYS TO SELECTED BASES DERIVED FROM THE 1951-80 NORMALS; AND MONTHLY PRECIPITATION PROBABILITIES, SELECTED PROBABILITY LEVELS DERIVED FROM THE 1951-80 NORMALS); NO. 84 - DAILY NORMALS; NO. 85 - DIVISIONAL NORMALS. A VARIETY OF DATA IS AVAILABLE EITHER ON MAGNETIC TAPE, MICROFICHE, OR PAPER COPY.

TO OBTAIN INFORMATION ABOUT CLIMATOLOGICAL DATA AND RELATED PUBLICATIONS, CONTACT:

DIRECTOR
NATIONAL CLIMATIC DATA CENTER
FEDERAL BUILDING
ASHEVILLE, NC 28801-2696
(OR TELEPHONE: (704) 259-0682)

DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE
NATIONAL CLIMATIC DATA CENTER
ASHEVILLE, NC

USCOMM-NOAA-ASHEVILLE, NC 7/84/200

FROM HELP MODEL USER'S GUIDE (V.3)

TABLE 4. DEFAULT SOIL, WASTE, AND GEOSYNTHETIC CHARACTERISTICS

Classification			Total Porosity	Field Capacity	Wilting Point	Saturated Hydraulic Conductivity
HELP	USDA	USCS	vol/vol	vol/vol	vol/vol	cm/sec
1	CoS	SP	0.417	0.045	0.018	1.0×10^{-2}
2	S	SW	0.437	0.062	0.024	5.8×10^{-3}
3	FS	SW	0.457	0.083	0.033	3.1×10^{-3}
4	LS	SM	0.437	0.105	0.047	1.7×10^{-3}
5	LFS	SM	0.457	0.131	0.058	1.0×10^{-3}
6	SL	SM	0.453	0.190	0.085	7.2×10^{-4}
7	FSL	SM	0.473	0.222	0.104	5.2×10^{-4}
8	L	ML	0.463	0.232	0.116	3.7×10^{-4}
9	SiL	ML	0.501	0.284	0.135	1.9×10^{-4}
10	SCL	SC	0.398	0.244	0.136	1.2×10^{-4}
11	CL	CL	0.464	0.310	0.187	6.4×10^{-5}
12	SiCL	CL	0.471	0.342	0.210	4.2×10^{-5}
13	SC	SC	0.430	0.321	0.221	3.3×10^{-5}
14	SiC	CH	0.479	0.371	0.251	2.5×10^{-5}
15	C	CH	0.475	0.378	0.265	1.7×10^{-5}
16	Barrier Soil		0.427	0.418	0.367	1.0×10^{-7}
17	Bentonite Mat (0.6 cm)		0.750	0.747	0.400	3.0×10^{-9}
18	Municipal Waste (900 lb/yd^3 or 312 kg/m^3)		0.671	0.292	0.077	1.0×10^{-3}
19	Municipal Waste (channeling and dead zones)		0.168	0.073	0.019	1.0×10^{-3}
20	Drainage Net (0.5 cm)		0.850	0.010	0.005	$1.0 \times 10^{+1}$
21	Gravel		0.397	0.032	0.013	3.0×10^{-1}
22	L*	ML	0.419	0.307	0.180	1.9×10^{-5}
23	SiL*	ML	0.461	0.360	0.203	9.0×10^{-6}
24	SCL*	SC	0.365	0.305	0.202	2.7×10^{-6}
25	CL*	CL	0.437	0.373	0.266	3.6×10^{-6}
26	SiCL*	CL	0.445	0.393	0.277	1.9×10^{-6}
27	SC*	SC	0.400	0.366	0.288	7.8×10^{-7}
28	SiC*	CH	0.452	0.411	0.311	1.2×10^{-6}
29	C*	CH	0.451	0.419	0.332	6.8×10^{-7}
30	Coal-Burning Electric Plant Fly Ash*		0.541	0.187	0.047	5.0×10^{-5}
31	Coal-Burning Electric Plant Bottom Ash*		0.578	0.076	0.025	4.1×10^{-3}
32	Municipal Incinerator Fly Ash*		0.450	0.116	0.049	1.0×10^{-2}
33	Fine Copper Slag*		0.375	0.055	0.020	4.1×10^{-2}
34	Drainage Net (0.6 cm)		0.850	0.010	0.005	$3.3 \times 10^{+1}$

* Moderately Compacted

(Continued)

FROM HELP MODEL USER'S GUIDE (V.3)

TABLE 4 (continued). DEFAULT SOIL, WASTE, AND GEOSYNTHETIC CHARACTERISTICS

Classification		Total Porosity	Field Capacity	Wilting Point	Saturated Hydraulic Conductivity
HELP	Geomembrane Material	vol/vol	vol/vol	vol/vol	cm/sec
35	High Density Polyethylene (HDPE)				2.0×10^{-13}
36	Low Density Polyethylene (LDPE)				4.0×10^{-13}
37	Polyvinyl Chloride (PVC)				2.0×10^{-11}
38	Butyl Rubber				1.0×10^{-12}
39	Chlorinated Polyethylene (CPE)				4.0×10^{-12}
40	Hypalon or Chlorosulfonated Polyethylene (CSPE)				3.0×10^{-12}
41	Ethylene-Propylene Diene Monomer (EPDM)				2.0×10^{-12}
42	Neoprene				3.0×10^{-12}

(concluded)

user-defined soil option accepts non-default soil characteristics for layers assigned soil type numbers greater than 42. This is especially convenient for specifying characteristics of waste layers. User-specified soil characteristics can be assigned any soil type number greater than 42.

When a default soil type is used to describe the top soil layer, the program adjusts the saturated hydraulic conductivities of the soils in the top half of the evaporative zone for the effects of root channels. The saturated hydraulic conductivity value is multiplied by an empirical factor that is computed as a function of the user-specified maximum leaf area index. Example values of this factor are 1.0 for a maximum LAI of 0 (bare ground), 1.8 for a maximum LAI of 1 (poor stand of grass), 3.0 for a maximum LAI of 2 (fair stand of grass), 4.2 for a maximum LAI of 3.3 (good stand of grass) and 5.0 for a maximum LAI of 5 (excellent stand of grass).

The manual option requires values for porosity, field capacity, wilting point, and saturated hydraulic conductivity. These and related soil properties are defined below.

Soil Water Storage (Volumetric Content): the ratio of the volume of water in a soil to the total volume occupied by the soil, water and voids.

Total Porosity: the soil water storage/volumetric content at saturation (fraction of total volume).

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      H:\DATA\COMMON\KORLESKS\HELP\DATA4.D4
TEMPERATURE DATA FILE:        H:\DATA\COMMON\KORLESKS\HELP\DATA7.D7
SOLAR RADIATION DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA13.D13
EVAPOTRANSPIRATION DATA:      H:\DATA\COMMON\KORLESKS\HELP\DATA11.D11
SOIL AND DESIGN DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA10.D10
OUTPUT DATA FILE:             H:\DATA\COMMON\KORLESKS\HELP\TESTOUT.OUT


TIME:  13:59     DATE:   8/31/1999


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

     TITLE:  WEYERHAEUSER PLYMOUTH/OPEN LANDFILL/ 2' OF WASTE

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


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


                                  LAYER  1
                                  --------
```

```
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     12.00   INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2365 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     12.00   INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.6648 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                        LAYER  3
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   2
THICKNESS                    =      6.00   INCHES
POROSITY                     =      0.4370 VOL/VOL
FIELD CAPACITY               =      0.0620 VOL/VOL
WILTING POINT                =      0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.1752 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.579999993000E-02 CM/SEC


                        LAYER  4
                        --------
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              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER  21
THICKNESS                    =      12.00    INCHES
POROSITY                     =       0.3970 VOL/VOL
FIELD CAPACITY               =       0.0320 VOL/VOL
WILTING POINT                =       0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0569 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000012000      CM/SEC
SLOPE                        =       2.00    PERCENT
DRAINAGE LENGTH              =     100.0     FEET


                         LAYER  5
                         --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
THICKNESS                    =       0.06    INCHES
POROSITY                     =       0.0000 VOL/VOL
FIELD CAPACITY               =       0.0000 VOL/VOL
WILTING POINT                =       0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =       1.00    HOLES/ACRE
FML INSTALLATION DEFECTS     =       8.00    HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                         LAYER  6
                         --------

               TYPE 3 - BARRIER SOIL LINER
               MATERIAL TEXTURE NUMBER  17
THICKNESS                    =       0.24    INCHES
POROSITY                     =       0.7500 VOL/VOL
FIELD CAPACITY               =       0.7470 VOL/VOL
WILTING POINT                =       0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	93.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	13.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.377	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.919	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.768	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	12.730	INCHES
TOTAL INITIAL WATER	=	12.730	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
PLYMOUTH NORTH CAROLINA

MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	94	
END OF GROWING SEASON (JULIAN DATE)	=	311	
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	77.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA WAS ~~SYNTHETICALLY GENERATED USING~~ ENTERED MANUALLY FOR
~~COEFFICIENTS FOR NORFOLK VIRGINIA~~
PLYMOUTH, NORTH CAROLINA.

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

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

4.17	3.98	4.18	3.14	4.66	4.53
6.30	5.85	4.62	3.35	3.10	3.32

NOTE: TEMPERATURE DATA WAS ENTERED MANUALLY FOR PLYMOUTH, NC ~~SYNTHETICALLY GENERATED USING COEFFICIENTS FOR NORFOLK VIRGINIA~~

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
42.10	43.90	50.90	60.30	67.70	74.30
78.00	77.30	72.00	61.50	52.40	44.60

NOTE: SOLAR RADIATION DATA WAS ENTERED MANUALLY FOR PLYMOUTH, NC ~~SYNTHETICALLY GENERATED USING COEFFICIENTS FOR NORFOLK VIRGINIA~~

STATION LATITUDE = 35.87 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

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	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.42	3.66	4.52	2.76	4.19	5.02
	7.36	7.52	4.98	2.34	2.74	3.83
STD. DEVIATIONS	2.25	1.38	1.86	1.27	1.84	2.52
	3.32	3.06	2.72	1.33	1.43	1.73

RUNOFF

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

EVAPOTRANSPIRATION

TOTALS	1.524	1.735	2.900	2.393	3.289	3.705
	4.082	4.017	3.073	1.822	1.496	1.414
STD. DEVIATIONS	0.400	0.453	0.816	0.997	1.148	1.523
	1.469	1.234	1.146	0.790	0.527	0.219

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	1.9900	1.4995	2.0321	1.4353	1.0149	1.0733
	1.4650	2.4987	3.2323	1.9762	1.0446	1.3210
STD. DEVIATIONS	1.4579	1.0815	1.3261	1.0699	1.0681	1.2320
	1.6159	1.8524	2.1318	1.3740	0.9967	1.1788

PERCOLATION/LEAKAGE THROUGH LAYER 6

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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 6

AVERAGES	0.2698	0.2133	0.2773	0.1768	0.1306	0.1421
	0.2005	0.3830	0.5351	0.2671	0.1297	0.1714

STD. DEVIATIONS	0.2762	0.2084	0.2420	0.2010	0.1863	0.2184
	0.2957	0.3485	0.4516	0.2634	0.1781	0.1943

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES		CU. FEET	PERCENT
PRECIPITATION	52.35	(8.675)	190032.3	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	31.452	(7.4949)	114170.05	60.079
LATERAL DRAINAGE COLLECTED FROM LAYER 4	20.58297	(8.48051)	74716.164	39.31761
PERCOLATION/LEAKAGE THROUGH FROM LAYER 6	0.00006	(0.00003)	0.205	0.00011
AVERAGE HEAD ACROSS TOP OF LAYER 6	0.241	(0.130)		
CHANGE IN WATER STORAGE	0.316	(2.0589)	1145.92	0.603

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	5.73	20799.900

RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.34003	1234.31641
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000002	0.00557
AVERAGE HEAD ACROSS LAYER 6	2.090	
SNOW WATER	2.95	10713.2930

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.7440
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1360

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	8.5252	0.7104
2	8.8920	0.7410
3	0.9547	0.1591
4	0.4917	0.0410
5	0.0000	0.0000
6	0.1800	0.7500
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
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PRECIPITATION DATA FILE:      H:\DATA\COMMON\KORLESKS\HELP\DATA4.D4
TEMPERATURE DATA FILE:        H:\DATA\COMMON\KORLESKS\HELP\DATA7.D7
SOLAR RADIATION DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA13.D13
EVAPOTRANSPIRATION DATA:      H:\DATA\COMMON\KORLESKS\HELP\DATA11.D11
SOIL AND DESIGN DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA10.D10
OUTPUT DATA FILE:             H:\DATA\COMMON\KORLESKS\HELP\TESTOUT.OUT


TIME:  14: 6     DATE:   8/31/1999


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     TITLE:  WEYERHAEUSER PLYMOUTH/OPEN LANDFILL/4' OF WASTE

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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
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          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =      36.00   INCHES
POROSITY                     =       0.7630 VOL/VOL
FIELD CAPACITY               =       0.2440 VOL/VOL
WILTING POINT                =       0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.5355 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                         LAYER  2
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =      12.00   INCHES
POROSITY                     =       0.7630 VOL/VOL
FIELD CAPACITY               =       0.2440 VOL/VOL
WILTING POINT                =       0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.6301 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                         LAYER  3
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            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   2
THICKNESS                    =       6.00   INCHES
POROSITY                     =       0.4370 VOL/VOL
FIELD CAPACITY               =       0.0620 VOL/VOL
WILTING POINT                =       0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.1365 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.579999993000E-02 CM/SEC


                         LAYER  4
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                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER  21
THICKNESS                    =      12.00    INCHES
POROSITY                     =       0.3970 VOL/VOL
FIELD CAPACITY               =       0.0320 VOL/VOL
WILTING POINT                =       0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0350 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000012000      CM/SEC
SLOPE                        =       2.00    PERCENT
DRAINAGE LENGTH              =     100.0     FEET


                          LAYER  5
                          --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
THICKNESS                    =       0.06    INCHES
POROSITY                     =       0.0000 VOL/VOL
FIELD CAPACITY               =       0.0000 VOL/VOL
WILTING POINT                =       0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =       1.00    HOLES/ACRE
FML INSTALLATION DEFECTS     =       8.00    HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                          LAYER  6
                          --------

                TYPE 3 - BARRIER SOIL LINER
                  MATERIAL TEXTURE NUMBER  17
THICKNESS                    =       0.24    INCHES
POROSITY                     =       0.7500 VOL/VOL
FIELD CAPACITY               =       0.7470 VOL/VOL
WILTING POINT                =       0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC
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GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	93.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	13.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.381	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.919	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.768	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	28.258	INCHES
TOTAL INITIAL WATER	=	28.258	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
PLYMOUTH NORTH CAROLINA

MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	94	
END OF GROWING SEASON (JULIAN DATE)	=	311	
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	77.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA WAS ~~SYNTHETICALLY GENERATED USING~~ ENTERED MANUALLY FOR PLYMOUTH, NC
~~COEFFICIENTS FOR NORFOLK VIRGINIA~~

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

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

4.17	3.98	4.18	3.14	4.66	4.53
6.30	5.85	4.62	3.35	3.10	3.32

NOTE: TEMPERATURE DATA WAS ~~SYNTHETICALLY GENERATED USING~~ ENTERED MANUALLY FOR PLYMOUTH, NC
~~COEFFICIENTS FOR NORFOLK VIRGINIA~~

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
42.10	43.90	50.90	60.30	67.70	74.30
78.00	77.30	72.00	61.50	52.40	44.60

NOTE: SOLAR RADIATION DATA WAS ~~SYNTHETICALLY GENERATED USING~~ ENTERED MANUALLY FOR PLYMOUTH, NC
~~COEFFICIENTS FOR NORFOLK VIRGINIA~~

STATION LATITUDE = 35.87 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.42	3.66	4.52	2.76	4.19	5.02
	7.36	7.52	4.98	2.34	2.74	3.83
STD. DEVIATIONS	2.25	1.38	1.86	1.27	1.84	2.52
	3.32	3.06	2.72	1.33	1.43	1.73

RUNOFF

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

EVAPOTRANSPIRATION

TOTALS	1.524	1.735	2.900	2.393	3.289	3.705
	4.086	4.018	3.073	1.822	1.496	1.414
STD. DEVIATIONS	0.400	0.453	0.816	0.997	1.148	1.523
	1.467	1.235	1.146	0.790	0.527	0.219

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	1.5563	1.7100	1.7480	1.7941	1.3667	1.1576
	1.2367	2.0033	2.7946	2.4613	1.5585	1.2162
STD. DEVIATIONS	1.1595	1.3770	1.2021	1.0082	0.9564	1.0991
	1.2375	1.7636	1.8165	1.1383	1.0231	0.8610

PERCOLATION/LEAKAGE THROUGH LAYER 6

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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 6

AVERAGES	0.1908	0.2452	0.2226	0.2203	0.1520	0.1433
	0.1556	0.2883	0.4482	0.3246	0.1858	0.1371

STD. DEVIATIONS	0.1871	0.2880	0.2179	0.1688	0.1794	0.1933
	0.2235	0.3254	0.3654	0.2102	0.1949	0.1424

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES		CU. FEET	PERCENT
PRECIPITATION	52.35	(8.675)	190032.3	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	31.456	(7.4940)	114184.73	60.087
LATERAL DRAINAGE COLLECTED FROM LAYER 4	20.60348	(8.54843)	74790.641	39.35680
PERCOLATION/LEAKAGE THROUGH FROM LAYER 6	0.00005	(0.00003)	0.187	0.00010
AVERAGE HEAD ACROSS TOP OF LAYER 6	0.226	(0.129)		
CHANGE IN WATER STORAGE	0.291	(2.3999)	1056.76	0.556

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	5.73	20799.900

RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.33544	1217.64282
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000002	0.00547
AVERAGE HEAD ACROSS LAYER 6	2.060	
SNOW WATER	2.95	10713.2930

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.7440
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1360

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	25.3259	0.7035
2	7.3368	0.6114
3	0.8312	0.1385
4	0.4065	0.0339
5	0.0000	0.0000
6	0.1800	0.7500
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      H:\DATA\COMMON\KORLESKS\HELP\DATA4.D4
TEMPERATURE DATA FILE:        H:\DATA\COMMON\KORLESKS\HELP\DATA7.D7
SOLAR RADIATION DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA13.D13
EVAPOTRANSPIRATION DATA:      H:\DATA\COMMON\KORLESKS\HELP\DATA11.D11
SOIL AND DESIGN DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA10.D10
OUTPUT DATA FILE:             H:\DATA\COMMON\KORLESKS\HELP\TESTOUT.OUT


TIME:  14:10      DATE:   8/31/1999


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     TITLE:  WEYERHAEUSER PLYMOUTH/OPEN LANDFILL/41' OF WASTE

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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
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```
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                      =    240.00    INCHES
POROSITY                       =      0.7630 VOL/VOL
FIELD CAPACITY                 =      0.2440 VOL/VOL
WILTING POINT                  =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.2893 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC


                         LAYER  2
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                      =    240.00    INCHES
POROSITY                       =      0.7630 VOL/VOL
FIELD CAPACITY                 =      0.2440 VOL/VOL
WILTING POINT                  =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.2792 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC


                         LAYER  3
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          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                      =     12.00    INCHES
POROSITY                       =      0.7630 VOL/VOL
FIELD CAPACITY                 =      0.2440 VOL/VOL
WILTING POINT                  =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.2588 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC


                         LAYER  4
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              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   2
THICKNESS                    =      6.00    INCHES
POROSITY                     =      0.4370 VOL/VOL
FIELD CAPACITY               =      0.0620 VOL/VOL
WILTING POINT                =      0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0681 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.579999993000E-02 CM/SEC


                          LAYER  5
                          --------

              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER  21
THICKNESS                    =     12.00    INCHES
POROSITY                     =      0.3970 VOL/VOL
FIELD CAPACITY               =      0.0320 VOL/VOL
WILTING POINT                =      0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0320 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000012000      CM/SEC
SLOPE                        =      2.00    PERCENT
DRAINAGE LENGTH              =    100.0     FEET


                          LAYER  6
                          --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06    INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00    HOLES/ACRE
FML INSTALLATION DEFECTS     =      8.00    HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD
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LAYER 7

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.24	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	93.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	13.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.381	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.919	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.768	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	140.520	INCHES
TOTAL INITIAL WATER	=	140.520	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
PLYMOUTH NORTH CAROLINA

MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	94
END OF GROWING SEASON (JULIAN DATE)	=	311

AVERAGE ANNUAL WIND SPEED = 7.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 68.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 68.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 77.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 73.00 %

NOTE: PRECIPITATION DATA WAS ~~SYNTHETICALLY GENERATED USING~~ ENTERED MANUALLY FOR PLYMOUTH, NC
~~COEFFICIENTS FOR NORFOLK VIRGINIA~~

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.17	3.98	4.18	3.14	4.66	4.53
6.30	5.85	4.62	3.35	3.10	3.32

NOTE: TEMPERATURE DATA WAS ~~SYNTHETICALLY GENERATED USING~~ ENTERED MANUALLY FOR PLYMOUTH, NC
~~COEFFICIENTS FOR NORFOLK VIRGINIA~~

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
42.10	43.90	50.90	60.30	67.70	74.30
78.00	77.30	72.00	61.50	52.40	44.60

NOTE: SOLAR RADIATION DATA WAS ~~SYNTHETICALLY GENERATED USING~~ ENTERED MANUALLY FOR PLYMOUTH, NC
~~COEFFICIENTS FOR NORFOLK VIRGINIA~~

STATION LATITUDE = 35.87 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.42	3.66	4.52	2.76	4.19	5.02
	7.36	7.52	4.98	2.34	2.74	3.83
STD. DEVIATIONS	2.25	1.38	1.86	1.27	1.84	2.52
	3.32	3.06	2.72	1.33	1.43	1.73
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	1.524	1.735	2.900	2.393	3.289	3.705
	4.086	4.018	3.073	1.822	1.496	1.414
STD. DEVIATIONS	0.400	0.453	0.816	0.997	1.148	1.523
	1.467	1.235	1.146	0.790	0.527	0.219
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	1.3971	1.5389	1.5706	1.7087	1.6269	1.3504
	1.2553	1.5588	2.1736	2.6892	1.9764	1.4734
STD. DEVIATIONS	1.1688	1.2378	1.0128	1.0726	1.1609	0.8056
	0.8635	1.5634	1.4320	1.6663	1.1787	0.8094
PERCOLATION/LEAKAGE THROUGH LAYER 7						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 7

AVERAGES	0.1647	0.2138	0.1831	0.2126	0.1865	0.1520
	0.1423	0.2126	0.3164	0.3798	0.2422	0.1603
STD. DEVIATIONS	0.1998	0.2433	0.1594	0.1746	0.2122	0.1418
	0.1374	0.2930	0.2679	0.3129	0.2276	0.1395

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES		CU. FEET	PERCENT
PRECIPITATION	52.35	(8.675)	190032.3	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	31.456	(7.4940)	114184.73	60.087
LATERAL DRAINAGE COLLECTED FROM LAYER 5	20.31914	(8.65141)	73758.461	38.81364
PERCOLATION/LEAKAGE THROUGH FROM LAYER 7	0.00005	(0.00003)	0.174	0.00009
AVERAGE HEAD ACROSS TOP OF LAYER 7	0.214	(0.125)		

CHANGE IN WATER STORAGE	0.575	(3.0661)	2088.95	1.099

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	5.73	20799.900
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 5	0.30308	1100.16296
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000001	0.00475
AVERAGE HEAD ACROSS LAYER 7	1.842	
SNOW WATER	2.95	10713.2930

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.7440
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1360

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	75.4760	0.3145
2	67.4821	0.2812

3	7.6089	0.6341
4	0.8784	0.1464
5	0.4043	0.0337
6	0.0000	0.0000
7	0.1800	0.7500
SNOW WATER	0.000	

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**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      H:\DATA\COMMON\KORLESKS\HELP\DATA4.D4
TEMPERATURE DATA FILE:        H:\DATA\COMMON\KORLESKS\HELP\DATA7.D7
SOLAR RADIATION DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA13.D13
EVAPOTRANSPIRATION DATA:      H:\DATA\COMMON\KORLESKS\HELP\DATA11.D11
SOIL AND DESIGN DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA10.D10
OUTPUT DATA FILE:             H:\DATA\COMMON\KORLESKS\HELP\TESTOUT.OUT


TIME:  14:20      DATE:   8/31/1999


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     TITLE:  WEYERHAEUSER PLYMOUTH/OPEN LANDFILL/81' OF WASTE

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


                                  LAYER  1
                                  --------
```

```
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =    240.00   INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2893 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =    240.00   INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2792 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =    240.00   INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2447 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                        LAYER  4
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          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                    =    240.00    INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                    =     12.00    INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                        LAYER  6
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER    2
THICKNESS                    =      6.00    INCHES
POROSITY                     =      0.4370 VOL/VOL
FIELD CAPACITY               =      0.0620 VOL/VOL
WILTING POINT                =      0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0681 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.579999993000E-02 CM/SEC


                        LAYER  7
                        --------

          TYPE 2 - LATERAL DRAINAGE LAYER
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                MATERIAL TEXTURE NUMBER  21
THICKNESS                    =      12.00    INCHES
POROSITY                     =       0.3970 VOL/VOL
FIELD CAPACITY               =       0.0320 VOL/VOL
WILTING POINT                =       0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0320 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000012000      CM/SEC
SLOPE                        =       2.00    PERCENT
DRAINAGE LENGTH              =     100.0     FEET


                         LAYER  8
                         --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
THICKNESS                    =       0.06    INCHES
POROSITY                     =       0.0000 VOL/VOL
FIELD CAPACITY               =       0.0000 VOL/VOL
WILTING POINT                =       0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =       1.00    HOLES/ACRE
FML INSTALLATION DEFECTS     =       8.00    HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                         LAYER  9
                         --------

                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  17
THICKNESS                    =       0.24    INCHES
POROSITY                     =       0.7500 VOL/VOL
FIELD CAPACITY               =       0.7470 VOL/VOL
WILTING POINT                =       0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	93.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	13.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.381	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.919	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.768	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	257.640	INCHES
TOTAL INITIAL WATER	=	257.640	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
PLYMOUTH NORTH CAROLINA

MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	94	
END OF GROWING SEASON (JULIAN DATE)	=	311	
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	77.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA WAS ~~SYNTHETICALLY GENERATED USING~~ ENTERED MANUALLY FOR PLYMOUTH, NC
~~COEFFICIENTS FOR NORFOLK VIRGINIA~~

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

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

4.17	3.98	4.18	3.14	4.66	4.53
6.30	5.85	4.62	3.35	3.10	3.32

NOTE: TEMPERATURE DATA WAS ~~SYNTHETICALLY GENERATED USING COEFFICIENTS FOR NORFOLK VIRGINIA~~ ENTERED MANUALLY FOR PLYMOUTH, NC

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
42.10	43.90	50.90	60.30	67.70	74.30
78.00	77.30	72.00	61.50	52.40	44.60

NOTE: SOLAR RADIATION DATA WAS ~~SYNTHETICALLY GENERATED USING COEFFICIENTS FOR NORFOLK VIRGINIA~~ ENTERED MANUALLY FOR PLYMOUTH, NC

STATION LATITUDE = 35.87 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

-

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.42	3.66	4.52	2.76	4.19	5.02
	7.36	7.52	4.98	2.34	2.74	3.83
STD. DEVIATIONS	2.25	1.38	1.86	1.27	1.84	2.52
	3.32	3.06	2.72	1.33	1.43	1.73

RUNOFF

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

EVAPOTRANSPIRATION

TOTALS	1.524	1.735	2.900	2.393	3.289	3.705
	4.086	4.018	3.073	1.822	1.496	1.414
STD. DEVIATIONS	0.400	0.453	0.816	0.997	1.148	1.523
	1.467	1.235	1.146	0.790	0.527	0.219

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	1.4779	1.2299	1.5294	1.5159	1.7074	1.4859
	1.4152	1.4107	1.5452	1.9497	2.2066	1.8652
STD. DEVIATIONS	0.9542	0.9421	1.2954	0.9357	1.0558	0.9651
	0.9056	0.9163	1.4419	1.4549	1.2406	1.1220

PERCOLATION/LEAKAGE THROUGH LAYER 9

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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 9

AVERAGES	0.1592	0.1540	0.1837	0.1766	0.1970	0.1688
	0.1541	0.1594	0.2064	0.2683	0.2919	0.2130
STD. DEVIATIONS	0.1449	0.1707	0.2227	0.1499	0.1654	0.1580

0.1477 0.1473 0.2747 0.2590 0.2083 0.1830

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES		CU. FEET	PERCENT
PRECIPITATION	52.35	(8.675)	190032.3	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	31.456	(7.4940)	114184.73	60.087
LATERAL DRAINAGE COLLECTED FROM LAYER 7	19.33913	(9.32229)	70201.039	36.94163
PERCOLATION/LEAKAGE THROUGH FROM LAYER 9	0.00004	(0.00003)	0.157	0.00008
AVERAGE HEAD ACROSS TOP OF LAYER 9	0.194	(0.125)		
CHANGE IN WATER STORAGE	1.555	(5.9108)	5646.42	2.971

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	5.73	20799.900

RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 7	0.27602	1001.95624
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000001	0.00416
AVERAGE HEAD ACROSS LAYER 9	1.654	
SNOW WATER	2.95	10713.2930

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.7440
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1360

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	75.4760	0.3145
2	67.4821	0.2812
3	67.9560	0.2832
4	68.3228	0.2847
5	7.9246	0.6604
6	0.9579	0.1597
7	0.4506	0.0376
8	0.0000	0.0000
9	0.1800	0.7500
SNOW WATER	0.000	

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**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.01    (14 OCTOBER 1994)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      H:\DATA\COMMON\KORLESKS\HELP\DATA4.D4
TEMPERATURE DATA FILE:        H:\DATA\COMMON\KORLESKS\HELP\DATA7.D7
SOLAR RADIATION DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA13.D13
EVAPOTRANSPIRATION DATA:      H:\DATA\COMMON\KORLESKS\HELP\DATA11.D11
SOIL AND DESIGN DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA10.D10
OUTPUT DATA FILE:             H:\DATA\COMMON\KORLESKS\HELP\TESTOUT.OUT


TIME:  14:25     DATE:   8/31/1999


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

     TITLE:  WEYERHAEUSER PLYMOUTH/OPEN LANDFILL/181' OF WASTE

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


                                  LAYER  1
                                  --------
```

```
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                      =     240.00    INCHES
POROSITY                       =       0.7630 VOL/VOL
FIELD CAPACITY                 =       0.2440 VOL/VOL
WILTING POINT                  =       0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =       0.2893 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC


                         LAYER  2
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                      =     240.00    INCHES
POROSITY                       =       0.7630 VOL/VOL
FIELD CAPACITY                 =       0.2440 VOL/VOL
WILTING POINT                  =       0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =       0.2792 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC


                         LAYER  3
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                      =     240.00    INCHES
POROSITY                       =       0.7630 VOL/VOL
FIELD CAPACITY                 =       0.2440 VOL/VOL
WILTING POINT                  =       0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =       0.2447 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC


                         LAYER  4
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          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                        =    240.00    INCHES
POROSITY                         =      0.7630 VOL/VOL
FIELD CAPACITY                   =      0.2440 VOL/VOL
WILTING POINT                    =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT       =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.        =  0.999999975000E-05 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                        =    240.00    INCHES
POROSITY                         =      0.7630 VOL/VOL
FIELD CAPACITY                   =      0.2440 VOL/VOL
WILTING POINT                    =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT       =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.        =  0.999999975000E-05 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                        =    240.00    INCHES
POROSITY                         =      0.7630 VOL/VOL
FIELD CAPACITY                   =      0.2440 VOL/VOL
WILTING POINT                    =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT       =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.        =  0.999999975000E-05 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
```

```
                MATERIAL TEXTURE NUMBER    0
THICKNESS                        =    240.00    INCHES
POROSITY                         =      0.7630 VOL/VOL
FIELD CAPACITY                   =      0.2440 VOL/VOL
WILTING POINT                    =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT       =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.        =  0.999999975000E-05 CM/SEC


                         LAYER  8
                         --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER    0
THICKNESS                        =    240.00    INCHES
POROSITY                         =      0.7630 VOL/VOL
FIELD CAPACITY                   =      0.2440 VOL/VOL
WILTING POINT                    =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT       =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.        =  0.999999975000E-05 CM/SEC


                         LAYER  9
                         --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER    0
THICKNESS                        =    240.00    INCHES
POROSITY                         =      0.7630 VOL/VOL
FIELD CAPACITY                   =      0.2440 VOL/VOL
WILTING POINT                    =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT       =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.        =  0.999999975000E-05 CM/SEC


                         LAYER 10
                         --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER    0
```

```
THICKNESS                    =      12.00    INCHES
POROSITY                     =       0.7630 VOL/VOL
FIELD CAPACITY               =       0.2440 VOL/VOL
WILTING POINT                =       0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC
```

LAYER 11

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

```
THICKNESS                    =       6.00    INCHES
POROSITY                     =       0.4370 VOL/VOL
FIELD CAPACITY               =       0.0620 VOL/VOL
WILTING POINT                =       0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0681 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.579999993000E-02 CM/SEC
```

LAYER 12

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

```
THICKNESS                    =      12.00    INCHES
POROSITY                     =       0.3970 VOL/VOL
FIELD CAPACITY               =       0.0320 VOL/VOL
WILTING POINT                =       0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0320 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000012000      CM/SEC
SLOPE                        =       2.00    PERCENT
DRAINAGE LENGTH              =     100.0     FEET
```

LAYER 13

TYPE 4 - FLEXIBLE MEMBRANE LINER

```
                    MATERIAL TEXTURE NUMBER  35
THICKNESS                    =       0.06    INCHES
POROSITY                     =       0.0000 VOL/VOL
FIELD CAPACITY               =       0.0000 VOL/VOL
WILTING POINT                =       0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =       1.00    HOLES/ACRE
FML INSTALLATION DEFECTS     =       8.00    HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                          LAYER 14
                          --------

                    TYPE 3 - BARRIER SOIL LINER
                    MATERIAL TEXTURE NUMBER  17
THICKNESS                    =       0.24    INCHES
POROSITY                     =       0.7500 VOL/VOL
FIELD CAPACITY               =       0.7470 VOL/VOL
WILTING POINT                =       0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC


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

 NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER              =     93.00
FRACTION OF AREA ALLOWING RUNOFF     =      0.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000   ACRES
EVAPORATIVE ZONE DEPTH               =     13.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      3.381   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      9.919   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      1.768   INCHES
INITIAL SNOW WATER                   =      0.000   INCHES
INITIAL WATER IN LAYER MATERIALS     =    550.441   INCHES
TOTAL INITIAL WATER                  =    550.441   INCHES
TOTAL SUBSURFACE INFLOW              =      0.00    INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
PLYMOUTH NORTH CAROLINA

MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	94
END OF GROWING SEASON (JULIAN DATE)	=	311
AVERAGE ANNUAL WIND SPEED	=	7.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	68.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	77.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00 %

NOTE: PRECIPITATION DATA WAS ENTERED MANUALLY FOR PLYMOUTH, NC ~~SYNTHETICALLY GENERATED USING COEFFICIENTS FOR NORFOLK VIRGINIA~~

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.17	3.98	4.18	3.14	4.66	4.53
6.30	5.85	4.62	3.35	3.10	3.32

NOTE: TEMPERATURE DATA WAS ENTERED MANUALLY FOR PLYMOUTH, NC ~~SYNTHETICALLY GENERATED USING COEFFICIENTS FOR NORFOLK VIRGINIA~~

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
42.10	43.90	50.90	60.30	67.70	74.30
78.00	77.30	72.00	61.50	52.40	44.60

NOTE: SOLAR RADIATION DATA WAS ~~SYNTHETICALLY GENERATED USING COEFFICIENTS FOR NORFOLK VIRGINIA~~ ENTERED MANUALLY FOR PLYMOUTH, NC

STATION LATITUDE = 35.87 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

-

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.42	3.66	4.52	2.76	4.19	5.02
	7.36	7.52	4.98	2.34	2.74	3.83
STD. DEVIATIONS	2.25	1.38	1.86	1.27	1.84	2.52
	3.32	3.06	2.72	1.33	1.43	1.73
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	1.524	1.735	2.900	2.393	3.289	3.705
	4.086	4.018	3.073	1.822	1.496	1.414
STD. DEVIATIONS	0.400	0.453	0.816	0.997	1.148	1.523
	1.467	1.235	1.146	0.790	0.527	0.219

LATERAL DRAINAGE COLLECTED FROM LAYER 12

TOTALS	1.7017	1.4120	1.6408	1.4801	1.3286	1.2745
	1.4249	1.4385	1.2290	1.2499	1.2079	1.3667
STD. DEVIATIONS	1.4169	0.9258	1.1231	1.1309	0.9283	0.9255
	0.9690	1.0712	0.8641	0.8859	1.1027	0.8894

PERCOLATION/LEAKAGE THROUGH LAYER 14

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 ACROSS LAYER 14

AVERAGES	0.2094	0.1725	0.1827	0.1726	0.1415	0.1420
	0.1579	0.1595	0.1325	0.1315	0.1406	0.1519
STD. DEVIATIONS	0.2294	0.1382	0.1694	0.1915	0.1340	0.1372
	0.1343	0.1548	0.1221	0.1336	0.2017	0.1268

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES		CU. FEET	PERCENT
PRECIPITATION	52.35	(8.675)	190032.3	100.00

RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	31.456	(7.4940)	114184.73	60.087
LATERAL DRAINAGE COLLECTED FROM LAYER 12	16.75467	(9.75302)	60819.434	32.00478
PERCOLATION/LEAKAGE THROUGH FROM LAYER 14	0.00003	(0.00003)	0.127	0.00007
AVERAGE HEAD ACROSS TOP OF LAYER 14	0.158	(0.116)		
CHANGE IN WATER STORAGE	4.140	(12.2103)	15028.01	7.908

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	5.73	20799.900
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 12	0.25326	919.34296
PERCOLATION/LEAKAGE THROUGH LAYER 14	0.000001	0.00367
AVERAGE HEAD ACROSS LAYER 14	1.491	
SNOW WATER	2.95	10713.2930

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.7440
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1360

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	75.4760	0.3145
2	67.4821	0.2812
3	67.9560	0.2832
4	68.3228	0.2847
5	68.6051	0.2859
6	68.7845	0.2866
7	68.9655	0.2874
8	69.0845	0.2879
9	69.0887	0.2879
10	7.9410	0.6617
11	0.9198	0.1533
12	0.4336	0.0361
13	0.0000	0.0000
14	0.1800	0.7500
SNOW WATER	0.000	

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      H:\DATA\COMMON\KORLESKS\HELP\DATA4.D4
TEMPERATURE DATA FILE:        H:\DATA\COMMON\KORLESKS\HELP\DATA7.D7
SOLAR RADIATION DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA13.D13
EVAPOTRANSPIRATION DATA:      H:\DATA\COMMON\KORLESKS\HELP\DATA11.D11
SOIL AND DESIGN DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA10.D10
OUTPUT DATA FILE:             H:\DATA\COMMON\KORLESKS\HELP\TESTOUT.OUT


TIME:  14:50      DATE:   8/31/1999


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

     TITLE:  WEYERHAEUSER PLYMOUTH/POST CLOSURE/SIDE OF THE LANDFILL

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


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


                                  LAYER  1
                                  --------
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```
                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   4
  THICKNESS                    =      18.00    INCHES
  POROSITY                     =       0.4370 VOL/VOL
  FIELD CAPACITY               =       0.1050 VOL/VOL
  WILTING POINT                =       0.0470 VOL/VOL
  INITIAL SOIL WATER CONTENT   =       0.0468 VOL/VOL
  EFFECTIVE SAT. HYD. COND.    =  0.170000002000E-02 CM/SEC
NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
         FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                          LAYER  2
                          --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                    MATERIAL TEXTURE NUMBER  20
  THICKNESS                    =       0.20    INCHES
  POROSITY                     =       0.8500 VOL/VOL
  FIELD CAPACITY               =       0.0100 VOL/VOL
  WILTING POINT                =       0.0050 VOL/VOL
  INITIAL SOIL WATER CONTENT   =       0.0100 VOL/VOL
  EFFECTIVE SAT. HYD. COND.    =   10.0000000000      CM/SEC
  SLOPE                        =      33.30    PERCENT
  DRAINAGE LENGTH              =      60.0     FEET


                          LAYER  3
                          --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                    MATERIAL TEXTURE NUMBER  35
  THICKNESS                    =       0.04    INCHES
  POROSITY                     =       0.0000 VOL/VOL
  FIELD CAPACITY               =       0.0000 VOL/VOL
  WILTING POINT                =       0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT   =       0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY          =       1.00    HOLES/ACRE
  FML INSTALLATION DEFECTS     =       8.00    HOLES/ACRE
  FML PLACEMENT QUALITY        =  3 - GOOD
```

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                    LAYER  4
                    --------

          TYPE 3 - BARRIER SOIL LINER
          MATERIAL TEXTURE NUMBER  17
THICKNESS                    =      0.24    INCHES
POROSITY                     =      0.7500 VOL/VOL
FIELD CAPACITY               =      0.7470 VOL/VOL
WILTING POINT                =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC


                    LAYER  5
                    --------

        TYPE 1 - VERTICAL PERCOLATION LAYER
          MATERIAL TEXTURE NUMBER   0
THICKNESS                    =    240.00    INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                    LAYER  6
                    --------

        TYPE 1 - VERTICAL PERCOLATION LAYER
          MATERIAL TEXTURE NUMBER   0
THICKNESS                    =    240.00    INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC
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                    LAYER  7
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                      =    240.00   INCHES
POROSITY                       =      0.7630 VOL/VOL
FIELD CAPACITY                 =      0.2440 VOL/VOL
WILTING POINT                  =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC


                    LAYER  8
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                      =    240.00   INCHES
POROSITY                       =      0.7630 VOL/VOL
FIELD CAPACITY                 =      0.2440 VOL/VOL
WILTING POINT                  =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC


                    LAYER  9
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                      =    240.00   INCHES
POROSITY                       =      0.7630 VOL/VOL
FIELD CAPACITY                 =      0.2440 VOL/VOL
WILTING POINT                  =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC
```

```
                    LAYER 10
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                      =    240.00    INCHES
POROSITY                       =      0.7630 VOL/VOL
FIELD CAPACITY                 =      0.2440 VOL/VOL
WILTING POINT                  =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC


                    LAYER 11
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                      =    240.00    INCHES
POROSITY                       =      0.7630 VOL/VOL
FIELD CAPACITY                 =      0.2440 VOL/VOL
WILTING POINT                  =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC


                    LAYER 12
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                      =    240.00    INCHES
POROSITY                       =      0.7630 VOL/VOL
FIELD CAPACITY                 =      0.2440 VOL/VOL
WILTING POINT                  =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC
```

```
                    LAYER 13
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                      =     240.00    INCHES
POROSITY                       =       0.7630 VOL/VOL
FIELD CAPACITY                 =       0.2440 VOL/VOL
WILTING POINT                  =       0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =       0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC

                    LAYER 14
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                      =      12.00    INCHES
POROSITY                       =       0.7630 VOL/VOL
FIELD CAPACITY                 =       0.2440 VOL/VOL
WILTING POINT                  =       0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =       0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC

                    LAYER 15
                    --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER    2
THICKNESS                      =       6.00    INCHES
POROSITY                       =       0.4370 VOL/VOL
FIELD CAPACITY                 =       0.0620 VOL/VOL
WILTING POINT                  =       0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT     =       0.0620 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.579999993000E-02 CM/SEC
```

LAYER 16

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	12.00	INCHES
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0320	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	100.0	FEET

LAYER 17

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	8.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 18

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.24	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	69.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	18.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.843	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.866	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.846	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	531.929	INCHES
TOTAL INITIAL WATER	=	531.929	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
PLYMOUTH NORTH CAROLINA

MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	94	
END OF GROWING SEASON (JULIAN DATE)	=	311	
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	77.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA WAS ENTERED MANUALLY FOR PLYMOUTH, NC ~~SYNTHETICALLY GENERATED USING COEFFICIENTS FOR NORFOLK VIRGINIA~~

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.17	3.98	4.18	3.14	4.66	4.53
6.30	5.85	4.62	3.35	3.10	3.32

NOTE: TEMPERATURE DATA WAS ~~SYNTHETICALLY GENERATED USING~~ ENTERED MANUALLY FOR PLYMOUTH, NC
~~COEFFICIENTS FOR NORFOLK VIRGINIA~~

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
42.10	43.90	50.90	60.30	67.70	74.30
78.00	77.30	72.00	61.50	52.40	44.60

NOTE: SOLAR RADIATION DATA WAS ~~SYNTHETICALLY GENERATED USING~~ ENTERED MANUALLY FOR PLYMOUTH, NC
~~COEFFICIENTS FOR NORFOLK VIRGINIA~~

STATION LATITUDE = 35.87 DEGREES

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*

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

-

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.42	3.66	4.52	2.76	4.19	5.02
	7.36	7.52	4.98	2.34	2.74	3.83

STD. DEVIATIONS	2.25	1.38	1.86	1.27	1.84	2.52
	3.32	3.06	2.72	1.33	1.43	1.73

RUNOFF

TOTALS	0.000	0.002	0.003	0.000	0.003	0.000
	0.055	0.084	0.040	0.001	0.000	0.000
STD. DEVIATIONS	0.000	0.007	0.009	0.000	0.013	0.002
	0.167	0.154	0.080	0.004	0.001	0.000

EVAPOTRANSPIRATION

TOTALS	0.393	0.412	0.821	0.387	0.575	0.691
	1.110	1.335	0.912	0.423	0.249	0.362
STD. DEVIATIONS	0.260	0.183	0.656	0.257	0.323	0.395
	0.962	0.855	0.730	0.450	0.165	0.156

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	3.0284	3.0635	3.8824	2.3827	3.6157	4.3462
	5.9440	6.0005	4.1852	2.1082	2.4821	3.4523
STD. DEVIATIONS	2.0589	1.3199	1.7201	1.0839	1.6026	2.1533
	2.3809	2.3571	2.1724	1.1517	1.2810	1.6146

PERCOLATION/LEAKAGE THROUGH LAYER 4

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

LATERAL DRAINAGE COLLECTED FROM LAYER 16

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 18

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 ACROSS LAYER 4

AVERAGES	0.0004	0.0005	0.0005	0.0004	0.0005	0.0007
	0.0008	0.0009	0.0006	0.0003	0.0004	0.0005
STD. DEVIATIONS	0.0003	0.0002	0.0002	0.0002	0.0002	0.0003
	0.0004	0.0004	0.0003	0.0002	0.0002	0.0003

DAILY AVERAGE HEAD ACROSS LAYER 18

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

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

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	INCHES		CU. FEET	PERCENT
PRECIPITATION	52.35	(8.675)	190032.3	100.00
RUNOFF	0.189	(0.2603)	685.86	0.361

EVAPOTRANSPIRATION	7.668	(2.0260)	27836.03	14.648
LATERAL DRAINAGE COLLECTED FROM LAYER 2	44.49126	(7.11093)	161503.266	84.98726
PERCOLATION/LEAKAGE THROUGH FROM LAYER 4	0.00000	(0.00000)	0.002	0.00000
AVERAGE HEAD ACROSS TOP OF LAYER 4	0.001	(0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 16	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH FROM LAYER 18	0.00000	(0.00000)	0.002	0.00000
AVERAGE HEAD ACROSS TOP OF LAYER 18	0.000	(0.000)		
CHANGE IN WATER STORAGE	0.002	(0.0593)	7.15	0.004

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	5.73	20799.900
RUNOFF	0.720	2612.8420
DRAINAGE COLLECTED FROM LAYER 2	3.36662	12220.84770
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000000	0.00005
AVERAGE HEAD ACROSS LAYER 4	0.017	
DRAINAGE COLLECTED FROM LAYER 16	0.00000	0.00001

PERCOLATION/LEAKAGE THROUGH LAYER 18	0.000000	0.00002
AVERAGE HEAD ACROSS LAYER 18	0.000	
SNOW WATER	2.95	10713.2930

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2745

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0411

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	0.8826	0.0490
2	0.0020	0.0100
3	0.0000	0.0000
4	0.1800	0.7500
5	58.5600	0.2440
6	58.5600	0.2440
7	58.5600	0.2440
8	58.5600	0.2440
9	58.5600	0.2440
10	58.5600	0.2440
11	58.5600	0.2440

12	58.5600	0.2440
13	58.5600	0.2440
14	2.9280	0.2440
15	0.3720	0.0620
16	0.3840	0.0320
17	0.0000	0.0000
18	0.1800	0.7500
SNOW WATER	0.000	

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      H:\DATA\COMMON\KORLESKS\HELP\DATA4.D4
TEMPERATURE DATA FILE:        H:\DATA\COMMON\KORLESKS\HELP\DATA7.D7
SOLAR RADIATION DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA13.D13
EVAPOTRANSPIRATION DATA:      H:\DATA\COMMON\KORLESKS\HELP\DATA11.D11
SOIL AND DESIGN DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA10.D10
OUTPUT DATA FILE:             H:\DATA\COMMON\KORLESKS\HELP\TESTOUT.OUT


TIME:  14:38     DATE:   8/31/1999


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

     TITLE:  WEYERHAEUSER PLYMOUTH/POST CLOSURE/ TOP OF THE LANDFILL

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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
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                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   4
  THICKNESS                      =      18.00   INCHES
  POROSITY                       =       0.4370 VOL/VOL
  FIELD CAPACITY                 =       0.1050 VOL/VOL
  WILTING POINT                  =       0.0470 VOL/VOL
  INITIAL SOIL WATER CONTENT     =       0.0468 VOL/VOL
  EFFECTIVE SAT. HYD. COND.      =  0.170000002000E-02 CM/SEC
NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
         FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                          LAYER  2
                          --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                    MATERIAL TEXTURE NUMBER  20
  THICKNESS                      =       0.20   INCHES
  POROSITY                       =       0.8500 VOL/VOL
  FIELD CAPACITY                 =       0.0100 VOL/VOL
  WILTING POINT                  =       0.0050 VOL/VOL
  INITIAL SOIL WATER CONTENT     =       0.0100 VOL/VOL
  EFFECTIVE SAT. HYD. COND.      =   10.0000000000      CM/SEC
  SLOPE                          =       5.00   PERCENT
  DRAINAGE LENGTH                =     150.0    FEET


                          LAYER  3
                          --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                    MATERIAL TEXTURE NUMBER  35
  THICKNESS                      =       0.04   INCHES
  POROSITY                       =       0.0000 VOL/VOL
  FIELD CAPACITY                 =       0.0000 VOL/VOL
  WILTING POINT                  =       0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT     =       0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.      =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY            =       1.00   HOLES/ACRE
  FML INSTALLATION DEFECTS       =       8.00   HOLES/ACRE
  FML PLACEMENT QUALITY          =  3 - GOOD
```

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                    LAYER  4
                    --------

          TYPE 3 - BARRIER SOIL LINER
          MATERIAL TEXTURE NUMBER  17
THICKNESS                    =      0.24    INCHES
POROSITY                     =      0.7500 VOL/VOL
FIELD CAPACITY               =      0.7470 VOL/VOL
WILTING POINT                =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC


                    LAYER  5
                    --------

        TYPE 1 - VERTICAL PERCOLATION LAYER
          MATERIAL TEXTURE NUMBER   0
THICKNESS                    =    240.00    INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                    LAYER  6
                    --------

        TYPE 1 - VERTICAL PERCOLATION LAYER
          MATERIAL TEXTURE NUMBER   0
THICKNESS                    =    240.00    INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC
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                    LAYER  7
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =    240.00   INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                    LAYER  8
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =    240.00   INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                    LAYER  9
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =    240.00   INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC
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                    LAYER 10
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                      =    240.00    INCHES
POROSITY                       =      0.7630 VOL/VOL
FIELD CAPACITY                 =      0.2440 VOL/VOL
WILTING POINT                  =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC


                    LAYER 11
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                      =    240.00    INCHES
POROSITY                       =      0.7630 VOL/VOL
FIELD CAPACITY                 =      0.2440 VOL/VOL
WILTING POINT                  =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC


                    LAYER 12
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER    0
THICKNESS                      =    240.00    INCHES
POROSITY                       =      0.7630 VOL/VOL
FIELD CAPACITY                 =      0.2440 VOL/VOL
WILTING POINT                  =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999975000E-05 CM/SEC
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```
                    LAYER 13
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =    240.00   INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                    LAYER 14
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     12.00   INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                    LAYER 15
                    --------

          TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   2
THICKNESS                    =      6.00   INCHES
POROSITY                     =      0.4370 VOL/VOL
FIELD CAPACITY               =      0.0620 VOL/VOL
WILTING POINT                =      0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0620 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.579999993000E-02 CM/SEC
```

LAYER 16

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	12.00	INCHES
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0320	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	100.0	FEET

LAYER 17

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	8.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 18

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.24	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	69.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	18.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.843	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.866	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.846	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	531.929	INCHES
TOTAL INITIAL WATER	=	531.929	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
PLYMOUTH NORTH CAROLINA

MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	94	
END OF GROWING SEASON (JULIAN DATE)	=	311	
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	77.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA WAS ~~SYNTHETICALLY GENERATED USING~~ ENTERED MANUALLY FOR PLYMOUTH, NC
~~COEFFICIENTS FOR NORFOLK VIRGINIA~~

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.17	3.98	4.18	3.14	4.66	4.53
6.30	5.85	4.62	3.35	3.10	3.32

NOTE: TEMPERATURE DATA WAS ~~SYNTHETICALLY GENERATED USING COEFFICIENTS FOR NORFOLK VIRGINIA~~ ENTERED MANUALLY FOR PLYMOUTH, NC

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
42.10	43.90	50.90	60.30	67.70	74.30
78.00	77.30	72.00	61.50	52.40	44.60

NOTE: SOLAR RADIATION DATA WAS ~~SYNTHETICALLY GENERATED USING COEFFICIENTS FOR NORFOLK VIRGINIA~~ ENTERED MANUALLY FOR PLYMOUTH, NC

STATION LATITUDE = 35.87 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

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	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.42	3.66	4.52	2.76	4.19	5.02
	7.36	7.52	4.98	2.34	2.74	3.83

STD. DEVIATIONS	2.25	1.38	1.86	1.27	1.84	2.52
	3.32	3.06	2.72	1.33	1.43	1.73

RUNOFF

TOTALS	0.000	0.002	0.002	0.000	0.003	0.000
	0.056	0.084	0.040	0.001	0.000	0.000
STD. DEVIATIONS	0.000	0.005	0.007	0.000	0.013	0.001
	0.168	0.154	0.080	0.004	0.001	0.000

EVAPOTRANSPIRATION

TOTALS	0.390	0.407	0.597	0.406	0.604	0.680
	1.135	1.151	0.856	0.409	0.236	0.334
STD. DEVIATIONS	0.246	0.181	0.250	0.291	0.337	0.420
	1.011	0.781	0.736	0.377	0.142	0.156

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	3.0264	3.1898	4.0023	2.3504	3.5929	4.3555
	5.9262	6.1887	4.2237	2.1278	2.4988	3.4728
STD. DEVIATIONS	2.0555	1.2760	1.7310	0.9970	1.5845	2.1399
	2.1998	2.3376	2.2198	1.1525	1.3123	1.6242

PERCOLATION/LEAKAGE THROUGH LAYER 4

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

LATERAL DRAINAGE COLLECTED FROM LAYER 16

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 18

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 ACROSS LAYER 4

AVERAGES	0.0052	0.0060	0.0068	0.0042	0.0061	0.0077
	0.0103	0.0123	0.0088	0.0036	0.0044	0.0059
STD. DEVIATIONS	0.0035	0.0024	0.0030	0.0018	0.0027	0.0038
	0.0042	0.0084	0.0072	0.0020	0.0023	0.0028

DAILY AVERAGE HEAD ACROSS LAYER 18

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

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES		CU. FEET	PERCENT
PRECIPITATION	52.35	(8.675)	190032.3	100.00
RUNOFF	0.189	(0.2608)	684.79	0.360

EVAPOTRANSPIRATION	7.205	(2.2178)	26152.52	13.762
LATERAL DRAINAGE COLLECTED FROM LAYER 2	44.95533	(7.21510)	163187.844	85.87373
PERCOLATION/LEAKAGE THROUGH FROM LAYER 4	0.00000	(0.00000)	0.009	0.00000
AVERAGE HEAD ACROSS TOP OF LAYER 4	0.007	(0.001)		
LATERAL DRAINAGE COLLECTED FROM LAYER 16	0.00000	(0.00000)	0.005	0.00000
PERCOLATION/LEAKAGE THROUGH FROM LAYER 18	0.00000	(0.00000)	0.004	0.00000
AVERAGE HEAD ACROSS TOP OF LAYER 18	0.000	(0.000)		
CHANGE IN WATER STORAGE	0.002	(0.0682)	7.17	0.004

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	5.73	20799.900
RUNOFF	0.720	2612.8420
DRAINAGE COLLECTED FROM LAYER 2	3.22145	11693.86330
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000001	0.00206
AVERAGE HEAD ACROSS LAYER 4	0.680	
DRAINAGE COLLECTED FROM LAYER 16	0.00000	0.00149

PERCOLATION/LEAKAGE THROUGH LAYER 18	0.000000	0.00002
AVERAGE HEAD ACROSS LAYER 18	0.000	
SNOW WATER	2.95	10713.2930

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2745

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0389

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	0.8827	0.0490
2	0.0020	0.0100
3	0.0000	0.0000
4	0.1800	0.7500
5	58.5600	0.2440
6	58.5600	0.2440
7	58.5600	0.2440
8	58.5600	0.2440
9	58.5600	0.2440
10	58.5600	0.2440
11	58.5600	0.2440

12	58.5600	0.2440
13	58.5600	0.2440
14	2.9280	0.2440
15	0.3720	0.0620
16	0.3840	0.0320
17	0.0000	0.0000
18	0.1800	0.7500
SNOW WATER	0.000	

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Attachment G3
Projected Leachate Generation Rates

AVERAGE DAILY PROJECTED LEACHATE GENERATION VOLUMES 9/9/99
WEYERHAEUSER NO. 3 LANDFILL, PLYMOUTH, NORTH CAROLINA RMT JOB NO. 5101.01

PHASE	AREA (acres)	AVERAGE HEIGHT WHEN FULL (ft.)	VOLUME/ACRE FULL LANDFILL (gpd/ac)	VOLUME /ACRE OPEN LANDFILL (gpd/ac)	VOLUME/PHASE FULL LANDFILL (gpd/phase)	VOLUME /PHASE OPEN LANDFILL (gpd/phase)	TOTAL VOLUME/ PHASE OF LANDFILL (gpd/phase)
1	14.36	41	1,512	1,531	21,712	21,985	43,927
2	14.51	41	1,512	1,531	21,939	22,215	30,620
3	5.67	81	1,439	1,531	8,159	8,681	17,070
4	5.82	111	1,381	1,531	8,037	8,910	16,688
5	5.65	131	1,343	1,531	7,588	8,650	15,917
6	5.44	161	1,207	1,531	6,566	8,329	14,895
7	5.44	181	1,246	1,531	6,778	8,329	14,724
8	5.19	161	1,207	1,531	6,264	7,946	13,246
9	4.56	121	1,362	1,531	6,211	6,981	14,631
10	5.5	111	1,381	1,531	7,596	8,421	15,419
11	5.11	81	1,439	1,531	7,353	7,823	11,319
12	2.59	81	1,439	1,531	3,727	3,965	7,524
13	2.48	81	1,439	1,531	3,569	3,797	7,350
14	2.47	81	1,439	1,531	3,554	3,782	7,259
15	2.42	81	1,439	1,531	3,482	3,705	7,141
16	2.39	81	1,439	1,531	3,439	3,659	7,006
17	2.33	81	1,439	1,531	3,353	3,567	7,732
18	2.86	41	1,512	1,531	4,324	4,379	4,324

NOTES: *Leachate generation rates are estimated based on HELP model results. If the landfill final design, construction, phasing, or operation is different than the parameters used to develop these projections, the leachate generation rate projections could be significantly affected.*

The "TOTAL" volume of leachate generated under a particular phase is the sum of the volumes from the previous phase---POST-CLOSURE; the referenced phase---FULL; and the subsequent phase---OPEN.

The "OPEN" status assumes 2 feet of waste is covering the bottom of the landfill phase.

The "FULL" status assumes the referenced phase is full of waste. The volume of leachate is based on an estimated average thickness of waste in each phase, just prior to closure.

The "POST-CLOSURE" status assumes the waste in the referenced phase has been capped. The leachate generation rates during post-closure were assumed negligible for these calculations, when compared to the leachate generation rates of the open and full landfill phase.

EXAMPLE: *Determine the "average" daily leachate generated during Phase 2, just prior to capping Phase 2. Note that at that time Phase 3 would be open and operating.*

Phase 1	closed	-	(gpd/phase)
Phase 2	full	21,939	(gpd/phase)
Phase 3	open	8,681	(gpd/phase)
	TOTAL	**30,620**	(gpd/phase)

PEAK DAILY PROJECTED LEACHATE GENERATION VOLUMES 9/9/99
WEYERHAEUSER NO. 3 LANDFILL, PLYMOUTH, NORTH CAROLINA RMT JOB NO. 5101.01

PHASE	AREA (acres)	AVERAGE HEIGHT WHEN FULL (ft.)	VOLUME/ACRE FULL LANDFILL (gpd/ac)	VOLUME /ACRE OPEN LANDFILL (gpd/ac)	VOLUME/PHASE FULL LANDFILL (gpd/phase)	VOLUME /PHASE OPEN LANDFILL (gpd/phase)	TOTAL VOLUME/ PHASE OF LANDFILL (gpd/phase)
1	14.36	41	8,235	9,238	118,255	132,658	252,298
2	14.51	41	8,235	9,238	119,490	134,043	171,869
3	5.67	81	7,495	9,238	42,497	52,379	96,262
4	5.82	111	7,679	9,238	44,692	53,765	96,886
5	5.65	131	7,189	9,238	40,618	52,195	90,873
6	5.44	161	7,005	9,238	38,107	50,255	88,362
7	5.44	181	6,882	9,238	37,438	50,255	85,383
8	5.19	161	7,005	9,238	36,356	47,945	78,481
9	4.56	121	7,434	9,238	33,899	42,125	84,708
10	5.5	111	7,679	9,238	42,235	50,809	89,441
11	5.11	81	7,495	9,238	38,299	47,206	62,226
12	2.59	81	7,495	9,238	19,412	23,926	42,322
13	2.48	81	7,495	9,238	18,588	22,910	41,405
14	2.47	81	7,495	9,238	18,513	22,818	40,869
15	2.42	81	7,495	9,238	18,138	22,356	40,217
16	2.39	81	7,495	9,238	17,913	22,079	39,438
17	2.33	81	7,495	9,238	17,463	21,525	43,884
18	2.86	41	8,235	9,238	23,552	26,421	23,552

NOTES: *Leachate generation rates are estimated based on HELP model results. If the landfill final design, construction, phasing, or operation is different than the parameters used to develop these projections, the leachate generation rate projections could be significantly affected.*

The "TOTAL" volume of leachate generated under a particular phase is the sum of the volumes from the previous phase---POST-CLOSURE; the referenced phase---FULL; and the subsequent phase---OPEN.

The "OPEN" status assumes 2 feet of waste is covering the bottom of the landfill phase.

The "FULL" status assumes the referenced phase is full of waste. The volume of leachate is based on an estimated average thickness of waste in each phase, just prior to closure.

The "POST-CLOSURE" status assumes the waste in the referenced phase has been capped. The leachate generation rates during post-closure were assumed negligible for these calculations, when compared to the leachate generation rates of the open and full landfill phase.

EXAMPLE: *Determine the "peak" daily leachate generated during Phase 2, just prior to capping Phase 2. Note that at that time Phase 3 would be open and operating.*

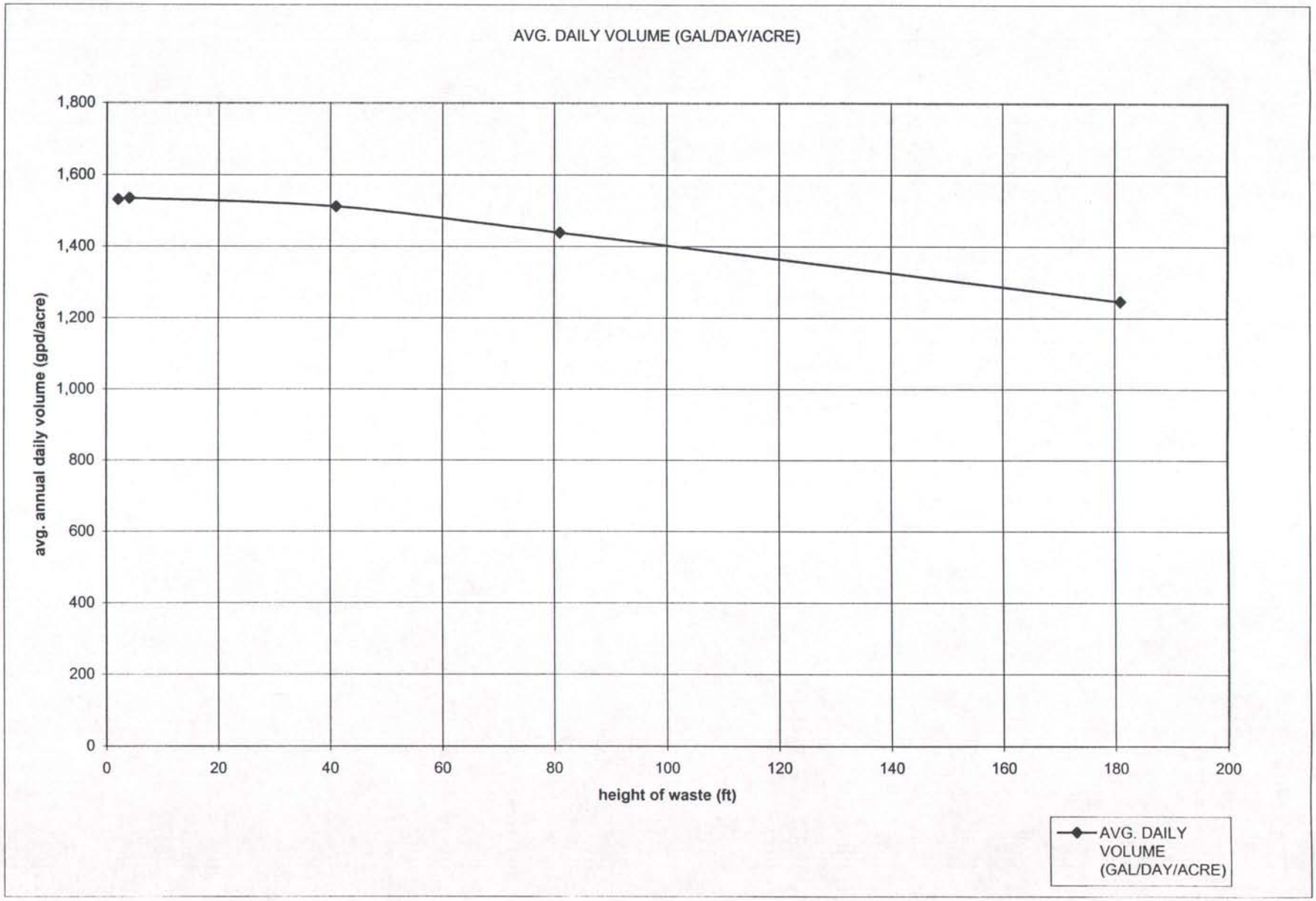
Phase 1	closed	-	(gpd/phase)
Phase 2	full	119,490	(gpd/phase)
Phase 3	open	52,379	(gpd/phase)
	TOTAL	**171,869**	(gpd/phase)

Weyerhaeuser Plymouth
Help Model Results

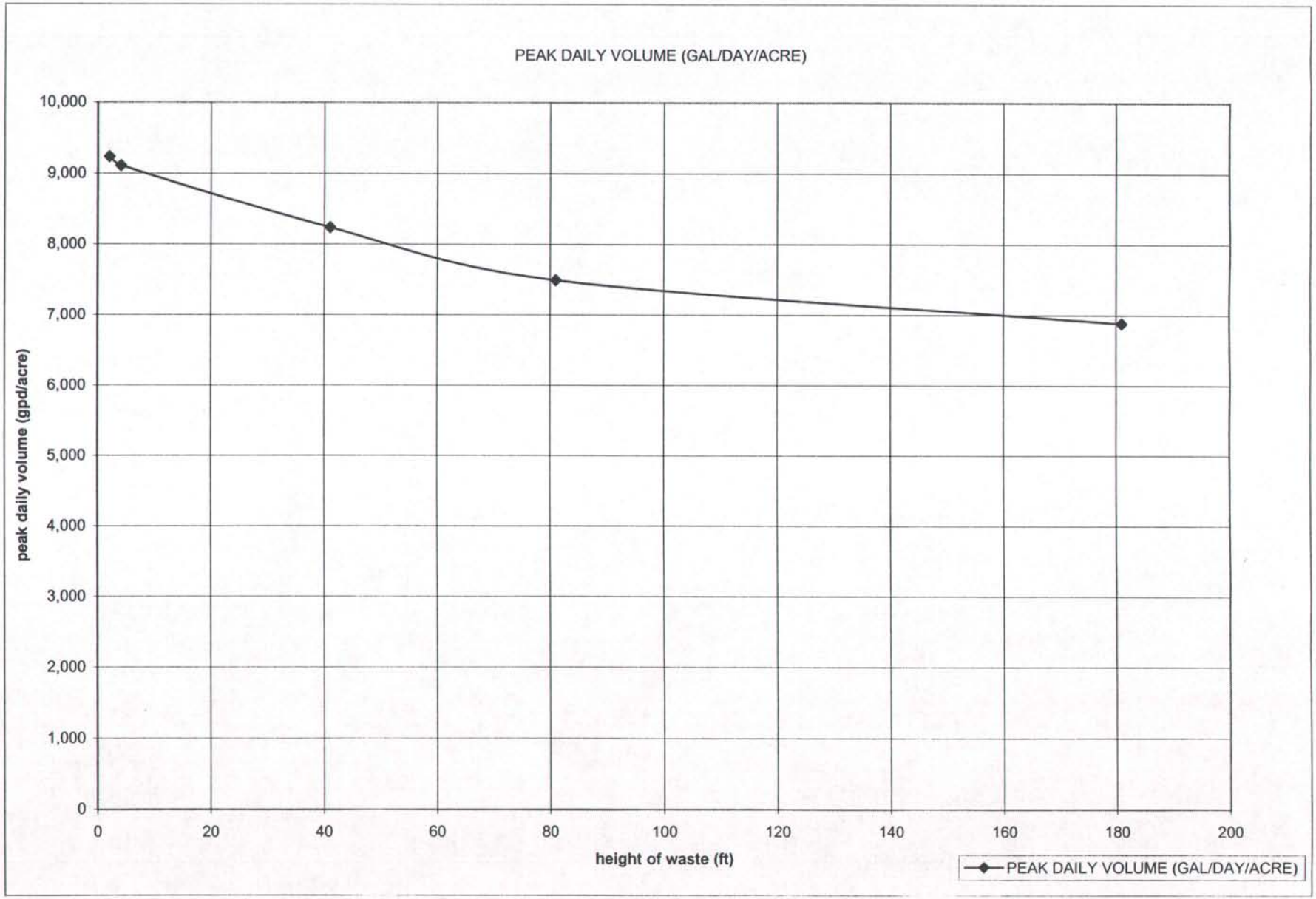
9/8/99

	OPEN LANDFILL:					CLOSED LANDFILL:	
Leachate Collection	waste height (feet)					waste height (feet)	
HT. OF WASTE (FT)	2	4	41	81	181	181	181
AVG. ANNUAL VOL.(CF/AC)	74,717	74,891	73,759	70,202	60,820	0.005	0.000
AVG. DAILY VOLUME (GAL/DAY/ACRE)	1,531	1,535	1,512	1,439	1,246	0.000	0.000
PEAK DAILY VOL. (CF/AC)	1,235	1,218	1,101	1,002	920	0.00150	0.00002
PEAK DAILY VOLUME (GAL/DAY/ACRE)	9,238	9,111	8,235	7,495	6,882	0.01122	0.00015

HELP MODEL RESULTS
CHART 1



HELP MODEL RESULTS
CHART 2



Attachment G4
Mass Balance Calculations for Liner Design of Landfill No. 3 Technical Memorandum dated September 27, 1999 (including Responses to NC DENR letter dated April 29, 1999)

Technical Memorandum

Date: September 27, 1999

To: Mr. Wynne Shaw - Weyerhaeuser

cc: Mac Jones, Joe Kloeker - Weyerhaeuser
Kathy Huibregtse, Dan Madison, Kent Nilsson - RMT

From: Jon Freitag/Sharon Korleski

Project No: 00-05101.01

Subject: Mass Balance Calculations for Liner Design of Landfill No. 3

Summary of Calculations

Mass balance calculations were used to evaluate the effectiveness of one liner design of Landfill No. 3 at the Weyerhaeuser facility in Plymouth, North Carolina. The concentrations of the constituents measured in waste stream Toxicity Characteristic Leaching Procedure (TCLP) tests were used in the calculations. Other parameter values were assigned conservatively or based upon available data. The calculated leachate concentrations were adjusted to account for mixing in the top 3.32 feet of aquifer thickness once the leachate percolated to groundwater. This volumetric rate suggests that the leachate concentration must be three orders of magnitude higher than the NCAC 2L standard to cause an exceedance. Based upon this rate, none of the leachate concentrations were high enough to exceed this threshold.

Calculations

Mass balance calculations allow a constituent concentration in groundwater to be calculated based on the rate of constituent mass being moved into the aquifer and mixing with unaffected groundwater. Mass balance calculations were used to demonstrate that the liner design of Landfill No. 3 at the Weyerhaeuser facility in Plymouth, North Carolina, would be protective of groundwater quality.

The following equation was used to perform the mass balance calculations:

$$C_{GW} = \frac{(Q_R)(C_P) + (Q_{GW})(C_a)}{Q_R + Q_{GW}}$$

Where:	C_{GW}	-	Constituent concentration in groundwater
	Q_R	-	Volumetric discharge through the landfill liner ($Q_R = rA_1$)
	A_1	-	Phase 1 Landfill area (21.1 acres)
	r	-	Recharge to the aquifer through the landfill liner
	C_P	-	Constituent concentration in leachate
	Q_{GW}	-	Volumetric discharge of groundwater moving beneath the landfill ($Q_{GW} = Kdh/dxA_2$)
	K	-	Hydraulic conductivity of the shallow aquifer unit
	dh/dx	-	Hydraulic gradient in the direction of groundwater flow
	A_2	-	Cross sectional area perpendicular to groundwater flow ($A_2 = wb$)
	w	-	Width of the Phase 1 Landfill
	b	-	Mixing zone thickness (generally, equivalent to aquifer thickness)
	C_a	-	Constituent concentration in groundwater upgradient from landfill

Parameter values were assigned conservatively and were obtained from existing data. Assignment of input parameters is discussed below.

Waste Characteristics

The pulp and paper production process results in various nonhazardous solid wastes, such as ash, dewatered secondary sludge, paper wastes, old corrugated container (OCC) rejects, green liquor dregs, slaker grits, lime mud, wood waste, and miscellaneous trash. Each of the above wastes was determined to be nonhazardous using the TCLP. Results of the TCLP tests indicate minor amounts of metals and volatile organic compounds (VOCs) leach from the waste. Analytical results from TCLP tests are presented in Table 1 (Attachment 1). Leachate constituent concentrations were assigned based on the TCLP data.

Landfill Footprint

The Phase 1 portion of Landfill No. 3 is located at the north end of the landfill. This phase has been designed to contain the production waste stream for a 5-year period. The design area of the Phase 1 landfill footprint is 14.37 acres. The landfill footprint is illustrated in Attachment 2.

Liner Leakage Rate

Recharge from the landfill liner was estimated using the United States Environmental Protection Agency (USEPA) Hydrologic Evaluation of Landfill Performance (HELP) model for a single composite liner design. The HELP model was developed by the US Army Engineer Waterways Experiment Station in Vicksburg, Mississippi (Schroeder, *et al.*, 1994, Version 3) to estimate the surface runoff, subsurface drainage, and leachate from various solid waste disposal facility designs. These calculated amounts are simulated by interpreting the combined effects of precipitation, surface storage, runoff, infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage. Input parameters used in the HELP model are provided in Attachments 3 and 4. Our modeling assumed the liner was installed with "good" quality control, producing a maximum of 8 holes per acre. This HELP model resulted in an average annual percolation or leakage rate through the bottom of the landfill of 0.208 cubic feet/acre/year. This was used in the mass balance calculations for the liner design. The HELP model data are provided in Attachment 5.

Subsurface Conditions

The hydrogeologic setting is illustrated on the Data Point Location Map and Geologic Cross Sections, which are provided as Attachments 6 through 8. Raw historical groundwater levels in summary tables are provided in Attachment 9. Note that the "LF" designations on the tables and the hydrographs are the same as "MW" designations on the site plans and associated documents. The "LFO" designations on the tables and the hydrographs are the same as the "OW" designations on the site plans and associated documents. The hydrogeologic setting consists of two aquifer units separated by an aquitard unit that appears to be laterally extensive throughout the site. The lower aquifer primarily consists of silty sand and exists under confined conditions. The shallow aquifer unit is unconfined and consists of silty sand with interbedded clay and clayey sand. Four shallow groundwater monitoring wells, OW-4, OW-5, OW-6, and OW-7, are located in the vicinity of the Phase 1 landfill. Boring logs and well construction diagrams for these four monitoring wells are provided in Attachments 10 and 11. The typical saturated thickness of the shallow aquifer unit, in the vicinity of the Phase 1 landfill,

is approximately 10 feet. The base of the Phase 1 landfill will be positioned above the water table in the shallow aquifer unit. Attachment 2 illustrates the locations of monitoring wells OW-4, OW-5, OW-6, and OW-7 in relation to the Phase 1 landfill footprint.

Groundwater Flow

The configuration of the water table in the shallow aquifer unit can generally be characterized as a groundwater divide with radial flow to the north, west, and east. The main axis of groundwater flow in the vicinity of the Phase 1 landfill is to the north. The hydraulic gradient along the main axis of flow, as mapped in 1993, is 0.013 ft/ft. The water table configuration as mapped in 1993 is illustrated in Attachment 2.

Hydraulic conductivity estimates for monitoring wells OW-4 through OW-7 were calculated from *in-situ* hydraulic conductivity tests using the Bouwer-Rice (1976) solution. The geometric mean of these estimates is 2.44×10^{-4} cm/sec. The hydraulic conductivity test data and results are provided as Attachment 12.

Mixing Zone Geometry

The mixing zone thickness was assigned conservatively as 33 percent of the calculated mixing zone thickness. The width of the mixing zone is 535 feet, which is the maximum width of the Phase 1 landfill. The resulting cross sectional area, perpendicular to groundwater flow is 1,771 ft^2. Groundwater migrating into the mixing zone is assumed to be unaffected.

Estimating the mixing zone thickness involved two steps:

1. Calculating the dispersion coefficient, and
2. Calculating the variance in constituent concentrations following migration beneath the Phase 1 footprint.

The dispersion coefficient was calculated using the average linear groundwater velocity and a dispersivity estimate. Dispersivity was assigned conservatively, using a discrete estimate for silty sand, rather than using an effective estimate. The difference in these two estimates is that an effective estimate is larger because it accounts for larger scale heterogeneities in aquifer material that cause greater variation in groundwater velocities on a pore scale. Discrete estimates are smaller, only accounting for variations in groundwater velocities within one material type, which results in less spreading of constituent mass. By using discrete estimates, the degree of spreading is smaller, resulting in a smaller mixing zone. The vertical dispersivity

estimate used was 0.005 feet (Garabedian *et al.*, 1991 and LeBlanc *et al.*, 1991). Effective estimates can be on the order of single feet in calibrated transport models. The average linear groundwater velocity calculation is discussed above.

The variance in constituent concentrations as a function of transport distance generally exhibits a normal distribution, allowing the dispersion coefficient to be related to the variance. A standard deviation can be calculated from the variance, which in turn can be used to estimate the mixing zone thickness. A variance (in the vertical direction) of 11 feet was calculated at 26,894 days. This is the number of days for the center of mass to migrate the length of the Phase 1 footprint (1,100 feet) based on the average linear groundwater velocity. A standard deviation of 3.32 feet was calculated from the variance. Because three standard deviations will encompass more than 99 percent of the constituents with a normal distribution, the mixing zone thickness would be 9.96 feet. The actual mixing zone thickness used in the mass balance calculations was 3.32 feet, which is 33 percent of the estimated mixing zone thickness. The 3.32 feet was chosen for the mixing zone thickness, so that mass balance calculations would be conservative, only accounting for the mixing zone thickness containing 68 percent of constituent mass. Mixing zone thickness calculations are presented in Attachment 14.

Mass Balance Calculations

Parameters used in the mass balance calculations were based on available data or assigned conservatively if no data were available. Parameters include constituent leachate concentrations, hydraulic conductivity, hydraulic gradient, landfill liner leakage rate, mixing zone thickness, and geometry of the Phase 1 footprint. Constituent leachate concentrations were assigned based on the results of waste stream TCLP tests. Hydraulic conductivity was assigned based on the geometric mean of hydraulic conductivity estimates for OW-4 through OW-7, calculated using the Bouwer and Rice (1976) solution for unconfined *in-situ* hydraulic conductivity tests. The hydraulic gradient was measured from the water table configuration, as mapped in April 1993, along the primary axis of flow, in the area of the Phase 1 footprint. The landfill liner leakage rate was based on the results of HELP model simulations. The mixing zone thickness was assigned as 3.32 feet, which is 33 percent of the calculated mixing zone thickness after 1,100 feet of migration (approximate length of the Phase 1 footprint). The supporting calculations for the mixing zone thickness are provided as Attachment 13. The geometry of the landfill footprint is based on the design as depicted in Attachment 2.

Manganese was the most common constituent identified in the TCLP data and also exceeded its NCAC 2L standard by the greatest magnitude. This constituent was therefore used as an indicator of the effectiveness of the landfill liner design. Given the amount of leachate estimated to percolate through the liner and mixing within the upper 3.32 feet of the aquifer, the resulting manganese concentration in groundwater would be 7.58×10^{-3} mg/L, compared to the NCAC 2L standard of 0.05 mg/L. Calculations are provided as Attachment 13.

The ratio of the leachate concentration to the NCAC 2L standard was calculated using the groundwater and leachate volumetric flow rates. This ratio demonstrates that the leachate concentration must be approximately three orders of magnitude greater than the NCAC 2L standard in order for the standard to be exceeded in groundwater following mixing. For example, a leachate concentration of 99 mg/L (for manganese) would be required for the 0.05 mg/L, NCAC 2L standard to be exceeded after mixing. The leachate concentration: 2L standard ratio, when compared to the TCLP data collected from waste samples, indicate that leachate concentrations are not great enough to exceed NCAC 2L standards for any of the samples.

The results of the mass balance calculations indicate a single composite liner with "good" quality control will be protective of groundwater. The leakage rate through the single composite liner increased to 4.71×10^{-6} feet per year from 1.38×10^{-7} feet per year with a dual composite liner design (See RMT Letter Report, January 1999). The increased leakage rate resulted in an increase in the volumetric flux through the liner; however, the volumetric flux through the single composite liner remained small in comparison to the volumetric flux of groundwater through the mixing zone. The volumetric flux through the mixing zone is four orders of magnitude larger than the volumetric flux through the single composite liner. The constituent concentration to NCAC 2L ratio protective of groundwater decreased from 2.19×10^{4} to 1.98×10^{3}, resulting from the change in liner design. Mass balance calculations from the dual composite liner design are included in Attachment 13 for comparison with the calculations with the single composite liner.

RMT's Response to NC DENR Comments Dated April 29, 1999

NC DENR Comment

There appears to be an error on page 2 for the unit between the geocomposite drainage layer and the geosynthetic clay liner.

RMT Response

The proposed liner system has since been changed from a double composite liner to a single composite liner. Therefore, the leak detection layer geocomposite, the secondary geomembrane liner and secondary GCL liner have been omitted from the design. The HELP model and mass balance calculations have been revised accordingly.

NC DENR Comment

Please expand on the comment in the cover letter to Cheryl Marks dated January 21, 1999, that the primary liner was considered a single liner.

RMT Response

The HELP model can only analyze landfill models with up to five barrier layers. Since the originally proposed landfill design included a double composite liner and single composite cap (a total of six barrier layers), the primary GCL liner was omitted in the original HELP model. This provided more conservative results. Since then, the landfill design and HELP model have been revised. See the previous comment. The new cover letter was revised accordingly.

NC DENR Comment

Typically 8 holes per acre is the minimum input parameter required when using the HELP model for the installed liner.

RMT Response

The HELP model was revised using 8 holes per acre for the installed liner, per NC DENR recommendation.

NC DENR Comment

Why was two feet of waste chosen for the HELP model input parameter?

RMT Response

The design requires that no less than 1 foot of select ash waste be placed over the sand filter layer of the leachate collection system. The select ash will be placed immediately following placement of the sand. Since the waste will typically be place in 2-foot to 3-foot thick lifts, 2 feet of waste was selected as a conservative thickness for the HELP model input parameter.

NC DENR Comment

How was evaporative zone depth of 22 inches chosen?

RMT Response

This was revised to 13 inches for the open landfill and 18 inches for the closed landfill. Although 22 inches was recommended for an evaporative zone for the closed landfill, in this geographical location, the depth was limited to 18 inches since the vegetation layer itself is only 18 inches thick over the geomembrane barrier. For the open landfill condition, our modeling assumed the ash layer in the upper level of the waste would be generally silt size particles. The HELP model for silt size soil recommended an evaporative zone depth of 8 to 18 inches; therefore, an average value of 13 inches was used for the waste material in the open landfill analysis.

NC DENR Comment

Is the leakage rate near steady state?

RMT Response

Yes. An average annual rate over a period of 20 years was used.

NC DENR Comment

The HELP model requires climatological data to generate the leakage/percolation values. It appears evapotranspiriation and weather data were obtained from Raleigh, North Carolina. Raleigh is in the Piedmont Physiographic Province while Plymouth is in the Coastal Plain Physiographic Province. Norfolk, Virginia is also in a coastal plain and has a climate similar to Plymouth. Use a location that provides as close a match as possible.

RMT Response

The HELP model analysis has been revised using a Coastal Plain Physiographic Province. The geographic location of Norfolk, Virginia was input in setting up data for the program, since Plymouth, North Carolina was not a selection under the synthetic generation of data. However, precipitation data, temperature data, and the latitude for Plymouth, North Carolina were entered manually, where we were allowed to override data for Norfolk, Virginia.

NC DENR Comment

The raw historical groundwater levels in Attachment 9 have several headings. Does the MP elevation indicate the monitoring point? If so, why does the monitoring point change? Does D in the depth to water mean the piezometer was dry at the time of reading? Are some of the columns reversed between Depth to Water and Water Elevation?

RMT Response

The MP Elevation indicates the elevation of the measuring point (typically the top of the casing). Some of the measuring point elevations for a given station did change, but have been corrected. The "D" previously used to denote dry wells has been changed to "Dry." Some of the Depth to Water and the corresponding Water Elevations were reversed, but have been corrected.

NC DENR Comment

The two aquifer units are reported to be separated by an aquitard. The cross-sections and boring logs support the north-south component of the silty-clay unit however, the boring logs provided do not have enough depth to validate the east-west component. Provide the boring logs and test pits.

RMT Response

Boring logs with additional depth in the east – west component have been included.

NC DENR Comment

Only OW-4 is located in the vicinity of the Phase 1 landfill. OW-7 is over 1200 feet from the cell footprint shown on the Data Point Location Map. Was OW-7 intended to be MW-7?

RMT Response

Monitoring well OW-7 is located approximately 130 feet north of the north end of the Phase 1 footprint. This monitoring well was intended to be used in various calculations.

NC DENR Comment

Are groundwater contours on Attachment 2 from a single day reading event? A drainage feature was restored on the eastern boundary of the site. Has there been any notable change in the groundwater table? Will it affect any portion of Phase 1?

RMT Response

The groundwater elevations used to map the water table configuration illustrated in Attachment 2 were all measured on the same day (April 2, 1993). Groundwater elevations in the vicinity of the drainage restoration have decreased since the time of the restoration. There has not been sufficient time to assess if the decrease is a result of the drainage restoration or seasonal fluctuations. Results of numerical groundwater modeling indicate the drainage restoration will have a significant effect on the water table configuration. Water levels in the vicinity of the drainage restoration are expected to decrease up to 5 feet, with a 0.5 foot decrease extending up to 500 feet into the landfill footprint. The drainage restoration is not expected to affect water levels as far north as the Phase 1 footprint.

NC DENR Comment

A mixing thickness of 10 percent of the aquifer saturated thickness was chosen. What criteria was used to determine the 10 percent assignment?

RMT Response

The only criteria used in the original assignment was a conservative approach. A new assignment has been made of 3.32 feet. This is based on a calculated mixing zone thickness of 9.96 feet. Thirty-three percent of the calculated mixing zone thickness was used to maintain the conservative approach. The 33 percent of the mixing zone thickness is one standard deviation, which would encompass 68 percent of the constituent mass.

NC DENR Comment

Provide the formula used to calculate the hydraulic conductivity.

RMT Response

Hydraulic conductivity estimates were calculated using the Bouwer and Rice (1976) solution. A detailed discussion of this solution is readily available in the literature or a standard textbook on Well Hydraulics.

Attachments:

1 Table 1 - Summary of TCLP Laboratory Analyses
2 New Landfill - Phase 1
3 Table 2 - HELP Model Input Parameters
4 Table 3 - HELP Model Barrier and Drainage Layer Parameters
5 HELP Model Data
6 Data Point Location Map
7 Geologic Cross Sections - Sheet 1
8 Geologic Cross Sections - Sheet 2
9 Groundwater Elevation Data
10 Boring Logs
11 Well Construction Diagrams
12 Hydraulic Conductivity Test Results
13 Mass Balance and Mixing Zone Calculations
14 NC DENR Letter Dated April 29, 1999

Table 1
Summary of TCLP Laboratory Analyses
April 1990

PARAMETER[1]	NCAC 2L Standards	LOCATION/SAMPLE DATE								LOCATION/SAMPLE DATE			
		Fly Ash 49119		Fly Ash 49134		DWT SLG 49121		DWT SLG 49136		COMP 3 49120		COMP 3 49135	
		4/5/90	Ratio	4/5/90	Ratio	4/5/90	Ratio	4/5/90	Ratio	4/5/90	Ratio	4/5/90	Ratio
Volatile Organics													
2-Butanone	0.17												
Methylene chloride	0.005					0.007 X	1.4E+00			0.002 XJ			
Toluene	1.0												
Inorganics													
Arsenic	0.05	0.02	4.0E-01			<0.003				0.086	1.7E+00		
Barium	2.0	0.24				0.31				1.5			
Cadmium	0.005	0.056	1.1E+01			<0.005				0.014	2.8E+00		
Chromium	0.05	0.03				<0.01				0.02			
Copper	1.0	0.05		<0.02		<0.02		<0.02		<0.02		0.07	
Iron	0.3	<0.1		<0.1		0.9	3.0E+00	0.4	1.3E+00	0.1		0.2	
Manganese	0.05	15	3.0E+02	0.006		0.92	1.8E+01	0.16	3.2E+00	6.6	1.3E+02	0.027	
Mercury	0.0011	<0.0002				<0.0002				<0.0002			
Nickel	0.1	0.3	3.0E+00	<0.02		0.08		<0.02		0.17	1.7E+00	<0.02	
Selenium	0.05	0.27	5.4E+00			<0.003				0.088	1.8E+00		
Zinc	2.1	3.2	1.5E+00	0.02		2.0		0.3		3.3	1.6E+00	20	9.5E+00
Chloride	250	69		66		11		8.1		32		44	
Fluoride	2.0	4.1	2.1E+00	0.67		<0.5		<0.5		<0.5		<0.5	
Nitrate	10	0.5		5.6		0.56		5.6		0.56		1.9	
Phenol	0.3	0.17		<0.012		0.23		0.013		<0.062		0.011	
Sulfate	250	810	3.2E+00	340	1.4E+00	<20		<10		160		140	

[1] Analytical results are reported in milligrams per liter (mg/L) unless otherwise noted.

J - Estimated concentration.

X - Recently removed from list of TCLP compounds. A screen was performed.

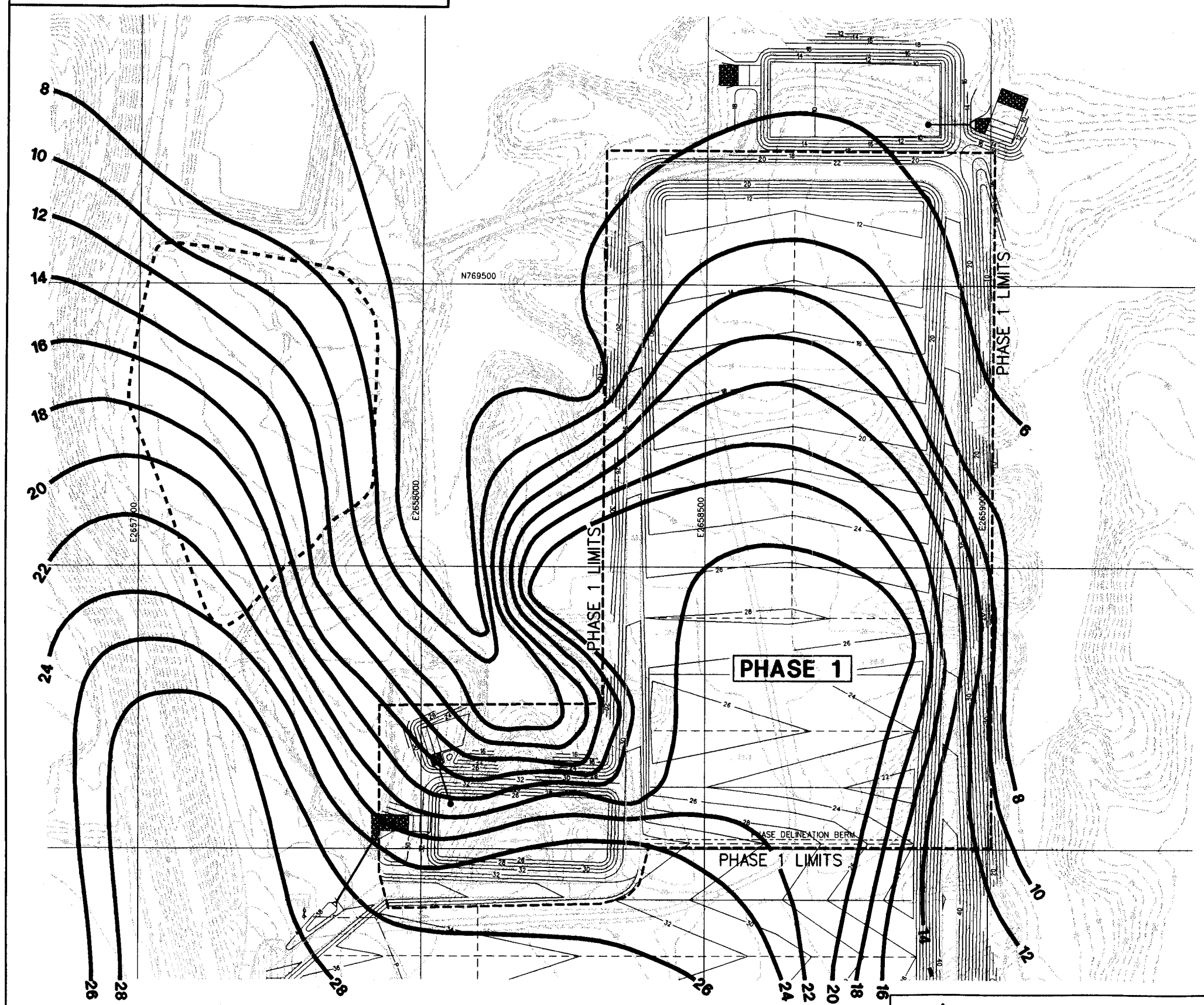
< - Concentration less than the Quantitation Limit or not validated if accompanied by "u" qualifier.

Shading indicates sample exceeds MCL.

j:\cad\civil\weyerhae\5101001c\north.exp
dmc 9-10-99

Weyerhaeuser

PLYMOUTH, NORTH CAROLINA



0 200' 400'

SCALE: 1" = 200'

LEGEND

	EXISTING CNTOUR
32	NEW LINER CONTOUR
18	1993 WATER TABLE CONTOUR
	PHASE 1 LIMITS

NEW LANDFILL
PHASE 1
FIGURE 11599

Weyerhaeuser

RMT®

Drawn By: D.M.C.	
Approved By: R.K.N.	
Date: 9-10-99	
Proj. No.: 5101.01	

Table 2
HELP Model Input Parameters

DESCRIPTION	PARAMETERS USED
Area of Landfill	1 acre
Landfill Condition	Open
Percentage of Area where Runoff is Possible	0 percent
Evaporative Zone Depth	13 inches
Maximum Leaf Area Index for Vegetative Cover	0 (bare ground)
Start of Growing Season (Julian Date)	94
End of Growing Season (Julian Date)	311
Number of Years for Synthetic Data Generation	20 years
Precipitation Input	User Input Data for Plymouth, NC
Temperature Input	User Input Data for Plymouth, NC
Solar Radiation Input	User Input Data for Plymouth, NC
Nearest City for Default Input	Norfolk, Virginia
Depth of Waste	2 feet
Leachate Collection System (LCS) Below Waste	18 inches of graded granular filter (6 inches sand and 12 inches crushed stone)
First Layer of Composite Liner	60-mil high density polyethylene (HDPE)
Second Layer of Composite Liner	Geosynthetic clay liner (GCL)
SCS Runoff Curve Number	93

Table 3
HELP Model Barrier and Drainage Layer Parameters

MATERIAL	THICK-NESS (inches)	SOIL TEXTURE	POROSITY	FIELD CAPACITY	WILTING POINT	INITIAL SOIL WATER CONTENT	EFFECTIVE SATURATED HYDRAULIC CONDUCT (cm/sec)	SLOPE (%)	DRAIN LENGTH (feet)	FML PINHOLE DENSITY (holes/ac)	FML INSTALLA-TION DEFECTS (holes/ac)	FML PLACE-MENT QUALITY
Waste	12	—	0.7625	0.2440	0.1360	0.1953	1.0E-05	—	—	—	—	—
Waste	12	—	0.7625	0.2440	0.1360	0.4655	1.0E-05	—	—	—	—	—
LCS (sand)	6	2	0.437	0.062	0.024	0.1752	5.8E-03	2	100	—	—	—
LCS (crushed stone)	12	21	0.3970	0.0320	0.0130	0.0322	3.0E-01	2	100	1	8	3–good
FML	0.06	35	0	0	0	0	2.0E-13	—	—	1	8	3–good
GCL	0.24	17	0.7500	0.7470	0.4000	0.7500	3.0E-09	—	—	—	—	—

LCS - leachate collection system
FML - flexible membrane liner (geomembrane)
GCL - geosynthetic clay liner

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      H:\DATA\COMMON\KORLESKS\HELP\DATA4.D4
TEMPERATURE DATA FILE:        H:\DATA\COMMON\KORLESKS\HELP\DATA7.D7
SOLAR RADIATION DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA13.D13
EVAPOTRANSPIRATION DATA:      H:\DATA\COMMON\KORLESKS\HELP\DATA11.D11
SOIL AND DESIGN DATA FILE:    H:\DATA\COMMON\KORLESKS\HELP\DATA10.D10
OUTPUT DATA FILE:             H:\DATA\COMMON\KORLESKS\HELP\TESTOUT.OUT


TIME:  13:59     DATE:   8/31/1999


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

     TITLE:  WEYERHAEUSER PLYMOUTH/OPEN LANDFILL/ 2' OF WASTE

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


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


                                  LAYER  1
                                  --------
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```
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     12.00   INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2365 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     12.00   INCHES
POROSITY                     =      0.7630 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.6648 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                        LAYER  3
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   2
THICKNESS                    =      6.00   INCHES
POROSITY                     =      0.4370 VOL/VOL
FIELD CAPACITY               =      0.0620 VOL/VOL
WILTING POINT                =      0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.1752 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.579999993000E-02 CM/SEC


                        LAYER  4
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                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER  21
THICKNESS                    =      12.00    INCHES
POROSITY                     =       0.3970 VOL/VOL
FIELD CAPACITY               =       0.0320 VOL/VOL
WILTING POINT                =       0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0569 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000012000      CM/SEC
SLOPE                        =       2.00    PERCENT
DRAINAGE LENGTH              =     100.0     FEET


                          LAYER  5
                          --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
THICKNESS                    =       0.06    INCHES
POROSITY                     =       0.0000 VOL/VOL
FIELD CAPACITY               =       0.0000 VOL/VOL
WILTING POINT                =       0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =       1.00    HOLES/ACRE
FML INSTALLATION DEFECTS     =       8.00    HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                          LAYER  6
                          --------

                TYPE 3 - BARRIER SOIL LINER
                  MATERIAL TEXTURE NUMBER  17
THICKNESS                    =       0.24    INCHES
POROSITY                     =       0.7500 VOL/VOL
FIELD CAPACITY               =       0.7470 VOL/VOL
WILTING POINT                =       0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	93.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	13.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.377	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.919	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.768	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	12.730	INCHES
TOTAL INITIAL WATER	=	12.730	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
PLYMOUTH NORTH CAROLINA

MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	94	
END OF GROWING SEASON (JULIAN DATE)	=	311	
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	77.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA WAS ~~SYNTHETICALLY GENERATED USING~~ ENTERED MANUALLY FOR
~~COEFFICIENTS FOR NORFOLK VIRGINIA~~
PLYMOUTH, NORTH CAROLINA.

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

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

4.17	3.98	4.18	3.14	4.66	4.53
6.30	5.85	4.62	3.35	3.10	3.32

NOTE: TEMPERATURE DATA WAS ~~SYNTHETICALLY GENERATED USING~~ ENTERED MANUALLY FOR PLYMOUTH, NC
~~COEFFICIENTS FOR NORFOLK VIRGINIA~~

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
42.10	43.90	50.90	60.30	67.70	74.30
78.00	77.30	72.00	61.50	52.40	44.60

NOTE: SOLAR RADIATION DATA WAS ~~SYNTHETICALLY GENERATED USING~~ ENTERED MANUALLY FOR PLYMOUTH, NC
~~COEFFICIENTS FOR NORFOLK VIRGINIA~~

STATION LATITUDE = 35.87 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

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	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.42	3.66	4.52	2.76	4.19	5.02
	7.36	7.52	4.98	2.34	2.74	3.83
STD. DEVIATIONS	2.25	1.38	1.86	1.27	1.84	2.52
	3.32	3.06	2.72	1.33	1.43	1.73

RUNOFF

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

EVAPOTRANSPIRATION

TOTALS	1.524	1.735	2.900	2.393	3.289	3.705
	4.082	4.017	3.073	1.822	1.496	1.414
STD. DEVIATIONS	0.400	0.453	0.816	0.997	1.148	1.523
	1.469	1.234	1.146	0.790	0.527	0.219

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	1.9900	1.4995	2.0321	1.4353	1.0149	1.0733
	1.4650	2.4987	3.2323	1.9762	1.0446	1.3210
STD. DEVIATIONS	1.4579	1.0815	1.3261	1.0699	1.0681	1.2320
	1.6159	1.8524	2.1318	1.3740	0.9967	1.1788

PERCOLATION/LEAKAGE THROUGH LAYER 6

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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 6

AVERAGES	0.2698	0.2133	0.2773	0.1768	0.1306	0.1421
	0.2005	0.3830	0.5351	0.2671	0.1297	0.1714

STD. DEVIATIONS	0.2762	0.2084	0.2420	0.2010	0.1863	0.2184
	0.2957	0.3485	0.4516	0.2634	0.1781	0.1943

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES		CU. FEET	PERCENT
PRECIPITATION	52.35	(8.675)	190032.3	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	31.452	(7.4949)	114170.05	60.079
LATERAL DRAINAGE COLLECTED FROM LAYER 4	20.58297	(8.48051)	74716.164	39.31761
PERCOLATION/LEAKAGE THROUGH FROM LAYER 6	0.00006	(0.00003)	0.205	0.00011
AVERAGE HEAD ACROSS TOP OF LAYER 6	0.241	(0.130)		
CHANGE IN WATER STORAGE	0.316	(2.0589)	1145.92	0.603

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	5.73	20799.900

RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.34003	1234.31641
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000002	0.00557
AVERAGE HEAD ACROSS LAYER 6	2.090	
SNOW WATER	2.95	10713.2930

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.7440
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1360

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	8.5252	0.7104
2	8.8920	0.7410
3	0.9547	0.1591
4	0.4917	0.0410
5	0.0000	0.0000
6	0.1800	0.7500
SNOW WATER	0.000	

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Drawings Under Seperate Cover

Ground Water Elevation Data
Weyerhaeuser Landfill
Plymouth, North Carolina

Well Number	*Date*	*Measuring Point Elevation(1)*	*Depth to Water (2)*	*Water Elevation(1)*	*Comment*
LF-01	8/16/89	37.59	4	33.59	
LF-01	8/16/90	37.59	7.91	29.68	
LF-01	11/20/90	37.59	11.42	26.17	
LF-01	12/14/90	37.59	8.88	28.71	
LF-01	1/14/91	37.59	8.17	29.42	
LF-01	2/14/91	37.59	6.21	31.38	
LF-01	3/20/91	37.59	5.42	32.17	
LF-01	4/2/93	37.59	2.92	34.67	
LF-01	6/4/93	37.59	6.21	31.38	
LF-01	8/17/93	37.59	8.29	29.3	
LF-01	9/20/93	37.59	8.88	28.71	
LF-01	10/14/93	37.59	9.25	28.34	
LF-01	11/29/93	37.59	9	28.59	
LF-01	12/22/93	37.59	8.27	29.32	
LF-01	1/10/94	37.59	8.12	29.47	
LF-01	2/22/94	37.59	5.53	32.06	
LF-01	5/23/94	37.59	7.05	30.54	
LF-01	6/21/94	37.59	7.96	29.63	
LF-01	7/27/94	37.59	9	28.59	
LF-01	10/20/94	37.59	7.95	29.62	
LF-01	2/28/95	37.59	4.92	32.65	
LF-01	4/20/95	37.59	6.76	30.83	
LF-01	1/26/96	37.59	7.05	30.54	
LF-01	10/7/96	37.59	5.9	31.69	
LF-01	11/5/96	37.59	4.65	32.94	
LF-01	12/4/96	37.59	5.96	31.63	
LF-01	1/8/97	37.59	4.25	33.34	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to Water (2)	Water Elevation(1)	Comment
LF-01	2/5/97	37.59	4.38	33.21	
LF-01	3/6/97	37.59	4.31	33.28	
LF-01	4/4/97	37.59	4.71	32.88	
LF-01	5/9/97	37.59	5.21	32.38	
LF-01	6/5/97	37.59	6.54	31.05	
LF-01	7/8/97	37.59	8.1	29.49	
LF-01	8/5/97	37.59	8.28	29.31	
LF-01	9/9/97	37.59	9.07	28.52	
LF-01	10/7/97	37.59	8.93	28.66	
LF-01	11/4/97	37.59	8.83	28.76	
LF-01	12/10/97	37.59	8.05	29.54	
LF-01	4/17/98	37.59	4.38	33.21	
LF-01A	11/20/90	37.62	31.54	6.08	
LF-01A	12/14/90	37.62	28.5	9.12	
LF-01A	1/14/91	37.62	28.42	9.2	
LF-01A	2/14/91	37.62	28	9.62	
LF-01A	3/20/91	37.62	27.67	9.95	
LF-01A	4/2/93	37.62	23.79	13.83	
LF-01A	6/4/93	37.62	25.54	12.08	
LF-01A	8/17/93	37.62	27.54	10.08	
LF-01A	9/20/93	37.62	28.25	9.37	
LF-01A	10/14/93	37.62	28.5	9.12	
LF-01A	11/29/93	37.62	28.45	9.17	
LF-01A	12/22/93	37.62	28.33	9.29	
LF-01A	1/10/94	37.62	28.69	8.93	
LF-01A	2/22/94	37.62	27.8	9.82	
LF-01A	5/23/94	37.62	27.3	10.32	
LF-01A	6/21/94	37.62	27.93	9.69	
LF-01A	7/27/94	37.62	28.57	9.05	
LF-01A	10/20/94	37.62	28.72	8.86	
LF-01A	2/28/95	37.62	27.26	10.36	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to Water (2)	Water Elevation(1)	Comment
LF-01A	4/20/95	37.62	27.15	10.47	
LF-01A	1/26/96	37.62	28.1	9.52	
LF-01A	10/7/96	37.62	26.55	11.07	
LF-01A	11/5/96	37.62	26.06	11.56	
LF-01A	12/4/96	37.62	26.47	11.15	
LF-01A	1/8/97	37.62	26.13	11.49	
LF-01A	2/5/97	37.62	25.9	11.72	
LF-01A	3/6/97	37.62	25.91	11.71	
LF-01A	4/4/97	37.62	25.9	11.72	
LF-01A	5/9/97	37.62	26.08	11.54	
LF-01A	6/5/97	37.62	26.74	10.88	
LF-01A	7/8/97	37.62	27.58	10.04	
LF-01A	8/5/97	37.62	27.99	9.63	
LF-01A	9/9/97	37.62	28.46	9.16	
LF-01A	10/7/97	37.62	28.55	9.07	
LF-01A	11/4/97	37.62	28.74	8.88	
LF-01A	12/10/97	37.62	28.32	9.3	
LF-01A	4/17/98	37.62	25.04	12.58	
LF-02	8/16/89	27.68	20.33	7.35	
LF-02	8/16/90	27.68	21.79	5.89	
LF-02	11/20/90	27.68	21.58	6.1	
LF-02	12/14/90	27.68	21.71	5.97	
LF-02	1/14/91	27.68	21.5	6.18	
LF-02	2/14/91	27.68	21.21	6.47	
LF-02	3/20/91	27.68	21.13	6.55	
LF-02	4/2/93	27.68	18.88	8.8	
LF-02	6/4/93	27.68	20.12	7.56	
LF-02	8/17/93	27.68	21.46	6.22	
LF-02	9/20/93	27.68	21.79	5.89	
LF-02	10/14/93	27.68	21.83	5.85	
LF-02	11/29/93	27.68	21.66	6.02	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to Water (2)	Water Elevation(1)	Comment
LF-02	1/10/94	27.68	22.04	5.64	
LF-02	2/22/94	27.68	21.35	6.33	
LF-02	5/23/94	27.68	21.62	6.06	
LF-02	6/21/94	27.68	22	5.68	
LF-02	7/27/94	27.68	22.49	5.19	
LF-02	10/20/94	27.68	22.39	5.15	
LF-02	2/28/95	27.68	21.08	6.6	
LF-02	4/20/95	27.68	21.59	6.09	
LF-02	1/26/96	27.68	21.84	5.84	
LF-02	10/7/96	27.68	20.94	6.74	
LF-02	11/5/96	27.68	20.73	6.95	
LF-02	12/4/96	27.68	21	6.68	
LF-02	1/8/97	27.68	19.69	7.99	
LF-02	2/5/97	27.68	20.61	7.07	
LF-02	3/6/97	27.68	20.57	7.11	
LF-02	4/4/97	27.68	20.51	7.17	
LF-02	5/9/97	27.68	20.59	7.09	
LF-02	6/5/97	27.68	21.13	6.55	
LF-02	7/8/97	27.68	21.73	5.95	
LF-02	8/5/97	27.68	21.98	5.7	
LF-02	9/9/97	27.68	22.22	5.46	
LF-02	10/7/97	27.68	22.08	5.6	
LF-02	11/4/97	27.68	22.08	5.6	
LF-02	12/10/97	27.68	21.8	5.88	
LF-02	4/17/98	27.68	19.89	7.79	
LF-03	8/16/89	10.7	5.92	4.78	
LF-03	8/16/90	10.7	6.12	4.58	
LF-03	11/20/90	10.7	6.12	4.58	
LF-03	12/14/90	10.7	6.21	4.49	
LF-03	1/14/91	10.7	5.92	4.78	
LF-03	2/14/91	10.7	5.96	4.74	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to Water (2)	Water Elevation(1)	Comment
LF-03	3/20/91	10.7	5.83	4.87	
LF-03	4/2/93	10.7	5.78	4.92	
LF-03	6/4/93	10.7	5.79	4.91	
LF-03	8/17/93	10.7	6.29	4.41	
LF-03	9/20/93	10.7	6.33	4.37	
LF-03	10/14/93	10.7	6.38	4.32	
LF-03	11/29/93	10.7	6.17	4.53	
LF-03	1/10/94	10.7	6.5	4.2	
LF-03	2/22/94	10.7	6.4	4.3	
LF-03	5/23/94	10.7	6.75	3.95	
LF-03	6/21/94	10.7	6.9	3.8	
LF-03	7/27/94	10.7	7.12	3.58	
LF-03	10/20/94	10.7	6.95	3.62	
LF-03	2/28/95	10.7	6.32	4.38	
LF-03	4/20/95	10.7	6.51	4.19	
LF-03	10/7/96	10.7	6.2	4.5	
LF-03	11/5/96	10.7	6.12	4.58	
LF-03	12/4/96	10.7	6.22	4.48	
LF-03	1/8/97	10.7	6.04	4.66	
LF-03	2/5/97	10.7	6.02	4.68	
LF-03	3/6/97	10.7	5.96	4.74	
LF-03	4/4/97	10.7	5.99	4.71	
LF-03	5/9/97	10.7	6.03	4.67	
LF-03	6/5/97	10.7	6.34	4.36	
LF-03	7/8/97	10.7	6.71	3.99	
LF-03	8/5/97	10.7	6.76	3.94	
LF-03	9/9/97	10.7	6.92	3.78	
LF-03	10/7/97	10.7	6.9	3.8	
LF-03	11/4/97	10.7	6.7	4	
LF-03	12/10/97	10.7	6.48	4.22	
LF-03	4/17/98	10.7	5.75	4.95	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to Water (2)	Water Elevation(1)	Comment
LF-04	8/16/89	12.09	7.79	4.3	
LF-04	8/16/90	12.09	8.75	3.34	
LF-04	11/20/90	12.09	8.13	3.96	
LF-04	12/14/90	12.09	8.17	3.92	
LF-04	1/14/91	12.09	7.75	4.34	
LF-04	2/14/91	12.09	7.5	4.59	
LF-04	3/20/91	12.09	7.33	4.76	
LF-04	4/2/93	12.09	6.85	5.24	
LF-04	6/4/93	12.09	7.46	4.63	
LF-04	8/17/93	12.09	8.15	3.94	
LF-04	9/20/93	12.09	8.29	3.8	
LF-04	10/14/93	12.09	8.5	3.59	
LF-04	11/29/93	12.09	8.08	4.01	
LF-04	1/10/94	12.09	8.38	3.71	
LF-04	2/22/94	12.09	8.05	4.04	
LF-04	5/23/94	12.09	8.71	3.38	
LF-04	6/21/94	12.09	8.71	3.38	
LF-04	7/27/94	12.09	8.99	3.1	
LF-04	10/20/94	12.09	8.72	3.18	
LF-04	2/28/95	12.09	7.96	4.13	
LF-04	4/20/95	12.09	8.43	3.66	
LF-04	1/26/96	12.09	8.24	3.85	
LF-04	10/7/96	12.09	7.79	4.3	
LF-04	11/5/96	12.09	7.85	4.24	
LF-04	12/4/96	12.09	7.85	4.24	
LF-04	1/8/97	12.09	7.73	4.36	
LF-04	2/5/97	12.09	7.74	4.35	
LF-04	3/6/97	12.09	7.65	4.44	
LF-04	4/4/97	12.09	7.68	4.41	
LF-04	5/9/97	12.09	7.68	4.41	
LF-04	6/5/97	12.09	8.07	4.02	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to Water (2)	Water Elevation(1)	Comment
LF-04	7/8/97	12.09	8.44	3.65	
LF-04	8/5/97	12.09	8.55	3.54	
LF-04	9/9/97	12.09	8.71	3.38	
LF-04	10/7/97	12.09	8.57	3.52	
LF-04	11/4/97	12.09	8.42	3.67	
LF-04	12/10/97	12.09	8.2	3.89	
LF-04	4/17/98	12.09	7.41	4.68	
LF-05	8/16/89	39.16	12.17	26.99	
LF-05	8/16/90	39.16	13.2	25.96	
LF-05	11/20/90	39.16	13.46	25.7	
LF-05	12/14/90	39.16	13.67	25.49	
LF-05	1/14/91	39.16	13.33	25.83	
LF-05	2/14/91	39.16	13.25	25.91	
LF-05	3/20/91	39.16	14.25	24.91	
LF-05	4/2/93	39.16	10.54	28.62	
LF-05	6/4/93	39.16	11.46	27.7	
LF-05	8/17/93	39.16	12.67	26.49	
LF-05	9/20/93	39.16	13.17	25.99	
LF-05	10/14/93	39.16	13.33	25.83	
LF-05	11/29/93	39.16	13.42	25.74	
LF-05	1/10/94	39.16	14.11	25.05	
LF-05	2/22/94	39.16	13.12	26.04	
LF-05	5/23/94	39.16	13.41	25.75	
LF-05	6/21/94	39.16	13.72	25.44	
LF-05	7/27/94	39.16	14.15	25.01	
LF-05	10/20/94	39.16	14.04	25.1	
LF-05	2/28/95	39.16	13.44	25.7	
LF-05	4/20/95	39.16	13.03	26.13	
LF-05	1/26/96	39.16	13.75	25.41	
LF-05	10/7/96	39.16	12.85	26.31	
LF-05	11/5/96	39.16	12.65	26.51	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to Water (2)	Water Elevation(1)	Comment
LF-05	12/4/96	39.16	12.58	26.58	
LF-05	1/8/97	39.16	12.25	26.91	
LF-05	2/5/97	39.16	12.28	26.88	
LF-05	3/6/97	39.16	12.2	26.96	
LF-05	4/4/97	39.16	12.19	26.97	
LF-05	5/9/97	39.16	12.29	26.87	
LF-05	6/5/97	39.16	12.8	26.36	
LF-05	7/8/97	39.16	13.43	25.73	
LF-05	8/5/97	39.16	13.64	25.52	
LF-05	9/9/97	39.16	13.78	25.38	
LF-05	10/7/97	39.16	13.82	25.34	
LF-05	11/4/97	39.16	13.74	25.42	
LF-05	12/10/97	39.16	13.42	25.74	
LF-05	4/17/98	39.16	12.23	26.93	
LF-06	8/16/89	14.02	10	4.02	
LF-06	8/16/90	14.02	11.5	2.52	
LF-06	11/20/90	14.02	10.58	3.44	
LF-06	12/14/90	14.02	10.58	3.44	
LF-06	1/14/91	14.02	10.17	3.85	
LF-06	2/14/91	14.02	10	4.02	
LF-06	3/20/91	14.02	10	4.02	
LF-06	4/2/93	14.02	8.08	5.94	
LF-06	6/4/93	14.02	10.21	3.81	
LF-06	8/17/93	14.02	10.94	3.08	
LF-06	9/20/93	14.02	11	3.02	
LF-06	10/14/93	14.02	10.88	3.14	
LF-06	11/29/93	14.02	10.5	3.52	
LF-06	1/10/94	14.02	10.63	3.39	
LF-06	2/22/94	14.02	10.6	3.42	
LF-06	5/23/94	14.02	11.22	2.8	
LF-06	6/21/94	14.02	11.5	2.52	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to Water (2)	Water Elevation(1)	Comment
LF-06	7/27/94	14.02	11.85	2.17	
LF-06	10/20/94	14.02	11.14	2.74	
LF-06	2/28/95	14.02	10.33	3.69	
LF-06	4/20/95	14.02	11.04	2.98	
LF-06	1/26/96	14.02	10.67	3.35	
LF-06	10/7/96	14.02	10.32	3.7	
LF-06	11/5/96	14.02	10.32	3.7	
LF-06	12/4/96	14.02	10.53	3.49	
LF-06	1/8/97	14.02	10.3	3.72	
LF-06	2/5/97	14.02	10.38	3.64	
LF-06	3/6/97	14.02	10.4	3.62	
LF-06	4/4/97	14.02	10.35	3.67	
LF-06	5/9/97	14.02	10.43	3.59	
LF-06	6/5/97	14.02	10.78	3.24	
LF-06	7/8/97	14.02	11.36	2.66	
LF-06	8/5/97	14.02	11.44	2.58	
LF-06	9/9/97	14.02	11.53	2.49	
LF-06	10/7/97	14.02	11.21	2.81	
LF-06	11/4/97	14.02	11.06	2.96	
LF-06	12/10/97	14.02	7.26	6.76	
LF-06	4/17/98	14.02	9.93	4.09	
LF-06A	11/20/90	14.05	10.08	3.97	
LF-06A	12/14/90	14.05	10.08	3.97	
LF-06A	1/14/91	14.05	9.83	4.22	
LF-06A	2/14/91	14.05	9.58	4.47	
LF-06A	3/20/91	14.05	9.51	4.54	
LF-06A	4/2/93	14.05	8.37	5.68	
LF-06A	6/4/93	14.05	9.54	4.51	
LF-06A	8/17/93	14.05	10.38	3.67	
LF-06A	9/20/93	14.05	10.37	3.68	
LF-06A	10/14/93	14.05	10.33	3.72	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to Water (2)	Water Elevation(1)	Comment
LF-06A	11/29/93	14.05	10	4.05	
LF-06A	1/10/94	14.05	10.25	3.8	
LF-06A	2/22/94	14.05	10.08	3.97	
LF-06A	5/23/94	14.05	10.55	3.5	
LF-06A	6/21/94	14.05	10.9	3.15	
LF-06A	7/27/94	14.05	11.27	2.78	
LF-06A	10/20/94	14.05	10.69	2.7	
LF-06A	2/28/95	14.05	9.78	4.27	
LF-06A	4/20/95	14.05	10.43	3.62	
LF-06A	1/26/96	14.05	10.29	3.76	
LF-06A	10/7/96	14.05	9.8	4.25	
LF-06A	11/5/96	14.05	9.73	4.32	
LF-06A	12/4/96	14.05	9.94	4.11	
LF-06A	1/8/97	14.05	9.71	4.34	
LF-06A	2/5/97	14.05	9.72	4.33	
LF-06A	3/6/97	14.05	9.73	4.32	
LF-06A	4/4/97	14.05	9.72	4.33	
LF-06A	5/9/97	14.05	9.81	4.24	
LF-06A	6/5/97	14.05	10.17	3.88	
LF-06A	7/8/97	14.05	10.77	3.28	
LF-06A	8/5/97	14.05	10.84	3.21	
LF-06A	9/9/97	14.05	10.99	3.06	
LF-06A	10/7/97	14.05	10.69	3.36	
LF-06A	11/4/97	14.05	10.57	3.48	
LF-06A	12/10/97	14.05	10.27	3.78	
LF-06A	4/17/98	14.05	9.22	4.83	
LF-07	8/16/89	36.33	6.96	29.37	
LF-07	8/16/90	36.33	10.83	25.5	
LF-07	11/20/90	36.33	11.17	25.16	
LF-07	12/14/90	36.33	11.17	25.16	
LF-07	1/14/91	36.33	10.75	25.58	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to Water (2)	Water Elevation(1)	Comment
LF-07	2/14/91	36.33	9.75	26.58	
LF-07	3/20/91	36.33	9.92	26.41	
LF-07	4/2/93	36.33	5.92	30.41	
LF-07	6/4/93	36.33	9.38	26.95	
LF-07	8/17/93	36.33	11.58	24.75	
LF-07	9/20/93	36.33	11.75	24.58	
LF-07	10/14/93	36.33	12.12	24.21	
LF-07	11/29/93	36.33	11.96	24.37	
LF-07	12/22/93	36.33	11.54	24.79	
LF-07	1/10/94	36.33	12.02	24.31	
LF-07	2/22/94	36.33	11.05	25.28	
LF-07	5/23/94	36.33	11.93	24.4	
LF-07	6/21/94	36.33	11.74	24.59	
LF-07	7/27/94	36.33	14.49	21.84	
LF-07	10/20/94	36.33	12.7	23.65	
LF-07	2/28/95	36.33	11.05	25.28	
LF-07	4/20/95	36.33	11.08	25.25	
LF-07	1/26/96	36.33	12.37	23.96	
LF-07	10/7/96	36.33	10.91	25.42	
LF-07	11/5/96	36.33	10	26.33	
LF-07	12/4/96	36.33	10.03	26.3	
LF-07	1/8/97	36.33	9.3	27.03	
LF-07	2/5/97	36.33	9.03	27.3	
LF-07	3/6/97	36.33	8.65	27.68	
LF-07	4/4/97	36.33	5.83	30.5	
LF-07	5/9/97	36.33	9.01	27.32	
LF-07	6/5/97	36.33	9.82	26.51	
LF-07	7/8/97	36.33	10.52	25.81	
LF-07	8/5/97	36.33	11.03	25.3	
LF-07	9/9/97	36.33	11.69	24.64	
LF-07	10/7/97	36.33	11.86	24.47	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to WaterP(2)	Water Elevation(1)	Comment
LF-07	11/4/97	36.33	11.77	24.56	
LF-07	12/10/97	36.33	11.86	24.47	
LF-07	4/17/98	36.33	9.43	26.9	
LF-08	11/20/90	36.19	29.71	6.48	
LF-08	12/14/90	36.19	29.46	6.73	
LF-08	1/14/91	36.19	29.67	6.52	
LF-08	2/14/91	36.19	29.33	6.86	
LF-08	3/20/91	36.19	29.25	6.94	
LF-08	4/2/93	36.19	26.83	9.36	
LF-08	6/4/93	36.19	27.88	8.31	
LF-08	8/17/93	36.19	29.25	6.94	
LF-08	9/20/93	36.19	29.67	6.52	
LF-08	10/14/93	36.19	29.83	6.36	
LF-08	11/29/93	36.19	29.69	6.5	
LF-08	12/22/93	36.19	29.54	6.65	
LF-08	1/10/94	36.19	30.07	6.12	
LF-08	2/22/94	36.19	29.5	6.69	
LF-08	5/23/94	36.19	29.43	6.76	
LF-08	6/21/94	36.19	29.44	6.75	
LF-08	7/27/94	36.19	30.25	5.94	
LF-08	10/20/94	36.19	29.81	6.31	
LF-08	2/28/95	36.19	28.82	7.37	
LF-08	4/20/95	36.19	29.03	7.16	
LF-08	1/26/96	36.19	29.66	6.53	
LF-08	10/7/96	36.19	28.55	7.64	
LF-08	11/5/96	36.19	28.29	7.9	
LF-08	12/4/96	36.19	28.5	7.69	
LF-08	1/8/97	36.19	28.26	7.93	
LF-08	2/5/97	36.19	28.07	8.12	
LF-08	3/6/97	36.19	28.08	8.11	
LF-08	4/4/97	36.19	28.02	8.17	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to WaterP(2)	Water Elevation(1)	Comment
LF-08	5/9/97	36.19	28.05	8.14	
LF-08	6/5/97	36.19	28.57	7.62	
LF-08	7/8/97	36.19	29.1	7.09	
LF-08	8/5/97	36.19	29.33	6.86	
LF-08	9/9/97	36.19	29.65	6.54	
LF-08	10/7/97	36.19	29.62	6.57	
LF-08	11/4/97	36.19	29.62	6.57	
LF-08	12/10/97	36.19	29.37	6.82	
LF-08	4/17/98	36.19	27.5	8.69	
LFO-01	12/14/90	36.98	29.13	7.85	
LFO-01	1/14/91	36.98	29.08	7.9	
LFO-01	2/14/91	36.98	28.75	8.23	
LFO-01	3/20/91	36.98	28.5	8.48	
LFO-01	4/2/93	36.98	25.5	11.48	
LFO-01	6/4/93	36.98	26.65	10.33	
LFO-01	8/17/93	36.98	28.33	8.65	
LFO-01	9/20/93	36.98	28.92	8.06	
LFO-01	10/14/93	36.98	29.12	7.86	
LFO-01	11/29/93	36.98	29.04	7.94	
LFO-01	12/22/93	36.98	28.94	8.04	
LFO-01	1/10/94	36.98	29.38	7.6	
LFO-01	2/22/94	36.98	28.8	8.18	
LFO-01	5/23/94	36.98	28.45	8.53	
LFO-01	6/21/94	36.98	28.45	8.53	
LFO-01	7/27/94	36.98	29.41	7.57	
LFO-01	10/20/94	36.98	29.55	7.34	
LFO-01	2/28/95	36.98	28.63	8.35	
LFO-01	4/20/95	36.98	28.31	8.67	
LFO-01	1/26/96	36.98	29.08	7.9	
LFO-01	10/7/96	36.98	28.92	8.06	
LFO-01	11/5/96	36.98	27.51	9.47	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to WaterP(2)	Water Elevation(1)	Comment
LFO-01	12/4/96	36.98	27.82	9.16	
LFO-01	1/8/97	36.98	27.52	9.46	
LFO-01	2/5/97	36.98	27.3	9.68	
LFO-01	3/6/97	36.98	27.31	9.67	
LFO-01	4/4/97	36.98	27.25	9.73	
LFO-01	6/5/97	36.98	27.86	9.12	
LFO-01	7/8/97	36.98	28.51	8.47	
LFO-01	8/5/97	36.98	28.82	8.16	
LFO-01	9/9/97	36.98	29.22	7.76	
LFO-01	10/7/97	36.98	29.25	7.73	
LFO-01	11/4/97	36.98	29.36	7.62	
LFO-01	12/10/97	36.98	29.04	7.94	
LFO-01	4/17/98	36.98	26.58	10.4	
LFO-02	12/14/90	33.83			Dry
LFO-02	1/14/91	33.83			Dry
LFO-02	2/14/91	33.83	11.04	22.79	
LFO-02	3/20/91	33.83	11.25	22.58	
LFO-02	4/2/93	33.83	3.73	30.1	
LFO-02	6/4/93	33.83	7.92	25.91	
LFO-02	8/17/93	33.83			Dry
LFO-02	9/20/93	33.83			Dry
LFO-02	10/14/93	33.83			Dry
LFO-02	11/29/93	33.83			Dry
LFO-02	12/22/93	33.83			Dry
LFO-02	1/10/94	33.83			Dry
LFO-02	2/22/94	33.83	13.45	20.38	
LFO-02	5/23/94	33.83	14.75	19.08	
LFO-02	6/21/94	33.83			Dry
LFO-02	7/27/94	33.83			Dry
LFO-02	10/20/94	33.83			Dry
LFO-02	2/28/95	33.83	12.23	21.6	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to WaterP(2)	Water Elevation(1)	Comment
LFO-02	4/20/95	33.83	14.69	19.14	
LFO-02	1/26/96	33.83	13.92	19.91	
LFO-02	10/7/96	33.83	14.3	19.53	
LFO-02	12/4/96	33.83	12.77	21.06	
LFO-02	1/8/97	33.83	11.52	22.31	
LFO-02	2/5/97	33.83	11.08	22.75	
LFO-02	3/6/97	33.83	11.28	22.55	
LFO-02	4/4/97	33.83	11.92	21.91	
LFO-02	6/5/97	33.83			Dry
LFO-02	7/8/97	33.83			Dry
LFO-02	8/5/97	33.83			Dry
LFO-02	9/9/97	33.83			Dry
LFO-02	10/7/97	33.83			Dry
LFO-02	11/4/97	33.83			Dry
LFO-02	12/10/97	33.83			Dry
LFO-03	12/14/90	45.58	20.79	24.79	
LFO-03	1/14/91	45.58	21.08	24.5	
LFO-03	2/14/91	45.58	21.25	24.33	
LFO-03	3/20/91	45.58	21.33	24.25	
LFO-03	4/2/93	45.58			Dry
LFO-03	8/17/93	45.58	19.83	25.75	
LFO-03	9/20/93	45.58	20.44	25.14	
LFO-03	10/14/93	45.58	20.75	24.83	
LFO-03	11/29/93	45.58	21.27	24.31	
LFO-03	12/22/93	45.58	21.27	24.31	
LFO-03	1/10/94	45.58	22.25	23.33	
LFO-03	2/22/94	45.58	22.37	23.21	
LFO-03	5/23/94	45.58	21.75	23.83	
LFO-03	6/21/94	45.58	21.34	24.24	
LFO-03	7/27/94	45.58	21.71	23.87	
LFO-03	10/20/94	45.58	22.5	23	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to WaterP(2)	Water Elevation(1)	Comment
LFO-03	2/28/95	45.58	22.74	22.84	
LFO-03	4/20/95	45.58	21.48	24.1	
LFO-03	1/26/96	45.58	20.62	24.96	
LFO-03	10/7/96	45.58	21.38	24.2	
LFO-03	12/4/96	45.58	20.56	25.02	
LFO-03	1/8/97	45.58	20.72	24.86	
LFO-03	2/5/97	45.58	20.39	25.19	
LFO-03	3/6/97	45.58	20.15	25.43	
LFO-03	4/4/97	45.58	20.14	25.44	
LFO-03	6/5/97	45.58	20.66	24.92	
LFO-03	7/8/97	45.58	20.93	24.65	
LFO-03	8/5/97	45.58	21.23	24.35	
LFO-03	9/9/97	45.58	21.61	23.97	
LFO-03	10/7/97	45.58	21.87	23.71	
LFO-03	11/4/97	45.58	22.06	23.52	
LFO-03	12/10/97	45.58	22.26	23.32	
LFO-03	4/17/98	45.58	18.91	26.67	
LFO-04	12/14/90	36.95	15	21.95	
LFO-04	1/14/91	36.95	15	21.95	
LFO-04	2/14/91	36.95	14.71	22.24	
LFO-04	3/20/91	36.95	14.67	22.28	
LFO-04	4/2/93	36.95	12.12	24.83	
LFO-04	6/4/93	36.95	13.6	23.35	
LFO-04	8/17/93	36.95	14.33	22.62	
LFO-04	9/20/93	36.95	14.67	22.28	
LFO-04	10/14/93	36.95	14.88	22.07	
LFO-04	11/29/93	36.95	14.88	22.07	
LFO-04	12/22/93	36.95	9.79	27.16	
LFO-04	1/10/94	36.95	15.25	21.7	
LFO-04	2/22/94	36.95	14.75	22.2	
LFO-04	5/23/94	36.95	14.85	22.1	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to WaterP(2)	Water Elevation(1)	Comment
LFO-04	6/21/94	36.95	15.14	21.81	
LFO-04	7/27/94	36.95	14.42	22.53	
LFO-04	10/20/94	36.95	15.75	21.1	
LFO-04	2/28/95	36.95	15.12	21.83	
LFO-04	4/20/95	36.95	14.96	21.99	
LFO-04	1/26/96	36.95	16.27	20.68	
LFO-04	11/5/96	36.95	14.87	22.08	
LFO-04	12/4/96	36.95	14.97	21.98	
LFO-04	1/8/97	36.95	14.74	22.21	
LFO-04	2/5/97	36.95	14.63	22.32	
LFO-04	3/6/97	36.95	14.51	22.44	
LFO-04	4/4/97	36.95	14.43	22.52	
LFO-04	6/5/97	36.95	14.68	22.27	
LFO-04	7/8/97	36.95	15.09	21.86	
LFO-04	8/5/97	36.95	15.27	21.68	
LFO-04	9/9/97	36.95	15.47	21.48	
LFO-04	10/7/97	36.95	15.48	21.47	
LFO-04	11/4/97	36.95	15.41	21.54	
LFO-04	12/10/97	36.95	5.41	31.54	
LFO-04	4/17/98	36.95	14.28	22.67	
LFO-05	12/14/90	34.1	16.5	17.6	
LFO-05	1/14/91	34.1	14.42	19.68	
LFO-05	2/14/91	34.1	13.83	20.27	
LFO-05	3/20/91	34.1			Dry
LFO-05	4/2/93	34.1	12.92	21.18	
LFO-05	6/4/93	34.1	13.9	20.2	
LFO-05	8/17/93	34.1	14.38	19.72	
LFO-05	9/20/93	34.1			Dry
LFO-05	10/14/93	34.1	14.88	19.22	
LFO-05	11/29/93	34.1	13.88	20.22	
LFO-05	12/22/93	34.1	13.6	20.5	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to WaterP(2)	Water Elevation(1)	Comment
LFO-05	1/10/94	34.1	14.01	20.09	
LFO-05	2/22/94	34.1	14.05	20.05	
LFO-05	5/23/94	34.1	14.8	19.3	
LFO-05	6/21/94	34.1	14.72	19.38	
LFO-05	7/27/94	34.1	15	19.1	
LFO-05	10/20/94	34.1	14.12	19.87	
LFO-05	2/28/95	34.1	13.72	20.38	
LFO-05	4/20/95	34.1	14.62	19.48	
LFO-05	1/26/96	34.1	14.3	19.8	
LFO-05	10/7/96	34.1	14.35	19.75	
LFO-05	11/5/96	34.1	14.29	19.81	
LFO-05	12/4/96	34.1	14.58	19.52	
LFO-05	1/8/97	34.1	14.26	19.84	
LFO-05	2/5/97	34.1	14.47	19.63	
LFO-05	3/6/97	34.1	14.31	19.79	
LFO-05	4/4/97	34.1	14.29	19.81	
LFO-05	6/5/97	34.1	14.3	19.8	
LFO-05	7/8/97	34.1	14.97	19.13	
LFO-05	8/5/97	34.1	15.06	19.04	
LFO-05	9/9/97	34.1	15.22	18.88	
LFO-05	10/7/97	34.1	14.89	19.21	
LFO-05	11/4/97	34.1	14.32	19.78	
LFO-05	12/10/97	34.1	14.81	19.29	
LFO-05	4/17/98	34.1	14.93	19.17	
LFO-06	1/14/90	34.27	23.75	10.52	
LFO-06	12/14/90	34.27	23.75	10.52	
LFO-06	3/20/91	34.27	20.33	13.94	
LFO-06	4/2/93	34.27	18.35	15.92	
LFO-06	6/4/93	34.27	17.67	16.6	
LFO-06	8/17/93	34.27	18.75	15.52	
LFO-06	9/20/93	34.27	19.08	15.19	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to WaterP(2)	Water Elevation(1)	Comment
LFO-06	10/14/93	34.27	19.29	14.98	
LFO-06	11/29/93	34.27	19.46	14.81	
LFO-06	12/22/93	34.27	19.44	14.83	
LFO-06	1/10/94	34.27	19.81	14.46	
LFO-06	2/22/94	34.27	18.83	15.44	
LFO-06	5/23/94	34.27	19.12	15.15	
LFO-06	6/21/94	34.27	19.5	14.77	
LFO-06	7/27/94	34.27	19.93	14.34	
LFO-06	10/20/94	34.27	19.55	14.54	
LFO-06	2/28/95	34.27	18.48	15.79	
LFO-06	4/20/95	34.27	18.68	15.59	
LFO-06	1/26/96	34.27	18.14	16.13	
LFO-06	10/7/96	34.27	18.08	16.19	
LFO-06	11/5/96	34.27	18.39	15.88	
LFO-06	12/4/96	34.27	19.14	15.13	
LFO-06	1/8/97	34.27	19.27	15	
LFO-06	2/5/97	34.27	19.3	14.97	
LFO-06	3/6/97	34.27	19.44	14.83	
LFO-06	4/4/97	34.27	19.23	15.04	
LFO-06	6/5/97	34.27	19.38	14.89	
LFO-06	7/8/97	34.27	20.07	14.2	
LFO-06	8/5/97	34.27	20.39	13.88	
LFO-06	9/9/97	34.27	20.58	13.69	
LFO-06	10/7/97	34.27	20.48	13.79	
LFO-06	11/4/97	34.27	20.49	13.78	
LFO-06	12/10/97	34.27	20.38	13.89	
LFO-06	4/17/98	34.27	19.98	14.29	
LFO-07	12/14/90	24.47	19.21	5.26	
LFO-07	1/14/91	24.47	19	5.47	
LFO-07	2/14/91	24.47	18.92	5.55	
LFO-07	3/20/91	24.47	18.88	5.59	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to WaterP(2)	Water Elevation(1)	Comment
LFO-07	4/2/93	24.47	17.71	6.76	
LFO-07	6/4/93	24.47	18.42	6.05	
LFO-07	8/17/93	24.47	18.96	5.51	
LFO-07	9/20/93	24.47	19.17	5.3	
LFO-07	10/14/93	24.47	19.29	5.18	
LFO-07	11/29/93	24.47	19.04	5.43	
LFO-07	12/22/93	24.47	19.83	4.64	
LFO-07	1/10/94	24.47	19.38	5.09	
LFO-07	2/22/94	24.47	19.2	5.27	
LFO-07	5/23/94	24.47	19.3	5.17	
LFO-07	6/21/94	24.47	19.58	4.89	
LFO-07	7/27/94	24.47	19.87	4.6	
LFO-07	10/20/94	24.47	19.69	4.66	
LFO-07	2/28/95	24.47	19.15	5.32	
LFO-07	4/20/95	24.47	19.3	5.17	
LFO-07	1/26/96	24.47	13	11.47	
LFO-07	10/7/96	24.47	19.08	5.39	
LFO-07	11/5/96	24.47	18.97	5.5	
LFO-07	12/4/96	24.47	19.02	5.45	
LFO-07	1/8/97	24.47	18.88	5.59	
LFO-07	2/5/97	24.47	18.87	5.6	
LFO-07	3/6/97	24.47	18.83	5.64	
LFO-07	4/4/97	24.47	18.8	5.67	
LFO-07	6/5/97	24.47	19.04	5.43	
LFO-07	7/8/97	24.47	19.32	5.15	
LFO-07	8/5/97	24.47	19.39	5.08	
LFO-07	9/9/97	24.47	19.58	4.89	
LFO-07	10/7/97	24.47	14.47	10	
LFO-07	11/4/97	24.47	19.35	5.12	
LFO-07	12/10/97	24.47	19.47	5	
LFO-08	5/9/97	36.63	7.33	29.3	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to WaterP(2)	Water Elevation(1)	Comment
LFO-08	6/5/97	36.63	9.18	27.45	
LFO-08	7/8/97	36.63	10.43	26.2	
LFO-08	8/5/97	36.63	10.8	25.83	
LFO-08	9/9/97	36.63	11.53	25.1	
LFO-08	10/7/97	36.63	11.6	25.03	
LFO-08	11/4/97	36.63	11.35	25.28	
LFO-08	12/10/97	36.63	11.05	25.58	
LFO-08	4/17/98	36.63	7.62	29.01	
LFO-09	5/9/97	33.67	3.93	29.74	
LFO-09	6/5/97	33.67	4.57	29.1	
LFO-09	7/8/97	33.67	5.82	27.85	
LFO-09	8/5/97	33.67	6.1	27.57	
LFO-09	9/9/97	33.67	7.14	26.53	
LFO-09	10/7/97	33.67	4.07	29.6	
LFO-09	11/4/97	33.67	6.46	27.21	
LFO-09	12/10/97	33.67	6.06	27.61	
LFO-09	4/17/98	33.67	3.35	30.32	
LFO-10	5/9/97	38.88	5.65	33.23	
LFO-10	6/5/97	38.88	7.1	31.78	
LFO-10	7/8/97	38.88	8.58	30.3	
LFO-10	8/5/97	38.88	8.81	30.07	
LFO-10	9/9/97	38.88	8.76	30.12	
LFO-10	10/7/97	38.88	8.32	30.56	
LFO-10	11/4/97	38.88	8.44	30.44	
LFO-10	12/10/97	38.88	7.53	31.35	
LFO-10	4/17/98	38.88	4.02	34.86	
LFO-11	5/9/97	39.52	6.74	32.78	
LFO-11	6/5/97	39.52	8.31	31.21	
LFO-11	7/8/97	39.52	10.3	29.22	
LFO-11	8/5/97	39.52	10.98	28.54	
LFO-11	9/9/97	39.52	11.41	28.11	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to WaterP(2)	Water Elevation(1)	Comment
LFO-11	10/7/97	39.52	11.47	28.05	
LFO-11	11/4/97	39.52	11.57	27.95	
LFO-11	12/10/97	39.52	11.08	28.44	
LFO-11	4/17/98	39.52	4.07	35.45	
LFO-12	5/9/97	39.44	7.79	31.65	
LFO-12	6/5/97	39.44	9.41	30.03	
LFO-12	7/8/97	39.44	10.8	28.64	
LFO-12	8/5/97	39.44	11.45	27.99	
LFO-12	9/9/97	39.44	12.03	27.41	
LFO-12	10/7/97	39.44	12.26	27.18	
LFO-12	11/4/97	39.44	12.54	26.9	
LFO-12	12/10/97	39.44	12.47	26.97	
LFO-12	4/17/98	39.44	5.83	33.61	
LFO-13	5/9/97	38.96	8.24	30.72	
LFO-13	6/5/97	38.96	9.51	29.45	
LFO-13	7/8/97	38.96	10.93	28.03	
LFO-13	8/5/97	38.96	11.78	27.18	
LFO-13	9/9/97	38.96	12.47	26.49	
LFO-13	10/7/97	38.96	12.64	26.32	
LFO-13	11/4/97	38.96	12.82	26.14	
LFO-13	12/10/97	38.96	12.51	26.45	
LFO-13	4/17/98	38.96	6.59	32.37	
LFO-14	5/9/97	39.89	10.57	29.32	
LFO-14	6/5/97	39.89	11.41	28.48	
LFO-14	7/8/97	39.89	12.53	27.36	
LFO-14	8/5/97	39.89	13.18	26.71	
LFO-14	9/9/97	39.89	13.77	26.12	
LFO-14	10/7/97	39.89	13.98	25.91	
LFO-14	11/4/97	39.89	14.2	25.69	
LFO-14	12/10/97	39.89	14.32	25.57	
LFO-14	4/17/98	39.89	9.21	30.68	

(1) Relative to mean sea level

(2) Feet below top of casing

Well Number	Date	Measuring Point Elevation(1)	Depth to WaterP(2)	Water Elevation(1)	Comment
LFO-15	5/9/97	41.61	15.25	26.36	
LFO-15	6/5/97	41.61	15.57	26.04	
LFO-15	7/8/97	41.61	16.06	25.55	
LFO-15	8/5/97	41.61	16.48	25.13	
LFO-15	9/9/97	41.61	16.97	24.64	
LFO-15	10/7/97	41.61	17.22	24.39	
LFO-15	11/4/97	41.61	17.45	24.16	
LFO-15	4/17/98	41.61	13.43	28.18	

(1) Relative to mean sea level

(2) Feet below top of casing

LOG OF TEST BORING

F-203 (R 01-87)

BORING NO. OW-1
SHEET NO. 1 OF 3

PROJECT NAME WEYERHAEUSER
LOCATION PLYMOUTH, NC
CONTRACTOR LAW ENGINEERING
DRILLING METHOD MUD ROTARY

PROJECT NO. 467.42
INSTALLATION
SURFACE ELEV. 34.5
BOREHOLE DIA. 10 IN.

SAMPLING NOTES						VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
INTERVAL		RECOVERY		MOISTURE		
NO.	TYPE	BLOWS			DEPTH	
1	SS	4-6-6-6	50			SILT (ML) - some very fine sand; brown. .5
						CLAY (CL) - trace fine grained sand; stiff; tan.
2	UD		0			CLAY (CL) - sandy (fine grained); silty; tan, gray, orange.
						- Increasing sand.
3	UD		100		5	
						6.0
4	SS	2-2-3-4	75			SILTY SAND (SM) - fine grained; trace clay; interlaminated gray and orange.
5	UD		65			- interlaminated with silty clay; micaceous; gray.
					10	
						- gray
6	SS	4-3-10-18	75			
						- more clayey
					15	
						- fine to medium grained; gray
7	SS	9-4-2-2	50			17.8
						SILTY SAND (SM) - as above, interbedded with CLAY (CL); silty; stiff; slightly micaceous; blue green and tan.
8	SS	3-4	100			SILTY CLAY (CL) - stiff; slightly micaceous; blue

GENERAL NOTES

DATE STARTED 20 APR 90
DATE COMPLETED 21 APR 90
RIG MOBILE B-56
CREW CHIEF TODD JOHNSON
LOGGED BTG CHECKED

WATER LEVEL OBSERVATIONS

WHILE DRILLING ▽ N/A
AT COMPLETION ▼
AFTER DRILLING
CAVE-IN: DATE/TIME DEPTH
WATER: DATE/TIME 5-4-90/1120 DEPTH 23.85 FT. BGS

LOG OF TEST BORING

F-203 (R 01-87)

BORING NO. OW-1
SHEET NO. 2 OF 3
PROJECT NAME WEYERHAEUSER
PROJECT NO. 467.42
LOCATION PLYMOUTH, NC
INSTALLATION
CONTRACTOR LAW ENGINEERING
SURFACE ELEV. 34.5
DRILLING METHOD MUD ROTARY
BOREHOLE DIA. 10 IN.

SAMPLING NOTES						VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
INTERVAL		RECOVERY		MOISTURE		
NO.	TYPE	BLOWS			DEPTH	
9	UD		100			green, tan.
						SILT (MH) - as determined from laboratory analysis.
					25	
10	SS	33-5-6-6	85			Change to 5 7/8 in. bit at 21.5 ft.
11	SS	3-3-4-6	100			
					30	
12	SS	4-4-4-5	100			
13	SS	3-4-4-6	100			SILTY CLAY (CL) - as above; with trace fine grained sand.
					35	
						SILTY SAND (SM) - fine grained; gray. 37.3
14	SS	23-43-47-54	50			SILTY SAND (SM) - fine to medium grained; trace coarse grained sand; laminated; tan; trace shell fragments.
					40	

LOG OF TEST BORING

F-203 (R 01-87)

BORING NO. OW-1
SHEET NO. 3 OF 3

PROJECT NAME WEYERHAEUSER
LOCATION PLYMOUTH, NC
CONTRACTOR LAW ENGINEERING
DRILLING METHOD MUD ROTARY

PROJECT NO. 467.42
INSTALLATION
SURFACE ELEV. 34.5
BOREHOLE DIA. 10 IN.

SAMPLING NOTES						VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
INTERVAL		RECOVERY		MOISTURE		
NO.	TYPE	BLOWS			DEPTH	
15	SS	28-32-41-52	65		45	
						BORING TERMINATED AT 47.0 FEET
					50	
					55	
					60	
					65	

LOG OF TEST BORING

F-203 (R 01-87)

BORING NO. OW-4
SHEET NO. 1 OF 1
PROJECT NAME WEYERHAEUSER
PROJECT NO. 467.42
LOCATION PLYMOUTH, NC
INSTALLATION
CONTRACTOR LAW ENGINEERING
SURFACE ELEV. 34.3
DRILLING METHOD HSA
BOREHOLE DIA. 10 IN.

SAMPLING NOTES						VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
INTERVAL		RECOVERY		MOISTURE		
NO.	TYPE	BLOWS			DEPTH	
					5	No soil samples collected. See boring MW-8 for lithology.
					10	
					15	
						BORING TERMINATED AT 16.5 FEET

GENERAL NOTES

DATE STARTED 22 APR 90
DATE COMPLETED 22 APR 90
RIG MOBILE B-56
CREW CHIEF TODD JOHNSON
LOGGED BTG CHECKED

WATER LEVEL OBSERVATIONS

WHILE DRILLING ▽
AT COMPLETION ▼
AFTER DRILLING
CAVE-IN: DATE/TIME DEPTH
WATER: DATE/TIME 5-2-90 DEPTH 10.8 FT. BGS.

LOG OF TEST BORING

F-203 (R 01-87)

BORING NO. MW-8
SHEET NO. 1 OF 3
PROJECT NO. 467.42
INSTALLATION
SURFACE ELEV. 34.3
BOREHOLE DIA. 10 IN.

PROJECT NAME WEYERHAEUSER
LOCATION PLYMOUTH, NC
CONTRACTOR LAW ENGINEERING
DRILLING METHOD MUD ROTARY

SAMPLING NOTES						VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
INTERVAL		RECOVERY		MOISTURE		
NO.	TYPE	BLOWS			DEPTH	
1	SS	6-6-7-10	50			SILTY SAND (SM) - fine grained; trace clay; brown. .4
2	UD		50			CLAY (CL) - silty; trace fine grained sand; orange, gray mottle.
3	SS	6-8-9-10	65		5	SILTY SAND (SM) - fine grained; trace clay in occasional thin partings (< .1 foot); mottled tan and orange. - no clay; 7.0-7.2 feet
4	SS	6-7-7-8	60			
5	SS	6-6-8-9	50		10	SILTY SAND (SM) - fine grained; interlaminated orange and gray, black (heavy minerals); trace clay.
6	SS	9-15-23-17	50		15	- no clay; 13.0-15.0 ft.
7	SS	3-3-3-5	90			SILTY CLAY (CL) - stiff; trace mica; mottled brown and blue green.

GENERAL NOTES

DATE STARTED 21 APR 90
DATE COMPLETED 23 APR 90
RIG MOBILE B-56
CREW CHIEF TODD JOHNSON
LOGGED BTG CHECKED

WATER LEVEL OBSERVATIONS

WHILE DRILLING ▽ N/A
AT COMPLETION ▼
AFTER DRILLING
CAVE-IN: DATE/TIME DEPTH
WATER: DATE/TIME 5-1-90 DEPTH 26.8 FT.BGS

LOG OF TEST BORING

F-203 (R 01-87)

BORING NO. MW-8
SHEET NO. 2 OF 3
PROJECT NO. 467.42
INSTALLATION
SURFACE ELEV. 34.3
BOREHOLE DIA. 10 IN.

PROJECT NAME WEYERHAEUSER
LOCATION PLYMOUTH, NC
CONTRACTOR LAW ENGINEERING
DRILLING METHOD MUD ROTARY

SAMPLING NOTES						VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
INTERVAL		RECOVERY		MOISTURE		
NO.	TYPE	BLOWS			DEPTH	
8	UD		100			CLAY (CH) - as determined from laboratory analysis.
9	SS	18-5-4-4	100		25	Change to 5 7/8 in. bit at 20.2 ft.
10	SS	3-3-5-7	100		30	SILT (ML) - some clay; as determined from laboratory analysis.
						CLAYEY SAND (SC) - fine grained; some zones more sandy.
11	SS	4-5-5-12	90		35	36.5
12	SS	23-31-32-44	75			SILTY SAND (SM) - fine grained; trace clay; gray, blue green. 36.8
					40	SILTY SAND (SM) - fine grained; trace clay; tan, gray, some black.
13	SS	11-15-	50			- some medium grained sand.

LOG OF TEST BORING

F-203 (R 01-87)

BORING NO. MW-8
SHEET NO. 3 OF 3

PROJECT NAME WEYERHAEUSER
PROJECT NO. 467.42
LOCATION PLYMOUTH, NC
INSTALLATION
CONTRACTOR LAW ENGINEERING
SURFACE ELEV. 34.3
DRILLING METHOD MUD ROTARY
BOREHOLE DIA. 10 IN.

SAMPLING NOTES						VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
INTERVAL		RECOVERY		MOISTURE		
NO.	TYPE	BLOWS			DEPTH	
		29-51				
					45	BORING TERMINATED AT 45.0 FEET
					50	
					55	
					60	
					65	

LOG OF TEST BORING

F-203 (R 01-87)

BORING NO. OW-7
SHEET NO. 1 OF 2
PROJECT NO. 467.42
INSTALLATION
SURFACE ELEV. 21.6
BOREHOLE DIA. 10 IN.

PROJECT NAME WEYERHAEUSER
LOCATION PLYMOUTH, NC
CONTRACTOR LAW ENGINEERING
DRILLING METHOD HSA

SAMPLING NOTES						VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
INTERVAL NO.	TYPE	BLOWS	RECOVERY	MOISTURE	DEPTH	
1	SS	2-2-3-3	75			SILTY SAND (SM) - fine grained; humic; light brown. .8
2	SS	4-4-3-5	75			CLAYEY SAND (SC) - fine grained; moderately stiff; orange.
						SILTY SAND (SM) - fine grained; orange-brown. 4.9
3	SS	5-4-4-7	75		5	CLAY (CL) - stiff; gray, brown, mottled. 5.5
4	SS	3-5-8-11	100			SILTY SAND (SM) - fine grained; orange-brown. 6.2
5	SS	4-13-14-15	60			CLAY (CL) - stiff; gray, brown, mottled. 8.0
					10	SAND (SP) - fine grained; white, brown and black laminations. 13.3
6	SS	4-8-11-10	75		15	SILTY SAND (SM) - fine grained; trace medium grained; laminated; tan, orange-brown.
7	SS	5-7-7-8	50			SILTY SAND (SM) - fine to medium grained; with white shell fragments; light gray to tan.

GENERAL NOTES

DATE STARTED 25 APR 90
DATE COMPLETED 25 APR 90
RIG MOBILE B-56
CREW CHIEF TODD JOHNSON
LOGGED BTG CHECKED

WATER LEVEL OBSERVATIONS

WHILE DRILLING ▽ 15.0 FT. BGS
AT COMPLETION ▼
AFTER DRILLING
CAVE-IN: DATE/TIME DEPTH
WATER: DATE/TIME 5-2-90 DEPTH 15.8 FT. BGS

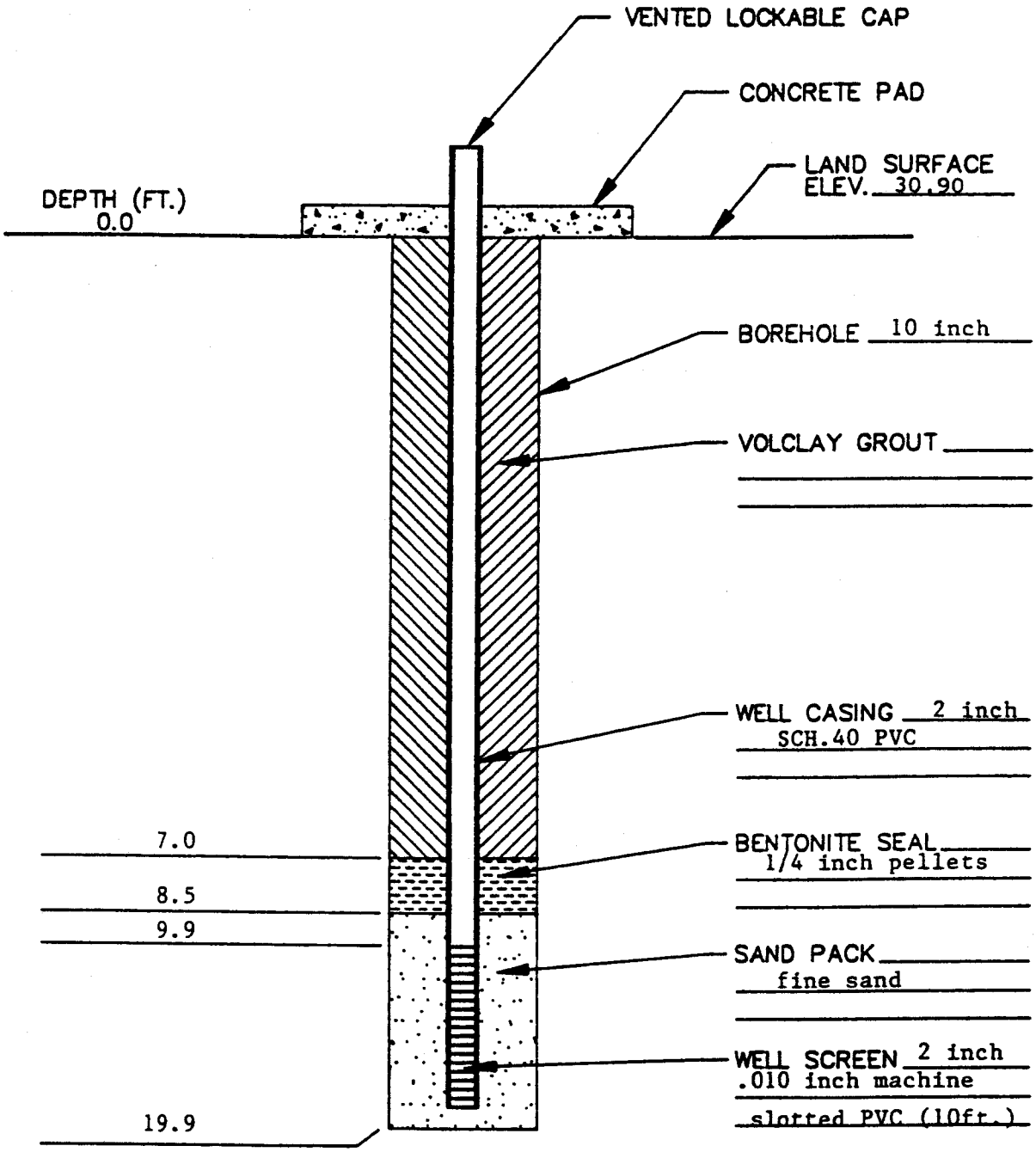
LOG OF TEST BORING

F-203 (R 01-87)

BORING NO. OW-7
SHEET NO. 2 OF 2
PROJECT NO. 467.42
INSTALLATION
SURFACE ELEV. 21.6
BOREHOLE DIA. 10 IN.

PROJECT NAME WEYERHAEUSER
LOCATION PLYMOUTH, NC
CONTRACTOR LAW ENGINEERING
DRILLING METHOD HSA

SAMPLING NOTES						VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
INTERVAL		RECOVERY		MOISTURE		
NO.	TYPE	BLOWS			DEPTH	
8	SS	2-2-5-6	100		25	- trace clay
						BORING TERMINATED AT 26.0 FEET
					30	
					35	
					40	



OBSERVATION WELL CONSTRUCTION DIAGRAM

Not To Scale

PROJECT Weyerhaeuser

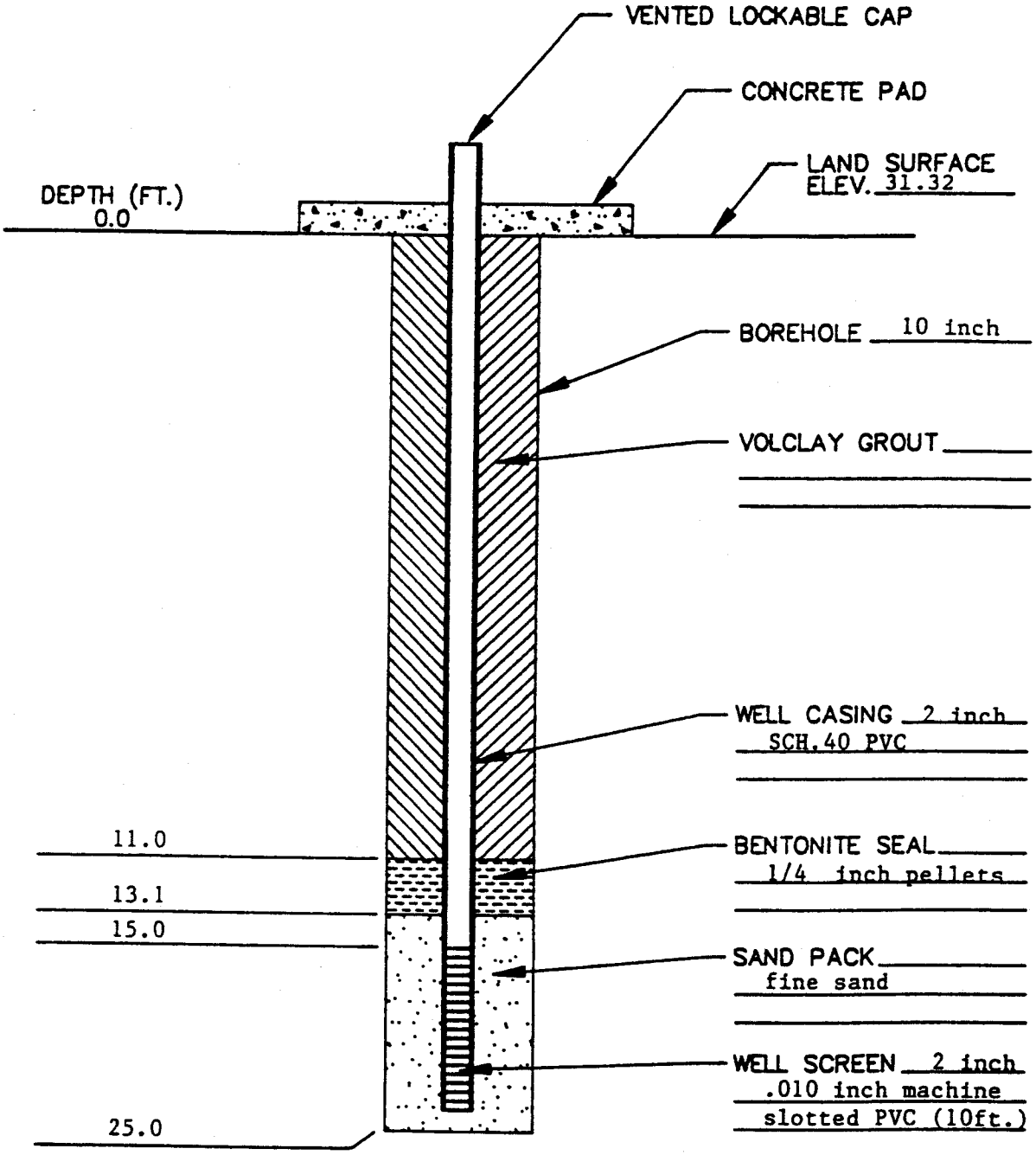
PROJECT NO. 467.42

WELL NO. OW-5 DATE INSTALLED 4/24/90

DRILLING CONTRACTOR Law Engineering

RMT GEOLOGIST B. Grothaus

RMT INC.



OBSERVATION WELL CONSTRUCTION DIAGRAM

Not To Scale

PROJECT Weyerhaeuser

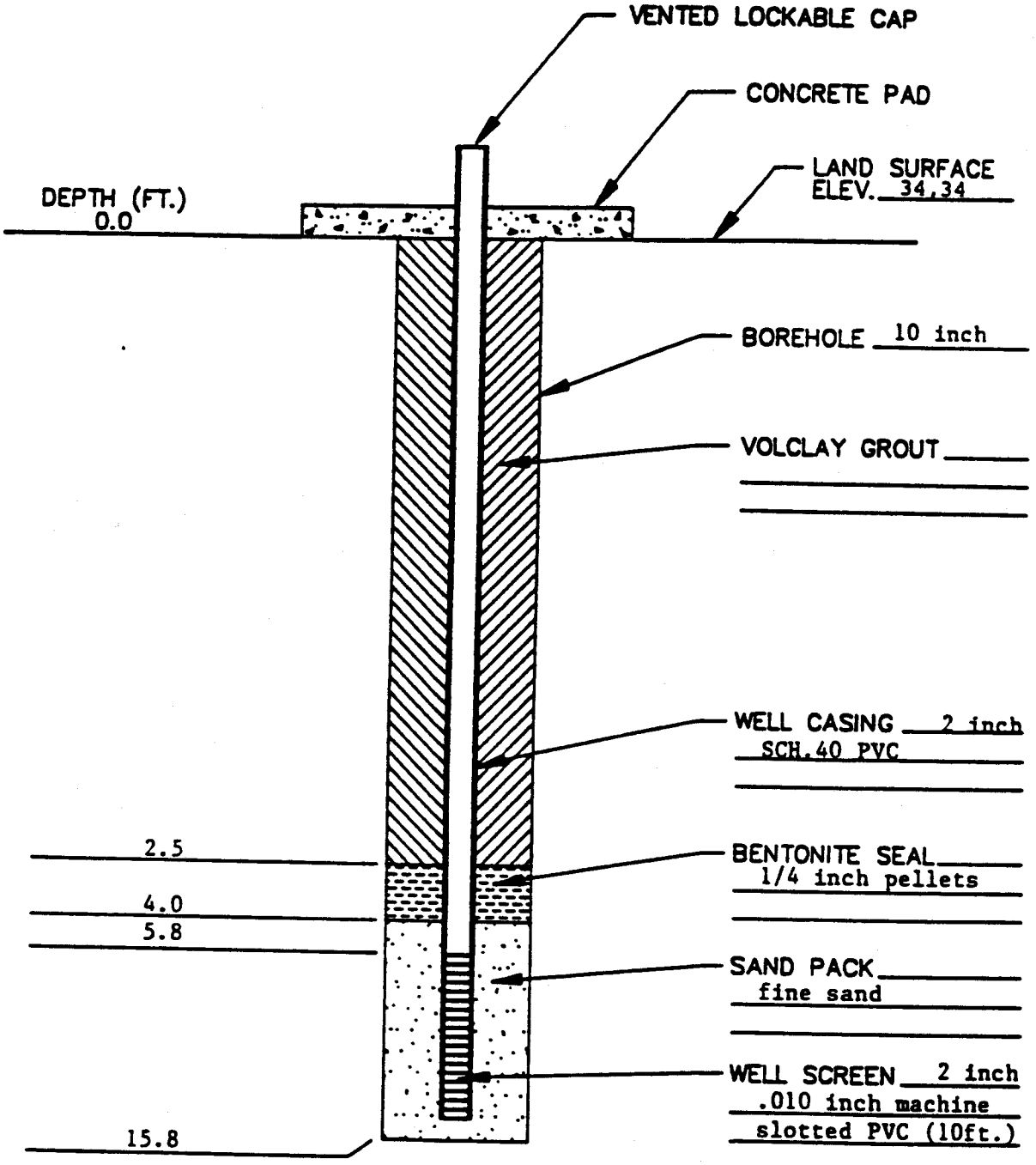
PROJECT NO. 467.42

WELL NO. OW-6 DATE INSTALLED 4/24/90

DRILLING CONTRACTOR Law Engineering

RMT GEOLOGIST B. Grothaus

RMT INC



OBSERVATION WELL CONSTRUCTION DIAGRAM

Not To Scale

PROJECT Weyerhaeuser

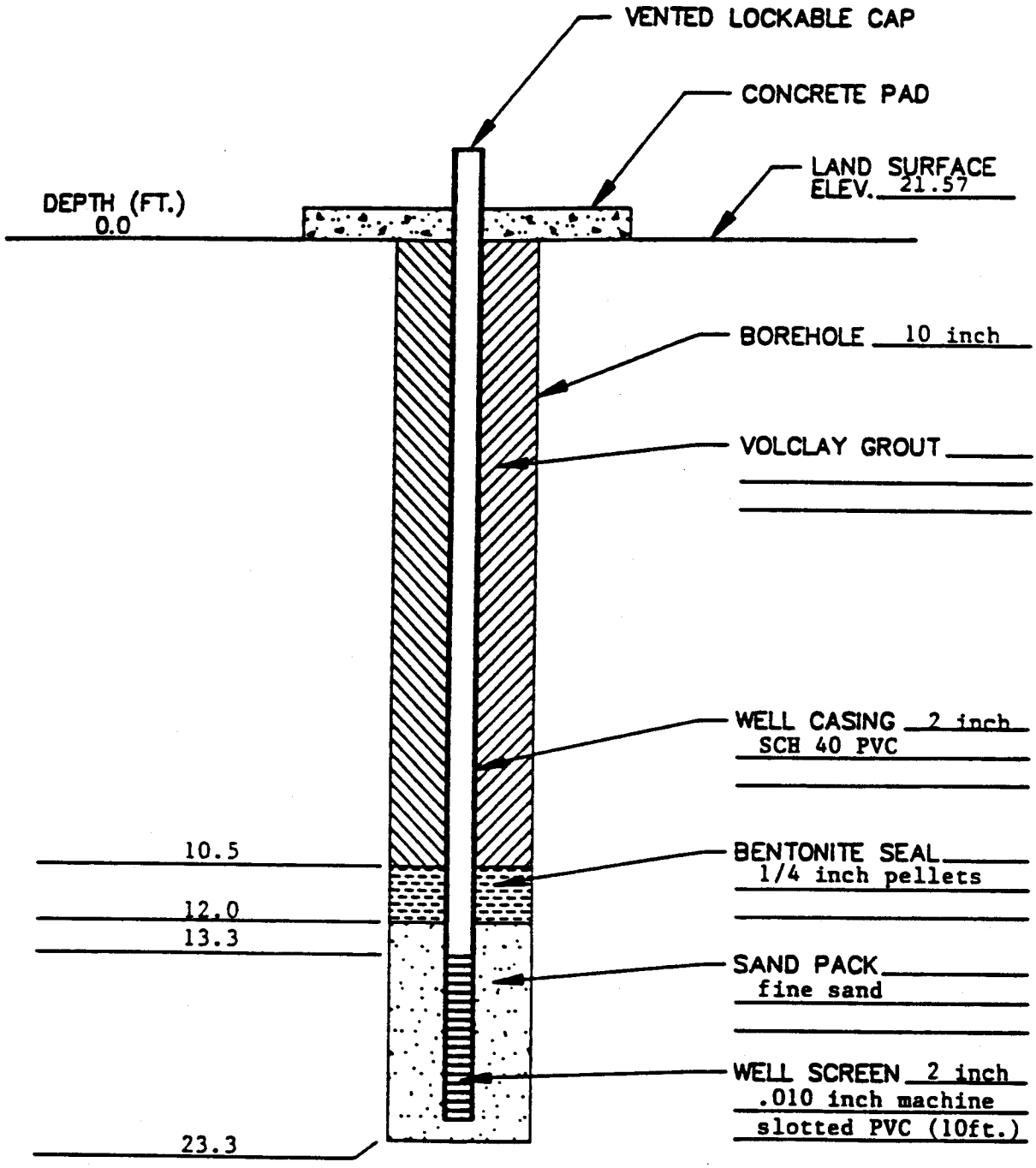
PROJECT NO. 467.42

WELL NO. OW-4 DATE INSTALLED 4/22/90

DRILLING CONTRACTOR Law Engineering

RMT GEOLOGIST B. Grothaus

RMT INC



OBSERVATION WELL CONSTRUCTION DIAGRAM

Not To Scale

PROJECT Weyerhaeuser

PROJECT NO. 467.42

WELL NO. OW-7 DATE INSTALLED 4/25/90

DRILLING CONTRACTOR Law Engineering

RMT GEOLOGIST B. Grothaus

RMT INC

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: OW-4

PROJECT NAME: WeyCo
PROJECT NUMBER: 467.42
FIELD WORK DATE(S): 22 MAY 1990

USER NAME: CVC
DATE: 7 June 1990

Rw - BORING RADIUS (IN): 5.51
L - SCREEN LENGTH (FT): 10
H - SCREEN BASE TO WATER TABLE (FT): 5
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 5
STATIC WATER LEVEL READING (FT): 13.6

Rc was corrected for response in well screen filter material to 3.132 inches

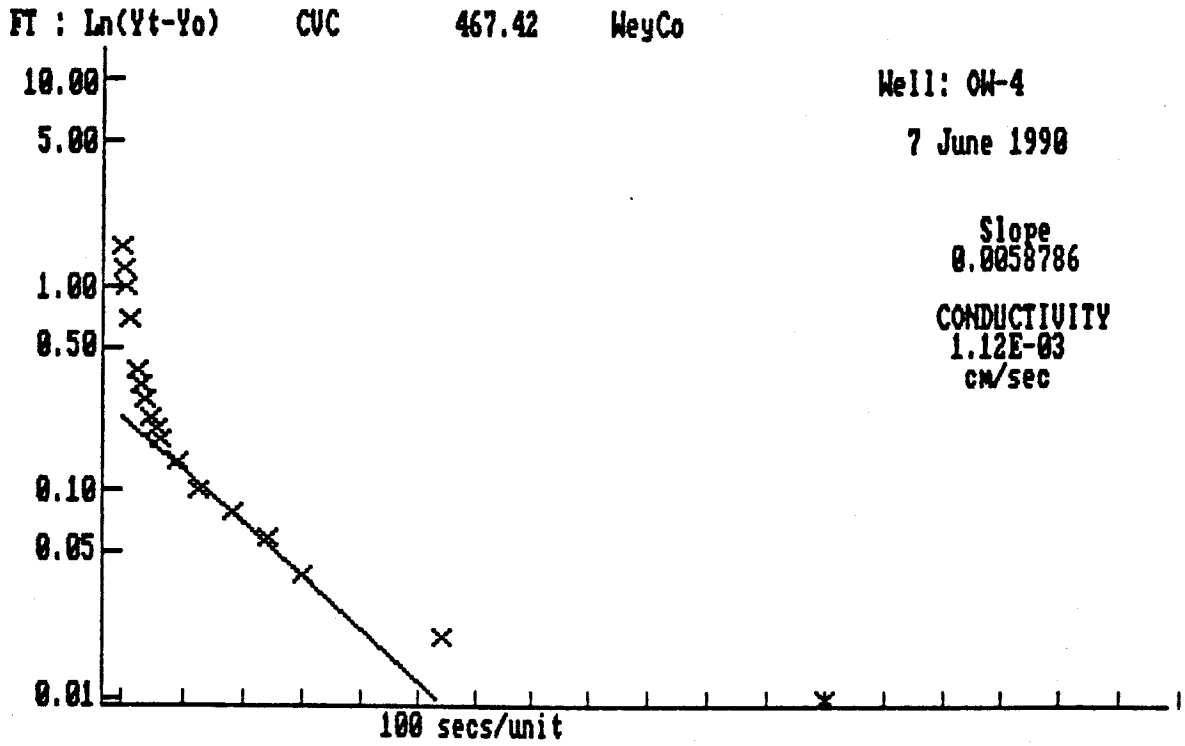
---

TIME (H,M,S)	DEPTH (FT)
0,0,0	15.17
0,0,2	14.81
0,0,6	14.57
0,0,12	14.29
0,0,25	13.98
0,0,30	13.93
0,0,36	13.88
0,0,46	13.83
0,0,56	13.8
0,1,1	13.78
0,1,31	13.74
0,2,6	13.7
0,3,1	13.68
0,4,1	13.66
0,5,1	13.64
0,9,1	13.62
0,20,1	13.6

(1/t) (ln(Yo/Yt))= 0.0058786

FULLY PENETRATING: C= 1.80

HYDRAULIC CONDUCTIVITY: 3.68E-05 ft/sec
1.12E-03 cm/sec


FT : Ln(Yt-Yo)
CVC
467.42
WeyCo
10.00
5.00
1.00
0.50
0.10
0.05
0.01
100 secs/unit
Well: OW-4
7 June 1990
Slope
0.0058786
CONDUCTIVITY
1.12E-03
cm/sec

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: OW-5

PROJECT NAME: WeyCo
PROJECT NUMBER: 467.42
FIELD WORK DATE(S): 22 MAY 1990

USER NAME: CVC
DATE: 7 June 1990

Rw - BORING RADIUS (IN): 4.49
L - SCREEN LENGTH (FT): 10
H - SCREEN BASE TO WATER TABLE (FT): 9.61
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 9.61
STATIC WATER LEVEL READING (FT): 14

Rc was corrected for response in well screen filter material to 2.598 inches

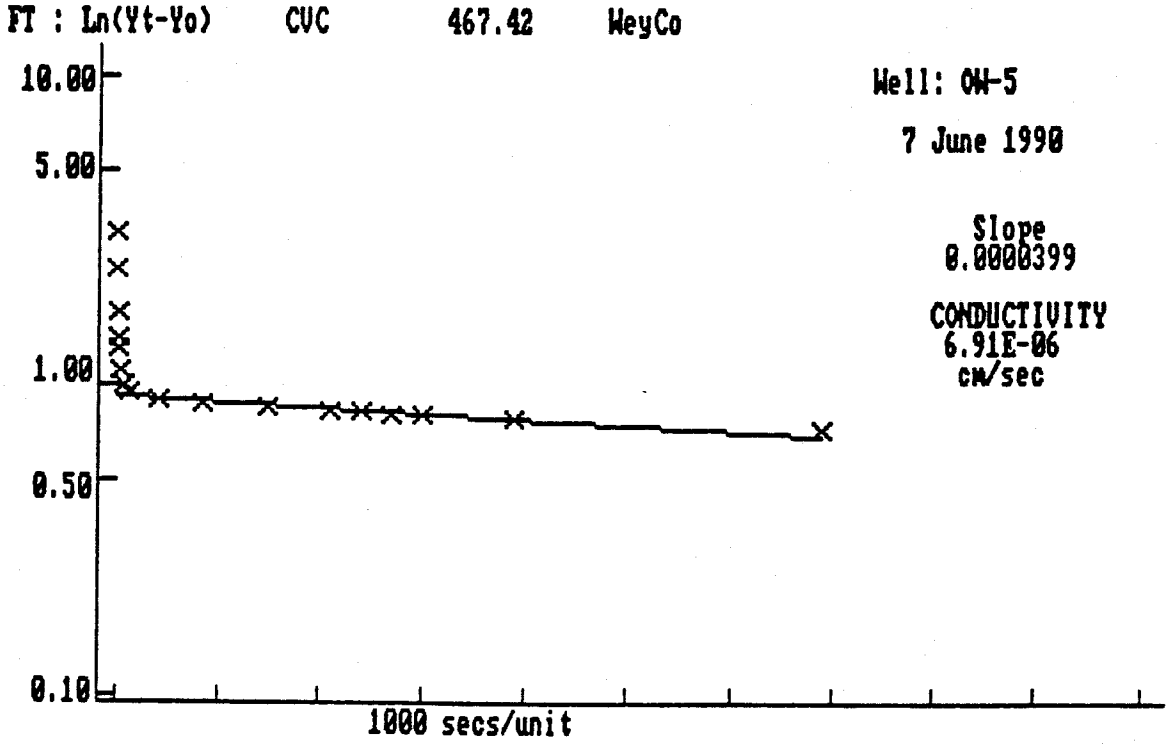
---

TIME (H,M,S)	DEPTH (FT)
0,0,0	17.1
0,0,6	16.36
0,0,15	15.73
0,0,21	15.44
0,0,25	15.3
0,0,35	15.12
0,1,5	15
0,2,0	14.95
0,7,0	14.9
0,14,0	14.87
0,25,0	14.85
0,35,0	14.83
0,40,0	14.82
0,45,0	14.81
0,50,0	14.8
1,5,0	14.79
1,55,0	14.73

(1/t) (ln(Yo/Yt))= 0.0000399

FULLY PENETRATING: C= 1.97

HYDRAULIC CONDUCTIVITY: 2.27E-07 ft/sec
6.91E-06 cm/sec


FT : Ln(Yt-Yo)
CVC
467.42
WeyCo
10.00
5.00
1.00
0.50
0.10
1000 secs/unit
Well: OW-5
7 June 1990
Slope
0.0000399
CONDUCTIVITY
6.91E-06
cm/sec

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: OW-6

PROJECT NAME: WeyCo
PROJECT NUMBER: 467.42
FIELD WORK DATE(S): 22 MAY 1990

USER NAME: CVC
DATE: 7 June 1990

Rw - BORING RADIUS (IN): 1.31
L - SCREEN LENGTH (FT): 10
H - SCREEN BASE TO WATER TABLE (FT): 1.35
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 6.85
STATIC WATER LEVEL READING (FT): 26.95

Rc was corrected for response in well screen filter material to 1.102 inches

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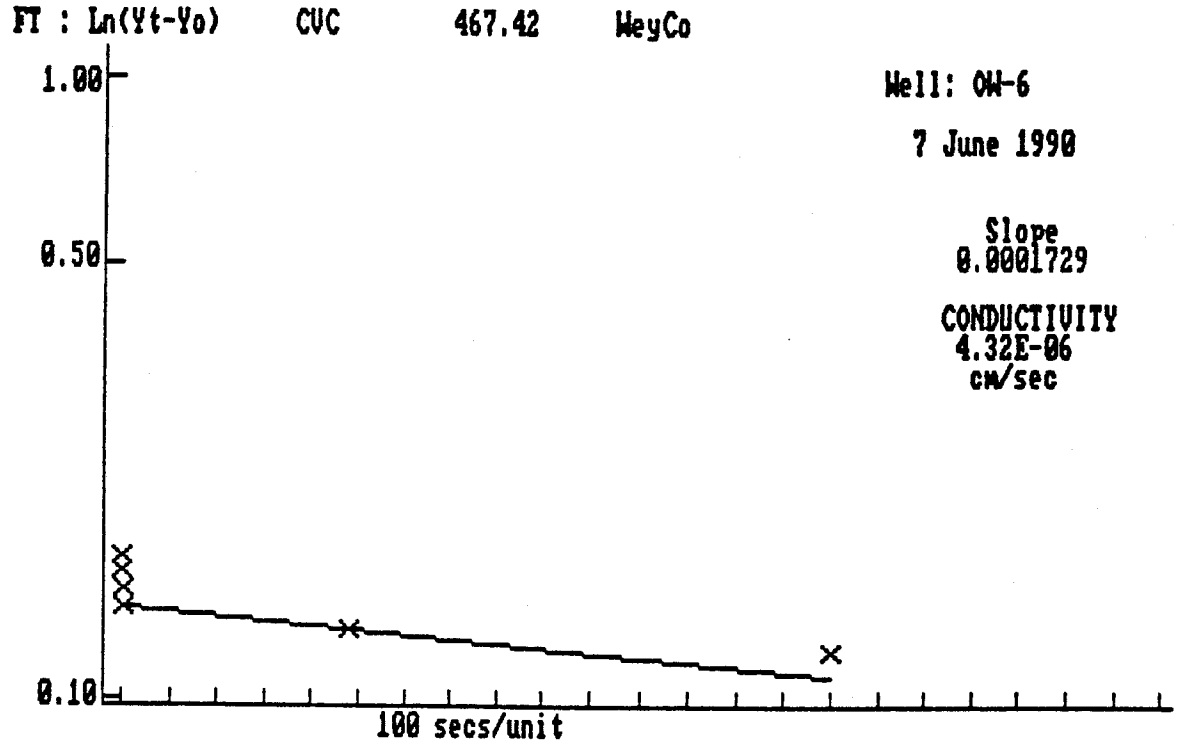
TIME (H,M,S)	DEPTH (FT)
0,0,0	27.12
0,0,1	27.11
0,0,2	27.1
0,0,3	27.09
0,8,0	27.08
0,25,0	27.07

(1/t) (ln(Yo/Yt))= 0.0001729

PARTIALLY PENETRATING: A= 4.15 B= 0.75

HYDRAULIC CONDUCTIVITY: 1.42E-07 ft/sec
4.32E-06 cm/sec


FT : Ln(Yt-Yo)
CVC
467.42
WeyCo
1.00
0.50
0.10
100 secs/unit
Well: OW-6
7 June 1990
Slope
0.0001729
CONDUCTIVITY
4.32E-06
cm/sec

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: OW-7

PROJECT NAME: WeyCo
PROJECT NUMBER: 467.42
FIELD WORK DATE(S): 22 May 1990

USER NAME: CVC
DATE: 1 June 1990

Rw - BORING RADIUS (IN): 8.06
L - SCREEN LENGTH (FT): 10
H - SCREEN BASE TO WATER TABLE (FT): 7.7
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 20
STATIC WATER LEVEL READING (FT): 18.94

Rc was corrected for response in well screen filter material to 4.493 inches

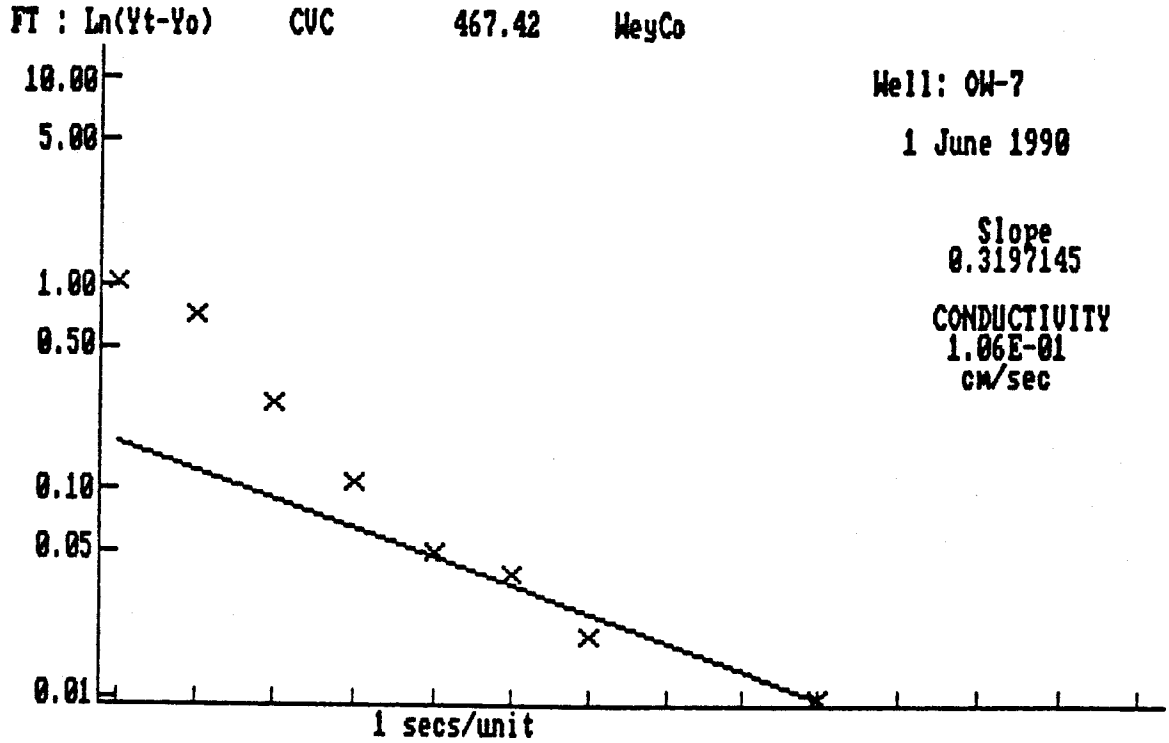
---

TIME (H,M,S)	DEPTH (FT)
0,0,0	19.95
0,0,1	19.65
0,0,2	19.21
0,0,3	19.05
0,0,4	18.99
0,0,5	18.98
0,0,6	18.96
0,0,9	18.95

(1/t) (ln(Yo/Yt))= 0.3197145

PARTIALLY PENETRATING: A= 2.00 B= 0.30

HYDRAULIC CONDUCTIVITY: 3.48E-03 ft/sec
1.06E-01 cm/sec


FT : Ln(Yt-Yo)
CVC
467.42
WeyCo
Well: OW-7
1 June 1990
Slope
0.3197145
CONDUCTIVITY
1.06E-01
cm/sec
10.00
5.00
1.00
0.50
0.10
0.05
0.01
1 secs/unit

DESIGN SHEET

Project/Proposal Name	Prepared: By:	Date:	Checked: By:	Date:	Project/Proposal No.
Weyerhaeuser	JAF	9/13/99	[illegible]	9/23/99	5101.01

The following calculations result in an estimate of the vertical thickness of constituents following migration from the up-gradient to the down-gradient end of the Phase 1 landfill. This is accomplished by using the average linear groundwater velocity in conjunction with vertical dispersivity with a normal distribution of constituents. The vertical thickness of constituents is equivalent to the aqufier thickness over which mixing would occur

Governing Equations

Average Linear Groundwater Velocity

$$\bar{v} = \frac{K \, dh/dx}{n}$$

Dispersion

$$\sigma^2 = 2Dt$$

$$D = \alpha \bar{v}$$

Parameters

v		L/t	Average linear groundwater velocity
K	2.44×10^{-4} 4.80×10^{-4}	cm/sec ft/min	Hydraulic conductivity - Geometric mean of OW-4, OW-5, OW-6, and OW-7
n	0.22	dimensionless	Porosity - Average value for silty sand
dh/dx	0.013	ft/ft	Hydraulic gradient - in the vicinity of Phase 1 - 4/93
σ^2		L	Variance - Variance of constituent concentration as a function of the distance of the center of mass
D		L^2/t	Dispersion coefficient
α	0.005	ft	Dispersivity - Aquifer property (vertical direction) Typical value for silty sand (Garabedian, et al. [1991])

Calculations

Average Linear Groundwater Velocity

$$v = \frac{4.80 \times 10^{-4} \text{ ft/min } (0.013 \text{ ft/ft})}{0.22}$$

$= 2.8 \times 10^{-5}$ ft/min; v = 0.0409 ft/day

Travel Time From End to End of Phase 1

t = x / v

$$t = \frac{1{,}100 \text{ ft}}{0.0409 \text{ ft/d}}$$

t = 26,894 days

x - Length of Phase 1 foot-print

v - Average linear groundwater velocity

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DESIGN SHEET

Project/Proposal Name	Prepared: By:	Date:	Checked: By:	Date:	Project/Proposal No.
Weyerhaeuser	JAF	9/22/99	DJK	9/23/99	5101.01

Calculations (Cont')

Variance

$$\sigma^2 = 0.005 \text{ ft} \times (0.0409 \text{ ft/d}) \times (2) \times (26{,}894 \text{ d})$$
$$\sigma^2 = 11 \text{ ft}^2$$
$$\sigma = 3.32 \text{ ft}$$

The variance is a measure of spread (in the vertical direction) of constituents in groundwater following 1,100 feet of migration. The square root of the variance is the standard deviation. Three standard deviations will encompass 99 percent of the mass, assuming a normal distribution. Therefore three standard deviations, or 9.96 feet, would be the aquifer thickness over which constituents have spread. This aquifer thickness is equivelent to th mixing zone thickness.

DESIGN SHEET

Project/Proposal Name	Prepared: By:	Date:	Checked: By:	Date:	Project/Proposal No.
Weyerhaeuser - Plymouth	JAF	9/22/99	DJK	9/23/99	5101.01

Mass Balance Calculations: (Single Composite Liner)
The liner design effectiveness of Landfill Number Three was evaluated using mass balance calculations to determine if the liner is protective of ground water quality.

Governing Equations:

$$C_{GW} = \frac{(Q_R)(C_P)+(Q_{GW})(C_a)}{Q_R + Q_{GW}}$$

$$Q_R = (r)(A_1)$$

$$Q_{GW} = (K)(dh/dx)(A_2)$$

Parameters:

K	2.44×10^{-4}	cm/sec	Geometric mean of OW-4 , OW-5, OW-6 and OW-7
	4.80×10^{-4}	ft/min	
r	0.205	ft^3/acre/yr	HELP model output with open configuration
	4.71×10^{-6}	ft/yr	
A_1	14.37	acres	Area of Phase 1 foot-print
	6.26×10^5	ft^2	
A_2	1776	ft^2	Cross sectional area perpendicular to groundwater flow assuming a 3.32 foot thick mixing zone (33% of mixing thickness) with the 535 foot width of phase 1
dh/dx	0.013	ft/ft	Hydraulic gradient in the vicinity of phase 1 as mapped in 1993
Q_R		ft^3/min	Volumetric discharge through landfill liner
Q_{GW}		ft^3/min	Volumetric discharge of groundwater through the mixing zone

Calculations:

$$Q_R = 4.71 \times 10^{-6}\ ft/yr\ (6.26 \times 10^5\ ft^2)$$

$$Q_R = 2.95\ ft^3/yr\ ;\ 5.61 \times 10^{-6}\ ft^3/min$$

$$Q_{GW} = 4.80 \times 10^{-4}\ ft/min\ (0.013\ ft/ft)\ (1776\ ft^2)$$

$$Q_{GW} = 0.0111\ ft^3/min$$

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DESIGN SHEET

Project/Proposal Name	Prepared: By:	Date:	Checked: By:	Date:	Project/Proposal No.
Weyerhaeuser - Plymouth	JAF	09/22/99	DJK	9/23/99	5101.01

Calculations: (Single Composite Liner)

$$C_{GW} = \frac{Q_R (C_P) + Q_{GW} (C_a)}{Q_R + Q_{GW}}$$

$$C_{GW} = \frac{Q_R (C_P)}{(Q_R + Q_{GW})}$$

Assuming upgradient groundwater is clean; Ca=0

$$C_P / C_{GW} = \frac{Q_R + Q_{GW}}{Q_R}$$

$$C_P / 2L = \frac{Q_R + Q_{GW}}{Q_R}$$

Assuming NCAC 2L standard is the maximum allowable concentration in groundwater

$$C_P / 2L = \frac{5.61 \times 10^{-6}\ ft^3/min + 0.0111\ ft^3/min}{5.61 \times 10^{-6}\ ft^3/min}$$

$$C_P / 2L = 1.98 \times 10^3$$

The landfill leachate concentration can be 3 orders of magnitude greater than the 2L standard for any given constituent

Sample # 49119

Contained some of the highest constituent concentrations from TCLP data.
Manganese concentrations 15 ppm vs. the 2L of 0.05 ppm

$$C_{GW} = \frac{5.61 \times 10^{-6}\ ft^3/min\ (15\ ppm)}{5.61 \times 10^{-6}\ ft^3/min + 0.0111\ ft^3/min}$$

$$C_{GW} = 7.58 \times 10^{-3}\ ppm$$

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DESIGN SHEET

Project/Proposal Name	Prepared: By:	Date:	Checked: By:	Date:	Project/Proposal No.
Weyerhaeuser - Plymouth	JAF	1/14/99	RJK.	9/23/99	5101.01

Mass Balance Calculations: (Dual Composite Liner)
The liner design effectiveness of Landfill Number Three was evaluated using mass balance calculations to determine if the liner is protective of ground water quality.

Governing Equations:

$$C_{GW} = \frac{(Q_R)(C_P)+(Q_{GW})(C_a)}{Q_R + Q_{GW}}$$

$Q_R = (r)(A_1)$

$Q_{GW} = (K)(dh/dx)(A_2)$

Parameters:

K	2.44×10^{-4}	cm/sec	Geometric mean of OW-4 , OW-5, OW-6 and OW-7
	4.80×10^{-4}	ft/min	
r	0.006	ft^3/acre/yr	HELP model output with open configuration
	1.38×10^{-7}	ft/yr	
A_1	21.1	acres	Area of Phase 1 foot-print
	9.19×10^5	ft^2	
A_2	1660	ft^2	Cross sectional area perpendicular to groundwater flow assuming a 3.32 foot thick mixing zone (33% of mixing thickness) with the 500 foot width of phase 1
dh/dx	0.013	ft/ft	Hydraulic gradient in the vicinity of phase 1 as mapped in 1993
Q_R		ft^3/min	Volumetric discharge through landfill liner
Q_{GW}		ft^3/min	Volumetric discharge of groundwater through the mixing zone

Calculations:

$$Q_R = 1.38 \times 10^{-7} \text{ ft/yr } (9.19 \times 10^5 \text{ ft}^2)$$

$$Q_R = 0.127 \text{ ft}^3\text{/yr} ; \; 2.41 \times 10^{-7} \text{ ft}^3\text{/min}$$

$$Q_{GW} = 2.44 \times 10^{-4} \text{ ft/min } (0.013 \text{ ft/ft}) (1660 \text{ ft}^2)$$

$$Q_{GW} = 5.27 \times 10^{-3} \text{ ft}^3\text{/min}$$

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DESIGN SHEET

Project/Proposal Name	Prepared: By:	Date:	Checked: By:	Date:	Project/Proposal No.
Weyerhaeuser - Plymouth	JAF	09/22/99	DJK	9/23/99	5101.01

Calculations: (Dual Composite)

$$C_{GW} = \frac{Q_R (C_P) + Q_{GW} (C_a)}{Q_R + Q_{GW}}$$

$$C_{GW} = \frac{Q_R (C_P)}{Q_R + Q_{GW}}$$

Assuming upgradient groundwater is clean
Ca = 0

$$C_P / C_{GW} = \frac{Q_R + Q_{GW}}{Q_R}$$

$$C_P / 2L = \frac{Q_R + Q_{GW}}{Q_R}$$

Assuming NCAC 2L standard is the maximum allowable concentration in groundwater

$$C_P / 2L = \frac{2.41 \times 10^{-7}\ ft^3/min + 5.27 \times 10^{-3}\ ft^3/min}{2.41 \times 10^{-7}\ ft^3/min}$$

$$C_P / 2L = 2.19 \times 10^4$$

The landfill leachate concentration can be 4 orders of magnitude greater than the 2L standard for any given constituent

Sample # 49119

Contained some of the highest constituent concentrations from TCLP data.
Manganese concentrations 15 ppm vs. the 2L of 0.05 ppm

$$C_{GW} = \frac{2.41 \times 10^{-7}\ ft^3/min\ (15\ ppm)}{2.41 \times 10^{-7}\ ft^3/min + 5.27 \times 10^{-3}\ ft^3/min}$$

$$C_{GW} = 6.89 \times 10^{-4}\ ppm$$

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NORTH CAROLINA DEPARTMENT OF
ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF WASTE MANAGEMENT

April 29, 1999

Joseph W. Kloeker, Environmental Director
Weyerhaeuser Company
P. O. Box 787
Plymouth, North Carolina 27962

Re: No., Weyerhaeuser Company.

Dear Mr. Kloeker,

A review of the alternate liner design demonstration has been completed by the Solid Waste Section for the proposed Weyerhaeuser No. 3 landfill. The submitted plan provides a mass balance demonstration to show the liner system is protective of groundwater. The model appears to be in order, however, some clarification needs to be provided. Please respond to the following comments and questions.

There appears to be an error on page 2 for the unit between the geocomposite drainage layer and the geosynthetic clay liner.

Please expand on the comment in the cover letter that the primary liner was considered a single liner.

Typically 8 holes per acre is the minimum input parameter required when using the HELP model for the installed liner.

Why was two feet of waste chosen for the HELP model input parameter? How was the evaporative zone depth of 22 inches chosen? Is the leakage rate near steady state?

The HELP model requires climatological data to generate the leakage/percolation values. It appears evapotranspiration and weather data were obtained from Raleigh, North Carolina. Raleigh is in the piedmont physiographic province while Plymouth is in the coastal plain physiographic province. Norfolk, Virginia is also in a coastal plain and has a climate similar to Plymouth. Use a location that provides as close a match as possible.

The raw historic groundwater levels in Attachment 9 have several headings. Does the MP elevation indicate the monitoring point? If so, why does the monitoring point change? Does the D in the depth to water column mean the

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PHONE 919-733-4996 FAX 919-715-3605

piezometer was dry at the time of reading? Are some of the columns reversed between Depth to Water and Water Elevation?

The two aquifer units are reported to be separated by an aquitard. The cross-sections and boring logs support the north-south component of the silty-clay unit however, the boring logs provided do not have enough depth to validate the east-west component. Provide the boring logs and test pits.

Only OW-4 is located in the vicinity of the Phase 1 landfill. OW-7 is over 1200 feet from the cell footprint shown on the Data Point Location Map. Was OW-7 intended to be MW-7?

OW-7 is not shown on Attachment 2.

Are the groundwater contours on Attachment 2 from a single day reading event? A drainage feature was restored on the eastern boundary of the site. Has there been any notable change in the groundwater table? Will it affect any portion of Phase 1?

A mixing zone thickness of 10 percent of the aquifer saturated thickness was chosen. What criteria was used to determine the 10 percent assignment?

Provide the formula used to calculate the hydraulic conductivity.

The proposed Weyerhauser industrial landfill alternate liner demonstration provides part of the requirement for rule .0503 (2)(d)(ii)(A). Response comments for this memo may be included with the site application submittal.

If you have any questions regarding this memo, please contact me at (919) 733-0692, extension 346.

Sincerely,

Cheryl Marks

Cheryl Marks
Hydrogeologist
Solid Waste Section

cc: Sherri Coghill, Solid Waste Section
Jim Coffey, Solid Waste Section
Bobby Nelms, SWS Washington
R. Kent Nilsson, RMT Inc.

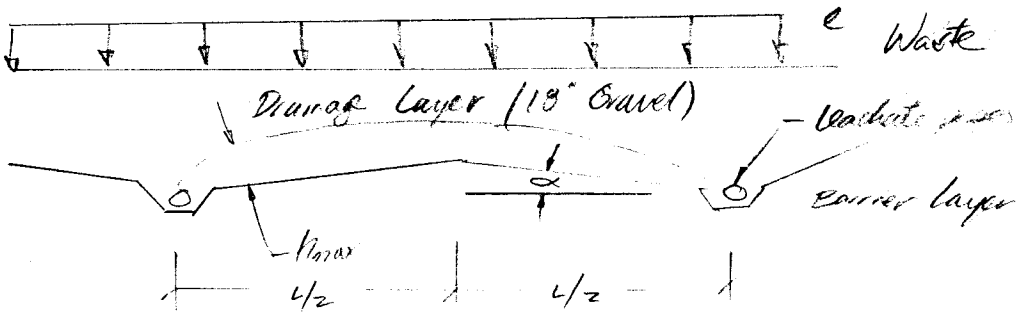
Appendix H
Leachate Line Hydraulic Calculations

DESIGN SHEET

RMT INC.
1054 Claussen Road Suite 306 Augusta, GA 30907-3215 Phone: 706-737-6026 FAX: 706-737-5962

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
Weyerhaeuser - Plymouth	EWT	9/9/99	RKN	6/10/99	5101.01

Determine minimal allowable spacing to leachate collection pipes given LF configuration. NCDENR regs require maximum head on liner not to exceed 1 foot.



① Use the following equation (Moon) to determine L/2:

$$h_{max} = (L/2)\left[\left(\tan^2\alpha + \frac{e}{K_d}\right)^{1/2} - \tan\alpha\right]$$

where, e = infiltration rate (peak monthly precip in inches)
K_d = hydraulic conductivity of drainage layer
α = slope between leachate collection pipes.

② Determine e, infiltration rate:

Infiltration rate shall equal peak monthly precipitation, = 14.95 inches

$$e = \frac{14.95 \text{ inches}}{\text{month}} \cdot \frac{1 \text{ month}}{30 \text{ days}} = 0.53 \frac{\text{in}}{\text{day}}$$

③ Determine lateral hydraulic conductivity, K_d

From HELP Model, $K_d = 0.3 \frac{\text{cm}}{\text{sec}} \cdot \frac{1 \text{ in}}{2.54 \text{ cm}} \cdot \frac{86{,}400 \text{ sec}}{1 \text{ day}} = 1.02 \times 10^4 \frac{\text{in}}{\text{day}}$

DESIGN SHEET

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PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
Weyerhaeuser - Plymouth	EWT	9/9/99	RKN	6/10/99	5101.01

(4) Determine α, slope angle between crest and trough of landfill base.

$$\alpha_1 = \tan^{-1}\frac{2}{100} = 1.15^\circ \qquad \alpha_2 = \tan^{-1}\frac{1}{120} = 0.5^\circ$$

$$\alpha_3 = \tan^{-1}\frac{6}{100} = 3.43^\circ \qquad \alpha_4 = \tan^{-1}\frac{1}{240} = 0.24$$

(5) Using h_{max} = 12 inches, solve for $L/2_{max}$ using Moore equation:

$$\frac{L}{2_{max}} = \frac{h_{max}}{\left(\tan^2\alpha + \frac{c}{h_d}\right)^{1/2} - \tan\alpha}$$

$$\frac{L}{2_{max}} = \frac{12 \text{ inches} \times 12}{\left(\tan^2(1.15) + \frac{0.53 \text{ in/day}}{10205 \text{ in/day}}\right)^{1/2} - \tan 1.15}$$

$$\frac{L}{2_{max}} = \frac{12 \text{ inches}}{0.0201 - 0.0201}$$

@ α_1 $\frac{L}{2_{max}}$ = 797 ft. → use 200'

@ α_2 $\frac{L}{2_{max}} = \frac{12 \times 12}{\left(\tan^2(0.5) + \frac{0.53}{10205}\right)^{1/2} - \tan 0.5}$ = 386 feet → use 200'

@ α_3 $\frac{L}{2_{max}} = \frac{12 \text{ in}}{\left(\tan^2(3.43) + \frac{0.53}{10205}\right)^{1/2} - \tan 3.43}$ = 2316 feet → use 200'

DESIGN SHEET

RMT INC.
1054 Claussen Road Suite 306 Augusta, GA 30907-3215 Phone: 706-737-6026 FAX: 706-737-5962

PROJECT/PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
Weyerhaeuser Plymouth	EMT	9/9/90			5101 01

@ α_4 $\frac{L}{2\ max} = \frac{12/10}{\left(\tan^2(0.24) + \frac{0.53}{10{,}205}\right)^{1/2} - \tan 0.24}$ = 241 feet

↳ In Phase 1, spacing is 240 feet

OK

DESIGN SHEET

Project/Proposal Name	Prepared:		Checked:		Project/Proposal No.
Weyco Plymouth	By:	Date:	By:	Date:	
	EWT	9/24/99	JA	9/24/99	5101.08

Determine leachate collection pipe size, pump and discharge pipe size, and force main size for Landfill No. 3 using the following:

1. HELP Model inputs for leachate amounts
2. Bernoulli equation for velocity, flow rate and head losses - utilizing spreadsheet
3. Flowmaster program
4. NC DEHNR regulations for landfill construction

1. Leachate amounts

From HELP Model generated by Sharon Korleski dated 5/11/99, attached spreadsheet tab entitled "HELP Results" was created. Leachate amounts for various heights of waste were calculated. To be conservative, and because waste height did not impact leachate volumes significantly, average daily flow and one peak daily flow was selected regardless of waste height. The per acre leachate volumes

Design Average Daily Flow: 1,531 gpdpac
Design Peak Daily Flow: 9,238 gpdpac

2. Leachate collection pipe size

From page 110 of NC DEHNR regs, leachate piping to have a minimal nominal diameter of 6". Check 6" pipe size for worst case flow (Phase 1) using Flowmaster program (output attached).

Using:
slope, S = 0.016 ft/ft
Mannings coefficient, n = 0.009
pipe diameter, D = 5.3 inches flowing full (using SDR 17 pipe)
Q max = 420.34 gpm > peak daily flow in any phase (e.g., Phase 1 = 94 gpm)

3. Pump, riser pipe and force main sizes

Select the above sizes based on design flow o 9,238 gpdpac. From spreadsheet tab entitled "HELP Results", flow per phase is calculated and a pump size is estimated. For the pump sizes, two scenarios are run utilizing:

a. The peak daily flow per pump
b. The "worst case flow" where pumps are run at capacity

For the force main, 4 scenarios are run based on flow from combined phases:

a. The peak daily flow from the landfill (185 gpm)
b. The "worst case flow" where Drainage Area 1 pumps are run at capacity (600 gpm)
c. The "worst case flow" where Drainage Area 2 pumps are run at capacity (400 gpm)
d. The "worst case flow" where Phase 3, 4, 5 and 6 pumps are run at capacity (320 gpm)

DESIGN SHEET

Project/Proposal Name	Prepared:		Checked:		Project/Proposal No.
Weyco Plymouth	By:	Date:	By:	Date:	
	EWT	9/24/99	JA	9/24/99	5101.08

Methodology

A. The spreadsheet tabs are linked such that flow rates are input into each of the tabs to calculate the head loss per foot utilizing Bernoulli's equation. For example, in tab "FM":

Flow rate = 185 gpm
viscosity = 1
spec. gravity = 1
spec. roughness = 5 x 10-6 for HDPE pipe
pressure drop/100 feet = 0.3010 ft for 6 inch pipe

B. Equivalent feet for each drainage area are then calculated using attached manhole detail as a "go-by". Pipe lengths are obtained from the leachate piping plan.

C. Values are summarized in a tabs entitled "Summary" and "Worst Case Summary". In both of these tabs, total equivalent feet is multiplied by head loss/100 feet to calculate the dynamic head. Static head is input based on the grading plan. Total head is then calculated by adding the dynamic and static head.

D. Using attached EPG pump curves, and worst case flow rate and head from "Worst Case Summary" Tab, a pump model is selected.

Worst Case Flow:	60	gpm @	147	feet of head
Worst Case Flow:	80	gpm @	92	feet of head

Add 10% on to head to compensate for smaller schedule 80 pipe thickness versus SDR 11

Worst Case Flow:	60	gpm @	162	feet of head
Worst Case Flow:	80	gpm @	101	feet of head

For all phases, select EPG Model WSD15-7

From pump curve sheet, WSD12-8 pump dimensions:

Length:	70.75 inches	5.9 feet
Diameter:	7.56 inches	0.6 feet
Outlet Diameter:	2 inches	0.2 feet

DESIGN SHEET

Project/Proposal Name	Prepared: By:	Date:	Checked: By:	Date:	Project/Proposal No.
Weyco Plymouth	EWT	9/24/99	JA	9/24/99	5101.08

Determine the time for Phases 1 and 2 to dewater given 25 year, 24 hour storm event and leachate collection system capacity.

q (25 yr, 24 hr) =	7	inches
Phase 1 Area =	14.36	acres
Phase 2 Area =	14.51	acres
Total Area =	28.87	acres
Volume =	733,587	cf
Volume =	5,487,229	gallons

Assume the following pump system:

Phase 1:	3	primary pumps @	60 gpm
	3	secondary pumps @	60 gpm
Phase 2:	2	primary pumps @	60 gpm
	2	secondary pumps @	60 gpm

Total System Flow =	600	gpm
Total System Flow =	864,000	gpd
Dewatering Time =	6.4	days

Weyerhaeuser Plymouth
Help Model Results and Flow Estimates
RMT Job No. 05101.01
24-Sep-99

From HELP Model:	
Design Average Daily Flow:	1,531 gpdpac
Design Peak Daily Flow:	9,238 gpdpac

Drainage Area	Phase(s)	Area (ac)	Average Daily Flow[1] (gpd)	Peak Daily Flow[2] (gpd)	Average Daily Flow[3] (gpm)	Peak Daily Flow[4] (gpm)	No. of Primary Pumps[5]	Peak Daily Flow per Pump[6] (gpm)	Selected Pump Size (gpm)	Worst Case Flow Rate[7] (gpm)	Combined Worst Case Flow Rate[8] (gpm)
1	1	14.36	21,985	132,658	15	92	3	31	60	360	**600**
2	2	14.51	22,215	134,043	15	93	2	47	60	240	400
3	3, 4	11.49	17,591	106,145	12	74	1	74	80	160	320
4	5, 6	11.1	16,994	102,542	12	71	1	71	80	160	320
5	7, 8	10.63	16,275	98,200	11	68	1	68	80	160	320
6	9, 10	10.01	15,325	92,472	11	64	1	64	80	160	

Phase	Total Average Flow from LF[9] (gpd)	Total Peak Flow from LF[10] (gpd)	Total Average Flow from LF[11] (gpm)	Total Peak Flow from LF[12] (gpm)
1				
	44,200	266,701	31	**185**
2				
	39,806	240,188	28	167
3				
	34,585	208,686	24	145
4				
	33,269	200,742	23	139
5				
	31,600	190,672	22	132
6				

1. Average Daily Flow: Area x Design Average Daily Flow
2. Peak Daily Flow: Area x Design Peak Daily Flow
3. Average Daily Flow (gpm): Typical flow rate for each phase
4. Peak Daily Flow (gpm): Design flow rate for each phase
5. No.of Primary Pumps: Number of primary pumps (not back-up) per phase
6. Peak Daily Flow per Pump (gpm): Peak Daily Flow/No. of Primary Pumps
7. Worst Case Flow Rate (gpm): Flow rate if primary and secondary pumps were running at capacity
8. Combined Worst Case Flow Rate (gpm): Flow rate if adjacent phases are being pumped from at capacity (e.g., Phase 1 worst case flow + Phase 2 worst case flow)
9. Total Average Flow from LF: Combines phases to determine the flow from the landfill; flow assumed to be the same if phase open or full.
10. Total Peak Flow from LF: Combines phases to determine the flow from the landfill; flow assumed to be the same if phase open or full.
11. Total Peak Flow from LF (gpm): Typical flow rate for force main
12. Total Peak Flow from LF (gpm): Design flow rate for force main

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Force Main
Material: Smooth HDPE

INPUT Assuming Phase 1 full and Phase 2 open

Fluid Name		Water
Flow	(gallons/minute)	185
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	12940.1449	29891.7346	253.79
	0.75	80	2780.8937	6423.8645	137.42
	1.00	80	786.6173	1817.0859	82.61
	1.50	80	86.6403	200.1391	33.63
	2.00	80	24.8416	57.3841	20.12
	2.50	80	10.3470	23.9016	14.02
	3.00	80	3.5411	8.1799	9.00
>>>>>	4.00	80	0.9314	2.1515	5.17
>>>>>	6.00	80	0.1303	0.3010	2.28
	8.00	80	0.0340	0.0785	1.30
	10.00	80	0.0115	0.0266	0.83
	12.00	80	0.0050	0.0116	0.58
	14.00	80	0.0032	0.0074	0.48
	16.00	40	0.0013	0.0031	0.34
	18.00	30	0.0007	0.0016	0.26
	20.00	30	0.0004	0.0010	0.21
	24.00	30	0.0002	0.0004	0.14
	30.00	20	0.0001	0.0001	0.09

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Force Main
Material: Smooth HDPE

INPUT Assuming worst case flow maximizing 10 pumps
(Phase 1: 3 primary and 3 secondary @ 60 gpm)
(Phase 2: 2 primary and 2 secondary @ 100 gpm)

Fluid Name		Water
Flow	(gallons/minute)	600
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	127385.3671	294260.1981	822.16
	0.75	80	26646.6249	61553.7036	445.18
	1.00	80	7355.6962	16991.6583	267.62
	1.50	80	777.8385	1796.8070	108.93
	2.00	80	218.7665	505.3507	65.19
	2.50	80	90.0794	208.0834	45.42
	3.00	80	30.4610	70.3649	29.14
	4.00	80	7.9136	18.2804	16.74
>>>>>	6.00	80	1.0911	2.5206	7.38
>>>>>	8.00	80	0.2822	0.6519	4.22
	10.00	80	0.0949	0.2192	2.68
	12.00	80	0.0412	0.0951	1.89
	14.00	80	0.0262	0.0604	1.57
	16.00	40	0.0109	0.0252	1.09
	18.00	30	0.0058	0.0133	0.84
	20.00	30	0.0035	0.0081	0.68
	24.00	30	0.0014	0.0033	0.47
	30.00	20	0.0005	0.0011	0.29

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Force Main
Material: Smooth HDPE

INPUT Assuming worst case flow maximizing 10 pumps
(Phase 1: 3 primary and 3 secondary @ 60 gpm)
(Phase 2: 2 primary and 2 secondary @ 100 gpm)

Fluid Name		Water
Flow	(gallons/minute)	400
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	57571.4505	132990.0508	548.11
	0.75	80	12142.2388	28048.5715	296.79
	1.00	80	3378.8921	7805.2407	178.41
	1.50	80	362.5831	837.5670	72.62
	2.00	80	102.7309	237.3085	43.46
	2.50	80	42.4901	98.1522	30.28
	3.00	80	14.4356	33.3462	19.43
	4.00	80	3.7681	8.7043	11.16
>>>>>	6.00	80	0.5224	1.2067	4.92
>>>>>	8.00	80	0.1355	0.3130	2.81
	10.00	80	0.0457	0.1055	1.79
	12.00	80	0.0199	0.0459	1.26
	14.00	80	0.0126	0.0292	1.05
	16.00	40	0.0053	0.0122	0.73
	18.00	30	0.0028	0.0065	0.56
	20.00	30	0.0017	0.0039	0.45
	24.00	30	0.0007	0.0016	0.31
	30.00	20	0.0002	0.0005	0.19

LIQUID PRESSURE DROP CALCULATION

FM - @320 gpm

Service: Weyerhaueser Plymouth Landfill Design - Force Main
Material: Smooth HDPE

INPUT

Assuming worst case flow maximizing 10 pumps
(Phase 1: 3 primary and 3 secondary @ 60 gpm)
(Phase 2: 2 primary and 2 secondary @ 100 gpm)

Fluid Name		Water
Flow	(gallons/minute)	320
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	37268.9730	86091.3276	438.49
	0.75	80	7900.3337	18249.7708	237.43
	1.00	80	2208.7872	5102.2984	142.73
	1.50	80	238.9026	551.8650	58.10
	2.00	80	67.9422	156.9466	34.77
	2.50	80	28.1639	65.0585	24.22
	3.00	80	9.5905	22.1541	15.54
>>>>>	4.00	80	2.5093	5.7965	8.93
>>>>>	6.00	80	0.3488	0.8058	3.94
	8.00	80	0.0906	0.2094	2.25
	10.00	80	0.0306	0.0707	1.43
	12.00	80	0.0133	0.0308	1.01
	14.00	80	0.0085	0.0196	0.84
	16.00	40	0.0035	0.0082	0.58
	18.00	30	0.0019	0.0043	0.45
	20.00	30	0.0011	0.0026	0.36
	24.00	30	0.0005	0.0011	0.25
	30.00	20	0.0002	0.0004	0.16

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Phase 1
Material: Smooth HDPE

INPUT

Fluid Name		Water
Flow	(gallons/minute)	31
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	439.6996	1015.7060	42.08
	0.75	80	98.7486	228.1093	22.78
	1.00	80	28.8285	66.5939	13.70
	1.50	80	3.3168	7.6618	5.58
>>>>>	2.00	80	0.9695	2.2395	3.34
>>>>>	2.50	80	0.4086	0.9439	2.32
>>>>>	3.00	80	0.1417	0.3274	1.49
	4.00	80	0.0379	0.0874	0.86
	6.00	80	0.0054	0.0125	0.38
	8.00	80	0.0014	0.0033	0.22
	10.00	80	0.0005	0.0011	0.14
	12.00	80	0.0002	0.0005	0.10
	14.00	80	0.0001	0.0003	0.08
	16.00	40	0.0001	0.0001	0.06
	18.00	30	0.0000	0.0001	0.04
	20.00	30	0.0000	0.0000	0.03
	24.00	30	0.0000	0.0000	0.02
	30.00	20	0.0000	0.0000	0.01

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Phase 1
Material: Smooth HDPE

INPUT Assuming worst case flow maximizing 60 gpm pumps

Fluid Name		Water
Flow	(gallons/minute)	60
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	1524.1483	3520.7826	82.22
	0.75	80	337.2434	779.0322	44.52
	1.00	80	97.4726	225.1617	26.76
	1.50	80	11.0625	25.5544	10.89
	2.00	80	3.2133	7.4227	6.52
>>>>>	2.50	80	1.3489	3.1160	4.54
>>>>>	3.00	80	0.4656	1.0755	2.91
>>>>>	4.00	80	0.1236	0.2856	1.67
	6.00	80	0.0175	0.0405	0.74
	8.00	80	0.0046	0.0107	0.42
	10.00	80	0.0016	0.0036	0.27
	12.00	80	0.0007	0.0016	0.19
	14.00	80	0.0004	0.0010	0.16
	16.00	40	0.0002	0.0004	0.11
	18.00	30	0.0001	0.0002	0.08
	20.00	30	0.0001	0.0001	0.07
	24.00	30	0.0000	0.0001	0.05
	30.00	20	0.0000	0.0000	0.03

EQUIVALENT FEET OF PIPE

Service: Weyerhaueser Plymouth - Phase 1

Segment	Pump to MH1		MH1 to Wet Well		Pump to MH2		MH2 to Wet Well		Pump to MH3		MH3 to Wet Well	
Pipe Size	3 inch		6 inch		3 inch		6 inch		3 inch		6 inch	
Fittings	Qty	Equiv.	Qty	Equiv.	Qty	Equiv.	Qty	Equiv.	Qty	Equiv.	Qty	Equiv.
90 deg Ell	1	4.4	2	30.0	1	4.4	3	45.0	1	4.4	3	45.0
Long Rad. Ell		0.0		0.0		0.0		0.0		0.0		0.0
45 deg Ell	2	5.2		0.0	2	5.2		0.0	2	5.2		0.0
TEE-Line Flow	1	2.2		0.0	1	2.2		0.0	1	2.2		0.0
TEE-Branch Flow	1	9.4		0.0	1	9.4		0.0	1	9.4		0.0
180 deg Bend		0.0		0.0		0.0		0.0		0.0		0.0
Globe Valve	1	94.0		0.0	1	94.0		0.0	1	94.0		0.0
Gate Valve	1	2.8		0.0	1	2.8		0.0	1	2.8		0.0
Sudden Expansion (6")	1	5.0		0.0	1	5.0		0.0	1	5.0		0.0
Swing Check Valve	1	27.0	1	50.5	1	27.0	1	50.5	1	27.0	1	50.5
Bell Mouth Inlet		0.0		0.0		0.0		0.0		0.0		0.0
Square Mouth Inlet		0.0		0.0		0.0		0.0		0.0		0.0
Re-Entrant Pipe		0.0		0.0		0.0		0.0		0.0		0.0
Straight Pipe	50	50.0	1800	1800.0	50	50.0	2400	2400.0	50	50.0	3500	3500.0
Total Equiv Feet		200		1880.5		200		2495.5		200		3595.5

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Phase 2
Material: Smooth HDPE

INPUT

Fluid Name		Water
Flow	(gallons/minute)	47
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	949.0448	2192.2935	63.78
	0.75	80	211.2448	487.9755	34.53
	1.00	80	61.3029	141.6097	20.76
	1.50	80	6.9955	16.1597	8.45
>>>>>	2.00	80	2.0370	4.7054	5.06
>>>>>	2.50	80	0.8564	1.9783	3.52
>>>>>	3.00	80	0.2961	0.6841	2.26
	4.00	80	0.0788	0.1821	1.30
	6.00	80	0.0112	0.0259	0.57
	8.00	80	0.0030	0.0068	0.33
	10.00	80	0.0010	0.0023	0.21
	12.00	80	0.0004	0.0010	0.15
	14.00	80	0.0003	0.0007	0.12
	16.00	40	0.0001	0.0003	0.08
	18.00	30	0.0001	0.0001	0.06
	20.00	30	0.0000	0.0001	0.05
	24.00	30	0.0000	0.0000	0.04
	30.00	20	0.0000	0.0000	0.02

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Phase 2
Material: Smooth HDPE

INPUT Assuming worst case flow maximizing 60 gpm pumps

Fluid Name		Water
Flow	(gallons/minute)	60
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	1524.1483	3520.7826	82.22
	0.75	80	337.2434	779.0322	44.52
	1.00	80	97.4726	225.1617	26.76
	1.50	80	11.0625	25.5544	10.89
	2.00	80	3.2133	7.4227	6.52
>>>>>	2.50	80	1.3489	3.1160	4.54
>>>>>	3.00	80	0.4656	1.0755	2.91
>>>>>	4.00	80	0.1236	0.2856	1.67
	6.00	80	0.0175	0.0405	0.74
	8.00	80	0.0046	0.0107	0.42
	10.00	80	0.0016	0.0036	0.27
	12.00	80	0.0007	0.0016	0.19
	14.00	80	0.0004	0.0010	0.16
	16.00	40	0.0002	0.0004	0.11
	18.00	30	0.0001	0.0002	0.08
	20.00	30	0.0001	0.0001	0.07
	24.00	30	0.0000	0.0001	0.05
	30.00	20	0.0000	0.0000	0.03

EQUIVALENT FEET OF PIPE

Service: Weyerhaueser Plymouth - Phase 2

Segment	Pump to MH4		MH4 to Wet Well		Pump to MH5		MH5 to Wet Well	
Pipe Size	3 inch		6 inch		3 inch		6 inch	
Fittings	Qty	Equiv.	Qty	Equiv.	Qty	Equiv.	Qty	Equiv.
90 deg Ell	1	4.4	3	45.0	1	4.4	3	45.0
Long Rad. Ell		0.0		0.0		0.0		0.0
45 deg Ell	2	5.2		0.0	2	5.2		0.0
TEE-Line Flow	1	2.2		0.0	1	2.2		0.0
TEE-Branch Flow	1	9.4		0.0	1	9.4		0.0
180 deg Bend		0.0		0.0		0.0		0.0
Globe Valve	1	94.0		0.0	1	94.0		0.0
Gate Valve	1	2.8		0.0	1	2.8		0.0
Sudden Expansion (6")	1	5.0		0.0	1	5.0		0.0
Swing Check Valve	1	27.0	1	50.5	1	27.0	1	50.5
Bell Mouth Inlet		0.0		0.0		0.0		0.0
Square Mouth Inlet		0.0		0.0		0.0		0.0
Re-Entrant Pipe		0.0		0.0		0.0		0.0
Straight Pipe	90	90.0	3700	3700.0	90	90.0	4100	4100.0
Total Equiv Feet		240		3795.5		240		4195.5

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Phase 3
Material: Smooth HDPE

INPUT

Fluid Name		Water
Flow	(gallons/minute)	74
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	2242.4237	5179.9988	101.00
	0.75	80	493.6660	1140.3684	54.69
	1.00	80	142.1831	328.4430	32.88
	1.50	80	16.0608	37.1004	13.38
	2.00	80	4.6554	10.7540	8.01
>>>>>	2.50	80	1.9518	4.5086	5.58
>>>>>	3.00	80	0.6727	1.5539	3.58
>>>>>	4.00	80	0.1783	0.4119	2.06
	6.00	80	0.0252	0.0583	0.91
	8.00	80	0.0066	0.0153	0.52
	10.00	80	0.0023	0.0052	0.33
	12.00	80	0.0010	0.0023	0.23
	14.00	80	0.0006	0.0015	0.19
	16.00	40	0.0003	0.0006	0.13
	18.00	30	0.0001	0.0003	0.10
	20.00	30	0.0001	0.0002	0.08
	24.00	30	0.0000	0.0001	0.06
	30.00	20	0.0000	0.0000	0.04

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Phase 3
Material: Smooth HDPE

INPUT Assuming worst case flow maximizing 60 gpm pumps

Fluid Name		Water
Flow	(gallons/minute)	80
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	2616.1441	6043.2928	109.62
	0.75	80	574.7497	1327.6718	59.36
	1.00	80	165.2958	381.8333	35.68
	1.50	80	18.6349	43.0466	14.52
	2.00	80	5.3969	12.4669	8.69
>>>>>	2.50	80	2.2615	5.2240	6.06
>>>>>	3.00	80	0.7790	1.7995	3.89
>>>>>	4.00	80	0.2064	0.4767	2.23
	6.00	80	0.0292	0.0674	0.98
	8.00	80	0.0077	0.0177	0.56
	10.00	80	0.0026	0.0060	0.36
	12.00	80	0.0011	0.0026	0.25
	14.00	80	0.0007	0.0017	0.21
	16.00	40	0.0003	0.0007	0.15
	18.00	30	0.0002	0.0004	0.11
	20.00	30	0.0001	0.0002	0.09
	24.00	30	0.0000	0.0001	0.06
	30.00	20	0.0000	0.0000	0.04

EQUIVALENT FEET OF PIPE

Service: Weyerhaueser Plymouth - Phase 3

Segment	Pump to MH6		MH6 to Wet Well					
Pipe Size	3 inch		6 inch		3 inch		6 inch	
Fittings	Qty	Equiv.	Qty	Equiv.	Qty	Equiv.	Qty	Equiv.
90 deg Ell	1	4.4	3	45.0		0.0		0.0
Long Rad. Ell		0.0		0.0		0.0		0.0
45 deg Ell	2	5.2		0.0		0.0		0.0
TEE-Line Flow	1	2.2		0.0		0.0		0.0
TEE-Branch Flow	1	9.4		0.0		0.0		0.0
180 deg Bend		0.0		0.0		0.0		0.0
Globe Valve	1	94.0		0.0		0.0		0.0
Gate Valve	1	2.8		0.0		0.0		0.0
Sudden Expansion (6")	1	5.0		0.0		0.0		0.0
Swing Check Valve	1	27.0	1	50.5		0.0		0.0
Bell Mouth Inlet		0.0		0.0		0.0		0.0
Square Mouth Inlet		0.0		0.0		0.0		0.0
Re-Entrant Pipe		0.0		0.0		0.0		0.0
Straight Pipe	50	50.0	4300	4300.0		0.0		0.0
Total Equiv Feet		200		4395.5		0		0

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Phase 4
Material: Smooth HDPE

INPUT

Fluid Name		Water
Flow	(gallons/minute)	71
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	2101.4627	4854.3788	97.58
	0.75	80	463.0336	1069.6075	52.84
	1.00	80	133.4410	308.2488	31.76
	1.50	80	15.0856	34.8476	12.93
	2.00	80	4.3743	10.1046	7.74
>>>>>	2.50	80	1.8343	4.2373	5.39
>>>>>	3.00	80	0.6324	1.4608	3.46
>>>>>	4.00	80	0.1677	0.3874	1.99
	6.00	80	0.0237	0.0548	0.88
	8.00	80	0.0062	0.0144	0.50
	10.00	80	0.0021	0.0049	0.32
	12.00	80	0.0009	0.0022	0.22
	14.00	80	0.0006	0.0014	0.19
	16.00	40	0.0003	0.0006	0.13
	18.00	30	0.0001	0.0003	0.10
	20.00	30	0.0001	0.0002	0.08
	24.00	30	0.0000	0.0001	0.06
	30.00	20	0.0000	0.0000	0.03

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Phase 4
Material: Smooth HDPE

INPUT Assuming worst case flow maximizing 60 gpm pumps

Fluid Name		Water
Flow	(gallons/minute)	80
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	2616.1441	6043.2928	109.62
	0.75	80	574.7497	1327.6718	59.36
	1.00	80	165.2958	381.8333	35.68
	1.50	80	18.6349	43.0466	14.52
	2.00	80	5.3969	12.4669	8.69
>>>>>	2.50	80	2.2615	5.2240	6.06
>>>>>	3.00	80	0.7790	1.7995	3.89
>>>>>	4.00	80	0.2064	0.4767	2.23
	6.00	80	0.0292	0.0674	0.98
	8.00	80	0.0077	0.0177	0.56
	10.00	80	0.0026	0.0060	0.36
	12.00	80	0.0011	0.0026	0.25
	14.00	80	0.0007	0.0017	0.21
	16.00	40	0.0003	0.0007	0.15
	18.00	30	0.0002	0.0004	0.11
	20.00	30	0.0001	0.0002	0.09
	24.00	30	0.0000	0.0001	0.06
	30.00	20	0.0000	0.0000	0.04

EQUIVALENT FEET OF PIPE

Service: Weyerhaueser Plymouth - Phase 4

Segment	Pump to MH7		MH7 to Wet Well					
Pipe Size	3 inch		6 inch		3 inch		4 inch	
Fittings	Qty	Equiv.	Qty	Equiv.	Qty	Equiv.	Qty	Equiv.
90 deg Ell	1	4.4	3	45.0		0.0		0.0
Long Rad. Ell		0.0		0.0		0.0		0.0
45 deg Ell	2	5.2		0.0		0.0		0.0
TEE-Line Flow	1	2.2		0.0		0.0		0.0
TEE-Branch Flow	1	9.4		0.0		0.0		0.0
180 deg Bend		0.0		0.0		0.0		0.0
Globe Valve	1	94.0		0.0		0.0		0.0
Gate Valve	1	2.8		0.0		0.0		0.0
Sudden Expansion (6")	1	5.0		0.0		0.0		0.0
Swing Check Valve	1	27.0	1	50.5		0.0		0.0
Bell Mouth Inlet		0.0		0.0		0.0		0.0
Square Mouth Inlet		0.0		0.0		0.0		0.0
Re-Entrant Pipe		0.0		0.0		0.0		0.0
Straight Pipe	50	50.0	4700	4700.0		0.0		0.0
Total Equiv Feet		200		4795.5		0		0

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Phase 5
Material: Smooth HDPE

INPUT

Fluid Name		Water
Flow	(gallons/minute)	68
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	1937.4461	4475.5005	93.44
	0.75	80	427.3535	987.1866	50.60
	1.00	80	123.2506	284.7089	30.42
	1.50	80	13.9476	32.2189	12.38
	2.00	80	4.0461	9.3465	7.41
>>>>>	2.50	80	1.6972	3.9204	5.16
>>>>>	3.00	80	0.5853	1.3520	3.31
>>>>>	4.00	80	0.1553	0.3586	1.90
	6.00	80	0.0220	0.0508	0.84
	8.00	80	0.0058	0.0133	0.48
	10.00	80	0.0020	0.0045	0.30
	12.00	80	0.0009	0.0020	0.22
	14.00	80	0.0006	0.0013	0.18
	16.00	40	0.0002	0.0005	0.12
	18.00	30	0.0001	0.0003	0.10
	20.00	30	0.0001	0.0002	0.08
	24.00	30	0.0000	0.0001	0.05
	30.00	20	0.0000	0.0000	0.03

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Phase 5
Material: Smooth HDPE

INPUT Assuming worst case flow maximizing 60 gpm pumps

Fluid Name		Water
Flow	(gallons/minute)	80
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	2616.1441	6043.2928	109.62
	0.75	80	574.7497	1327.6718	59.36
	1.00	80	165.2958	381.8333	35.68
	1.50	80	18.6349	43.0466	14.52
	2.00	80	5.3969	12.4669	8.69
>>>>>	2.50	80	2.2615	5.2240	6.06
>>>>>	3.00	80	0.7790	1.7995	3.89
>>>>>	4.00	80	0.2064	0.4767	2.23
	6.00	80	0.0292	0.0674	0.98
	8.00	80	0.0077	0.0177	0.56
	10.00	80	0.0026	0.0060	0.36
	12.00	80	0.0011	0.0026	0.25
	14.00	80	0.0007	0.0017	0.21
	16.00	40	0.0003	0.0007	0.15
	18.00	30	0.0002	0.0004	0.11
	20.00	30	0.0001	0.0002	0.09
	24.00	30	0.0000	0.0001	0.06
	30.00	20	0.0000	0.0000	0.04

EQUIVALENT FEET OF PIPE

Service: Weyerhaueser Plymouth - Phase 5

Segment	Pump to MH8		MH8 to Wet Well					
Pipe Size	3 inch		6 inch		3 inch		4 inch	
Fittings	Qty	Equiv.	Qty	Equiv.	Qty	Equiv.	Qty	Equiv.
90 deg Ell	1	4.4	5	75.0		0.0		0.0
Long Rad. Ell		0.0		0.0		0.0		0.0
45 deg Ell	2	5.2	1	5.6		0.0		0.0
TEE-Line Flow	1	2.2		0.0		0.0		0.0
TEE-Branch Flow	1	9.4		0.0		0.0		0.0
180 deg Bend		0.0		0.0		0.0		0.0
Globe Valve	1	94.0		0.0		0.0		0.0
Gate Valve	1	2.8		0.0		0.0		0.0
Sudden Expansion (6")	1	5.0		0.0		0.0		0.0
Swing Check Valve	1	27.0	1	50.5		0.0		0.0
Bell Mouth Inlet		0.0		0.0		0.0		0.0
Square Mouth Inlet		0.0		0.0		0.0		0.0
Re-Entrant Pipe		0.0		0.0		0.0		0.0
Straight Pipe	50	50.0	5150	5150.0		0.0		0.0
Total Equiv Feet		200		5281.1		0		0

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Phase 6
Material: Smooth HDPE

INPUT

Fluid Name		Water
Flow	(gallons/minute)	64
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	1730.9004	3998.3799	87.99
	0.75	80	382.3595	883.2504	47.65
	1.00	80	110.3870	254.9940	28.64
	1.50	80	12.5091	28.8960	11.66
	2.00	80	3.6310	8.3877	6.98
>>>>>	2.50	80	1.5236	3.5196	4.86
>>>>>	3.00	80	0.5257	1.2143	3.12
>>>>>	4.00	80	0.1395	0.3223	1.79
	6.00	80	0.0198	0.0457	0.79
	8.00	80	0.0052	0.0120	0.45
	10.00	80	0.0018	0.0041	0.29
	12.00	80	0.0008	0.0018	0.20
	14.00	80	0.0005	0.0011	0.17
	16.00	40	0.0002	0.0005	0.12
	18.00	30	0.0001	0.0003	0.09
	20.00	30	0.0001	0.0002	0.07
	24.00	30	0.0000	0.0001	0.05
	30.00	20	0.0000	0.0000	0.03

LIQUID PRESSURE DROP CALCULATION

Service: Weyerhaueser Plymouth Landfill Design - Phase 6
Material: Smooth HDPE

INPUT Assuming worst case flow maximizing 60 gpm pumps

Fluid Name		Water
Flow	(gallons/minute)	80
Specific Gravity		1.00
Viscosity	(centipoise)	1.00
Roughness	(feet)	0.000005

OUTPUT

	Nom Size (inches)	Pipe Schedule	Press Drop/100 equiv.ft. (psi)	(ft.water)	Velocity (ft/sec)
	0.50	80	2616.1441	6043.2928	109.62
	0.75	80	574.7497	1327.6718	59.36
	1.00	80	165.2958	381.8333	35.68
	1.50	80	18.6349	43.0466	14.52
	2.00	80	5.3969	12.4669	8.69
>>>>>	2.50	80	2.2615	5.2240	6.06
>>>>>	3.00	80	0.7790	1.7995	3.89
>>>>>	4.00	80	0.2064	0.4767	2.23
	6.00	80	0.0292	0.0674	0.98
	8.00	80	0.0077	0.0177	0.56
	10.00	80	0.0026	0.0060	0.36
	12.00	80	0.0011	0.0026	0.25
	14.00	80	0.0007	0.0017	0.21
	16.00	40	0.0003	0.0007	0.15
	18.00	30	0.0002	0.0004	0.11
	20.00	30	0.0001	0.0002	0.09
	24.00	30	0.0000	0.0001	0.06
	30.00	20	0.0000	0.0000	0.04

EQUIVALENT FEET OF PIPE

Service: Weyerhaueser Plymouth - Phase 6

Segment	Pump to MH9		MH9 to Wet Well					
Pipe Size	3 inch		6 inch		3 inch		4 inch	
Fittings	Qty	Equiv.	Qty	Equiv.	Qty	Equiv.	Qty	Equiv.
90 deg Ell	1	4.4	8	120.0		0.0		0.0
Long Rad. Ell		0.0		0.0		0.0		0.0
45 deg Ell	2	5.2	2	11.2		0.0		0.0
TEE-Line Flow	1	2.2		0.0		0.0		0.0
TEE-Branch Flow	1	9.4		0.0		0.0		0.0
180 deg Bend		0.0		0.0		0.0		0.0
Globe Valve	1	94.0		0.0		0.0		0.0
Gate Valve	1	2.8		0.0		0.0		0.0
Sudden Expansion (6")	1	5.0		0.0		0.0		0.0
Swing Check Valve	1	27.0	1	50.5		0.0		0.0
Bell Mouth Inlet		0.0		0.0		0.0		0.0
Square Mouth Inlet		0.0		0.0		0.0		0.0
Re-Entrant Pipe		0.0		0.0		0.0		0.0
Straight Pipe	70	70.0	5625	5625.0		0.0		0.0
Total Equiv Feet		220		5806.7		0		0

Weyerhaeuser Plymouth
Help Model Results and Flow Estimates - Summary
RMT Job No. 05101.01
24-Sep-99

Drainage Area	Segment	Flow Rate (gpm)	Pipe Size (inches)	Total Equivalent Feet	Head Loss/100 feet (feet)	Dynamic Head (feet)	Static Head (feet)	Total System Head (feet)
1	Pump to MH1	31	3	200	0.3274	0.7	14	14.7
1	MH1 to Wet Well	185	6	1881	0.3010	5.7	20	25.7
		Phase 1 Pump 1:		**31**	**gpm @**	**40**	**ft of head**	
1	Pump to MH2	31	3	200	0.3274	0.7	14	14.7
1	MH2 to Wet Well	185	6	2496	0.3010	7.5	25	32.5
		Phase 1 Pump 2:		**31**	**gpm @**	**47**	**ft of head**	
1	Pump to MH3	31	3	200	0.3274	0.7	18	18.7
1	MH3 to Wet Well	185	6	3596	0.3010	10.8	25	35.8
		Phase 1 Pump 3:		**31**	**gpm @**	**54**	**ft of head**	
2	Pump to MH4	47	3	240	0.6841	1.6	24	25.6
2	MH4 to Wet Well	185	6	3796	0.3010	11.4	25	36.4
		Phase 2 Pump 1:		**47**	**gpm @**	**62**	**ft of head**	
2	Pump to MH5	47	3	240	0.0068	0.0	24	24.0
2	MH5 to Wet Well	185	6	4196	0.0116	0.5	25	25.5
		Phase 2 Pump 22:		**47**	**gpm @**	**50**	**ft of head**	
3	Pump to MH6	74	3	200	1.5539	3.1	10	13.1
3	MH6 to Wet Well	185	6	4396	0.3010	13.2	25	38.2
		Phase 3 Pump 1:		**74**	**gpm @**	**51**	**ft of head**	
4	Pump to MH7	71	3	200	1.4608	2.9	10	12.9
4	MH7 to Wet Well	185	6	4796	0.3010	14.4	25	39.4
		Phase 4 Pump 1:		**71**	**gpm @**	**52**	**ft of head**	
5	Pump to MH8	68	3	200	1.3520	2.7	12	14.7
5	MH8 to Wet Well	185	6	5281.1	0.3010	15.9	25	40.9
		Phase 5 Pump 1:		**68**	**gpm @**	**56**	**ft of head**	
6	Pump to MH9	64	3	220	1.2143	2.7	14	16.7
6	MH9 to Wet Well	185	6	5807	0.3010	17.5	25	42.5
		Phase 6 Pump 1:		**64**	**gpm @**	**59**	**ft of head**	

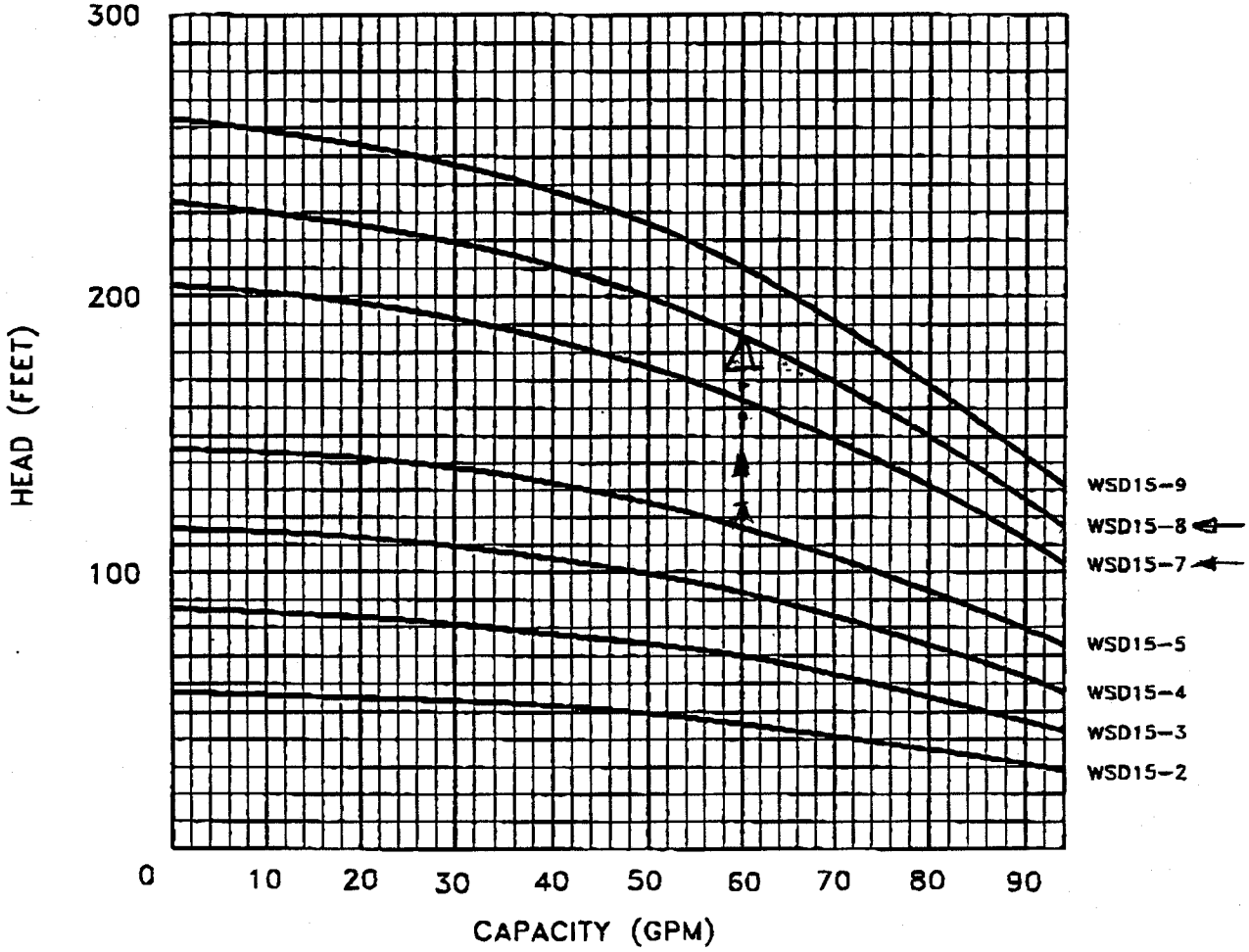
Weyerhaeuser Plymouth
Help Model Results and Flow Estimates - Worst Case Summary
RMT Job No. 05101.01
24-Sep-99

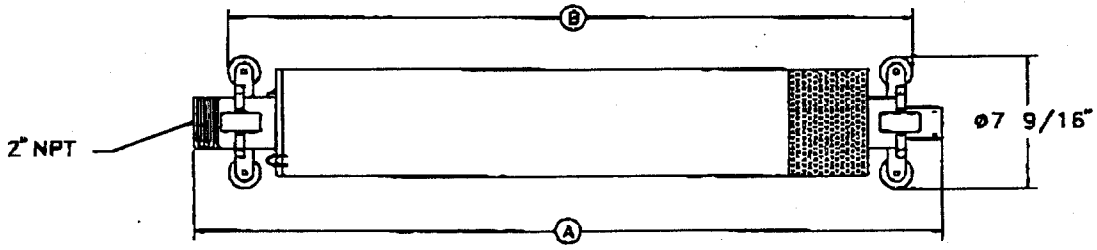
Drainage Area	Segment	Flow Rate (gpm)	Pipe Size (inches)	Total Equivalent Feet	Head Loss/100 feet (feet)	Dynamic Head (feet)	Static Head (feet)	Total System Head (feet)
1	Pump to MH1	60	3	200	1.0755	2.2	14	16.2
1	MH1 to Wet Well	600	6	1881	2.5206	47.4	20	67.4
		Phase 1 Pump 1:		60	gpm @	84	ft of head	
1	Pump to MH2	60	3	200	1.0755	2.2	14	16.2
1	MH2 to Wet Well	600	6	2496	2.5206	62.9	25	87.9
		Phase 1 Pump 2:		60	gpm @	104	ft of head	
1	Pump to MH3	60	3	200	1.0755	2.2	18	20.2
1	MH3 to Wet Well	600	6	3596	2.5206	90.6	25	115.6
		Phase 1 Pump 3:		60	gpm @	136	ft of head	
2	Pump to MH4	60	3	240	1.0755	2.6	24	26.6
2	MH4 to Wet Well	600	6	3796	2.5206	95.7	25	120.7
		Phase 2 Pump 1:		60	gpm @	147	ft of head	
2	Pump to MH5	60	3	240	1.0755	2.6	24	26.6
2	MH5 to Wet Well	600	6	4196	2.5206	105.7	25	130.7
		Phase 2 Pump 2:		60	gpm @	157	ft of head	
3	Pump to MH6	80	3	200	1.7995	3.6	10	13.6
3	MH6 to Wet Well	400	6	4396	1.2067	53.0	25	78.0
		Phase 3 Pump 1:		80	gpm @	92	ft of head	
4	Pump to MH7	80	3	200	1.7995	3.6	10	13.6
4	MH7 to Wet Well	320	6	4796	0.8058	38.6	25	63.6
		Phase 4 Pump 1:		80	gpm @	77	ft of head	
5	Pump to MH8	80	3	200	1.7995	3.6	12	15.6
5	MH8 to Wet Well	320	6	5281.1	0.8058	42.6	25	67.6
		Phase 5 Pump 1:		80	gpm @	83	ft of head	
6	Pump to MH9	80	3	220	1.7995	4.0	14	18.0
6	MH9 to Wet Well	320	6	5807	0.8058	46.8	25	71.8
		Phase 6 Pump 1:		80	gpm @	90	ft of head	

J 31

WSD15 SurePump™
WHEELED SUMP DRAINER

695





PUMP MODEL	SINGLE PHASE			THREE PHASE			SHIPPING WEIGHT (LBS)	
	MOTOR HP	A (in)	B (in)	MOTOR HP	A (in)	B (in)	1ø	3ø
WSD15-2	2.0	41.00	39.00	2.0	39.50	37.50	69.0	64.2
WSD15-3	2.0	43.50	41.50	2.0	42.00	40.00	72.3	67.5
WSD15-4	3.0	54.50	52.50	3.0	51.75	49.75	100.1	89.6
WSD15-5	3.0	57.00	55.00	3.0	54.25	52.25	103.5	93.0
WSD15-7	5.0	68.25	66.25	5.0	62.25	60.25	129.4	110.2
WSD15-8	5.0	70.75	68.75	5.0	64.75	62.75	132.7	113.5
WSD15-9	5.0	73.25	71.25	5.0	67.25	65.25	136.1	116.9

SEE 0577-2 FOR HIGH HEAD MODELS.

Appendix I
Pipe Strength Calculations

DESIGN SHEET

RMT INC.

SHEET 1 OF 3

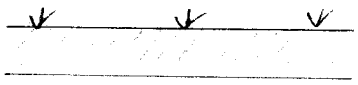
41 Perimeter Center, East Suite 399 Atlanta, GA 30346 Phone: 770-913-0280 FAX: 770-913-9353

PROJECT/PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
Weyerhaeuser Plymouth LF #3	RMT	5/25/99	RKN	6/1/99	5101.01

Pipe Strength Calculations for leachate system

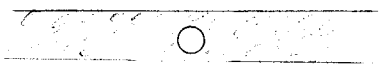
Based on loading, determine standard dimension ratio, SDR, of leachate collection and transfer pipe.

$$SDR = \frac{O.D.}{\text{Wall Thickness}}$$



Soil/Vegetative layer (1' @ 100 pcf)

Waste layer (19.7' @ 70 pcf) (W.C.)



Drainage layer (1.5' @ 130 pcf)

P_s = Total Static Load on Pipe = 1(100) + 19.7(70) + 1.5(130)
= 13,385 psf
= 93.0 psi

① Design by wall crushing:

Assume SF of 2.0. $SF = 1500 / S_A$ where 1,500 = compressive yield strength (psi) of pipe

S_A = actual compressive stress (psi)

$SF = 2 = 1{,}500 / S_A \therefore S_A = 750$ psi

$S_A = \left(\frac{SDR-1}{2}\right) P_t$ where $P_t = P_s = 93$ psi

$\therefore SDR = \frac{2S_A}{P_t} + 1 = 2\left(\frac{750 \text{ psi}}{93 \text{ psi}}\right) + 1 = \underline{\underline{17.1}}$

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SHEET 2 OF 3

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PROJECT/PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
Weyerhaeuser Plymouth LF #3	[illegible]	5/25/99	RKN	6/1/99	5101.01

② Design by wall buckling:

Assume $SF = 2.0$

$SF = P_{CB} / P_t$ where P_{CB} = critical buckling soil pressure at top of pipe (psi)

$SF = 2 = P_{CB} / 93.0 \quad \therefore P_{CB} = 186$ psi

$P_{CB} = 0.9\sqrt{E' \cdot P_c}$ where: E' = soil modulus in psi calculated as the ratio of vertical soil pressure to vertical soil strain at a specified density (13,900 for gravel bed)

P_c = hydrostatic critical collapse differential pressure

$$P_c = \frac{\left[\frac{P_{CB}}{0.9}\right]^2}{E'} = \frac{\left(\frac{186}{0.9}\right)^2}{13{,}900} = 3.89 \text{ psi}$$

$$P_c = \frac{2.32\,E}{(SDR)^3} \quad \therefore \quad SDR = \sqrt[3]{\frac{2.32\,E}{P_c}}$$

where: E = Stress & time dependent tensile modulus of elasticity for HDPE pipe, @ 750 psi & 50 yrs $E = 14{,}000$ psi

$$SDR = \sqrt[3]{\frac{(2.32)(14{,}000)}{3.89}} = \underline{\underline{20.3}}$$

DESIGN SHEET

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SHEET 3 OF 3

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PROJECT/PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
Weyerhaeuser Plymouth	EWT	5/25	RKN	6/1/99	5101.01

(3) Design by Ring Deflection:

Assume $\varepsilon_s < \Delta Y / D$ where ε_s = vertical soil strain = P_t / E'

$$\varepsilon_s = \frac{93}{13{,}900} = 0.007$$

ΔY = vertical pipe deflection
D = pipe O.D.

$$\frac{\Delta Y}{D} = 0.0025 \text{ SDR}$$

$$\text{SDR} > \frac{\Delta Y}{D} \Big/ 0.0025 = \frac{0.007}{0.0025} = 2.8$$

$\therefore$ SDR > 2.8

(4) Conclusion

SDR of 17 satisfies all conditions.

Using 6 O.D. pipe, wall thickness = 0.35 inches

$\therefore$ Resultant pipe I.D. = 6 − 2(0.35) = 5.3 inches

Appendix J
Material Volume Calculations

DESIGN SHEET

RMT®

SHEET 1 OF 4

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - LANDFILL No 3	DMC	9/22/99	JK	9/23/99	5101.01

CAPACITY FOR EACH PHASE:

1A - 373,000 cy
1B - 223,673 cy

PHASE 1:	TOTAL	665,143 C.Y.
	CAP MAT'L (-)	31,470 C.Y.
	LEACHATE (-)	37,000 C.Y.
	NET	596,673 C.Y.
PHASE 2:	TOTAL	782,601 C.Y.
	CAP MAT'L (-)	27,840 C.Y.
	LEACHATE (-)	36,600 C.Y.
	NET	718,161 C.Y.
PHASE 3:	TOTAL	616,873 C.Y.
	CAP MAT'L (-)	6,800 C.Y.
	LEACHATE (-)	13,526 C.Y.
	NET	596,547 C.Y.
PHASE 4:	TOTAL	894,204 C.Y.
	CAP MAT'L (-)	15,270 C.Y.
	LEACHATE (-)	14,880 C.Y.
	NET	864,054 C.Y.
PHASE 5:	TOTAL	805,032 C.Y.
	CAP MAT'L (-)	8,290 C.Y.
	LEACHATE (-)	14,600 C.Y.
	NET	782,142 C.Y.
PHASE 6:	TOTAL	831,488 C.Y.
	CAP MAT'L (-)	9,030 C.Y.
	LEACHATE (-)	12,359 C.Y.
	NET	810,099 C.Y.

NOTE: LEACHATE REFERS TO THE LEACHATE COLLECTION SYSTEM; 6 IN SAND & 12 IN. STONE

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SHEET 2 OF 4

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - LANDFILL № 3	DMC	9/22/99			5101.01

CAPACITY FOR EACH PHASE:

PHASE 7:	TOTAL	777,643 C.Y.
	CAP MAT'L (-)	8,750 C.Y.
	LEACHATE (-)	11,642 C.Y.
	NET	757,251 C.Y.
PHASE 8:	TOTAL	792,100 C.Y.
	CAP MAT'L (-)	7,450 C.Y.
	LEACHATE (-)	11,462 C.Y.
	NET	773,188 C.Y.
PHASE 9:	TOTAL	637,146 C.Y.
	CAP MAT'L (-)	7,450 C.Y.
	LEACHATE (-)	11,426 C.Y.
	NET	618,270 C.Y.
PHASE 10:	TOTAL	532,169 C.Y.
	CAP MAT'L (-)	20,300 C.Y.
	LEACHATE (-)	13,364 C.Y.
	NET	498,505 C.Y.
PHASE 11:	TOTAL	619,504 C.Y.
	CAP MAT'L (-)	14,900 C.Y.
	LEACHATE (-)	15,970 C.Y.
	NET	588,634 C.Y.
PHASE 12:	TOTAL	382,170 C.Y.
	CAP MAT'L (-)	8,010 C.Y.
	LEACHATE (-)	6,245 C.Y.
	NET	367,915 C.Y.

DESIGN SHEET

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SHEET 3 OF 4

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - LANDFILL No 3	DMC	9/23/99	[illegible]	9/23/99	5101.01

CAPACITY FOR EACH PHASE:

PHASE 13:	TOTAL	446,978 C.Y.	8,783,051
	CAP MAT'L (-)	8,570 C.Y.	
	LEACHATE (-)	6,115 C.Y.	
	NET	432,293 C.Y.	
PHASE 14:	TOTAL	471,936 C.Y.	9,254,987
	CAP MAT'L (-)	8,100 C.Y.	
	LEACHATE (-)	6,022 C.Y.	
	NET	457,814 C.Y.	
PHASE 15:	TOTAL	528,105 C.Y.	9,783,092
	CAP MAT'L (-)	8,010 C.Y.	
	LEACHATE (-)	5,894 C.Y.	
	NET	514,201 C.Y.	
PHASE 16:	TOTAL	578,736 C.Y.	10,361,828
	CAP MAT'L (-)	11,360 C.Y.	
	LEACHATE (-)	5,710 C.Y.	
	NET	561,666 C.Y.	
PHASE 17:	TOTAL	376,347 C.Y.	10,738,175
	CAP MAT'L (-)	3,540 C.Y.	
	LEACHATE (-)	5,662 C.Y.	
	NET	367,145 C.Y.	
PHASE 18:	TOTAL	575,521 C.Y.	11,313,696
	CAP MAT'L (-)	40,500 C.Y.	
	LEACHATE (-)	6,929 C.Y.	
	NET	528,092 C.Y.	

DESIGN SHEET

SHEET 4 OF 4

RMT®
100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - LANDFILL No 3	DUC	9/22/99			5101.01

TOTALS FOR PHASE 1 THROUGH 18

1. CAPACITY (AIRSPACE) — 10,832,650 C.Y.
2. CAP MATERIAL - TOPSOIL - 82,200 C.Y.
   * GEN FILL - 179,784 C.Y.
3. LEACHATE COLLECTION LAYER — 235,406 C.Y.
4. FOOTPRINT (EDGE OF WASTE) — 98.61 ACRES

* 10% SHRINKAGE WAS USED FOR GEN. FILL IN CAP

Appendix K
Borrow Investigation

BORROW INVESTIGATION REPORT OF THE FORMER SNELL AND BEASLEY PROPERTIES

WEYERHAEUSER COMPANY
PLYMOUTH, NORTH CAROLINA

January 1999

R. Kent Nilsson, P.E.
Project Manager/Consulting Engineer

RMT, INC., NORTH CAROLINA
100 VERDAE BLVD. - 29607-3825
P.O. BOX 16778 - 29606-6778
GREENVILLE, SC
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Section 1
Introduction

Weyerhaeuser Company (Weyerhaeuser) purchased the former Snell and Beasley Properties, South and adjacent to the site of the proposed No. 3 Landfill. The property locations are shown on Figure 1 in Section 2 of this report. Weyerhaeuser retained RMT, Inc., North Carolina (RMT), to investigate the soil on these properties for potential use as borrow material for closure of Weyerhaeuser's No. 2 Landfill and construction of Weyerhaeuser's No. 3 Landfill.

1.1 Background

In 1993, RMT developed a Construction Plan Application (CPA) for Weyerhaeuser for permiting a new landfill at the Plymouth facility. Weyerhaeuser has recently acquired some adjacent property, and RMT is redesigning the proposed landfill to increase its capacity and possibly upgrade its liner system. Two of the property acquisitions (Snell and Beasley), could result in more "on-site" borrow source material being available for landfill construction and closure. Each of these properties is approximately 40 acres.

1.2 Scope

In October 1998, RMT conducted an investigation of soils on both the Snell and Beasley Properties to determine if a suitable source of clay borrow for liner or cap construction existed on either site. The investigation was to evaluate availability, suitability, and quantity of clay.

The borrow investigation included the following tasks:

- Reviewing existing Soil Conservation Service (SCS) soil survey maps and data
- Exploring the sites by excavating test pits
- Performing laboratory testing
- Estimating order of magnitude soil quantities

This report documents RMT's findings, conclusions, and recommendations. It also includes test pit logs, laboratory data, and a data point location and soil survey map.

1.3 Qualification

The conclusions and recommendations presented in this report represent RMT's professional engineering judgment based on the information reviewed, the interpretation of field and laboratory test data, and past experience. RMT's evaluation included the extrapolation of data

that represents subsurface conditions at the locations and times sampled. Given the inherent variability of soil conditions, actual conditions in the areas not sampled may differ from predictions. Therefore, the discovery of any site or subsurface conditions that deviate from data generated during the investigation should be reported to RMT for evaluation.

This report has been prepared for the exclusive use of Weyerhaeuser and its designates for specific application to the clay borrow source for the liner of the proposed landfill and the cap of the existing landfill. If the project information is incorrect or modified, RMT should be contacted so that the recommendations outlined in Section 4 can be reviewed.

RMT's services have been performed in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied.

1.4 Site Conditions

The Snell Property consists of approximately 40 acres located on the west side of Ken Trowbridge Road, approximately 1,300 feet north of its intersection with Highway 64. At the time of our investigation, nearly half of the property had been cultivated as two separate cotton fields. The remainder of the site was covered with a heavy growth of mixed hardwoods and softwoods. The topography is relatively planar, generally sloping to the east at a rate of between 0.5 to 1 percent. A shallow natural drainage swale trending in a northerly direction is located in the northeast quadrant of the site. Drainage ditches 2 to 3 feet in depth were observed in and adjacent to the cotton fields. Elevations across the site range from approximately 37 feet mean sea level (msl) at the southwest corner of the west cotton field to 22 feet msl in the drainage swale.

The Beasley Property consists of approximately 37 acres located on the north side of Highway 64, approximately 1,500 feet west of its intersection with Ken Trowbridge Road. The property adjoins the Snell Property along its northeasterly side. At the time of our investigation, an abandoned retail business building occupied an area at the southwest corner of the site. Foundation remains along the Highway 64 frontage indicated the former presence of two houses on the south side. An unimproved access road, trending south to north, bisected the site. The north side of the parcel is bordered by a recently improved drainage swale. With the exception of grassed areas in the vicinity of the existing building and former residences and areas cleared in conjunction with construction of the drainage improvements on the north, the site was covered with dense underbrush or undeveloped woodland. Topographic mapping indicates that a gentle ridge extends across the site in a north-south direction. The topography is relatively planar, generally sloping to the east and to the drainage swale at the northwest at a

rate of between 0.5 to 6 percent. Elevations across the site range from approximately 41 feet msl on the top of the ridge to 24 feet msl at the southeast corner.

Although wetlands delineation was still in progress at the time of the preparation of this report, there do not appear to be wetlands on either of the two properties.

Section 2
Borrow Investigation

2.1 Review of Soil Survey Data

To assist in planning our subsurface investigation and in providing some general delineation of soil units for estimating material volumes, RMT reviewed soil survey maps and tables for Washington County prepared by the Soil Conservation Service (Soil Survey, Washington County, North Carolina, December, 1981). Our review included review of tabulated engineering data for each of the map units, including soil classifications, grain size distribution, and index properties.

2.2 Subsurface Exploration

The Beasley Property was investigated by excavating 12 test pits across the site to depths between 7 to 10 feet. The Snell Property was investigated by excavating 14 test pits across the site to depths between 8 to 12 feet. The test pits were typically spaced about 500 to 600 feet apart to provide representative areal coverage. The test pits were excavated using a tractor-mounted backhoe.

RMT's geotechnical engineer visually classified the soil from each test pit in the field and collected representative samples for laboratory testing as soil types appeared to change. Test pit logs summarizing the visual classifications are provided in Appendix A. The stratification lines shown on the test pit logs represent approximate boundaries between soil types. Actual transitions between soil types may be gradual. The approximate test pit locations are shown on Figure 1, the Soil Classification Map, SCS soil units are also shown, included in Appendix A, with some minor adjustment to the boundaries to reflect conditions encountered by our subsurface exploration.

RMT's soils laboratory performed testing on the soil samples submitted. Laboratory data are included as Appendix B. Laboratory testing consisted of Atterberg limits testing, grain size analysis, hydrometer analyses, specific gravity testing, Standard Proctor testing, falling head permeability testing, and natural moisture content determination. Atterberg limits testing and grain size analyses were used for soil classification, as well as correlating data to engineering properties such as permeability. The natural moisture content determination was also used to establish a correlation to soil behavior. The specific gravity was used to establish a Zero Air Voids curve, which is a boundary on the Proctor test curve. Data from the Standard Proctor tests were used for remolding the soil to simulate field conditions, such as densities and

moisture contents, of the liner during construction. Falling head permeability testing was performed on the remolded soil samples to determine which soil could meet the permeability requirements under the typical compaction conditions. Results of the laboratory testing are presented in Appendix B. A summary of the laboratory test data is provided in Table 1.

Table 1
Summary of Laboratory Test Data

SAMPLE	SCS SOIL UNIT	MOISTURE CONTENT %	% GRAIN SIZE (%)			ATTERBERG LIMITS			USCS CLASS	STANDARD PROCTOR		HYDRAULIC CONDUCTIVITY
			SAND	SILT	CLAY	LL	PL	PI		O.M.C. (%)	M.D.D. (pcf)	(cm/s)
TP-2 @ 0.5′	DgA	18.7				41	22	19	CL			
TP-3 @ 0-1′	DgA	6.2	67	18	15				SM			
TP-3 @ 1-6′	DgA		64			29	21	8	SC			
TP-4 @ 8″-5′	DgA	25.3	25	24	51	58	28	30	CH	23.3	98.6	9.6×10^{-9}
TP-4 @ 10-11′	DgA	41.0	12	29	59	55	31	24	MH	25.6	94.3	1.2×10^{-8}
TP-5 @ 0.5-3′	DgA	23.0				45	22	23	CL			
TP-5 @ 7-11′	DgA	41.2				56	27	29	CL			
TP-6 @ 2-5′	DgA	19.6				46	22	24	CL			
TP-6 @ 7-8.5′	DgA	33.8				63	32	31	CH			
TP-7 @ 8-10′	DgA	27.3	16	28	56	54	27	27	CH	24.0	96.1	1.1×10^{-8}
TP-8 @ 3.5-6.5′	DgA	27.9	14	32	54				CL			
TP-8 @ 10.5-11′	DgA	30.8	21	43	36	43	23	20	CL			
TP-9 @ 1.5-6′	DgA	22.8	33	14	53	56	26	30	CH	22.7	96.6	2.9×10^{-8}
TP-9 @ 6-9′	DgA	9.5	79	7	14				SM			
TP-9 @ 9-11′	DgA	21.4	24	39	37				CL			
TP-12 @ 4.5′	At	15.9				28	16	12	CL			
TP-13 @ 2-5′	AaA	20.3	51	9	40	40	27	13	SC	17.6	107.0	6.0×10^{-8}
TP-13 @ 5′	AaA	18.0				32	18	14	SC			
TP-16 @ 2.5-5.5′	At	24.1	48	27	25				CL			
TP-18 @ 3-8′	WkB		62			33	19	14	SC			
TP-19 @ 1.5-2.5′	AaA	14.8				31	17	14	SC			
TP-21 @ 2.5-6.5′	WkB	17.0				25	19	6	CL-ML			
TP-22 @ 3-4′	CtA	16.0	70	11	19				SM			
TP-22 @ 8.5-9.5	CtA	33.8	37	23	40				CL			
TP-25 @ 2-3.5′	WkB	24.6				60	31	29	CH			
TP-25 @ 5.5′	WkB	10.6	74	4	22				SC			

Section 3
Findings and Conclusions

The findings from this borrow source investigation are presented in Subsection 3.1. The conclusions drawn from these findings are presented in Subsection 3.2.

3.1 Findings

The laboratory test results are summarized in Table 1. The following findings were based on RMT's observations and laboratory test results.

- Review of Soil Conservation Service soil maps indicates that the Snell and Beasley properties are underlain by five major soil units as follows:
  1. Altavista fine sandy loam (AaA)
  2. Augusta fine sandy loam (At)
  3. Conetoe loamy fine sand (CtA)
  4. Dogue fine sandy loam (DgA)
  5. Wickham loamy sand (WkB)

  Approximately two-thirds of the Snell Property is underlain by the same soil unit that comprises the existing borrow area adjacent to the No. 2 Landfill, DgA. It should be recognized, however, that any of the map units may include scattered areas of soils of different properties. Observations in excavating the existing borrow source and the drainage ditch south of the landfill found significant soil variability.
- Subsurface exploration indicates that both properties are generally underlain by interbedded layers of poorly-graded sands, silty sands, clayey sands, sandy clays, and clayey silts. Based on visual classifications, test pits located in the map units identified as DgA typically encountered the largest concentration of soils classified as clays (CL, CH). Other map units showed layers of clayey sands (SC) more predominately.
- The proposed borrow sites contain a surficial layer of topsoil between 0.5 and 1-foot thick.
- Groundwater or seepage was noted in Test Pits 17 and 21 at depths of 4 feet and 10 feet, respectively. Wet to saturated soils were encountered in Test Pit 19 at a depth of 6 feet, but free water or seepage was not observed.
- Soil units identified as DgA and AaA on the former Snell Property were determined to be the most likely sources of clay suitable for liner and material that will provide remolded permeabilities of less than 1×10^{-7} cm/sec.
- Soil units identified as WkB, At, and CtA also contain layers of clayey sands that, though marginal in providing permeability of 1×10^{-7} cm/sec required for a liner, should probably meet the 1×10^{-6} cm/sec specification for cap materials for the No. 2 Landfill.

- Exploration on the Snell Property encountered one or two suitable clayey soil layers (CH, CL, and SC) at each of the test pit locations. Clay soil layers varied in thickness from 1 to 6.5 feet with an average aggregate thickness of all layers in each test pit of about 5.5 feet within the total depth of exploration. Total clay soil available for borrow from the upper 11 feet of the property is estimated to be approximately 290,000 cubic yards.
- Clayey materials were encountered at all locations on the Beasley Property except at Test Pit TP-17. Typically, these materials consisted of clayey sands (SC), which varied in thickness from 2 to 6.5 feet, averaging approximately 3.5 feet thick. Total clayey soil available per borrow is estimated to be approximately 225,000 cubic yards, assuming soils are excavated to a depth of 11 feet.
- Nearly all of the samples taken from the clayey soil strata demonstrated index properties that are favorable for the construction of low permeability clay liners or caps with hydraulic conductivities of less than 1×10^{-7} cm/sec. Typical minimum criteria are as follows:
  - Liquid Limit (LL) ≥ 30
  - Plasticity Index (PI) ≥ 10
  - Percentage of fines (P200) ≥ 50 percent passing No. 200 sieve
  - Percentage of clay ≥ 20 percent
- Clay samples tested for hydraulic conductively were generally remolded at moisture contents of 2 to 3 percent above its optimum moisture content established by the Standard Proctor test. With the exception of the sample taken from TP-4 at a 10-foot depth, the moisture content of the clays tested were close to the remolding moistures. Therefore, we expect that much of the clay material can be used directly in construction without significant moisture conditioning.
- Permeability tests performed on remolded samples of soil from TP-4, TP-7, TP-9, and TP-13 ranged from 2.9×10^{-8} cm/sec to 9.5×10^{-9} cm/sec. Lower permeabilities were derived from the fat clays samples from Test Pits TP-4 and TP-7, while higher permeabilities were measured in the clayey sands from Test Pit TP-13.
- Although our wetlands delineation effort is still in progress, preliminary delineation has not identified any jurisdictional wetlands on either of the properties that would be impacted by borrowing activities.
- Approximately 250,000 cubic yards of overburden will need to be removed to expose the underlying clayey soil layers.

3.2 Conclusions

Clay soils that are suitable for liner and cap construction are found at the former Snell and Beasley Properties within 11 feet of the ground surface. Based on the data provided herein, RMT projects the quantity of suitable clay available from both sites to range between 400,000 to 500,000 cubic yards. Due to the variation in the soil stratum between widely spaced test pits, the quantity of suitable clay projected by RMT is to be considered only as an order of magnitude estimate. In general, this estimate would be considered somewhat accurate if the average clay depths found on 40 to 50 percent of the potential borrow areas equals the clay depths found in the soil samples. Additional test pits excavations should be done prior to construction to identify locations of the thickest layers of suitable clay.

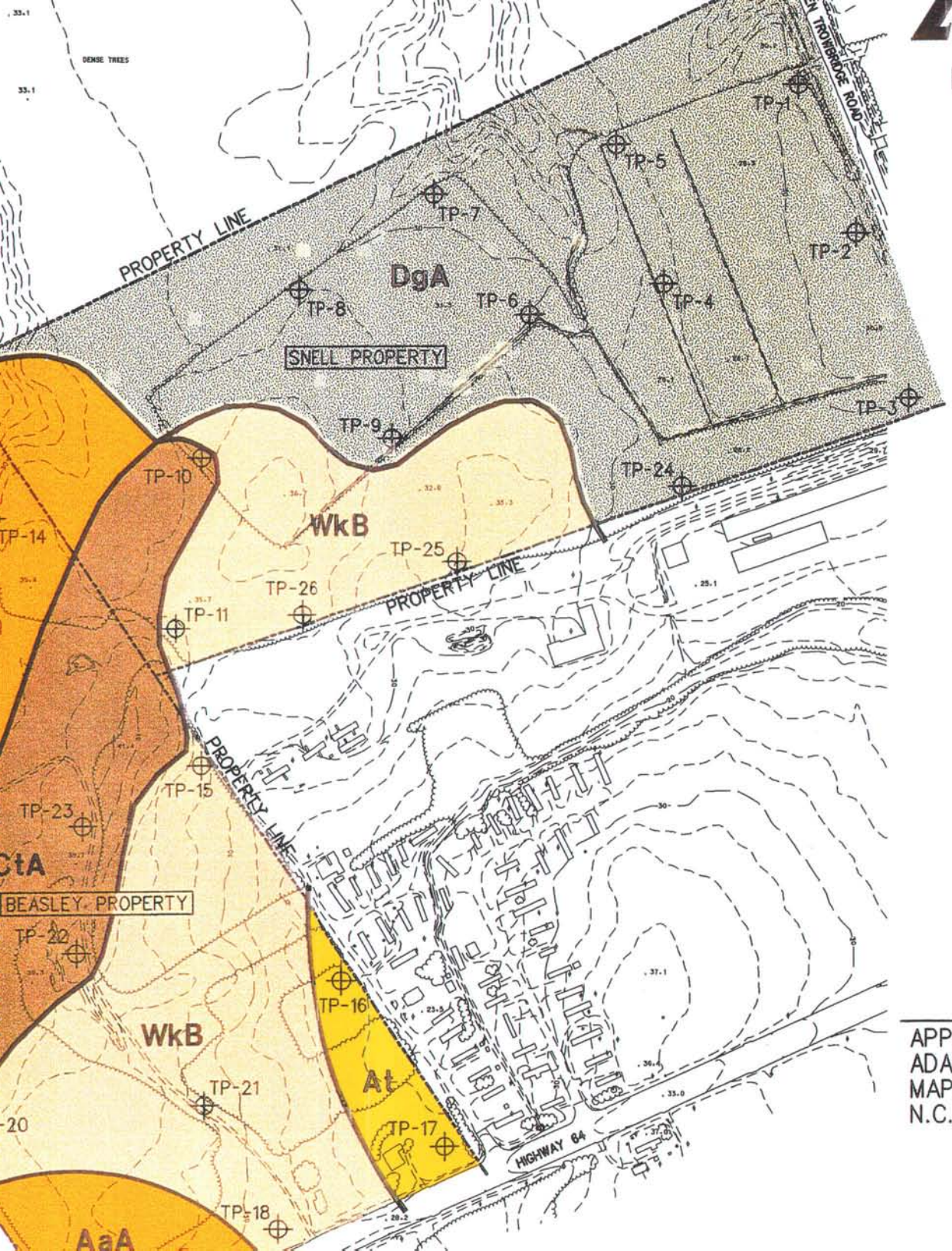
Section 4
Recommendations

The following recommendations pertain to development of the proposed borrow areas on the properties shown on Figure 1. They are based on subsurface exploration data, laboratory test results, soil survey data, and RMT's past experience with similar projects.

- After being cleared of timber and vegetation, the borrow areas should be thoroughly grubbed of roots. Topsoil should be stockpiled for use on the landfill cover and for revegetation of the borrow area.
- After removal of any unsuitable overburden material, the excavated clay soils should also be stockpiled on site. This will allow for more effective segregation of unsuitable soil layers as they are encountered and will facilitate a homogenization of the clayey soils.
- The select clay fill removed from the site should be free from topsoil, significant concentrations of roots, bark, organic debris, and other deleterious material.
- The select clay soil should be thoroughly blended prior to placement as liner material to incorporate the sand that was observed in the test pits as pockets and lenses within the clay. If adequate blending does not occur during excavation and loading of the soil, winnowing the clay prior to placement at the construction site might be necessary. Winnowing may also be used to decrease the moisture content in the clay, if needed.
- The clay must be placed at appropriate moisture conditions to attain the desired permeability. During liner construction, the contractor should have access to a water truck with a spray bar and a disc so that moisture content can be adjusted to achieve desired compaction results.
- During excavation of construction materials, one representative (grab) soil sample should be obtained from the borrow source for testing for every 5,000 cubic yards of clay excavated. One Atterberg limits test, one grain size analysis (sieve and hydrometer), one moisture content determination, and one moisture-density relationship using the Standard Proctor compaction should be performed on the sample. One falling head permeability test should be performed on the borrow source material remolded to 95 percent compaction at +2 percent of the optimum moisture content. A second falling head permeability test should be performed on the borrow source material remolded to 100 percent compaction at the optimum moisture content. The results from these tests will be used to confirm that clay from the borrow source will be suitable liner materials before it is transported to the project site.
- Additional soil testing may be required to establish other engineering properties of the clay as the new landfill design is finalized. This may need to include shear strength testing and liner interface friction testing.

- A borrow site development plan should be prepared which should include design measures for control of run-on/run-off, erosion control, siltation control, and reclamation of disturbed areas. North Carolina stormwater and mining permits will be required that will incorporate this information.

Appendix A
Test Pit Locations and Logs



Weyerhaeuser

PLYMOUTH, NORTH CAROLINA

N

LEGEND

DgA	DOGUE FINE SANDY LOAM
AaA	ALTAVISTA FINE SANDY LOAM
At	AUGUSTA FINE SANDY LOAM
CtA	CONETOE LOAMY FINE SAND
WkB	WICKHAM LOAMY AND
⊕	TEST PIT LOCATION

NOTE

APPROXIMATE SOIL UNIT DELINEATIONS WERE ADAPTED FROM SOIL CONSERVATION SERVICE MAP, "SOIL SURVEY FOR WASHINGTON COUNTY," N.C., DECEMBER, 1981.

FIGURE 1
SOIL CLASSIFICATION MAP

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN
CHECKED BY

PIT NO. TP-1
PROJECT NO. 5101.02
DATE 10-20-98
WIDTH 24 INCHES
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.5'						TAN SILTY FINE SAND (SM); DAMP & LOOSE
1'						MOTTLED LIGHT ORANGE & GRAY SANDY CLAY (CL); DAMP & HARD, DIFFICULT DIGGING
2'						
3'						
4'						
5'						
6'						LIGHT YELLOW BROWN/TAN FINE SAND (SP) WITH SILT; DAMP AND MED. DENSE
7'						
8'						
8.5'						
9'						TOTAL DEPTH - 8.5 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING
10'						
11'						

J:/CAD/HYDRO/WEYHAUS/TP2.FIG

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN

PIT NO. TP-2
PROJECT NO. 5101.02
DATE 10-20-98
WIDTH 24 INCHES

CHECKED BY _____

PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.5'						GRAY BROWN SILTY SAND (SM) W/SOME ROOTS AND ORGANIC MATERIAL (TOP SOIL); DAMP & LOOSE
1'	18.7		41	22	19	ORANGE BROWN SANDY CLAY (CL); MOIST AND MODERATELY DENSE
2'						
3'						
4'						
5'						
6'						
7'						
8'						MOTTLED LIGHT GRAY AND ORANGE FINE POORLY-GRADED SAND (SP) WITH SILT; MOIST AND MODERATELY DENSE
9'						
10'						
11'						TOTAL DEPTH = 10 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING.

J:/CAD/HYDRO/WEYHAUS/TP3.FIG

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN CHECKED BY

PIT NO. TP-3
PROJECT NO. 5101.02
DATE 10-20-98
WIDTH 24 INCHES
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
	6.2	33				LIGHT GRAY SILTY FINE SAND (SM): DAMP AND LOOSE (TOPSOIL)
1'						
2'		36	29	21	9	
3'						
4'						ORANGE CLAYEY FINE SAND (SC) WITH SILT: DAMP AND MODERATELY DENSE
5'						
6'						
7'						LIGHT ORANGE TO TAN FINE SAND (SP) WITH SILT: DAMP AND MODERATELY DENSE
8'						
9'						
10'						TOTAL DEPTH = 9.0 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING
11'						

J:/CAD/HYDRO/WEYHAUS/TP4.FIG

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN
CHECKED BY

PIT NO. TP-4
PROJECT NO. 5101.02
DATE 10-20-98
WIDTH 24 INCHES
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.6'						LIGHT GRAY SILTY FINE SAND (SM) (TOPSOIL); DAMP AND LOOSE
1'	25.3	75	58	28	30	MOTTLED ORANGE TO GRAY SANDY CLAY (CH); STIFF AND MOIST
2'						
3'						
4'						
5'						
6'						MOTTLED TAN TO ORANGE FINE POORLY-GRADED SAND (SP) W/SILT; BECOMING INCREASINGLY MOIST WITH DEPTH; MODERATELY DENSE
7'						
8'						
9'						
10'						
11'	41.0	88	55	31	24	MOTTLED ORANGE AND LIGHT GRAY CLAYEY SILT (MH) WET AND STIFF
						TOTAL DEPTH = 11 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING

J:/CAD/HYDRO/WEYHAUS/TP5.FIG

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN

PIT NO. TP-5
PROJECT NO. 5101.02
DATE 10-20-98
WIDTH 24 INCHES
CHECKED BY
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.5'						LIGHT SILTY GRAY FINE SAND (SM) WITH ORGANIC MATERIAL (TOPSOIL) DAMP AND LOOSE
1'	23.0		45	22	23	MOTTLED ORANGE AND GRAY SANDY CLAY (CL): MOIST AND STIFF
2'						
3'						ORANGE SILTY FINE SAND (SM): MOIST AND MODERATELY DENSE
4'						
5'						
6'						
7'	41.2		56	27	29	MOTTLED ORANGE AND GRAY SANDY CLAY (CL), HEAVILY INTERBEDDED WITH FINE SAND (SP) LAYERS AND SILT LAYERS (SM): VERY MOIST AND STIFF
8'						
9'						
10'						
11'						
12'						MOTTLED ORANGE AND GRAY FINE SAND (SP)

TOTAL DEPTH = 12 FT.
NO FREE GROUNDWATER ENCOUNTERED
NO CAVING

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN

PIT NO. TP-6
PROJECT NO. 5101.02
DATE 10-20-98
WIDTH 24 INCHES
CHECKED BY
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.5'						GRAY BROWN SILTY FINE SAND (SM) (TOPSOIL); DAMP AND LOOSE
1'						TAN SILTY FINE SAND (SM) WITH CLAY (CL) LAYERS; DAMP AND MEDIUM DENSE
2'	19.6		46	22	24	
3'						MOTTLED ORANGE AND GRAY SANDY CLAY (CL); MOIST AND HARD
4'						
5'						MOTTLED ORANGE AND GRAY CLAYEY FINE SAND (SC) MOIST AND MODERATELY DENSE
6'						
7'	33.8		63	32	31	LIGHT GRAY SLIGHTLY SANDY CLAY (CH), HIGHLY PLASTIC, MOIST AND STIFF.
8'						
8.5'						
9'						AS ABOVE BUT HIGHLY INTERBEDDED WITH SAND LAYERS
10'						
11'						MOTTLED ORANGE AND GRAY SLIGHTLY SILTY FINE TO MEDIUM SAND (SM); MOIST AND MEDIUM DENSE
						TOTAL DEPTH - 11 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING

J:/CAD/HYDRO/WEYHAUS/TP7.FIG

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN

PIT NO. TP-7
PROJECT NO. 5101.02
DATE 10-20-98
WIDTH 24 INCHES
CHECKED BY
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.7'						LIGHT SILTY GRAY FINE SAND (SM) (TOPSOIL): MOIST AND LOOSE
1' 2' 3' 4' 5' 6'						MOTTLED ORANGE SAND GRAY SANDY CLAY (CL): MOIST AND STIFF, GOOD PLASTICITY
7'						MOTTLED ORANGE AND GRAY FINE SAND (SP): BECOMING INCREASINGLY MOIST WITH DEPTH
8'	27.3	84	54	27	27	
9' 10' 11'						MOTTLED ORANGE AND GRAY SILTY CLAY (CH) WITH SAND BECOMING PREDOMINATELY GRAY WITH DEPTH: MOIST AND FIRM.
11.5'						ORANGE FINE SAND (SP): MOIST AND MEDIUM DENSE.
						TOTAL DEPTH = 11.5 FT.

NO FREE GROUNDWATER ENCOUNTERED
NO CAVING

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN
CHECKED BY

PIT NO. TP-8
PROJECT NO. 5101.02
DATE 10-20-98
WIDTH 24 INCHES
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.5'						GRAY SILTY FINE SAND (SM) (TOPSOIL); MOIST AND LOOSE
1' 2' 3' 3.5'						ORANGE SILTY SAND (SM) WITH CLAY; MOIST AND DENSE
4' 5' 6' 6.5'	27.9	86				MOTTLED GRAY AND ORANGE SILTY CLAY (CL) WITH SAND; MOIST AND FIRM
7' 8' 9' 10' 10.5'						MOTTLED ORANGE AND GRAY SILTY FINE SAND (SM) WITH TRACE OF CLAY; BECOMING CLEANER WITH DEPTH
11'	30.8	79	43	28	20	MOTTLED GRAY AND ORANGE SANDY CLAY (CL); MOIST AND FIRM
						TOTAL DEPTH = 11 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING

J:/CAD/HYDRO/WEYHAUS/TP9.FIG

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN

PIT NO. TP-9
PROJECT NO. 5101.02
DATE 10-20-98
WIDTH 24 INCHES
CHECKED BY
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.5'						GRAY SILTY FINE SAND (SM), (TOPSOIL): MOIST AND LOOSE
1'						ORANGE SILTY FINE (SM), WITH CLAY; MOIST AND DENSE
2'	22.8	67	56	26	30	MOTTLED ORANGE AND GRAY SILTY CLAY (CH) WITH SAND: MOIST AND HARD
3'						
4'						
5'						
6'	9.5	21				LIGHT ORANGE SILTY FINE SAND (SM): DAMP AND MODERATELY LOOSE
7'						
8'						
9'	21.4	76				MOTTLED GRAY WITH ORANGE SILTY CLAY (CL), WITH SAND AND SILT LAYERS: MOIST AND STIFF; HARD DIGGING, BECOMING HARD AT 10.5 FT.
10'						
11'						TOTAL DEPTH - 11.0 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN CHECKED BY

PIT NO. TP-10
PROJECT NO. 5101.02
DATE 10-21-98
WIDTH 24 INCHES
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
1'						DARK GRAY SILTY FINE SAND (SM): MOIST AND LOOSE
1.5'						
2'						TAN FINE SAND (SP): MOIST AND MODERATELY DENSE
3'						
4'						ORANGE SILTY FINE SAND (SM) WITH CLAY: WITH LAYERS OF SANDY CLAY (6" MAXIMUM THICKNESS): MOIST AND MODERATELY DENSE
5'						
6'						
7'						
8'						
9'						TAN WITH ORANGE MOTTLING FINE SAND (SP): MOIST AND MODERATELY DENSE
10'						
11'						
						TOTAL DEPTH - 11.0 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING

J:/CAD/HYDRO/WEYHAUS/TP11.FIG

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN

PIT NO. TP-11
PROJECT NO. 5101.02
DATE 10-21-98
WIDTH 24 INCHES

CHECKED BY _____

PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.5'						DARK GRAY SILTY FINE (SM) WITH ROOTS AND ORGANIC MATERIAL (TOPSOIL); DAMP AND LOOSE
1'						TAN SILTY FINE SAND (SM); DAMP AND LOOSE
2'						
3'						ORANGE CLAYEY FINE SAND (SC). HARD DIGGING; DAMP AND DENSE
4'						
4.5'						
5'						AS ABOVE, WITH INCREASING CLAY CONTENT; MORE MOTTLED WITH DEPTH
6'						
7'						YELLOW TAN FINE CLEAN SAND (SP); DAMP AND DENSE
8'						
9'						MOTTLED REDDISH BROWN TO GRAY SILTY CLAY (CL); SLIGHTLY MOIST AND VERY STIFF
10'						
11'						TOTAL DEPTH = 10.0 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN CHECKED BY

PIT NO. TP-12
PROJECT NO. 5101.02
DATE 10-21-98
WIDTH 24 INCHES
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.5'						GRAY SILTY FINE SAND (SM) WITH ORGANIC MATERIAL (TOPSOIL): DAMP LOOSE
1'						GRAY FINE SAND (SP): DAMP AND SLIGHTLY DAMP
2'						
3'						TAN FINE SAND (SP) WITH SOME ORANGE MOTTLING: DAMP AND MODERATELY DENSE
4'						
5'	15.9		28	16	12	MOTTLED TAN AND ORANGE CLAYEY FINE SAND (SC): MOIST AND MODERATELY DENSE
6'						
7'						
8'						MOTTLED LIGHT TAN AND ORANGE FINE SAND (SP) WITH SILT: WET AND LOOSE: CAVING TO TOP OF STRATUM
9'						
10'						
11'						TOTAL DEPTH = 10.0 FT. NO FREE GROUNDWATER ENCOUNTERED CAVING FROM 8.0 FT.

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN CHECKED BY

PIT NO. TP-13
PROJECT NO. 5101.02
DATE 10-21-98
WIDTH 24 INCHES
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
1' 1.5'						DARK GRAY SILTY FINE SAND (SM), WITH HEAVY ORGANIC CONCENTRATION (FILL), DAMP AND LOOSE
2'	20.3	49	40	27	13	TAN FINE SAND (SP) WITH SOME SILT AND TRACE OF CLAY; SOME ORANGE MOTTLING (ORGINAL GROUND); DAMP AND SLIGHTLY DENSE
3' 4'						ORANGE BROWN CLAYEY FINE SAND (SC) MODERATELY DENSE AND MOIST; TRACE OF ORGANIC MATERIAL
5' 6' 7' 8'	18.0		32	18	14	AS ABOVE; LESS CLAYEY
9' 10'						MOTTLED TAN WITH ORANGE FINE SAND (SP) WITH SILT; VERY MOIST AND SLIGHTLY DENSE; SLIGHT CAVING FROM 8.5'
11'						TOTAL DEPTH - 10.0 FT. NO FREE GROUNDWATER ENCOUNTERED

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN CHECKED BY

PIT NO. TP-14
PROJECT NO. 5101.02
DATE 10-21-98
WIDTH 24 INCHES
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
1'						ORANGE CLAYEY SAND (SC), SOME MOTTLING; DAMP AND SLIGHTLY DENSE
2'						
3'						LIGHT TO DARK ORANGE SILTY FINE SAND (SM): MOIST AND SLIGHTLY DENSE
4'						
5'						
6'						
7'						MOTTLED TAN AND ORANGE FINE SAND (SP): MOIST AND MODERATELY DENSE
8'						
9'						
9.5'						
10'						DARK GRAY FINE SAND (SP): WET AND MODERATELY DENSE
11'						TOTAL DEPTH - 10.0 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING

J:/CAD/HYDRO/WEYHAUS/TP15.FIG

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN CHECKED BY

PIT NO. TP-15
PROJECT NO. 5101.02
DATE 10-21-98
WIDTH 24 INCHES
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.5'						DARK GRAY SILTY BROWN FINE SAND (SM); WITH ROOTS AND ORGANIC MATERIAL (TOPSOIL); DAMP AND LOOSE
1'						
2'						TAN FINE SAND (SP) WITH SILT AND SOME ROOTS; DAMP AND LOOSE
2.5'						
3'						ORANGE BROWN CLAYEY FINE SAND (SC) GRADING TO SILTY FINE SAND (SM) WITH CLAY; MOIST AND MODERATELY DENSE
4'						
5'						
5.5'						GRAY BROWN CLAYEY FINE SAND (SC)
6'						TAN AND ORANGE CLEAN FINE SAND (SP); DAMP AND MODERATELY DENSE
7'						
8'						
9'						
10'						
11'						TOTAL DEPTH - 10.0 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN CHECKED BY

PIT NO. TP-16
PROJECT NO. 5101.02
DATE 10-21-98
WIDTH 24 INCHES
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.5'						DARK GRAY SILTY FINE SAND (SM), WITH ORGANIC MATERIAL (TOPSOIL) DAMP AND LOOSE
1' 2'						LIGHT GRAY FINE SAND WITH SILT (SP); DAMP AND MODERATELY DENSE
2.5' 3'	24.1	52				MOTTLED LIGHT BROWN AND ORANGE SANDY CLAY (CL), GRADING TO CLAYEY SAND (SC); VERY MOIST AND MODERATELY DENSE
4' 5' 5.5' 6' 7' 8'						MOTTLED TAN WITH ORANGE FINE SAND (SP) WITH TRACE OF CLAY; MOIST AND MODERATELY DENSE
9' 10'						LIGHT GRAY FINE SAND (SP); MOIST AND MODERATELY DENSE
11'						TOTAL DEPTH = 10.0 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN

PIT NO. TP-17
PROJECT NO. 5101.02
DATE 10-21-98
WIDTH 24 INCHES
CHECKED BY
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
						DARK GRAY SILTY FINE SAND (SM), WITH HIGH ORGANIC CONCENTRATION (TOP SOIL); DAMP AND LOOSE
1'						
2'						MOTTLED GRAY WITH ORANGE FINE SAND (SP); DAMP TO MOIST, BECOMING MORE MOIST WITH DEPTH, SLIGHTLY DENSE
3'						
4'						
5'						LIGHT GRAY FINE SAND (SP), WITH SILT; WET AND MODERATELY DENSE; CAVING FROM 4.0 FT.
6'						
7'						TOTAL DEPTH = 7.0 FT. SEEPING OBSERVED AT 4.0 FT. DEPTH CAVING FROM 4.0 FT.
8'						
9'						
10'						
11'						

J:/CAD/HYDRO/WEYHAUS/TP18.FIG

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN CHECKED BY

PIT NO. TP-18
PROJECT NO. 5101.02
DATE 10-21-98
WIDTH 24 INCHES
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
						DARK GRAY SILTY FINE SAND (SM), (TOPSOIL): DAMP AND LOOSE
1'						
2'						GRAY BROWN TO TAN FINE SAND (SP) WITH SILT: DAMP AND MODERATELY DENSE
3'						
4'	38	33	19	14		ORANGE CLAYEY FINE SAND (SC) GRADING TO A SILTY FINE SAND WITH CLAY: MOIST AND MODERATELY DENSE
5'						
6'						
7'						
8'						REDDISH BROWN SILTY FINE TO MEDIUM SAND (SM): MOIST AND MODERATELY DENSE
8.5'						MOTTLED TAN AND ORANGE SILTY FINE TO MEDIUM SAND: MOIST AND MODERATELY DENSE
9'						
10'						TOTAL DEPTH = 9.0 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING
11'						

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN

PIT NO. TP-19
PROJECT NO. 5101.02
DATE 10-21-98
WIDTH 24 INCHES
CHECKED BY
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
1' 1.5'						ORANGE SILTY FINE SAND (SM) WITH CONCRETE AND ASPHALT RUBBLE (FILL); DAMP AND MODERATELY DENSE
2' 2.5'	14.8		31	17	14	LIGHT ORANGE BROWN CLAYEY SAND (SC); VERY DIFFICULT DIGGING; DAMP AND DENSE (ORIGINAL GROUND)
3' 3.5'						MOTTLED ORANGE AND GRAY SILTY FINE SAND (SM); MOIST AND MODERATELY DENSE
4' 5' 6'						MOTTLED ORANGE AND GRAY SILTY FINE SAND (SM) WITH CLAY, BECOMING LESS SILTY WITH DEPTH; MOIST TO WET AND MODERATELY DENSE
7' 8' 9' 9.5'						LIGHT GRAY WITH ORANGE MOTTLING FINE SAND (SP); SLIGHTLY DENSE AND SATURATED CAVING FROM 6.0 FT. DEPTH
10'						DARK GRAY FINE SAND (SP); SATURATED AND MODERATELY DENSE
11'						TOTAL DEPTH = 10.0 FT. SOILS SATURATED FROM 6.0 FT. DEPTH, BUT NO SEEPAGE. CAVING FROM 6.0 FT. DEPTH

J:/CAD/HYDRD/WEYHAUS/TP20.FIG

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN

PIT NO. TP-20
PROJECT NO. 5101.02
DATE 10-21-98
WIDTH 24 INCHES

CHECKED BY _____

PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.5'						DARK GRAY SILTY FINE SAND (SM) (TOP SOIL); DAMP AND LOOSE
1'						TAN FINE SAND (SP) WITH SILT; DAMP AND LOOSE
2'						
3'						ORANGE CLAYEY FINE SAND (SC); DAMP AND DENSE, SOME TREE ROOTS, HARD DIGGING
4'						
4.5'						MOTTLED GRAY AND ORANGE CLAYEY FINE SAND (SC)
5'						YELLOW-ORANGE SILTY FINE SAND (SM) GRADING TO FINE SAND WITH SILT (SM) WITH DEPTH; DAMP AND DENSE, HARD DIGGING
6'						
7'						TOTAL DEPTH = 7.0 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING
8'						
9'						
10'						
11'						

J:/CAD/HYDRO/WEYHAUS/TP21.FIG

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN

PIT NO. TP-21
PROJECT NO. 5101.02
DATE 10-21-98
WIDTH 24 INCHES

CHECKED BY _____

PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.5'						DARK GRAY SILYTY ASND (SM), WITH ROOTS AND ORGANIC MATERIAL (TOPSOIL); DAMP AND LOOSE
1'						TAN FINE SAND (SP) WITH SILT; MOIST AND MODERATELY DENSE
2'						
2.5'						
3'						ORANGE SANDY CLAY (CL-ML) GRADING TO CLAYEY SAND (SC); MOIST AND MODERATELY DENSE
4'						
5'						
6'						
6.5'						
7'						MOTTLED GRAY WITH ORANGE SILTY FINE SAND (SM) GRADING TO CLAYEY FINE SAND (SC) AT BOTTOM OF TEST PIT; WET AND MODERATELY DENSE
8'						
9'						
10'						
11'						TOTAL DEPTH - 10.0 FT. SEEPAGE NOTED AT BOTTOM OF EXCAVATION NO CAVING

J:/CAD/HYDRO/WEYHAUS/TP22.FIG

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN

PIT NO. TP-22
PROJECT NO. 5101.02
DATE 10-22-98
WIDTH 24 INCHES

CHECKED BY _____

PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
						DARK GRAY SILTY FINE SAND (SM) ROOTS AND ORGANIC MATERIAL (TOPSOIL); DAMP AND LOOSE
1'						
2'						TAN FINE SAND (SP); DAMP AND MODERATELY DENSE
3'						
						LIGHT ORANGE BROWN SILTY FINE SAND (SM) WITH CLAY; MOIST AND MOTERATELY DENSE
4'						
						LIGHT TAN FINE SAND (SP); DAMP AND MODERATELY DENSE
5'						
6'						YELLOW BROWN CLAYEY FINE SAND (SC); MOIST AND MODERATELY DENSE
7'						
8'						
8.5'						
9'						MOTTLED ORANGE AND GRAY SANDY CLAY (CL); VERY MOIST AND MODERATELY DENSE
9.5'						
10'						TOTAL DEPTH - 9.5 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING
11'						

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN

PIT NO. TP-23
PROJECT NO. 5101.02
DATE 10-22-98
WIDTH 24 INCHES

CHECKED BY _____

PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
						DARK GRAY SILTY FINE SAND (SM) ROOTS AND ORGANIC MATERIAL (TOP SOIL); DAMP AND LOOSE
1'						TAN FINE SAND (SP); MOIST AND MODERATELY DENSE
2'						ORANGE SILTY FINE SAND (SM) WITH CLAY, BECOMING LESS SILTY WITH DEPTH; MOIST AND MODERATELY DENSE
3'						
4'						
5'						LIGHT ORANGE FINE SAND (SP) WITH SILT; MOIST AND MODERATELY DENSE
6'						
7'						
8'						
9'						TOTAL DEPTH - 9.0 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING
10'						
11'						

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
PIT NO. TP-24
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
PROJECT NO. 5101.02
CONTRACTOR B.E. SINGELTON
DATE 10-22-98
METHOD CASE 580K BACKHOE
WIDTH 24 INCHES
LOGGED BY RKN
CHECKED BY
PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
						DARK GRAY SILTY FINE SAND (SM) WITH ROOTS AND ORGANIC MATTER (TOPSOIL); DAMP AND LOOSE
1'						
2'						YELLOW BROWN SAND CLAY (CL),HARD DIGGING, INCREASED ORANGE AND GRAY MOTTLING WITH DEPTH; DAMP AND HARD
3'						
4'						
5'						
6'						AS ABOVE, BUT HIGHER SAND CONTENT; EASIER TO DIG
7'						
7.5'						MOTTLED GRAY AND ORANGE SANDY CLAY (CL); HARD DIGGING; DAMP AND VERY STIFF
8'						
9'						TOTAL DEPTH - 8.0 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING
10'						
11'						

LOG OF TEST PIT OR EXCAVATION

PROJECT NAME WEYERHAEUSER BORROW INVESTIGATION
LOCATION BEASLEY & SNELL PROPERTIES, PLYMOUTH, NC
CONTRACTOR B.E. SINGELTON
METHOD CASE 580K BACKHOE
LOGGED BY RKN

PIT NO. TP-25
PROJECT NO. 5101.02
DATE 10-22-98
WIDTH 24 INCHES

CHECKED BY _____

PAGE 1 OF 1

DEPTH	MOISTURE CONTENT	P200	LL	PL	PI	VISUAL CLASSIFICATION
0.5'						DARK GRAY SILTY FINE SAND (SM) (TOPSOIL); DAMP AND LOOSE
1'						TAN FINE SAND (SP); DAMP AND MODERATELY DENSE
2'	24.6		60	31	29	ORANGE FINE SANDY CLAY (CH); MOIST AND DENSE
3' 3.5'						
4'						MOTTLED ORANGE AND RED BROWN SILTY FINE SAND (SM); MOIST AND DENSE
5' 5.5'						
6'	10.6	26				ORANGE CLAYEY FINE SAND (SC); MOIST AND DENSE
7'						
8'						TOTAL DEPTH = 8.0 FT. NO FREE GROUNDWATER ENCOUNTERED NO CAVING
9'						
10'						
11'						

Appendix B
Laboratory Testing Results

RMT, Inc.

Moisture Content / Dry Density Determination

QC: [illegible]

QA: [illegible]

Project Name: WEYERHAEUSER

Project #: 5101.02

	Sample Location	Moisture Tare Wt. (g)	Moisture Wet Wt. + Tare (g)	Moisture Dry Wt. +Tare (g)	Moisture (%)	Sample Diameter (in)	Sample Height (in)	Density Tare Wt. (g)	Density Wet Wt. + Tare (g)	Wet Density (pcf)	Dry Density (pcf)
1	TP-2, 0.5'	84.08	215.60	194.88	18.7						
2	TP-5, 0.5-3'	83.65	322.53	277.82	23.0						
3	TP-5, 7-11'	84.35	277.64	221.22	41.2						
4	TP-6, 2-5'	83.74	292.51	258.29	19.6						
5	TP-6, 7-8.5'	83.55	270.71	223.47	33.8						
6	TP-12, 4.5'	83.12	257.40	233.45	15.9						
7	TP-13, 5'	83.86	221.86	200.79	18.0						
8	TP-19, 1.5-2.5'	83.02	300.84	272.82	14.8						
9	TP-21, 2.5-6.5'	83.52	344.70	306.76	17.0						
10	TP-25, 2-3.5'	83.87	253.72	220.24	24.6						
11	TP-8, 10.5-11'	266.27	485.31	433.76	30.8						
12	TP-16, 2.5-5.5'	278.36	698.00	616.60	24.1						
13	TP-22, 3-4'	274.51	790.70	719.60	16.0						
14	TP-22, 8.5-9.5'	267.18	661.80	562.22	33.8						
15	TP-25, 5.5'	273.53	796.00	746.10	10.6						
16	TP-3, 0-1'	276.94	619.00	599.14	6.2						
17	TP-9, 6-9'	266.58	758.20	715.70	9.5						
18	TP-9, 9-11'	267.67	925.70	809.70	21.4						
19	TP-8, 3.5-6.5'	272.97	780.20	669.50	27.9						
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											

RMT, Inc.

Percent Passing #200 Sieve (P200)

QC: KW

QA: JW

Project Name: WEYERHAEUSER Project #: 5101.02

	Sample Location	Tare Wt. (g)	Dry Wt. + Tare (g)	Wash Wt. + Tare (g)	P200 (%)
1	TP-3, 1-6'	273.36	578.09	467.60	36.3
2	TP-18, 3-8'	266.34	485.36	403.00	37.6
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

RMT, Inc.

Specific Gravity Determination

QC: dry

QA: mt

Project Name: WEYERHAEUSER Project #: 5101

	Sample Location	Flask Vol. @ 20° C	Flask Wt. +Water	Dry Soil Wt.	Flask+Soil +Water	Temp. (c)	Specific Gravity
1	TP-4, 8"-5'	250	341.95	51.86	374.37	23.0	2.67
2	TP-4, 10-11'	250	352.65	52.70	385.51	23.0	2.65
3	TP-7, 8-10'	250	355.43	56.17	390.59	23.0	2.67
4	TP-9, 1.5-6'	250	354.02	54.95	388.40	23.0	2.67
5	TP-13, 2-5'	250	353.66	58.47	390.26	23.0	2.67
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
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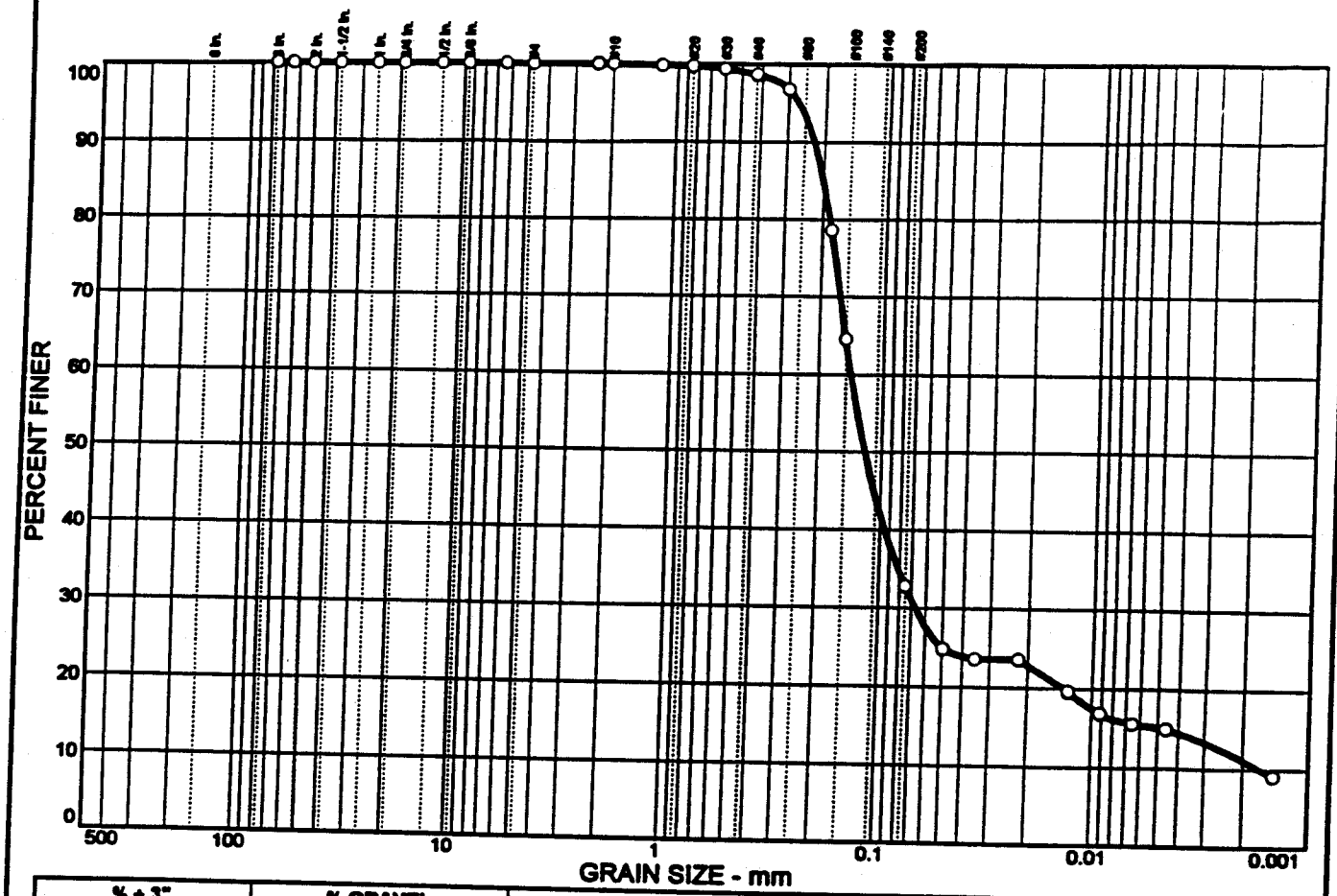
25							
26							
27							
28							
29							
30							

GRAIN SIZE DISTRIBUTION TEST REPORT (ASTM D422)



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	67.2	17.7	15.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0 in.	100.0		
2.5 in.	100.0		
2.0 in.	100.0		
1.5 in.	100.0		
1.0 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
.25 in.	100.0		
#4	100.0		
#8	100.0		
#10	100.0		
#16	99.8		
#20	99.7		
#30	99.4		
#40	98.7		
#50	96.8		
#80	78.6		
#100	64.6		
#200	32.8		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.200 D_{60}= 0.141 D_{50}= 0.119
D_{30}= 0.0670 D_{15}= 0.0048 D_{10}= 0.0017
C_u= 84.59 C_c= 19.19

Classification

USCS= AASHTO=

Remarks

Sample No.:
Location:

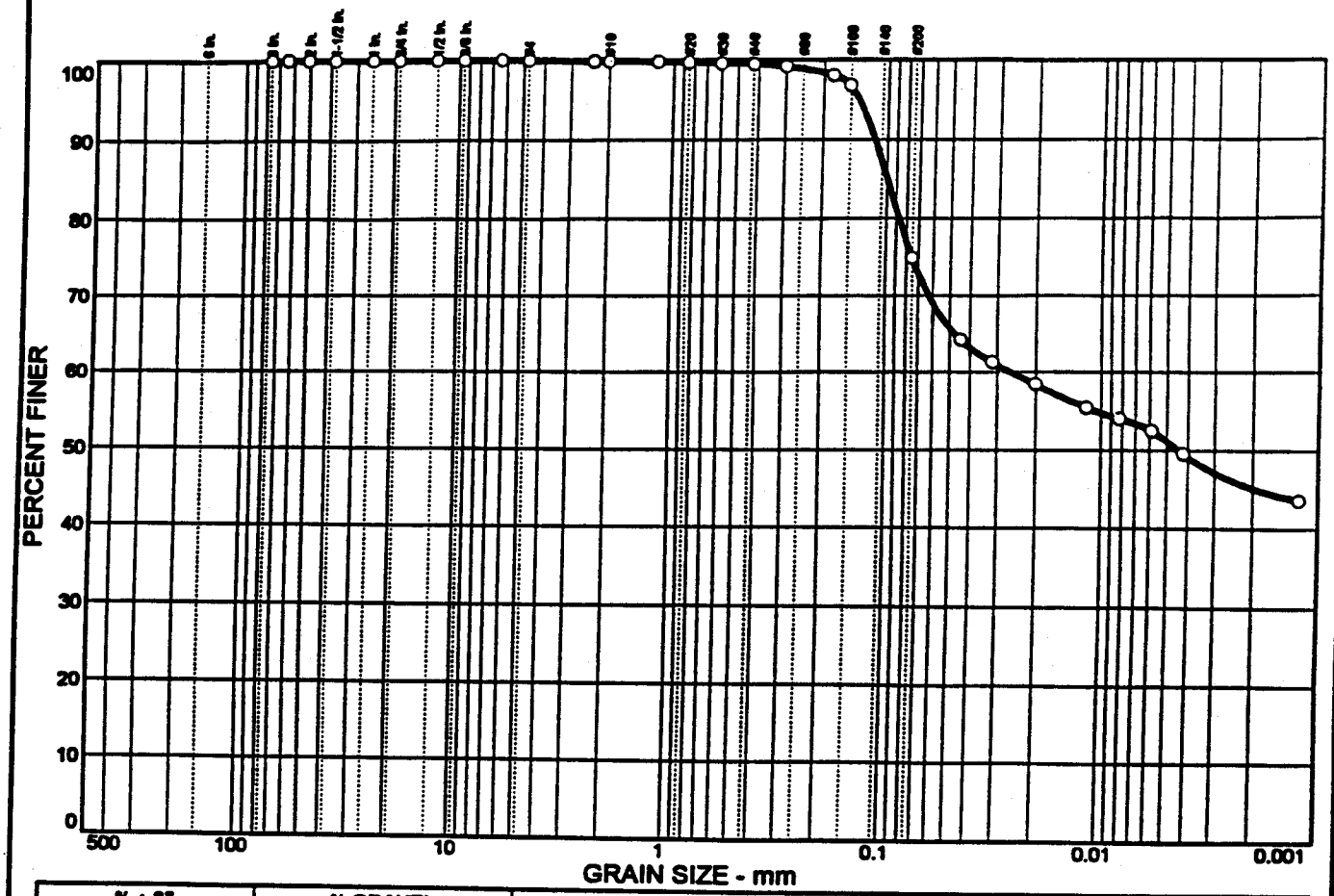
Source of Sample: TP-3

Date: 11/4/98
Elev./Depth: 0-1'

RMT, Inc.

Client:
Project: WEYERHAEUSER
Project No: 5101.02
Figure:

GRAIN SIZE DISTRIBUTION TEST REPORT (ASTM D422)



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	25.0	23.8	51.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0 in.	100.0		
2.5 in.	100.0		
2.0 in.	100.0		
1.5 in.	100.0		
1.0 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
.25 in.	100.0		
#4	100.0		
#8	99.9		
#10	99.9		
#16	99.8		
#20	99.7		
#30	99.6		
#40	99.5		
#50	99.2		
#80	98.1		
#100	96.8		
#200	75.0		

* (no specification provided)

Soil Description

Fat clay with sand

Atterberg Limits

PL= 28 LL= 58 PI= 30

Coefficients

D_{85}= 0.0992 D_{60}= 0.0259 D_{50}= 0.0044
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

Remarks

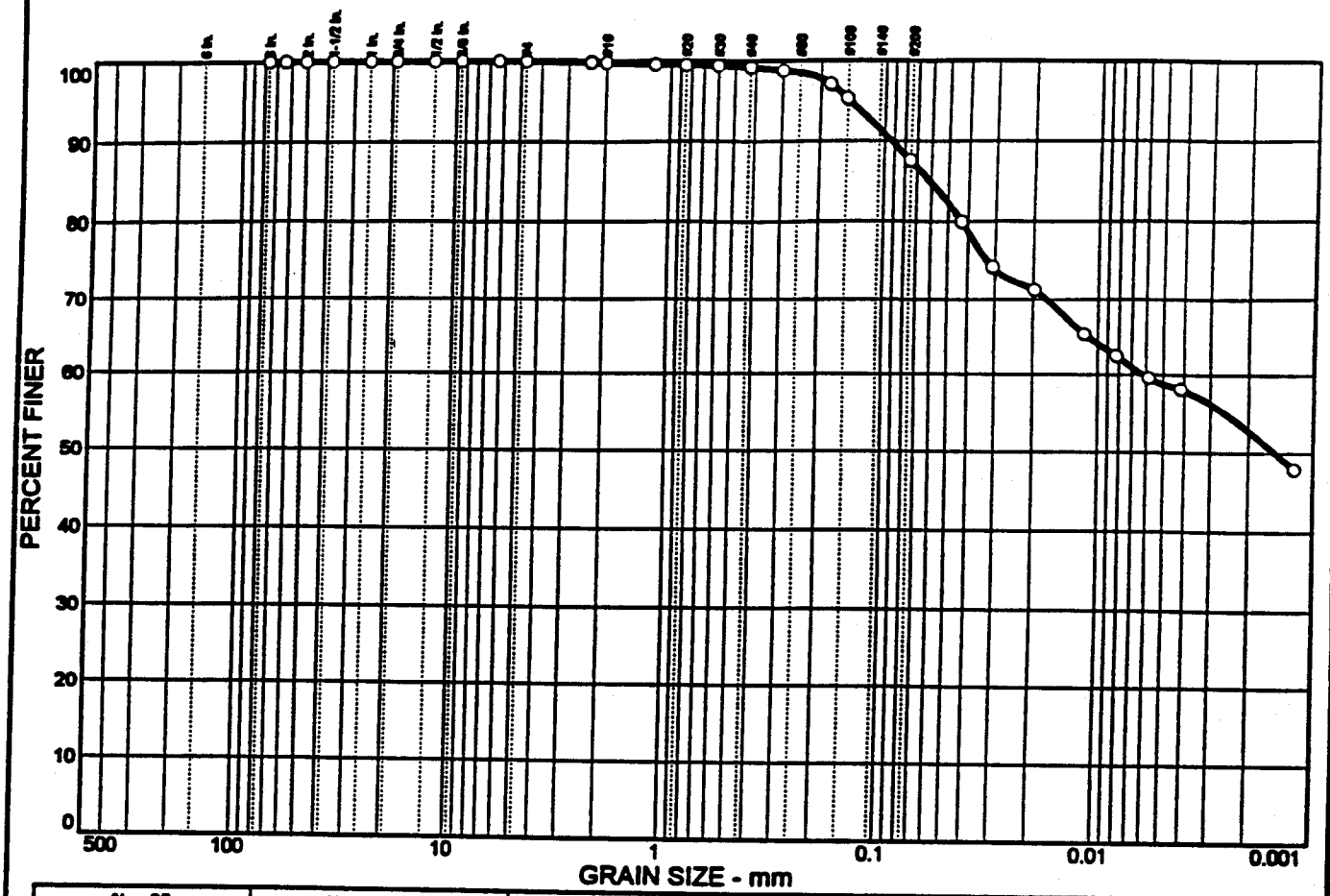
Sample No.:
Location:
Source of Sample: TP-4
Date:
Elev./Depth: 8"-5.0'

RMT, Inc.

Client:
Project: WEYERHAEUSER
Project No: 5101.02
Figure:

JAN

GRAIN SIZE DISTRIBUTION TEST REPORT (ASTM D422)



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	12.4	28.8	58.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0 in.	100.0		
2.5 in.	100.0		
2.0 in.	100.0		
1.5 in.	100.0		
1.0 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
.25 in.	100.0		
#4	100.0		
#8	99.9		
#10	99.8		
#16	99.6		
#20	99.5		
#30	99.4		
#40	99.2		
#50	98.8		
#80	97.1		
#100	95.3		
#200	87.6		

* (no specification provided)

Soil Description

Elastic silt

Atterberg Limits

PL= 31 LL= 55 PI= 24

Coefficients

D_{85}= 0.0601 D_{60}= 0.0062 D_{50}= 0.0015
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

Sample No.:
Location:

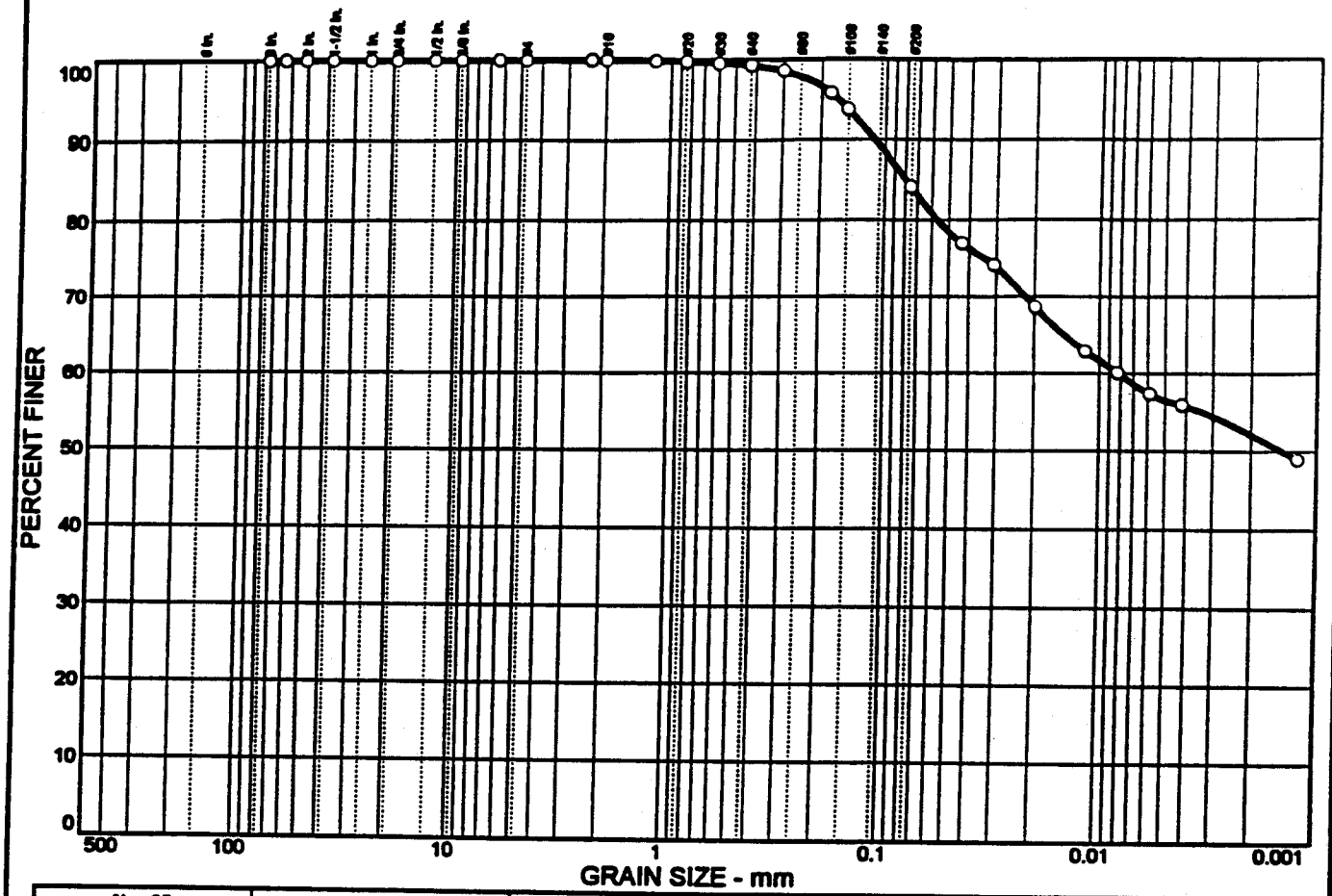
Source of Sample: TP-4

Date:
Elev./Depth: 10-11'

RMT, Inc.

Client:
Project: WEYERHAEUSER
Project No: 5101.02
Figure:

GRAIN SIZE DISTRIBUTION TEST REPORT (ASTM D422)



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	15.8	27.7	56.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0 in.	100.0		
2.5 in.	100.0		
2.0 in.	100.0		
1.5 in.	100.0		
1.0 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
.25 in.	100.0		
#4	100.0		
#8	100.0		
#10	100.0		
#16	99.9		
#20	99.8		
#30	99.6		
#40	99.3		
#50	98.6		
#80	95.8		
#100	93.8		
#200	84.2		

* (no specification provided)

Soil Description

Fat clay with sand

Atterberg Limits

PL= 27 LL= 54 PI= 27

Coefficients

D_{85}= 0.0791 D_{60}= 0.0082 D_{50}= 0.0014
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

Remarks

Sample No.:
Location:

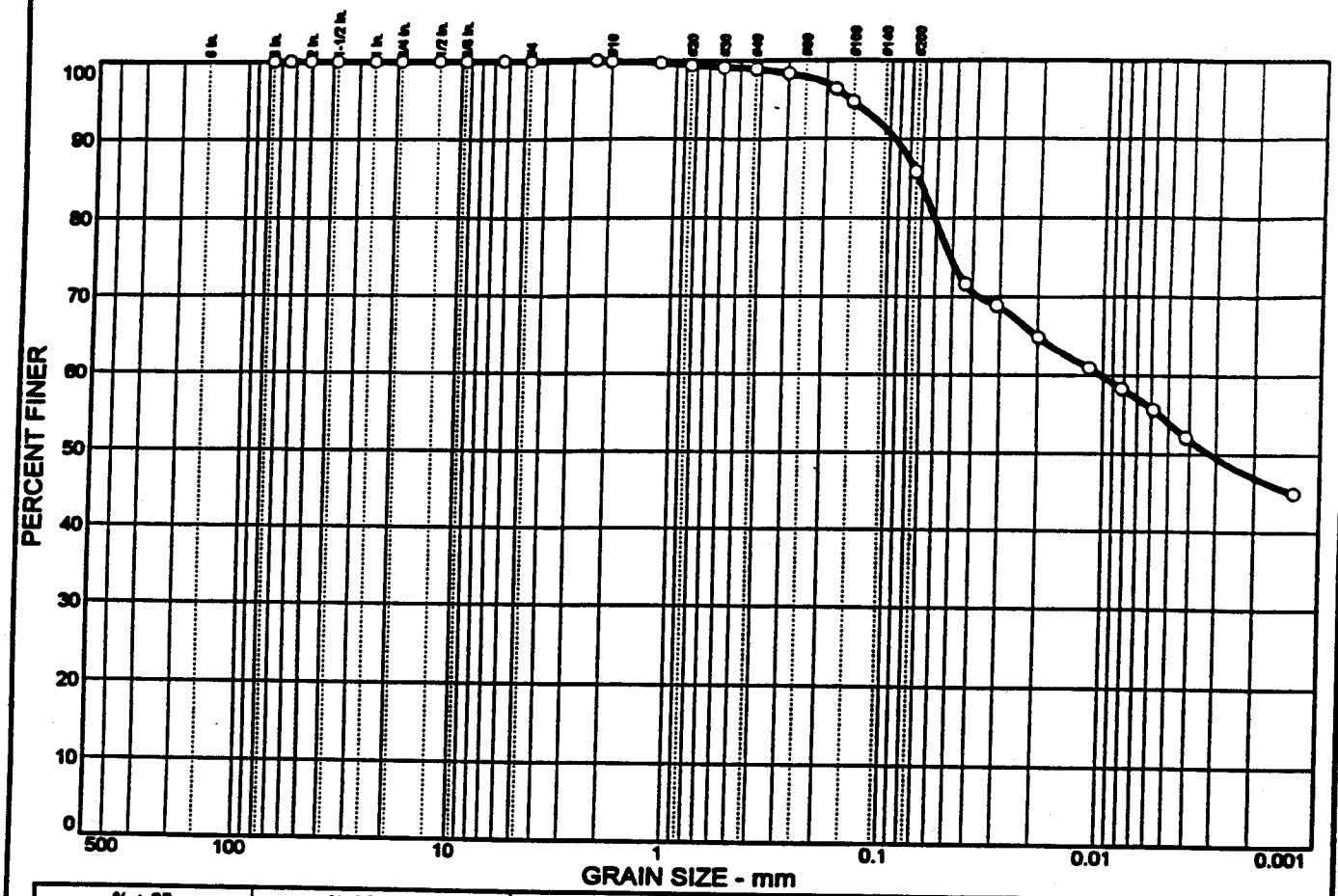
Source of Sample: TP-7

Date:
Elev./Depth: 8-10'

RMT, Inc.

Client:
Project: WEYERHAEUSER
Project No: 5101.02
Figure:

GRAIN SIZE DISTRIBUTION TEST REPORT (ASTM D422)



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	14.2	31.7	54.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0 in.	100.0		
2.5 in.	100.0		
2.0 in.	100.0		
1.5 in.	100.0		
1.0 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
.25 in.	100.0		
#4	100.0		
#8	100.0		
#10	99.9		
#16	99.7		
#20	99.4		
#30	99.1		
#40	98.9		
#50	98.3		
#80	96.4		
#100	94.7		
#200	85.8		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.0726 D_{60}= 0.0102 D_{50}= 0.0032
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample No.:
Location:

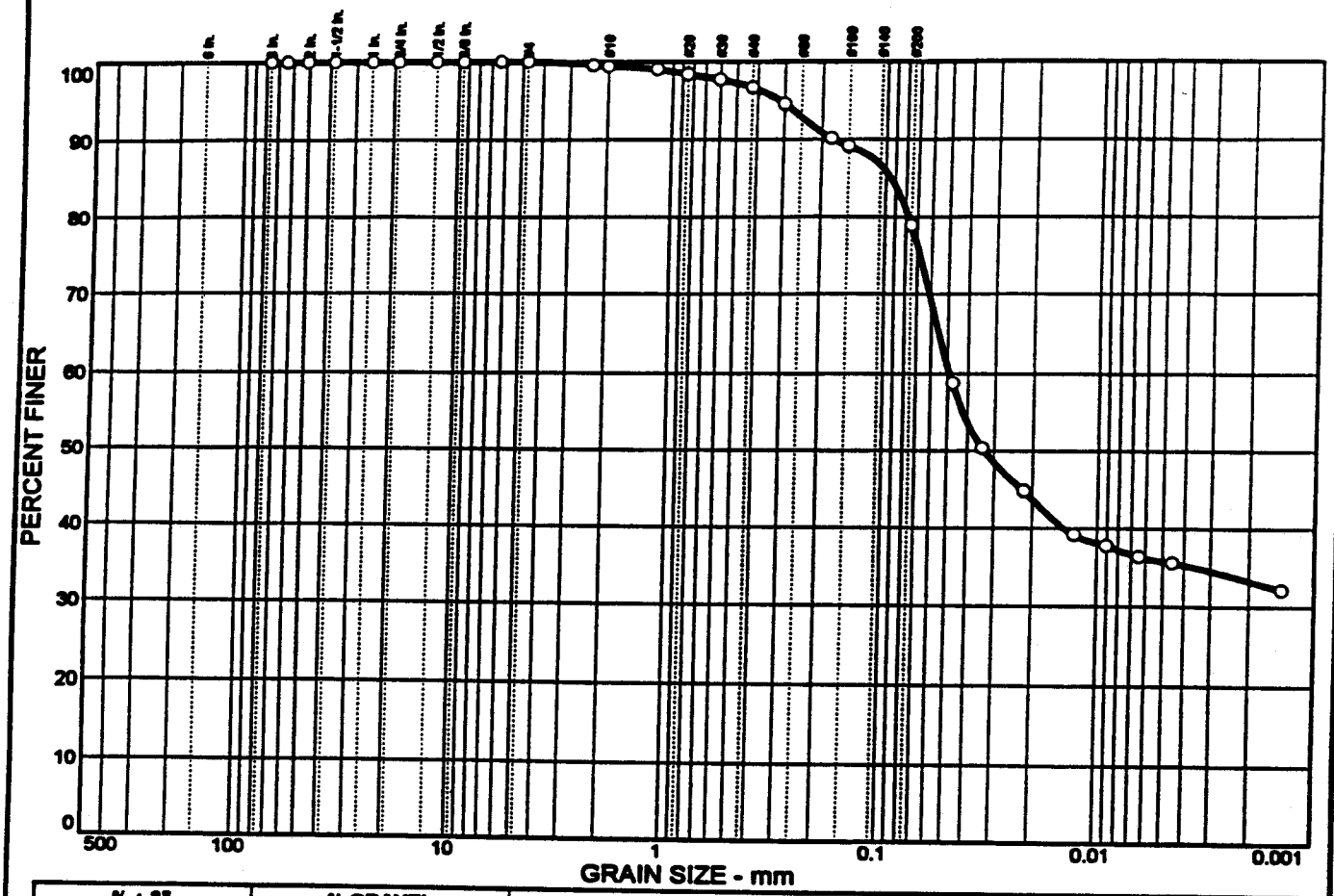
Source of Sample: TP-8

Date: 11/4/98
Elev./Depth: 3.5-6.5'

RMT, Inc.

Client:
Project: WEYERHAEUSER
Project No: 5101.02
Figure:

GRAIN SIZE DISTRIBUTION TEST REPORT (ASTM D422)



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	21.1	43.1	35.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0 in.	100.0		
2.5 in.	100.0		
2.0 in.	100.0		
1.5 in.	100.0		
1.0 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
.25 in.	100.0		
#4	100.0		
#8	99.6		
#10	99.4		
#16	99.0		
#20	98.4		
#30	97.7		
#40	96.7		
#50	94.6		
#80	90.1		
#100	89.1		
#200	78.9		

* (no specification provided)

Soil Description

Lean clay with sand

Atterberg Limits

PL= 23 LL= 43 PI= 20

Coefficients

D_{85}= 0.0945 D_{60}= 0.0488 D_{50}= 0.0333
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

Sample No.:
Location:

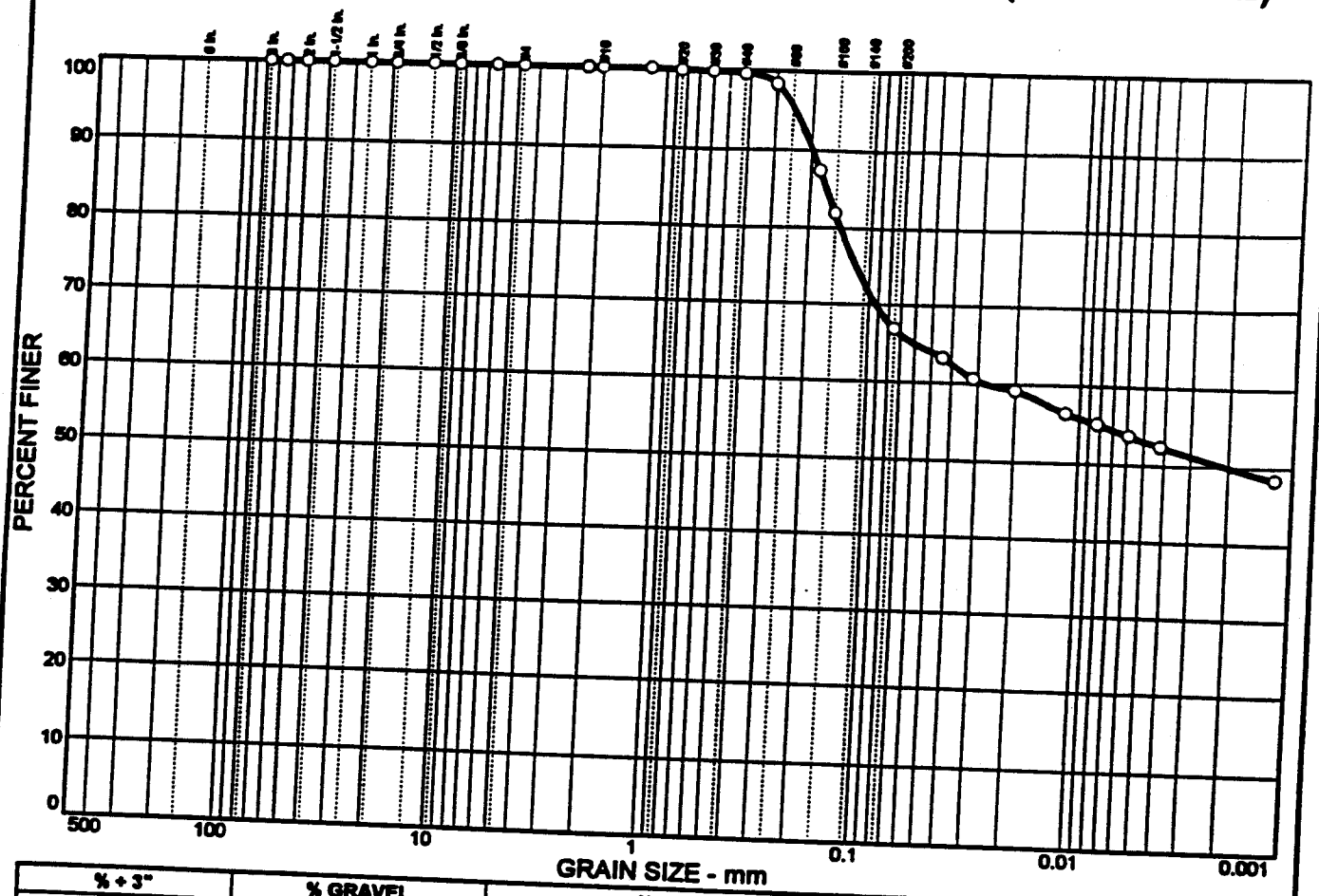
Source of Sample: TP-8

Date:
Elev./Depth: 10.5-11'

RMT, Inc.

Client:
Project: WEYERHAEUSER
Project No: 5101.02
Figure:

GRAIN SIZE DISTRIBUTION TEST REPORT (ASTM D422)



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	33.1	13.7	53.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0 in.	100.0		
2.5 in.	100.0		
2.0 in.	100.0		
1.5 in.	100.0		
1.0 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
.25 in.	100.0		
#4	100.0		
#8	100.0		
#10	100.0		
#16	100.0		
#20	99.9		
#30	99.8		
#40	99.6		
#50	98.3		
#80	87.5		
#100	82.0		
#200	66.9		

* (no specification provided)

Soil Description

Sandy fat clay

Atterberg Limits

PL= 26 LL= 56 PI= 30

Coefficients

D_{85}= 0.166 D_{60}= 0.0276 D_{50}= 0.0020
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

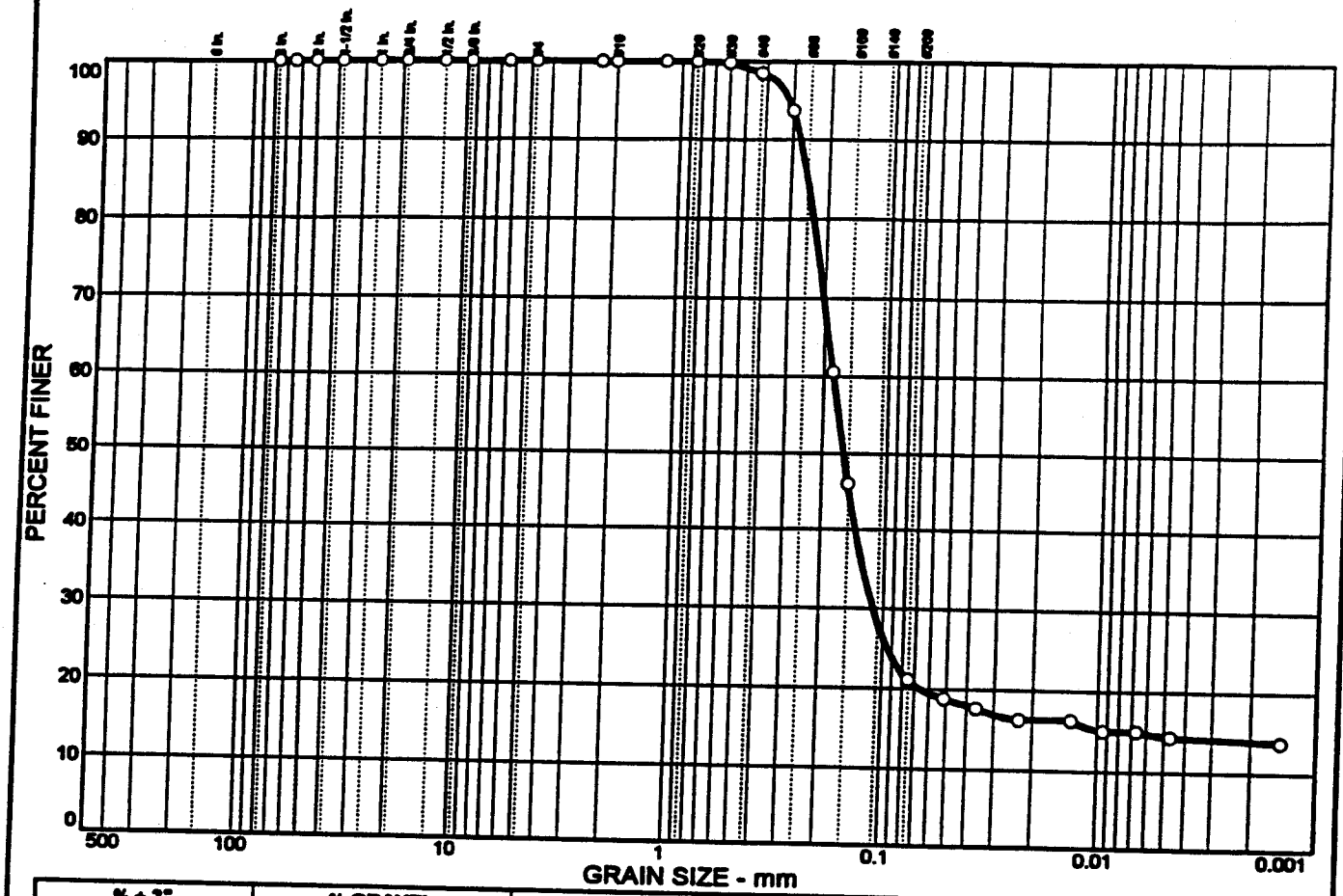
Remarks

Sample No.:
Location:
Source of Sample: TP-9
Date:
Elev./Depth: 1.5-6'

RMT, Inc.

Client:
Project: WEYERHAEUSER
Project No: 5101.02
Figure:

GRAIN SIZE DISTRIBUTION TEST REPORT (ASTM D422)



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	78.9	6.7	14.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0 in.	100.0		
2.5 in.	100.0		
2.0 in.	100.0		
1.5 in.	100.0		
1.0 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
.25 in.	100.0		
#4	100.0		
#8	100.0		
#10	100.0		
#16	100.0		
#20	100.0		
#30	99.8		
#40	98.5		
#50	93.6		
#80	60.6		
#100	46.0		
#200	21.1		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.250 D_{60}= 0.179 D_{50}= 0.158
D_{30}= 0.112 D_{15}= 0.0066 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample No.:
Location:

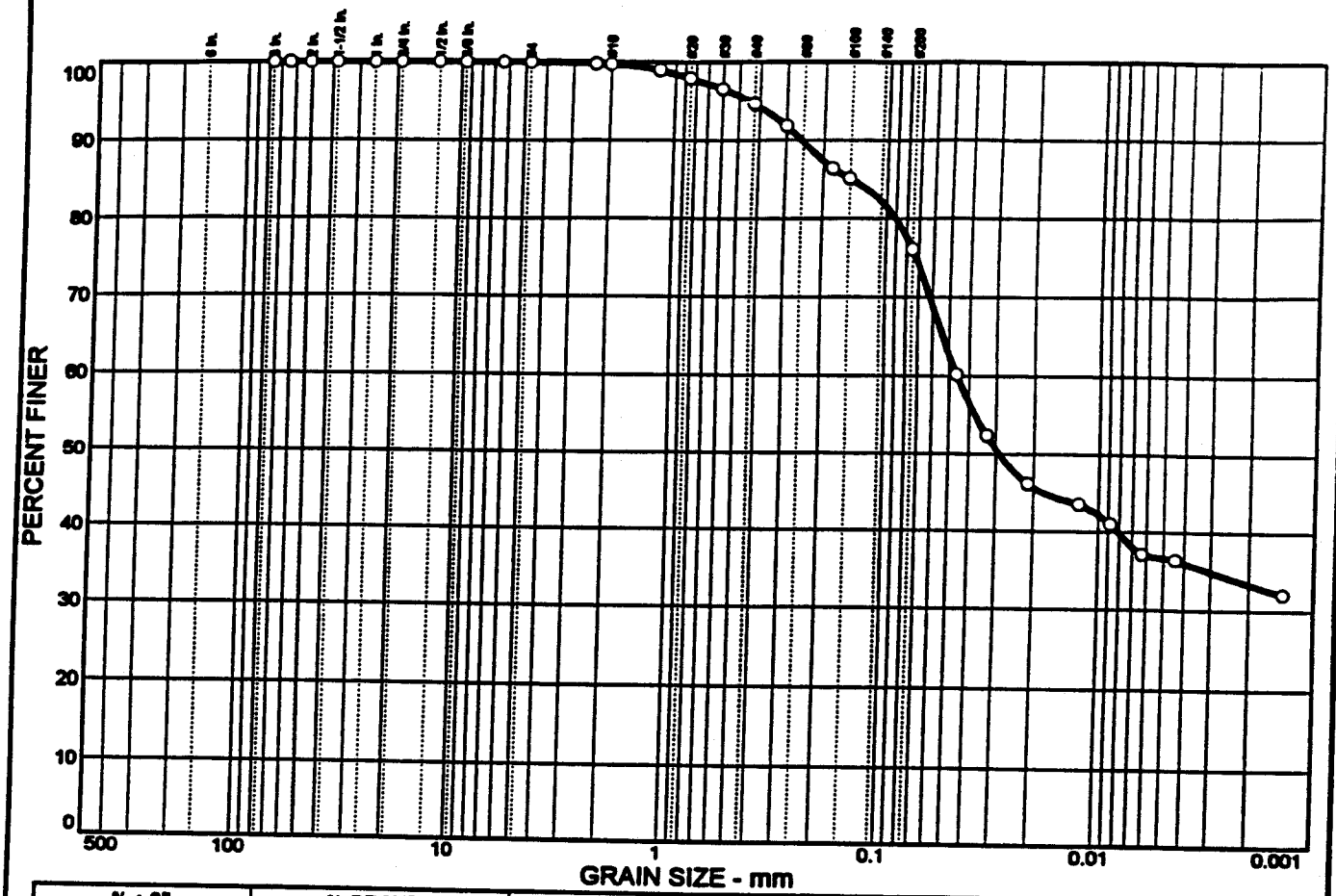
Source of Sample: TP-9

Date: 11/4/98
Elev./Depth: 6-9'

RMT, Inc.

Client:
Project: WEYERHAEUSER
Project No: 5101.02
Figure:

GRAIN SIZE DISTRIBUTION TEST REPORT (ASTM D422)



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	24.0	39.4	36.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0 in.	100.0		
2.5 in.	100.0		
2.0 in.	100.0		
1.5 in.	100.0		
1.0 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
.25 in.	100.0		
#4	100.0		
#8	99.8		
#10	99.7		
#16	99.0		
#20	98.0		
#30	96.6		
#40	94.7		
#50	91.8		
#80	86.4		
#100	85.1		
#200	76.0		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.148 D_{60}= 0.0455 D_{50}= 0.0288
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

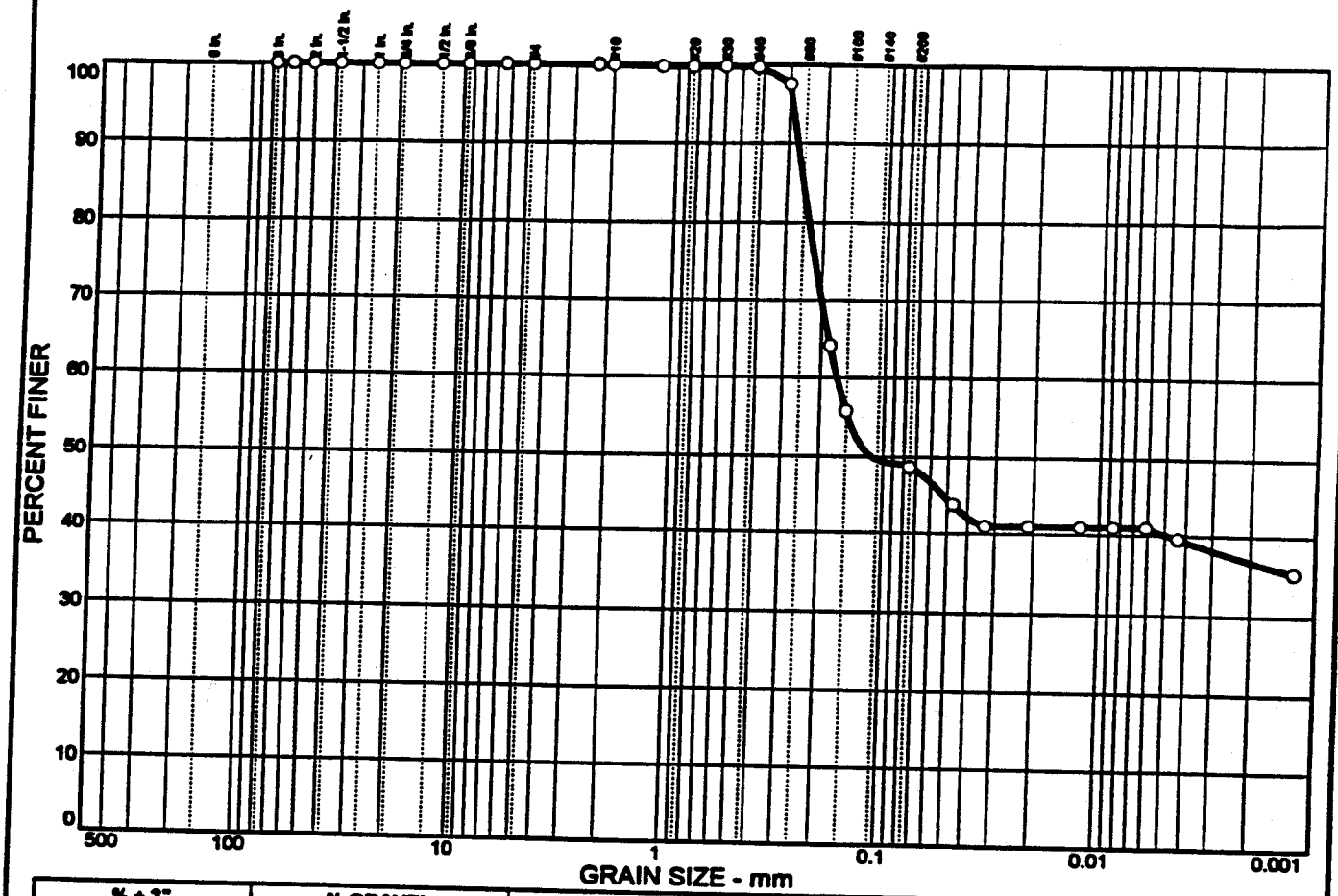
Remarks

Sample No.:
Location:
Source of Sample: TP-9
Date: 11/4/98
Elev./Depth: 9-11'

RMT, Inc.

Client:
Project: WEYERHAEUSER
Project No: 5101.02
Figure:

GRAIN SIZE DISTRIBUTION TEST REPORT (ASTM D422)



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	51.3	8.5	40.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0 in.	100.0		
2.5 in.	100.0		
2.0 in.	100.0		
1.5 in.	100.0		
1.0 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
.25 in.	100.0		
#4	100.0		
#8	100.0		
#10	100.0		
#16	99.9		
#20	99.9		
#30	99.9		
#40	99.7		
#50	97.5		
#80	64.1		
#100	55.8		
#200	48.7		

* (no specification provided)

Soil Description

Clayey sand

Atterberg Limits

PL= 21 LL= 40 PI= 19

Coefficients

D_{85}= 0.251 D_{60}= 0.166 D_{50}= 0.112
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

Sample No.:
Location:

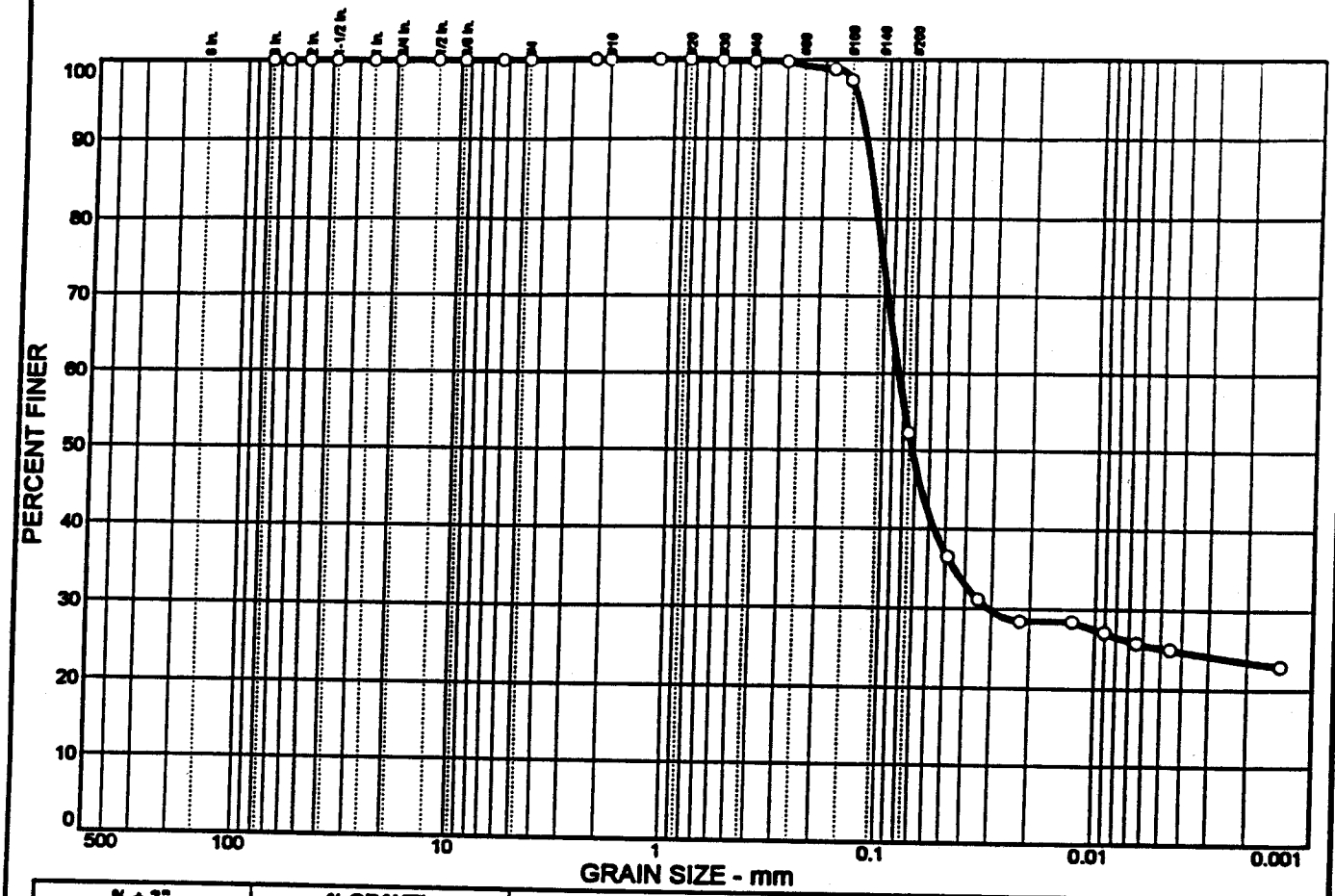
Source of Sample: TP-13

Date:
Elev./Depth: 2-5'

RMT, Inc.

Client:
Project: WEYERHAEUSER
Project No: 5101.02
Figure:

GRAIN SIZE DISTRIBUTION TEST REPORT (ASTM D422)



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	47.7	27.2	25.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0 in.	100.0		
2.5 in.	100.0		
2.0 in.	100.0		
1.5 in.	100.0		
1.0 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
.25 in.	100.0		
#4	100.0		
#8	100.0		
#10	100.0		
#16	100.0		
#20	100.0		
#30	99.9		
#40	99.9		
#50	99.8		
#80	98.8		
#100	97.4		
#200	52.3		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.117 D_{60}= 0.0841 D_{50}= 0.0720
D_{30}= 0.0311 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample No.:
Location:

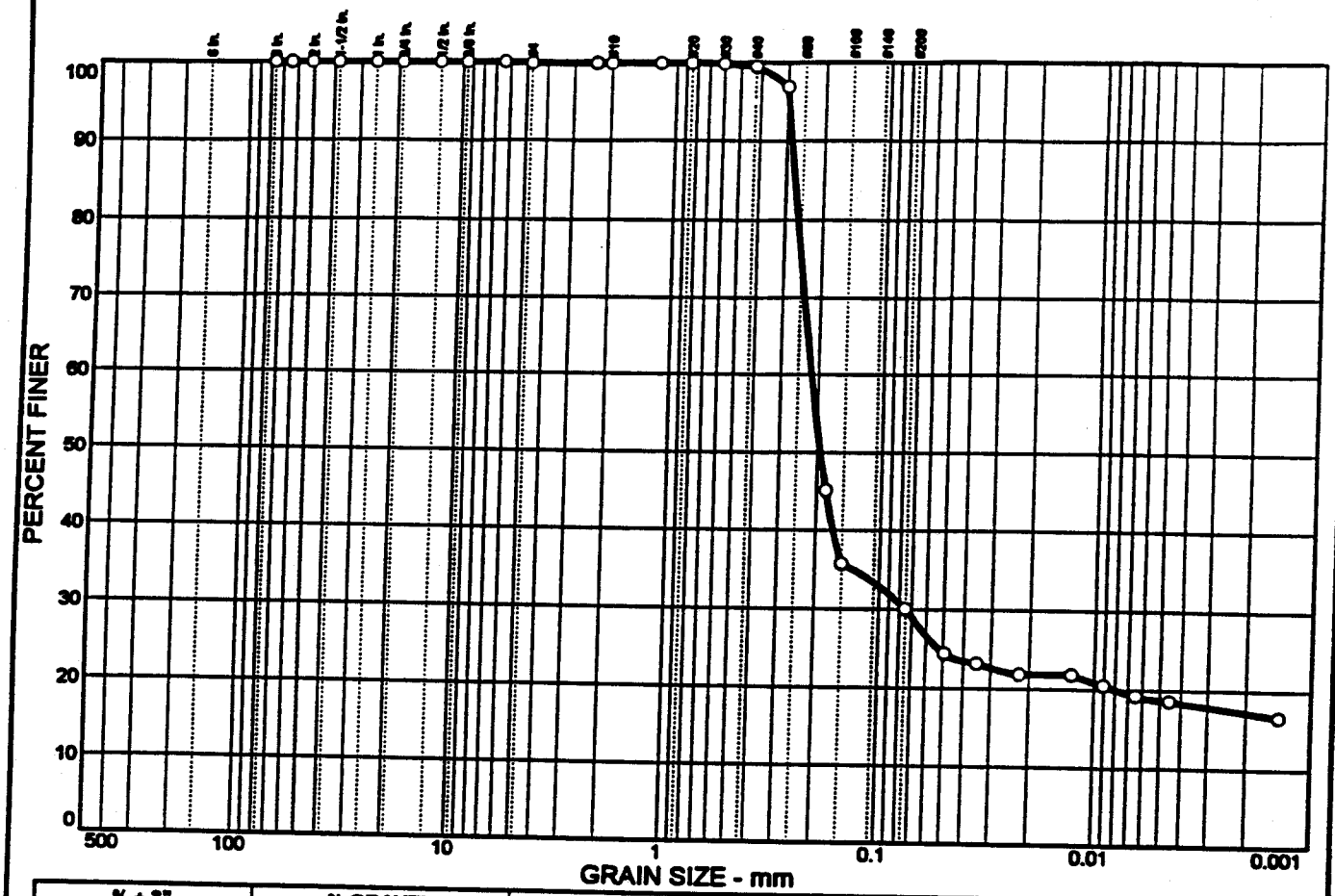
Source of Sample: TP-16

Date: 11/4/98
Elev./Depth: 2.5-5.5'

RMT, Inc.

Client:
Project: WEYERHAEUSER
Project No: 5101.02
Figure:

GRAIN SIZE DISTRIBUTION TEST REPORT (ASTM D422)



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	69.9	11.3	18.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0 in.	100.0		
2.5 in.	100.0		
2.0 in.	100.0		
1.5 in.	100.0		
1.0 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
.25 in.	100.0		
#4	99.9		
#8	99.9		
#10	99.9		
#16	99.9		
#20	99.9		
#30	99.8		
#40	99.5		
#50	96.9		
#80	45.1		
#100	35.8		
#200	30.0		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.271 D_{60}= 0.215 D_{50}= 0.192
D_{30}= 0.0750 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

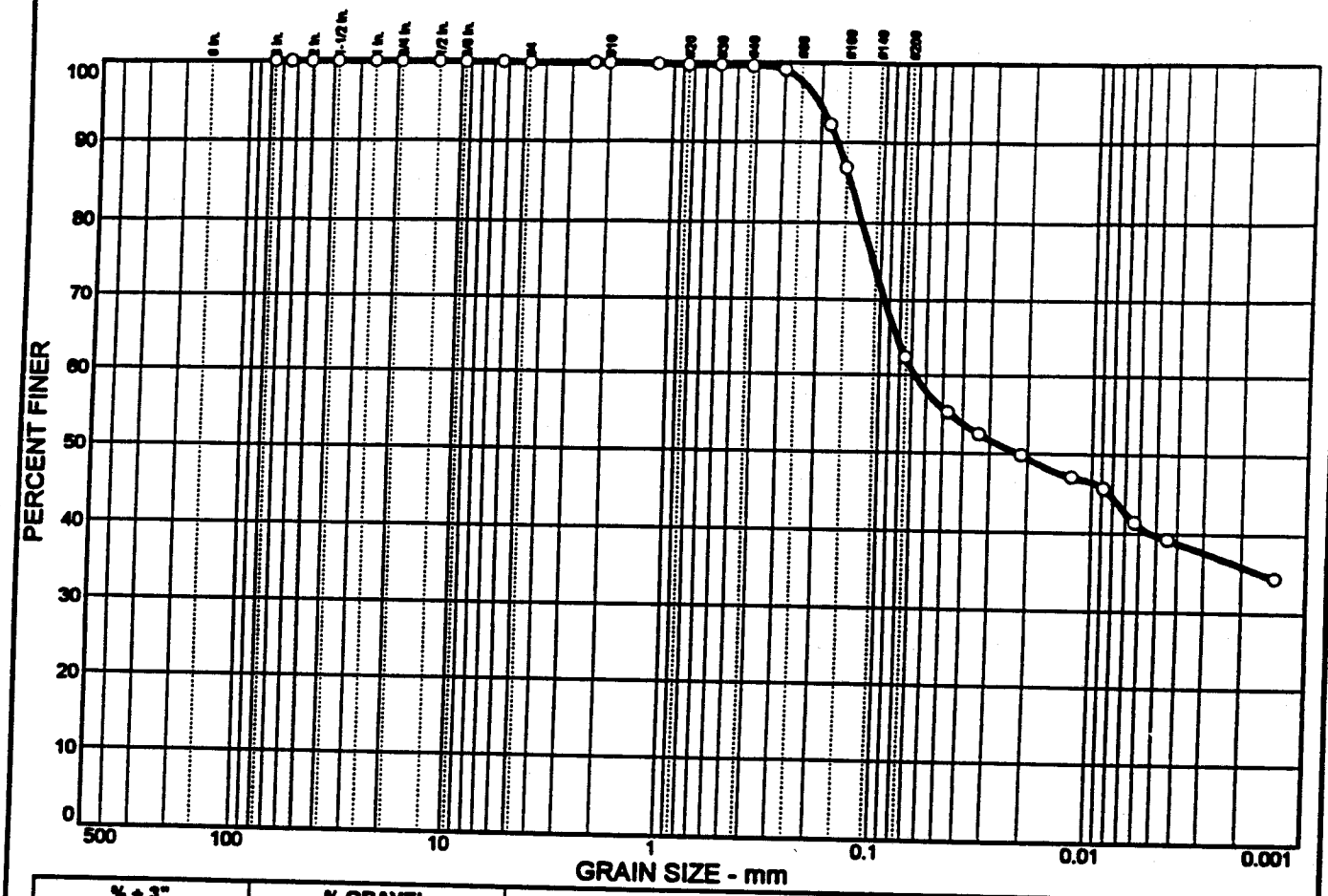
Remarks

Sample No.:
Location:
Source of Sample: TP-22
Date: 11/4/98
Elev./Depth: 3-4'

RMT, Inc.

Client:
Project: WEYERHAEUSER
Project No: 5101.02
Figure:

GRAIN SIZE DISTRIBUTION TEST REPORT (ASTM D422)



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	37.5	22.6	39.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0 in.	100.0		
2.5 in.	100.0		
2.0 in.	100.0		
1.5 in.	100.0		
1.0 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
.25 in.	100.0		
#4	99.9		
#8	99.9		
#10	99.9		
#16	99.8		
#20	99.7		
#30	99.7		
#40	99.6		
#50	99.1		
#80	92.2		
#100	86.9		
#200	62.4		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.142 D_{60}= 0.0674 D_{50}= 0.0222
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample No.:
Location:

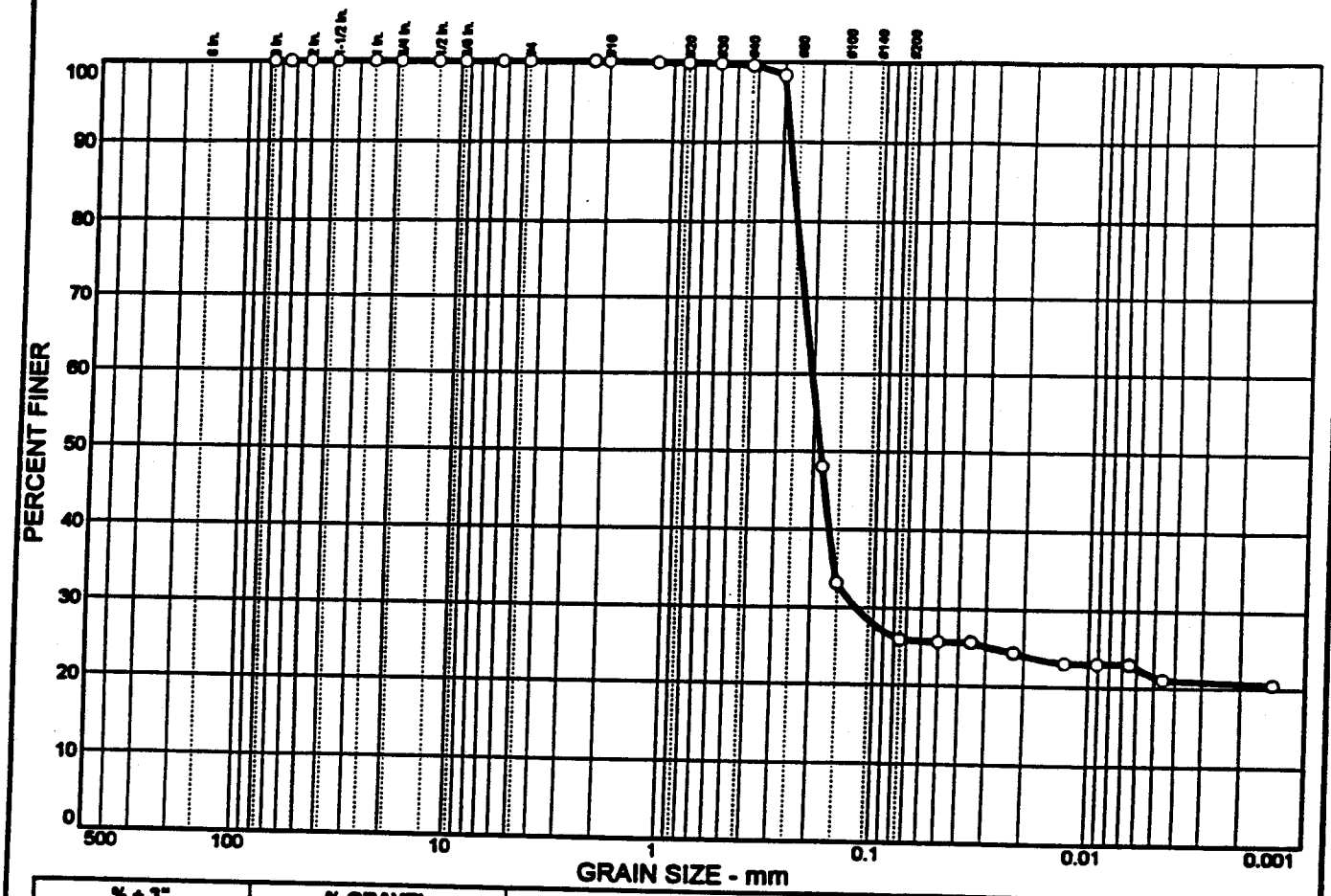
Source of Sample: TP-22

Date: 11/4/98
Elev./Depth: 8.5-9.5'

RMT, Inc.

Client:
Project: WEYERHAEUSER
Project No: 5101.02
Figure:

GRAIN SIZE DISTRIBUTION TEST REPORT (ASTM D422)



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	74.1	4.4	21.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0 in.	100.0		
2.5 in.	100.0		
2.0 in.	100.0		
1.5 in.	100.0		
1.0 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
.25 in.	100.0		
#4	100.0		
#8	100.0		
#10	100.0		
#16	99.9		
#20	99.9		
#30	99.8		
#40	99.6		
#50	98.3		
#80	48.0		
#100	33.1		
#200	25.9		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.263 D_{60}= 0.204 D_{50}= 0.184
D_{30}= 0.121 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample No.:
Location:

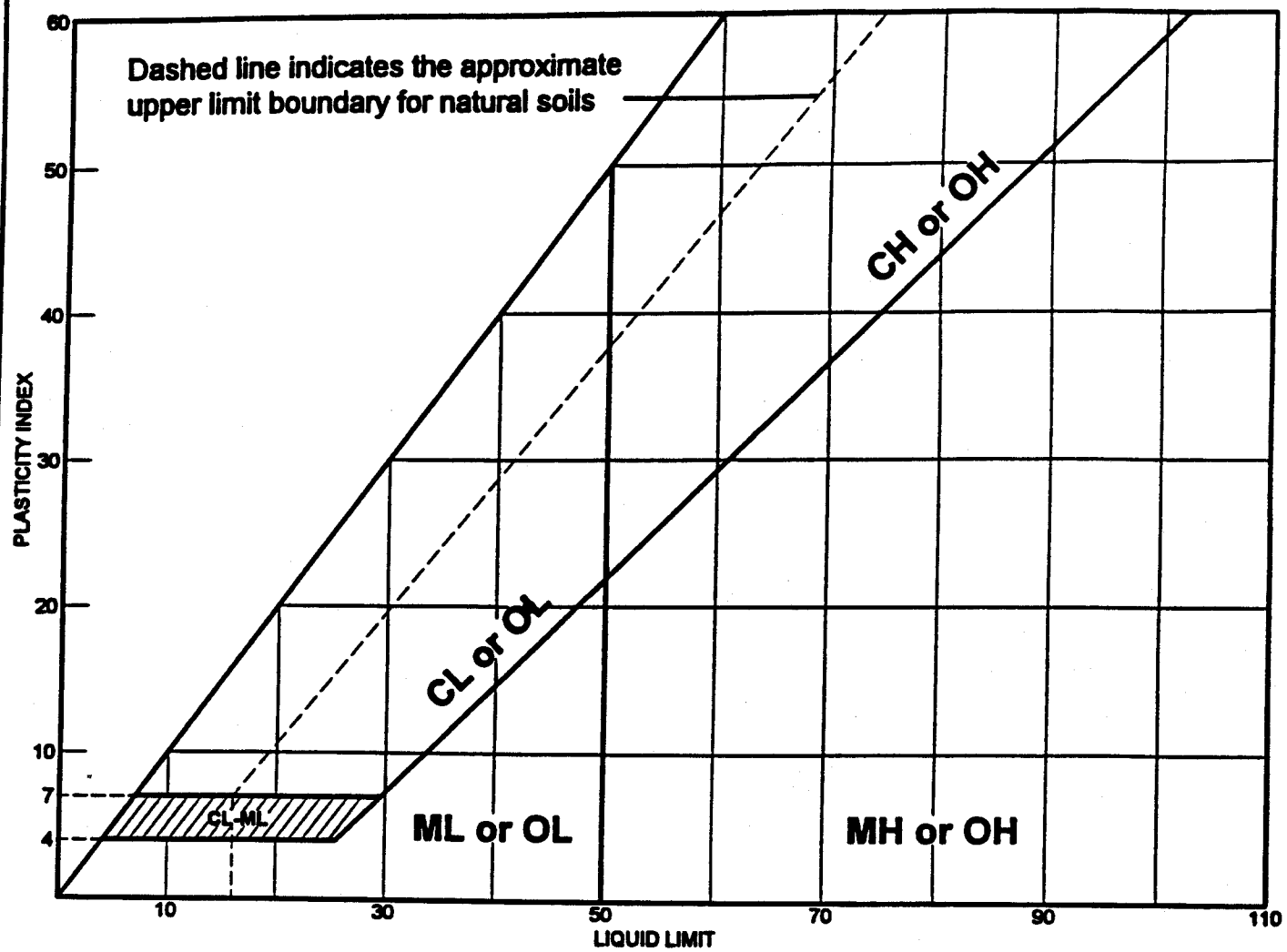
Source of Sample: TP-25

Date: 11/4/98
Elev./Depth: 5.5'

RMT, Inc.

Client:
Project: WEYERHAEUSER
Project No: 5101.02
Figure:

LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Lean clay with sand	43	23	20	96.7	78.9	CL

Project No. 5101.02 **Client:**

Project: WEYERHAEUSER

● **Source:** TP-8 **Elev./Depth:** 10.5-11'

Remarks:

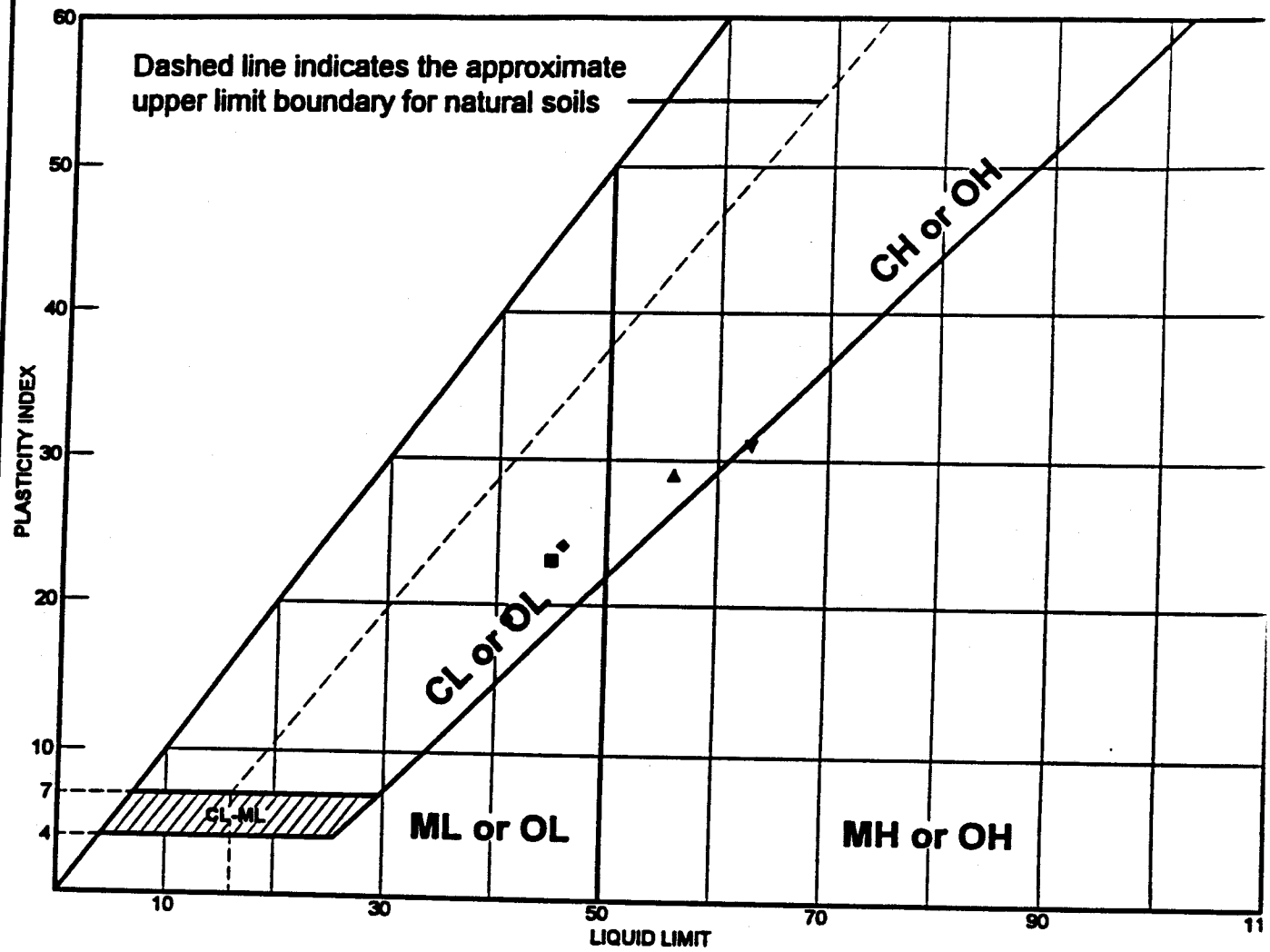
●

LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)

RMT, Inc.

Figure:

LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		41	22	19			
■		45	22	23			
▲		56	27	29			
◆		46	22	24			
▼		63	32	31			

Project No. 5101.02 **Client:**

Project: WEYERHAEUSER

● **Source:** TP-2 **Elev./Depth:** 0.5'
■ **Source:** TP-5 **Elev./Depth:** 0.5-3'
▲ **Source:** TP-5 **Elev./Depth:** 7-11'
◆ **Source:** TP-6 **Elev./Depth:** 2-5'
▼ **Source:** TP-6 **Elev./Depth:** 7-8.5'

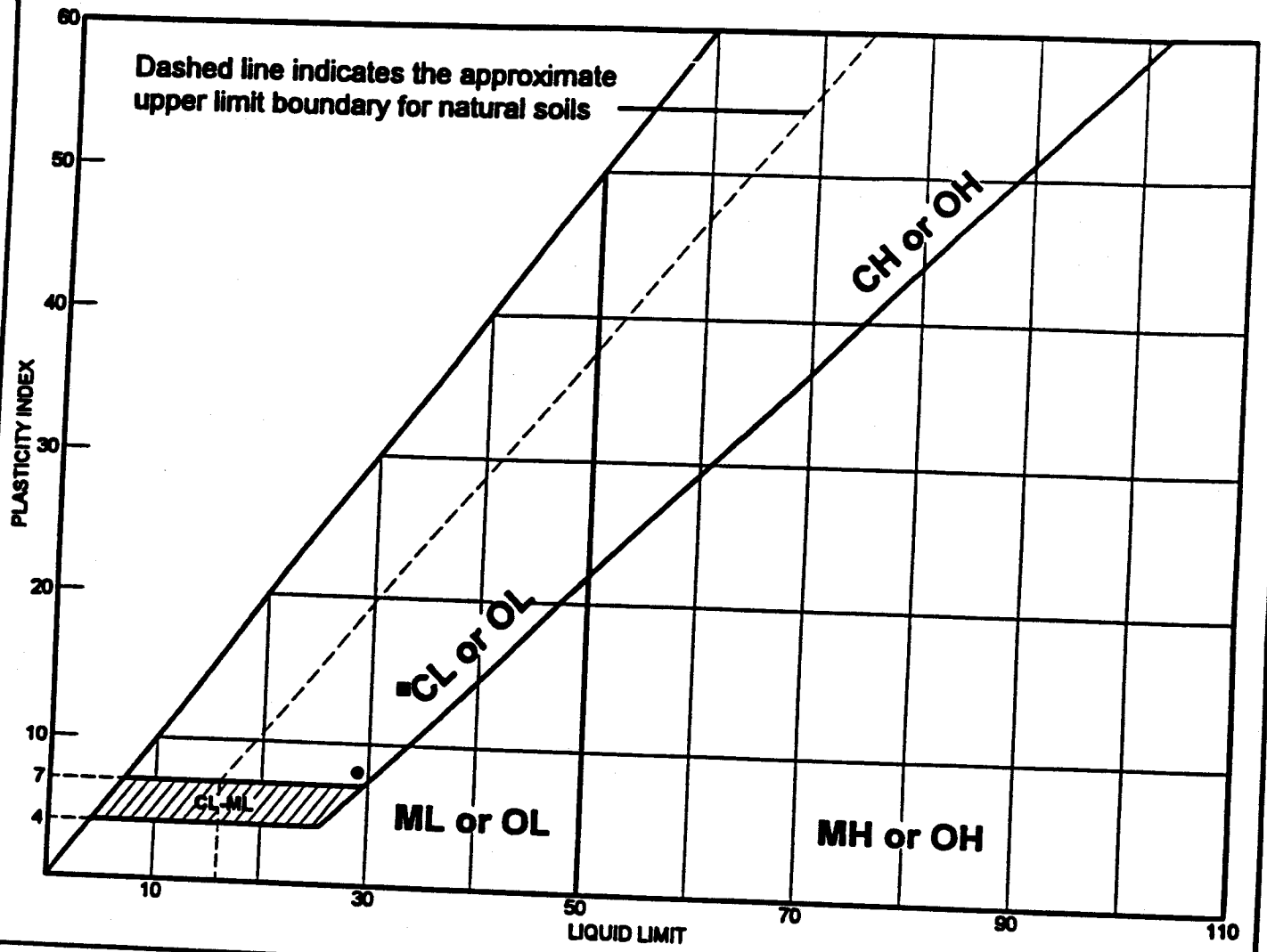
Remarks:
●
■
▲
◆
▼

LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)

RMT, Inc.

Figure:

LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		29	21	8		36.3	
■		33	19	14		37.6	

Project No. 5101.02 **Client:**

Project: WEYERHAEUSER

● **Source:** TP-3 **Elev./Depth:** 1-6'

■ **Source:** TP-18 **Elev./Depth:** 3-8'

Remarks:

●

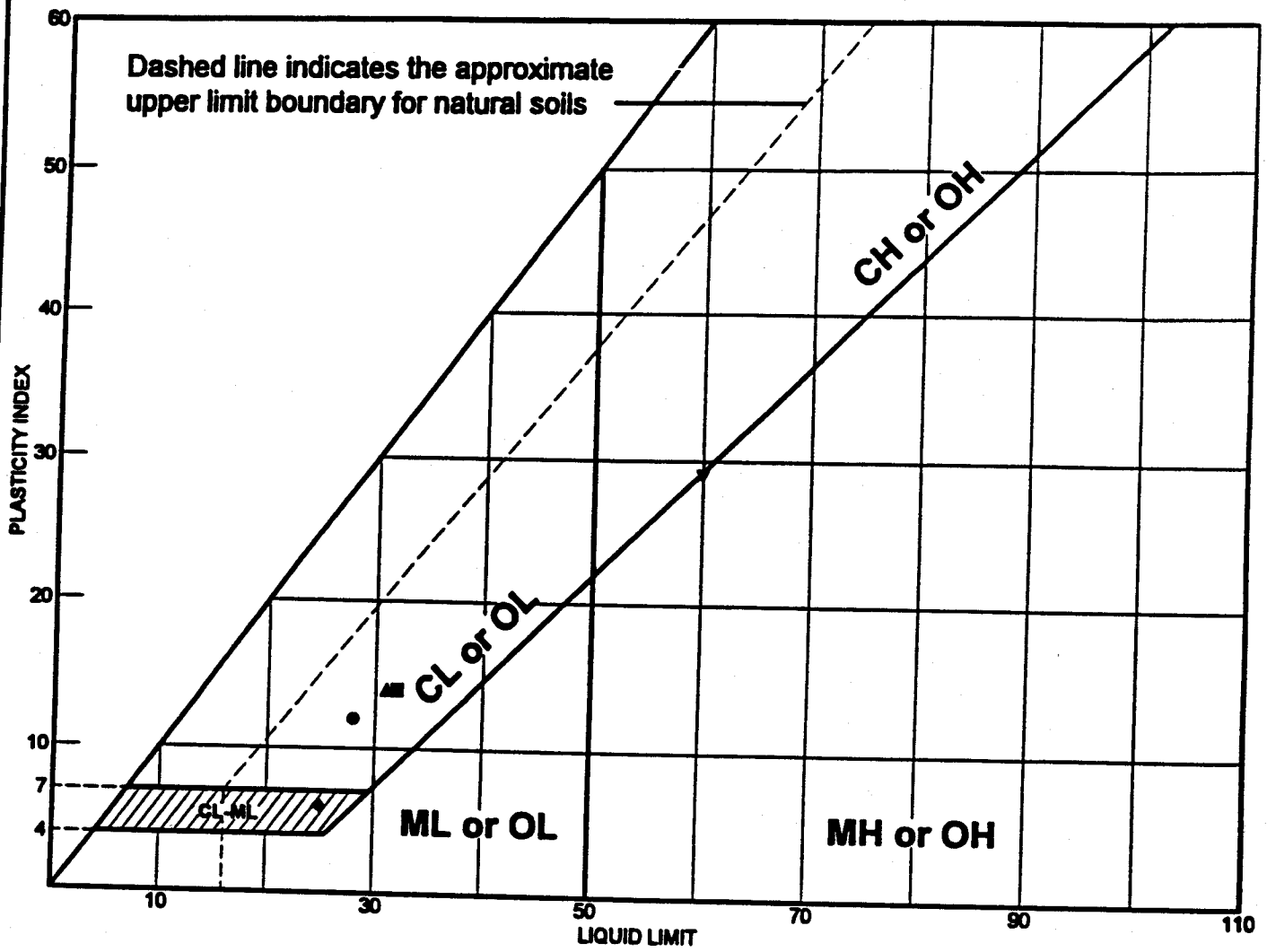
■

LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)

RMT, Inc.

Figure:

LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		28	16	12			
■		32	18	14			
▲		31	17	14			
◆		25	19	6			
▼		60	31	29			

Project No. 5101.02 **Client:**

Project: WEYERHAEUSER

● **Source:** TP-12 **Elev./Depth:** 4.5'
■ **Source:** TP-13 **Elev./Depth:** 5'
▲ **Source:** TP-19 **Elev./Depth:** 1.5-2.5'
◆ **Source:** TP-21 **Elev./Depth:** 2.5-6.5'
▼ **Source:** TP-25 **Elev./Depth:** 2-3.5'

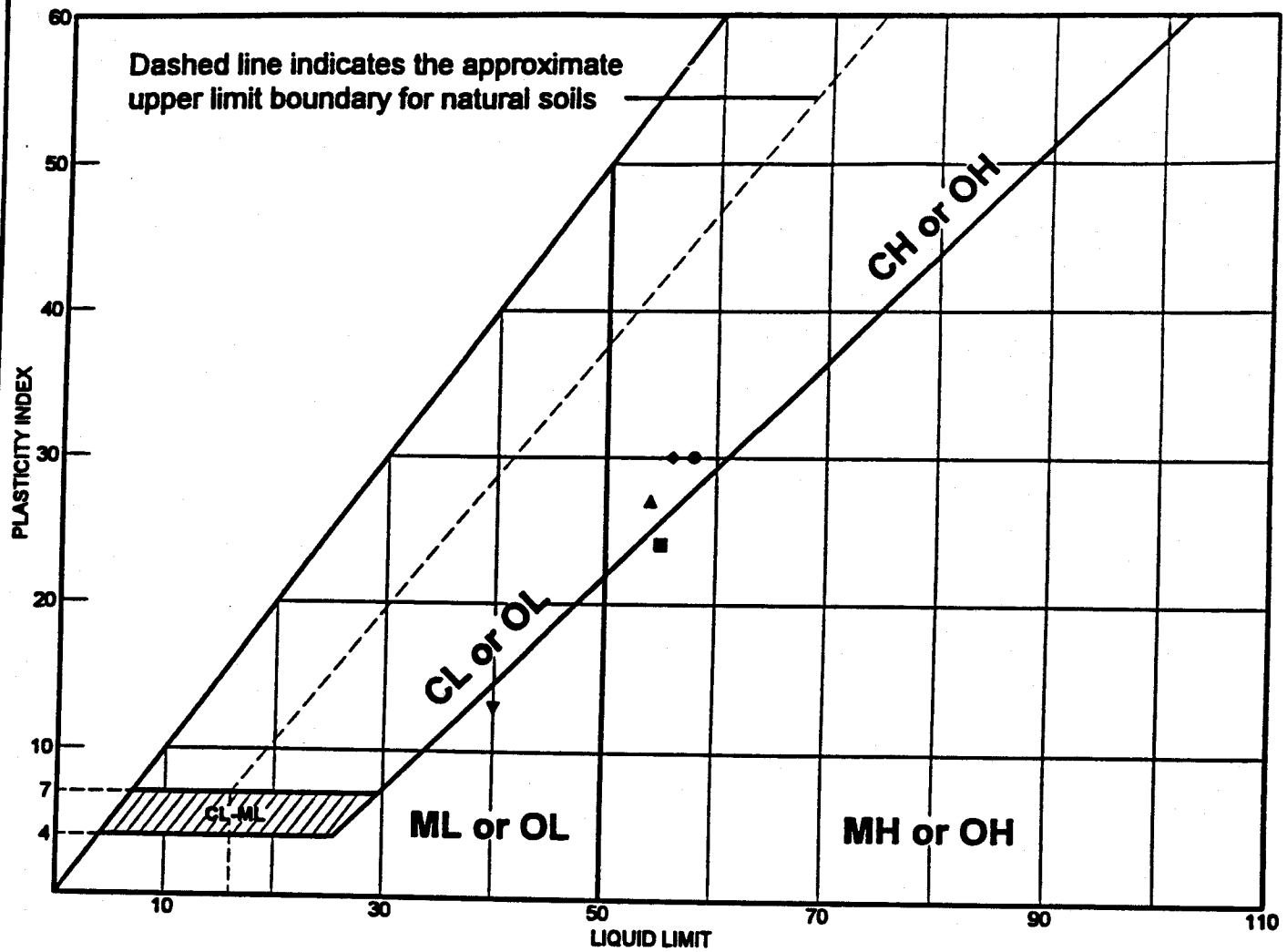
Remarks:
●
■
▲
◆
▼

LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)

RMT, Inc.

Figure:

LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Fat clay with sand	58	28	30	99.5	75.0	CH
■	Elastic silt	55	31	24	99.2	87.6	MH
▲	Fat clay with sand	54	27	27	99.3	84.2	CH
◆	Sandy fat clay	56	26	30	99.6	66.9	CH
▼	Clayey sand	40	27	13	99.7	48.7	SC

Project No. 5101.02 **Client:**

Project: WEYERHAEUSER

● **Source:** TP-4 **Elev./Depth:** 8"-5.0'
■ **Source:** TP-4 **Elev./Depth:** 10-11'
▲ **Source:** TP-7 **Elev./Depth:** 8-10'
◆ **Source:** TP-9 **Elev./Depth:** 1.5-6'
▼ **Source:** TP-13 **Elev./Depth:** 2-5'

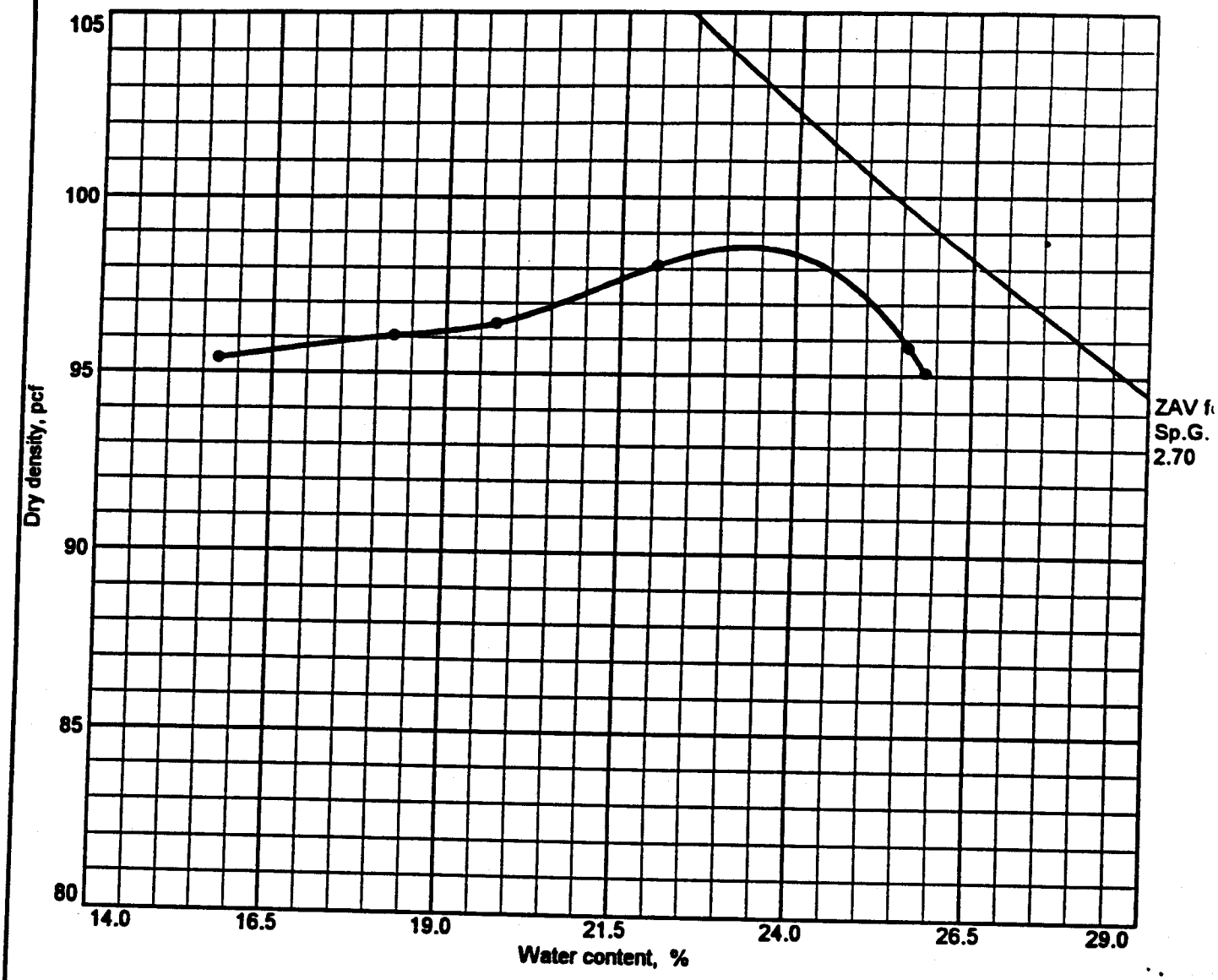
Remarks:
●
■
▲
◆
▼

LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)

RMT, Inc.

Figure:

COMPACTION TEST REPORT (ASTM D698 or D1557)



Test specification: ASTM D 698-91 Procedure A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
8"-5.0'	CH		25.3		58	30	0.0	75.0

TEST RESULTS

Maximum dry density = 98.6 pcf

Optimum moisture = 23.3 %

MATERIAL DESCRIPTION

Fat clay with sand

Project No. 5101.02 **Client:**

Project: WEYERHAEUSER

● **Source:** TP-4 **Elev./Depth:** 8"-5.0'

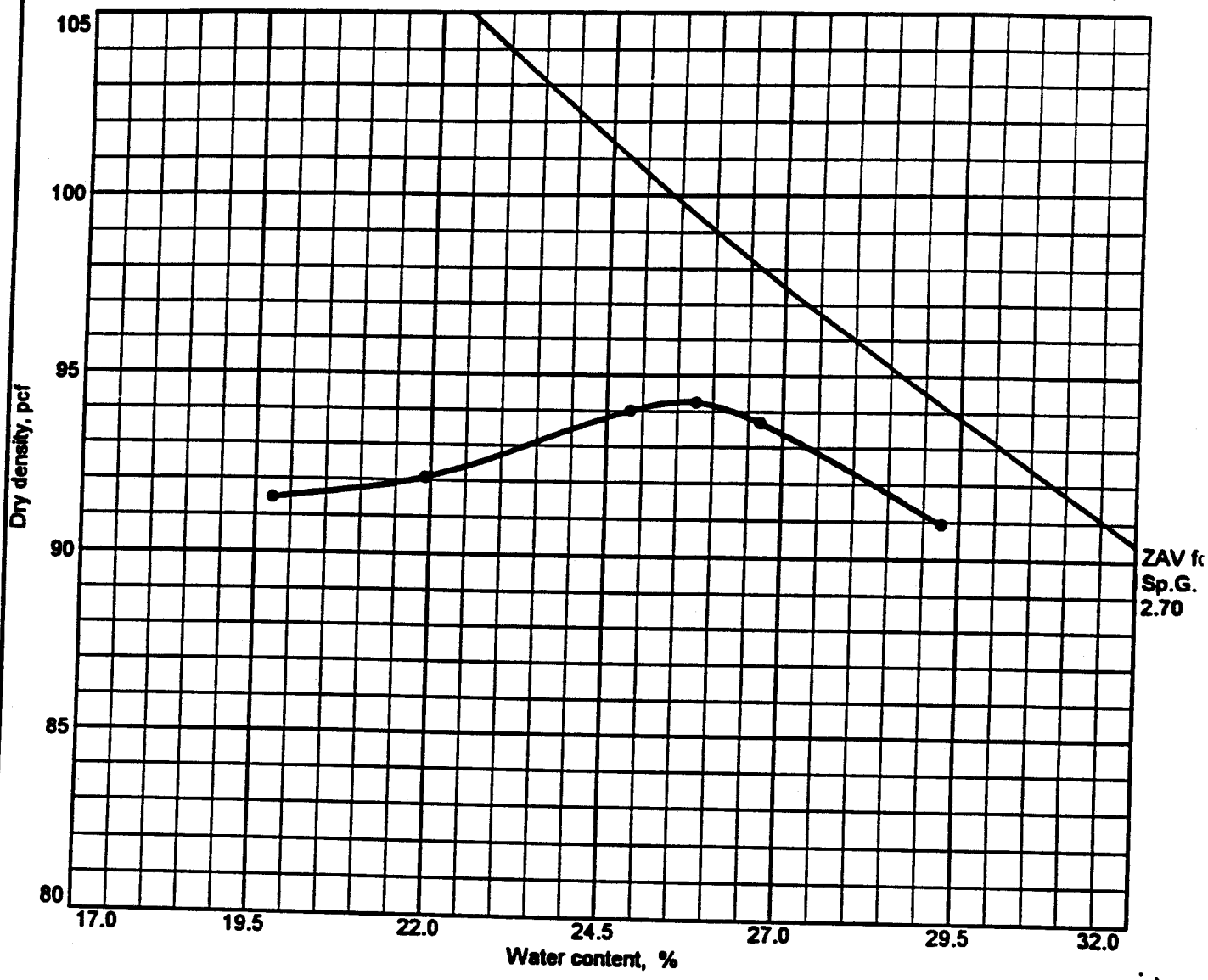
Remarks:

COMPACTION TEST REPORT (ASTM D698 or D1557)

RMT, Inc.

Figure:

COMPACTION TEST REPORT (ASTM D698 or D1557)



Test specification: ASTM D 698-91 Procedure A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
10-11'	MH		41.0		55	24	0.0	87.6

TEST RESULTS

Maximum dry density = 94.3 pcf

Optimum moisture = 25.6 %

MATERIAL DESCRIPTION

Elastic silt

Project No. 5101.02 **Client:**

Project: WEYERHAEUSER

Source: TP-4 **Elev./Depth:** 10-11'

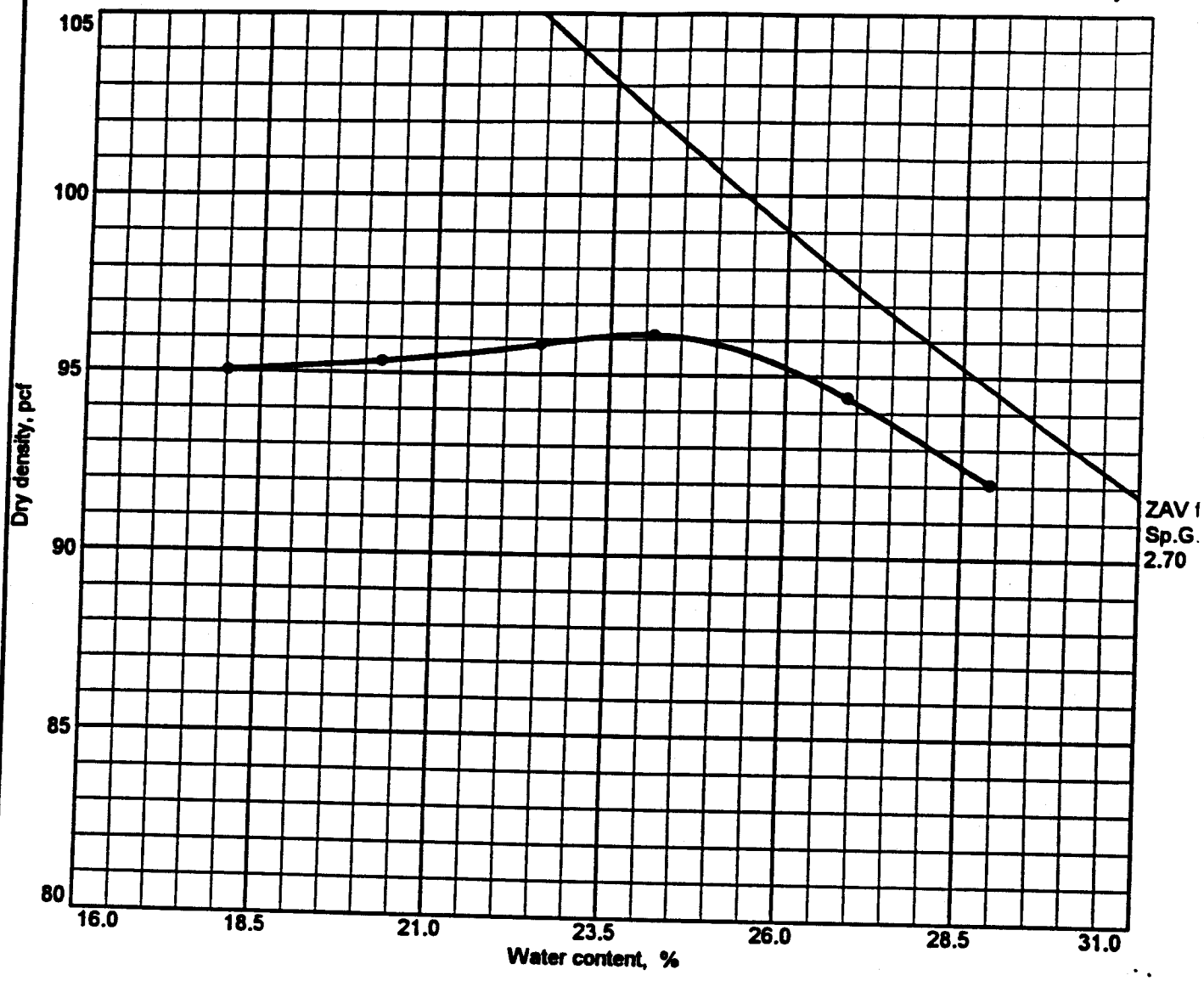
Remarks:

COMPACTION TEST REPORT (ASTM D698 or D1557)

RMT, Inc.

Figure:

COMPACTION TEST REPORT (ASTM D698 or D1557)



Test specification: ASTM D 698-91 Procedure A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
8-10'	CH		27.3		54	27	0.0	84.2

TEST RESULTS

Maximum dry density = 96.1 pcf

Optimum moisture = 24.0 %

MATERIAL DESCRIPTION

Fat clay with sand

Project No. 5101.02 **Client:**

Project: WEYERHAEUSER

Source: TP-7 **Elev./Depth:** 8-10'

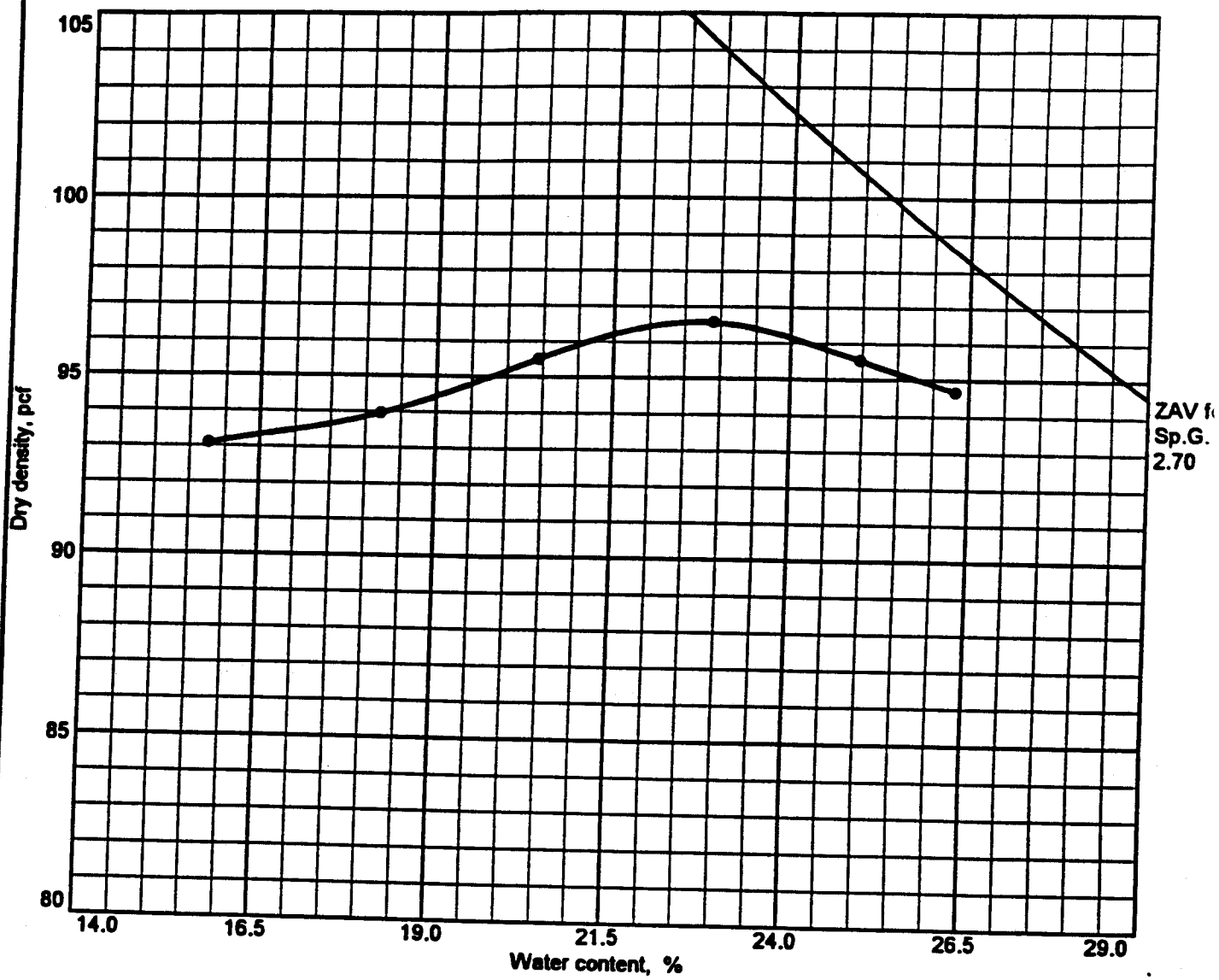
Remarks:

COMPACTION TEST REPORT (ASTM D698 or D1557)

RMT, Inc.

Figure:

COMPACTION TEST REPORT (ASTM D698 or D1557)



Test specification: ASTM D 698-91 Procedure A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
1.5-6'	CH		22.8		56	30	0.0	66.9

TEST RESULTS

Maximum dry density = 96.6 pcf

Optimum moisture = 22.7 %

MATERIAL DESCRIPTION

Sandy fat clay

Project No. 5101.02 **Client:**

Project: WEYERHAEUSER

Source: TP-9 **Elev./Depth:** 1.5-6'

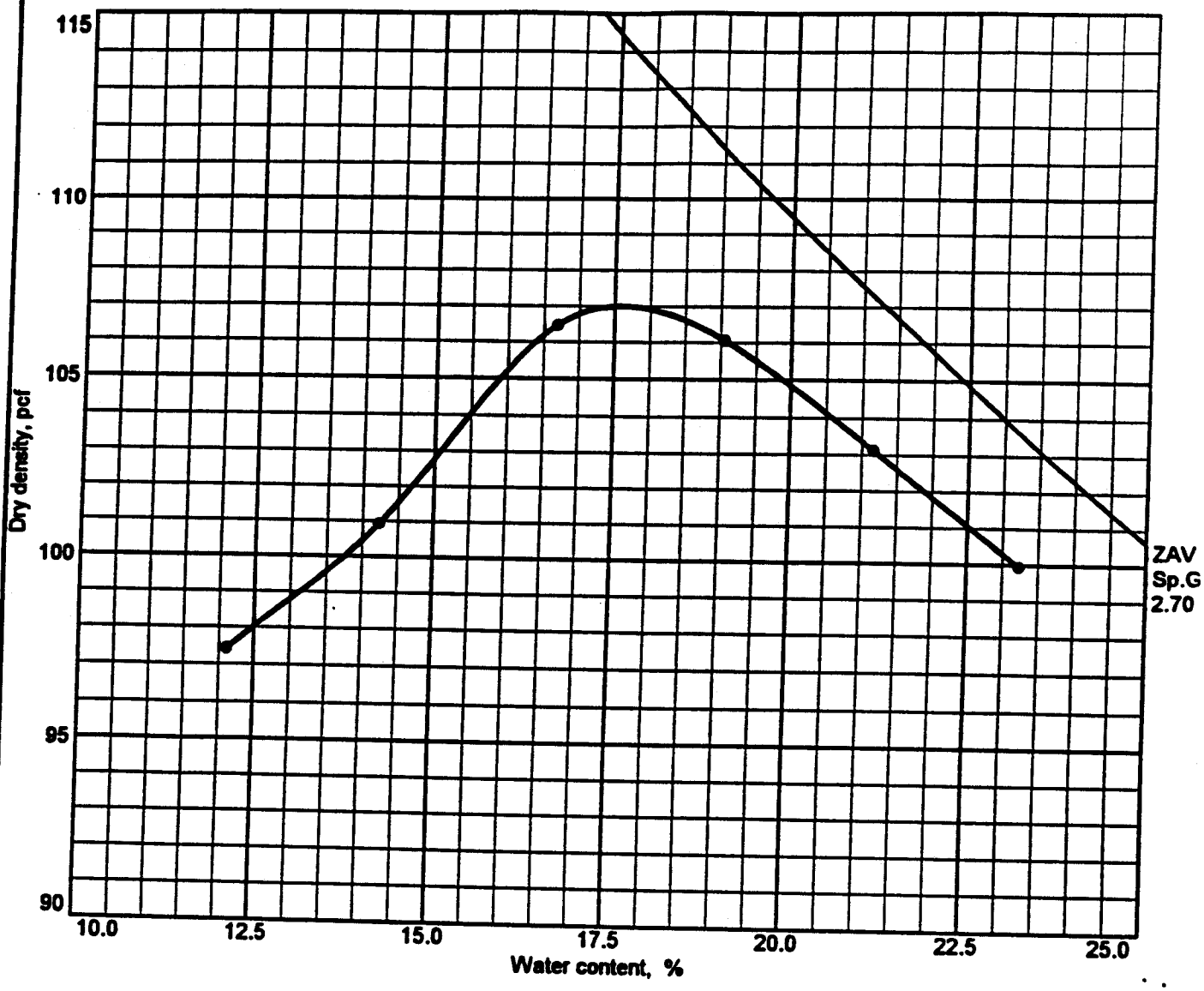
Remarks:

COMPACTION TEST REPORT (ASTM D698 or D1557)

RMT, Inc.

Figure:

COMPACTION TEST REPORT (ASTM D698 or D1557)



Test specification: ASTM D 698-91 Procedure A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
2-5'	SC		20.3		40	13	0.0	48.7

TEST RESULTS

Maximum dry density = 107.0 pcf

Optimum moisture = 17.6 %

MATERIAL DESCRIPTION

Clayey sand

Project No. 5101.02 **Client:**

Project: WEYERHAEUSER

Source: TP-13 **Elev./Depth:** 2-5'

Remarks:

COMPACTION TEST REPORT (ASTM D698 or D1557)

RMT, Inc.

Figure:

RMT, Inc.

Falling Head Permeability Test

QC: [illegible]

QA: [illegible]

Project Name:	WEYERHAEUSER	Cell #:	
Project #:	5101.02	USCS Description:	Fat clay with san
Sample Name:	TP-4, 8'-5.0'	USCS Classification:	C
Visual Descript:	Fat clay with sand	Average Kv =	9.6E-09 cm/se

Sample Type: Remolded	Initial Values	Final Values		
Sample Dia. (in)	2.87	2.87	Maximum Proctor Density:	98.6
Sample Ht. (in)	2.30	2.28	Optimum Moisture Content:	23.3
Tare & Wet (g)	458.00	750.60	Permeant:	Water
Tare & Dry (g)	365.56	644.60	Permeant Specific Gravity:	1.00
Tare (g)	0.00	276.89	Sample Specific Gravity:	2.67
Sample Wt. (g)	458.00	473.71	Confining Pressure (psi):	100.0
			Burette Diameter (in):	0.250
			Burette Zero (cm):	100.0
% of Proctor Density:	94.9%	96.3%		
% (+/-) of Optimum Moisture Content:	2.0%	5.5%		
Moisture (%)	25.3	28.8	Maximum Gradient:	
Wet Density (pcf)	117.3	122.4	Average Gradient:	
Dry Density (pcf)	93.6	95.0	Max. Effect. Stress (psi):	6.3
Saturation (%)	86.6	102.0	Min. Effect. Stress (psi):	4.9
			Ave. Effect. Stress (psi):	5.4

	Date Yr.	Mo.	Day	Time Hr.	Min.	Run Time	Temp C***	Pressure (psi) Bot	Top	Cham	Cham. Dif.	Bot	Bot. Dif.	Top	Top Dif.	Flow Dif.%	Kv *** cm/sec	Ave.* 0.1
1	98	11	12	4	57.00		0.0	95	95	5.15		21.95		99.05				
2	98	11	12	7	0.00	7380	21.0	95	95	28.90	23.75	22.05	0.10	98.35	0.70	-75.0	3.0E-08	
3	98	11	12	8	53.00	6780	21.5	95	95	30.90	2.00	22.30	0.25	98.30	0.05	66.7	1.2E-08	
4	98	11	12	10	54.00	7260	21.5	95	95	31.30	0.40	22.55	0.25	98.15	0.15	25.0	1.6E-08	
5	98	11	12	12	54.00	7200	21.5	95	95	31.70	0.40	22.80	0.25	98.05	0.10	42.9	1.4E-08	
6	98	11	12	14	54.00	7200	22.0	95	95	32.00	0.30	23.00	0.20	97.85	0.20	0.0	1.5E-08	
7	98	11	12	16	20.00	5160	22.0	95	95	32.10	0.10	23.15	0.15	97.80	0.05	50.0	1.1E-08	
8	98	11	13	4	47.00	44820	20.0	95	95	32.10	0.00	24.35	1.20	97.05	0.75	23.1	1.3E-08	
9	98	11	13	6	46.00	7140	20.5	95	95	32.35	0.25	24.55	0.20	96.90	0.15	14.3	1.5E-08	
10	98	11	13	8	55.00	7740	21.0	95	95	32.90	0.55	24.80	0.25	96.80	0.10	42.9	1.3E-08	
11	98	11	13	10	58.00	7380	21.5	95	95	33.15	0.25	25.00	0.20	96.70	0.10	33.3	1.2E-08	
12	98	11	13	12	50.00	6720	22.0	95	95	33.45	0.30	25.15	0.15	96.55	0.15	0.0	1.3E-08	
13	98	11	13	16	22.00	12720	22.5	95	95	33.80	0.35	25.50	0.35	96.40	0.15	40.0	1.2E-08	
14	98	11	16	6	45.00	224580	20.0	95	95	35.30	1.50	29.90	4.40	93.25	3.15	16.6	1.1E-08	
15	98	11	16	8	45.00	7200	21.0	95	95	35.80	0.50	30.05	0.15	93.20	0.05	50.0	9.4E-09	
16	98	11	16	10	14.00	5340	21.5	95	95	36.10	0.30	30.20	0.15	93.15	0.05	50.0	1.3E-08	
17	98	11	16	11	11.00		0.0	95	95	36.50		30.40		93.25				
18	98	11	16	13	11.00	7200	21.5	95	95	36.40	-0.10	30.70	0.30	93.20	0.05	71.4	1.7E-08	
19	98	11	16	15	12.00	7260	21.5	95	95	36.40	0.00	30.85	0.15	93.05	0.15	0.0	1.4E-08	
20	98	11	16	16	52.00	6000	21.5	95	95	36.00	-0.40	30.95	0.10	93.00	0.05	33.3	8.6E-09	
21	98	11	17	7	19.00	52020	20.5	95	95	36.00	0.00	31.95	1.00	92.25	0.75	14.3	1.2E-08	
22	98	11	17	9	21.00	7320	21.0	95	95	36.40	0.40	32.15	0.20	92.20	0.05	60.0	1.2E-08	
23	98	11	17	11	27.00	7560	21.5	95	95	36.75	0.35	32.30	0.15	92.15	0.05	50.0	9.5E-09	
24	98	11	17	13	38.00	7860	22.0	95	95	36.60	-0.15	32.45	0.15	91.95	0.20	-14.3	1.6E-08	
25	98	11	17	16	25.00	10020	22.0	95	95	36.60	0.00	32.55	0.10	91.80	0.15	-20.0	8.8E-09	
26	98	11	18	5	59.00	48840	20.5	95	95	36.10	-0.50	33.40	0.85	91.05	0.75	6.3	1.2E-08	

**A zero in this column starts a series of measurements.

(Termination determined by stable Kv and low flow differential.)

*Average Kv for those rows with a 1 in the Ave. column.

***Kv adjusted for temperature.

RMT, Inc.

Falling Head Permeability Test

QC: KLW

QA: [illegible]

Project Name:	WEYERHAEUSER	Cell #:	1
Project #:	5101.02	USCS Description:	Fat clay with san
Sample Name:	TP-4, 8'-5.0'	USCS Classification:	CH
Visual Descript:	Fat clay with sand		

Sample Type:	Remolded	Initial Values	Final Values	Maximum Proctor Density:	98.6	
				Optimum Moisture Content:	23.3	
Sample Dia. (in)		2.87	2.87	Permeant:	Water	
Sample Ht. (in)		2.30	2.28	Permeant Specific Gravity:	1.00	
Tare & Wet (g)		458.00	750.60	Sample Specific Gravity:	2.67	Est
Tare & Dry (g)		365.56	644.60	Confining Pressure (psi):	100.0	
Tare (g)		0.00	276.89	Burette Diameter (in):	0.250	
Sample Wt. (g)		458.00	473.71	Burette Zero (cm):	100.0	
% of Proctor Density:		94.9%	96.3%			
% (+/-) of Optimum Moisture Content:		2.0%	5.5%			
Moisture (%)		25.3	28.8	Maximum Gradient:	9.8	
Wet Density (pcf)		117.3	122.4	Average Gradient:	9.6	
Dry Density (pcf)		93.6	95.0	Max. Effect. Stress (psi):	6.2	
Saturation (%)		86.6	102.0	Min. Effect. Stress (psi):	4.9	
				Ave. Effect. Stress (psi):	5.4	

	Date Yr.	Mo.	Day	Time Hr.	Min.	Run Time	Temp C***	Pressure (psi) Bot	Top	Cham	Cham. Dif.	Bot	Bot Dif.	Top	Top Dif.	Flow Dif.%	Kv *** cm/sec	Ave.* 0,1
1	98	11	18	5	59.00		0.0	95	95	36.10		33.40		91.05				
2	98	11	18	8	2.00	7380	21.0	95	95	36.75	0.65	33.55	0.15	91.05	0.00	100.0	7.6E-09	
3	98	11	18	10	2.00	7200	21.5	95	95	37.20	0.45	33.70	0.15	91.00	0.05	50.0	1.0E-08	
4	98	11	18	12	7.00	7500	22.5	95	95	37.80	0.60	33.80	0.10	90.95	0.05	33.3	7.3E-09	
5	98	11	18	14	6.00	7140	23.5	95	95	3.15	-34.65	33.90	0.10	90.80	0.15	-20.0	1.3E-08	
6	98	11	18	16	12.00	7560	23.0	95	95	37.75	34.60	34.05	0.15	90.75	0.05	50.0	9.5E-09	
7	98	11	19	6	29.00	51420	20.5	95	95	36.50	-1.25	34.80	0.75	90.05	0.70	3.4	1.1E-08	1
8	98	11	19	8	45.00	8160	21.0	95	95	37.05	0.55	34.90	0.10	89.95	0.10	0.0	9.5E-09	1
9	98	11	19	10	29.00	6240	21.0	95	95	37.05	0.00	35.00	0.10	89.90	0.05	33.3	9.4E-09	1
10	98	11	19	12	29.00		0.0	95	95	37.20		35.20		89.85				
11	98	11	19	14	28.00	7140	21.0	95	95	37.10	-0.10	35.30	0.10	89.80	0.05	33.3	8.3E-09	1
12																		
13																		
14																		
15																		
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17																		
18																		
19																		
20																		
21																		
22																		
23																		
24																		
25																		
26																		

**A zero in this column starts a series of measurements.
(Termination determined by stable Kv and low flow differential.)

*Average Kv for those rows with a 1 in the Ave. column. 9.6E-09 cm/sec

***Kv adjusted for temperature.

RMT, Inc.

Falling Head Permeability Test

QC: KJG
QA: [illegible]

Project Name:	WEYERHAEUSER	Cell #:	2
Project #:	5101.02	USCS Description:	Elastic silt
Sample Name:	TP-4, 10-11'	USCS Classification:	MH
Visual Descript:	Elastic silt	Average Kv =	1.2E-08 cm/sec

Sample Type: Remolded	Initial Values	Final Values		
			Maximum Proctor Density:	94.3
			Optimum Moisture Content:	25.6
Sample Dia. (in)	2.87	2.87	Permeant:	Water
Sample Ht. (in)	2.30	2.29	Permeant Specific Gravity:	1.00
Tare & Wet (g)	445.95	730.20	Sample Specific Gravity:	2.65 Est.
Tare & Dry (g)	349.49	618.60	Confining Pressure (psi):	100.0
Tare (g)	0.00	267.33	Burette Diameter (in):	0.250
Sample Wt. (g)	445.95	462.87	Burette Zero (cm):	100.0
% of Proctor Density:	94.9%	95.8%		
% (+/-) of Optimum Moisture Content	2.0%	6.2%		
Moisture (%)	27.6	31.8	Maximum Gradient:	
Wet Density (pcf)	114.2	119.0	Average Gradient:	
Dry Density (pcf)	89.5	90.3	Max. Effect. Stress (psi):	6.2
Saturation (%)	86.3	101.4	Min. Effect. Stress (psi):	5.1
			Ave. Effect. Stress (psi):	5.6

	Date			Time		Run	Temp	Pressure (psi)			Cham.		Bot.		Top		Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time	C***	Bot	Top	Cham	Dif.	Bot	Dif.	Top	Dif.	Dif.%	cm/sec	0,1
1	98	11	12	4	58.00		0.0	95	95	13.10		18.85		96.80				
2	98	11	12	7	1.00	7380	21.0	95	95	13.95	0.85	19.15	0.30	96.40	0.40	-14.3	2.6E-08	
3	98	11	12	8	54.00	6780	21.5	95	95	14.10	0.15	19.45	0.30	96.35	0.05	71.4	1.4E-08	
4	98	11	12	10	55.00	7260	21.5	95	95	14.50	0.40	19.70	0.25	96.25	0.10	42.9	1.4E-08	
5	98	11	12	12	55.00	7200	22.0	95	95	14.70	0.20	20.10	0.40	96.15	0.10	60.0	1.9E-08	
6	98	11	12	14	55.00	7200	22.0	95	95	14.85	0.15	20.35	0.25	96.00	0.15	25.0	1.5E-08	
7	98	11	12	16	22.00	5220	22.0	95	95	14.90	0.05	20.45	0.10	95.90	0.10	0.0	1.1E-08	
8	98	11	13	4	48.00	44760	20.0	95	95	14.90	0.00	22.15	1.70	95.05	0.85	33.3	1.7E-08	
9	98	11	13	6	47.00	7140	20.5	95	95	15.15	0.25	22.40	0.25	94.85	0.20	11.1	1.9E-08	
10	98	11	13	8	58.00	7860	21.0	95	95	15.10	-0.05	22.65	0.25	94.75	0.10	42.9	1.3E-08	
11	98	11	13	10	59.00	7260	21.5	95	95	15.80	0.70	22.90	0.25	94.60	0.15	25.0	1.7E-08	
12	98	11	13	12	51.00	6720	22.0	95	95	16.15	0.35	23.15	0.25	94.55	0.05	66.7	1.3E-08	
13	98	11	13	16	24.00	12780	22.5	95	95	16.30	0.15	23.55	0.40	94.25	0.30	14.3	1.6E-08	
14	98	11	16	6	45.00	224460	20.0	95	95	17.85	1.55	29.75	6.20	89.85	4.40	17.0	1.6E-08	
15	98	11	16	8	46.00	7260	21.0	95	95	18.25	0.40	29.95	0.20	89.70	0.15	14.3	1.7E-08	
16	98	11	16	10	15.00	5340	21.5	95	95	18.55	0.30	30.10	0.15	89.65	0.05	50.0	1.4E-08	
17	98	11	16	11	12.00		0.0	95	95	18.90		30.15		89.60				
18	98	11	16	13	13.00	7260	21.5	95	95	18.80	-0.10	30.30	0.15	89.50	0.10	20.0	1.3E-08	
19	98	11	16	15	13.00	7200	21.5	95	95	18.70	-0.10	30.40	0.10	89.40	0.10	0.0	1.0E-08	
20	98	11	16	16	52.00	5940	21.5	95	95	18.40	-0.30	30.60	0.20	89.30	0.10	33.3	1.8E-08	
21	98	11	17	7	20.00	52080	20.5	95	95	18.65	0.25	31.70	1.10	88.50	0.80	15.8	1.4E-08	
22	98	11	17	9	22.00	7320	21.0	95	95	19.05	0.40	31.90	0.20	88.45	0.05	60.0	1.3E-08	
23	98	11	17	11	28.00	7560	21.5	95	95	19.20	0.15	32.05	0.15	88.40	0.05	50.0	1.0E-08	
24	98	11	17	13	39.00	7860	22.0	95	95	19.20	0.00	32.25	0.20	88.30	0.10	33.3	1.4E-08	
25	98	11	17	16	26.00	10020	22.0	95	95	19.00	-0.20	32.40	0.15	88.15	0.15	0.0	1.1E-08	
26	98	11	18	6	0.00	48840	20.5	95	95	18.90	-0.10	33.40	1.00	87.40	0.75	14.3	1.4E-08	

**A zero in this column starts a series of measurements.
(Termination determined by stable Kv and low flow differential.)

*Average Kv for those rows with a 1 in the Ave. column.

***Kv adjusted for temperature.

RMT, Inc.

Falling Head Permeability Test

QC: [illegible]

QA: [illegible]

Project Name:	WEYERHAEUSER	Cell #:	2
Project #:	5101.02	USCS Description:	Elastic silt
Sample Name:	TP-4, 10-11'	USCS Classification:	MH
Visual Descript:	Elastic silt		

Sample Type: Remolded	Initial Values	Final Values			
			Maximum Proctor Density:	94.3	
			Optimum Moisture Content:	25.6	
Sample Dia. (in)	2.87	2.87	Permeant:	Water	
Sample Ht. (in)	2.30	2.29	Permeant Specific Gravity:	1.00	
Tare & Wet (g)	445.95	730.20	Sample Specific Gravity:	2.65	Est.
Tare & Dry (g)	349.49	618.60	Confining Pressure (psi):	100.0	
Tare (g)	0.00	267.33	Burette Diameter (in):	0.250	
Sample Wt. (g)	445.95	462.87	Burette Zero (cm):	100.0	
% of Proctor Density:	94.9%	95.8%			
% (+/-) of Optimum Moisture Content:	2.0%	6.2%			
Moisture (%)	27.6	31.8	Maximum Gradient:	9.1	
Wet Density (pcf)	114.2	119.0	Average Gradient:	8.8	
Dry Density (pcf)	89.5	90.3	Max. Effect. Stress (psi):	6.0	
Saturation (%)	86.3	101.4	Min. Effect. Stress (psi):	5.2	
			Ave. Effect. Stress (psi):	5.6	

	Date			Time		Run	Temp	Pressure (psi)			Cham.		Bot.		Top	Flow		Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time	C***	Bot	Top	Cham	Dif.	Bot	Dif.	Top	Dif.	Dif.%		cm/sec	0,1
1	98	11	18	6	0.00		0.0	95	95	18.90		33.40		87.40					
2	98	11	18	8	4.00	7440	21.0	95	95	19.40	0.50	33.55	0.15	87.30	0.10	20.0		1.3E-08	
3	98	11	18	10	3.00	7140	21.5	95	95	19.80	0.40	33.75	0.20	87.25	0.05	60.0		1.4E-08	
4	98	11	18	12	8.00	7500	22.5	95	95	20.40	0.60	33.90	0.15	87.15	0.10	20.0		1.3E-08	
5	98	11	18	14	1.00	6780	23.5	95	95	20.50	0.10	34.00	0.10	87.10	0.05	33.3		8.5E-09	
6	98	11	18	16	13.00	7920	23.0	95	95	20.20	-0.30	34.15	0.15	86.95	0.15	0.0		1.5E-08	
7	98	11	19	6	30.00	51420	20.5	95	95	19.20	-1.00	35.10	0.95	86.05	0.90	2.7		1.5E-08	1
8	98	11	19	8	46.00	8160	21.0	95	95	19.65	0.45	35.20	0.10	85.95	0.10	0.0		1.0E-08	1
9	98	11	19	10	31.00		0.0	95	95	19.65		35.40		85.90					
10	98	11	19	12	31.00	7200	21.0	95	95	19.70	0.05	35.50	0.10	85.80	0.10	0.0		1.2E-08	1
11	98	11	19	14	29.00	7080	21.0	95	95	19.70	0.00	35.60	0.10	85.70	0.10	0.0		1.2E-08	1
12																			
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26																			

**A zero in this column starts a series of measurements.

(Termination determined by stable Kv and low flow differential.)

*Average Kv for those rows with a 1 in the Ave. column.

1.2E-08 cm/sec

***Kv adjusted for temperature.

RMT, Inc.

Falling Head Permeability Test

QC: NJW

QA: NB

Project Name:	WEYERHAEUSER	Cell #:	
Project #:	5101.02	USCS Description:	Fat clay with san
Sample Name:	TP-7, 8-10'	USCS Classification:	C
Visual Descript:	Fat clay with sand	Average Kv =	1.1E-08 cm/se

Sample Type: Remolded	Initial Values	Final Values		
Sample Dia. (in)	2.87	2.87	Maximum Proctor Density:	96.1
Sample Ht. (in)	2.30	2.27	Optimum Moisture Content:	24.0
Tare & Wet (g)	453.36	790.00	Permeant:	Water
Tare & Dry (g)	356.14	625.20	Permeant Specific Gravity:	1.00
Tare (g)	0.00	265.64	Sample Specific Gravity:	2.67
Sample Wt. (g)	453.36	464.36	Confining Pressure (psi):	100.0
			Burette Diameter (in):	0.250
			Burette Zero (cm):	100.0
% of Proctor Density:	94.9%	97.1%		
% (+/-) of Optimum Moisture Content:	3.3%	5.1%		
Moisture (%)	27.3	29.1	Maximum Gradient:	
Wet Density (pcf)	116.1	120.5	Average Gradient:	
Dry Density (pcf)	91.2	93.3	Max. Effect. Stress (psi):	6.0
Saturation (%)	88.1	99.0	Min. Effect. Stress (psi):	4.9
			Ave. Effect. Stress (psi):	5.4

	Date			Time		Run	Temp	Pressure (psi)			Chan.		Bot.		Top		Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time	C***	Bot	Top	Chan	Dif.	Bot	Dif.	Top	Dif.	Dif.%	cm/sec	0,1
1	98	11	12	4	58.00		0.0	95	95	20.00		16.65		93.35				
2	98	11	12	7	2.00	7440	21.0	95	95	21.60	1.60	16.85	0.20	92.85	0.50	-42.9	2.6E-08	
3	98	11	12	8	55.00	6780	21.5	95	95	21.30	-0.30	17.10	0.25	92.75	0.10	42.9	1.5E-08	
4	98	11	12	10	56.00	7260	21.5	95	95	21.50	0.20	17.30	0.20	92.65	0.10	33.3	1.2E-08	
5	98	11	12	12	56.00	7200	21.5	95	95	21.80	0.30	17.50	0.20	92.66	-0.01	110.5	7.5E-09	
6	98	11	12	14	56.00	7200	22.0	95	95	22.05	0.25	17.70	0.20	92.40	0.26	-13.0	1.8E-08	
7	98	11	12	16	23.00	5220	22.0	95	95	22.05	0.00	17.80	0.10	92.30	0.10	0.0	1.1E-08	
8	98	11	13	4	48.00	44700	20.0	95	95	22.15	0.10	18.90	1.10	91.60	0.70	22.2	1.2E-08	
9	98	11	13	6	48.00	7200	20.5	95	95	22.35	0.20	19.05	0.15	91.45	0.15	0.0	1.3E-08	
10	98	11	13	8	58.00	7800	21.0	95	95	22.80	0.45	19.25	0.20	91.40	0.05	60.0	9.5E-09	
11	98	11	13	11	0.00	7320	21.5	95	95	23.20	0.40	19.40	0.15	91.30	0.10	20.0	1.0E-08	
12	98	11	13	12	52.00	6720	22.0	95	95	23.60	0.40	19.55	0.15	91.15	0.15	0.0	1.3E-08	
13	98	11	13	16	25.00	12780	22.5	95	95	23.90	0.30	19.95	0.40	91.05	0.10	60.0	1.1E-08	
14	98	11	16	6	46.00	224460	20.0	95	95	25.75	1.85	24.20	4.25	87.55	3.50	9.7	1.1E-08	
15	98	11	16	8	47.00	7260	21.0	95	95	26.20	0.45	24.30	0.10	87.45	0.10	0.0	9.3E-09	
16	98	11	16	10	16.00	5340	21.5	95	95	26.50	0.30	24.45	0.15	87.40	0.05	50.0	1.3E-08	
17	98	11	16	11	13.00		0.0	95	95	26.60		24.60		87.45				
18	98	11	16	13	13.00	7200	21.5	95	95	26.55	-0.05	24.70	0.10	87.40	0.05	33.3	7.1E-09	
19	98	11	16	15	14.00	7260	21.5	95	95	26.50	-0.05	24.85	0.15	87.25	0.15	0.0	1.4E-08	
20	98	11	16	16	53.00	5940	21.5	95	95	26.10	-0.40	24.90	0.05	87.10	0.15	-50.0	1.2E-08	
21	98	11	17	7	20.00	52020	20.5	95	95	26.45	0.35	25.85	0.95	86.30	0.80	8.6	1.2E-08	
22	98	11	17	9	23.00	7380	21.0	95	95	26.85	0.40	26.00	0.15	86.25	0.05	50.0	9.6E-09	
23	98	11	17	11	29.00	7560	21.5	95	95	27.00	0.15	26.15	0.15	86.15	0.10	20.0	1.2E-08	
24	98	11	17	13	39.00	7800	22.0	95	95	27.00	0.00	26.30	0.15	86.05	0.10	20.0	1.1E-08	
25	98	11	17	16	26.00	10020	22.0	95	95	26.85	-0.15	26.40	0.10	85.95	0.10	0.0	7.0E-09	
26	98	11	18	6	1.00	48900	20.5	95	95	26.75	-0.10	27.25	0.85	85.15	0.80	3.0	1.3E-08	

**A zero in this column starts a series of measurements.

*Average Kv for those rows with a 1 in the Ave. column.

(Termination determined by stable Kv and low flow differential.)

***Kv adjusted for temperature.

RMT, Inc.

Falling Head Permeability Test

QC: [illegible]

QA: [illegible]

Project Name:	WEYERHAEUSER	Call #:	
Project #:	5101.02	USCS Description:	Fat clay with san
Sample Name:	TP-7, 8-10'	USCS Classification:	Cl
Visual Descript:	Fat clay with sand		

Sample Type: Remolded	Initial Values	Final Values		
			Maximum Proctor Density:	96.1
			Optimum Moisture Content:	24.0
Sample Dia. (in)	2.87	2.87	Permeant:	Water
Sample Ht. (in)	2.30	2.27	Permeant Specific Gravity:	1.00
Tare & Wet (g)	453.36	730.00	Sample Specific Gravity:	2.67 Est
Tare & Dry (g)	356.14	625.20	Confining Pressure (psi):	100.0
Tare (g)	0.00	265.64	Burette Diameter (in):	0.250
Sample Wt. (g)	453.36	464.36	Burette Zero (cm):	100.0

% of Proctor Density:	94.9%	97.1%		
% (+/-) of Optimum Moisture Content:	3.3%	5.1%		
Moisture (%)	27.3	29.1	Maximum Gradient:	9.9
Wet Density (pcf)	116.1	120.5	Average Gradient:	9.7
Dry Density (pcf)	91.2	93.3	Max. Effect. Stress (psi):	5.8
Saturation (%)	88.1	99.0	Min. Effect. Stress (psi):	5.0
			Ave. Effect. Stress (psi):	5.4

	Date			Time		Run	Temp	Pressure (psi)			Cham.		Bot.		Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time	C***	Bot	Top	Cham	Dif.	Bot	Dif.	Top	Dif.	Dif.%	cm/sec	0,1
1	98	11	18	6	1.00		0.0	95	95	26.75		27.25		85.15				
2	98	11	18	8	6.00	7500	21.0	95	95	27.20	0.45	27.40	0.15	85.05	0.10	20.0	1.2E-08	
3	98	11	18	10	3.00	7020	21.5	95	95	27.55	0.35	27.50	0.10	85.00	0.05	33.3	7.9E-09	
4	98	11	18	12	9.00	7560	22.5	95	95	28.30	0.75	27.70	0.20	84.90	0.10	33.3	1.4E-08	
5	98	11	18	14	1.00	6720	23.5	95	95	28.45	0.15	27.80	0.10	84.85	0.05	33.3	8.0E-09	
6	98	11	18	16	14.00	7980	23.0	95	95	28.00	-0.45	27.90	0.10	84.75	0.10	0.0	9.0E-09	
7	98	11	19	6	31.00	51420	20.5	95	95	27.10	-0.90	28.65	0.75	83.90	0.85	-6.2	1.2E-08	1
8	98	11	19	8	46.00	8100	21.0	95	95	27.55	0.45	28.75	0.10	83.80	0.10	0.0	9.6E-09	1
9	98	11	19	10	32.00		0.0	95	95	27.50		28.90		83.75				
10	98	11	19	12	32.00	7200	21.0	95	95	27.60	0.10	29.00	0.10	83.65	0.10	0.0	1.1E-08	1
11	98	11	19	14	30.00	7080	21.0	95	95	27.50	-0.10	29.10	0.10	83.55	0.10	0.0	1.1E-08	1
12																		
13																		
14																		
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22																		
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24																		
25																		
26																		

**A zero in this column starts a series of measurements.

(Termination determined by stable Kv and low flow differential.)

*Average Kv for those rows with a 1 in the Ave. column.

1.1E-08 cm/sec

***Kv adjusted for temperature.

RMT, Inc.
Falling Head Permeability Test

QC: KJ
QA: MH

Project Name:	WEYERHAEUSER	Cell #:	4
Project #:	5101.02	USCS Description:	Sandy fat clay
Sample Name:	TP-9, 1.5-6'	USCS Classification:	CH
Visual Descript:	Sandy fat clay	Average Kv =	2.9E-08 cm/sec

Sample Type: Remolded	Initial Values	Final Values		
Sample Dia. (in)	2.87	2.87	Maximum Proctor Density:	96.6
Sample Ht. (in)	2.30	2.28	Optimum Moisture Content:	22.7
Tare & Wet (g)	446.50	743.60	Permeant:	Water
Tare & Dry (g)	358.06	638.60	Permeant Specific Gravity:	1.00
Tare (g)	0.00	278.00	Sample Specific Gravity:	2.67 Est.
Sample Wt. (g)	446.50	465.60	Confining Pressure (psi):	100.0
			Burette Diameter (in):	0.250
			Burette Zero (cm):	100.0
% of Proctor Density:	94.9%	96.4%		
% (+/-) of Optimum Moisture Content:	2.0%	6.4%		
Moisture (%)	24.7	29.1	Maximum Gradient:	
Wet Density (pcf)	114.3	120.3	Average Gradient:	
Dry Density (pcf)	91.7	93.1	Max. Effect. Stress (psi):	6.0
Saturation (%)	80.7	98.6	Min. Effect. Stress (psi):	4.8
			Ave. Effect. Stress (psi):	5.3

	Date			Time		Run	Temp	Pressure (psi)			Chan.		Bot.		Top		Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time	C***	Bot	Top	Chan	Dif.	Bot	Dif.	Top	Dif.	Dif.%	cm/sec	0.1
1	98	11	12	4	59.00		0.0	95	95	28.20		13.90		97.35				
2	98	11	12	7	2.00	7380	21.0	95	95	29.05	0.85	15.65	1.75	95.25	2.10	-9.1	1.4E-07	
3	98	11	12	8	57.00	6900	21.5	95	95	29.40	0.35	16.90	1.25	94.20	1.05	8.7	9.1E-08	
4	98	11	12	10	57.00	7200	21.5	95	95	29.65	0.25	18.00	1.10	93.30	0.90	10.0	7.8E-08	
5	98	11	12	12	57.00	7200	21.5	95	95	30.00	0.35	18.90	0.90	92.45	0.85	2.9	7.0E-08	
6	98	11	12	14	58.00	7260	22.0	95	95	30.30	0.30	19.80	0.90	91.70	0.75	9.1	6.5E-08	
7	98	11	12	16	23.00	5100	22.0	95	95	30.35	0.05	20.40	0.60	91.25	0.45	14.3	6.0E-08	
8	98	11	13	4	49.00	44760	20.0	95	95	30.60	0.25	24.20	3.80	87.90	3.35	6.3	5.2E-08	
9	98	11	13	6	49.00	7200	20.5	95	95	30.75	0.15	24.75	0.55	87.50	0.40	15.8	4.6E-08	
10	98	11	13	8	59.00	7800	21.0	95	95	31.20	0.45	25.30	0.55	87.10	0.40	15.8	4.2E-08	
11	98	11	13	11	0.00	7260	21.5	95	95	31.40	0.20	25.80	0.50	86.70	0.40	11.1	4.3E-08	
12	98	11	13	12	53.00	6780	22.0	95	95	31.80	0.40	26.25	0.45	86.35	0.35	12.5	4.1E-08	
13	98	11	13	16	26.00	12780	22.5	95	95	31.90	0.10	27.10	0.85	85.70	0.65	13.3	4.1E-08	
14	98	11	16	6	46.00	224400	20.0	95	95	33.95	2.05	37.45	10.35	76.95	8.75	8.4	3.9E-08	
15	98	11	16	8	48.00	7320	21.0	95	95	34.40	0.45	37.90	0.45	76.75	0.20	38.5	4.9E-08	
16	98	11	16	10	17.00	5340	21.5	95	95	34.70	0.30	37.90	0.00	76.65	0.10	-100.0	1.0E-08	
17	98	11	16	11	13.00		0.0	95	95	35.20		37.90		76.50				
18	98	11	16	13	15.00	7320	21.5	95	95	35.00	-0.20	38.10	0.20	76.40	0.10	33.3	2.3E-08	
19	98	11	16	15	14.00	7140	21.5	95	95	35.10	0.10	38.30	0.20	76.20	0.20	0.0	3.2E-08	
20	98	11	16	16	53.00	5940	21.5	95	95	34.70	-0.40	38.50	0.20	76.00	0.20	0.0	3.8E-08	
21	98	11	17	7	21.00	52080	20.5	95	95	35.10	0.40	40.05	1.55	74.80	1.20	12.7	3.2E-08	
22	98	11	17	9	25.00	7440	21.0	95	95	35.45	0.35	40.30	0.25	74.70	0.10	42.9	2.9E-08	
23	98	11	17	11	30.00	7500	21.5	95	95	35.70	0.25	40.50	0.20	74.50	0.20	0.0	3.3E-08	
24	98	11	17	13	40.00	7800	22.0	95	95	35.65	-0.05	40.65	0.15	74.35	0.15	0.0	2.4E-08	
25	98	11	17	16	29.00	10140	22.0	95	95	35.40	-0.25	40.90	0.25	74.10	0.25	0.0	3.1E-08	
26	98	11	18	6	1.00	48720	20.5	95	95	35.45	0.05	42.05	1.15	73.15	0.95	9.5	2.9E-08	

**A zero in this column starts a series of measurements.
(Termination determined by stable Kv and low flow differential.)

*Average Kv for those rows with a 1 in the Ave. column.

***Kv adjusted for temperature.

RMT, Inc.

Falling Head Permeability Test

QC: MKL

QA: JPL

Project Name:	WEYERHAEUSER	Cell #:	
Project #:	5101.02	USCS Description:	Sandy fat cla
Sample Name:	TP-9, 1.5-6'	USCS Classification:	C
Visual Descript:	Sandy fat clay		

Sample Type: Remolded	Initial Values	Final Values			
			Maximum Proctor Density:	96.6	
			Optimum Moisture Content:	22.7	
Sample Dia. (in)	2.87	2.87	Permeant:	Water	
Sample Ht. (in)	2.30	2.28	Permeant Specific Gravity:	1.00	
Tare & Wet (g)	446.50	743.60	Sample Specific Gravity:	2.67	Es
Tare & Dry (g)	368.06	638.60	Confining Pressure (psi):	100.0	
Tare (g)	0.00	278.00	Burette Diameter (in):	0.250	
Sample Wt. (g)	446.50	465.60	Burette Zero (cm):	100.0	
% of Proctor Density:	94.9%	96.4%			
% (+/-) of Optimum Moisture Content:	2.0%	6.4%			
Moisture (%)	24.7	29.1	Maximum Gradient:	5.2	
Wet Density (pcf)	114.3	120.3	Average Gradient:	4.9	
Dry Density (pcf)	91.7	93.1	Max. Effect. Stress (psi):	5.5	
Saturation (%)	80.7	98.6	Min. Effect. Stress (psi):	5.1	
			Ave. Effect. Stress (psi):	5.3	

	Date			Time		Run	Temp	Pressure (psi)			Cham.		Bot.		Top	Flow		Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time	C***	Bot	Top	Cham	Dif.	Bot	Dif.	Top	Dif.	Dif.%		cm/sec	0.1
1	98	11	18	6	1.00		0.0	95	95	35.45		42.05		73.15					
2	98	11	18	8	8.00	7620	21.0	95	95	35.90	0.45	42.30	0.25	73.00	0.15	25.0		3.6E-08	
3	98	11	18	10	4.00	6960	21.5	95	95	36.30	0.40	42.45	0.15	72.90	0.10	20.0		2.5E-08	
4	98	11	18	12	10.00	7560	22.5	95	95	37.00	0.70	42.60	0.15	72.80	0.10	20.0		2.3E-08	
5	98	11	18	14	2.00	6720	23.5	95	95	37.25	0.25	42.80	0.20	72.70	0.10	33.3		3.0E-08	
6	98	11	18	16	14.00	7920	23.0	95	95	36.80	-0.45	42.95	0.15	72.55	0.15	0.0		2.6E-08	1
7	98	11	19	6	31.00	51420	20.5	95	95	35.90	-0.90	43.95	1.00	71.55	1.00	0.0		3.0E-08	1
8	98	11	19	8	47.00	8160	21.0	95	95	36.30	0.40	44.15	0.20	71.40	0.15	14.3		3.4E-08	1
9	98	11	19	10	33.00	6360	21.0	95	95	36.30	0.00	44.30	0.15	71.30	0.10	20.0		3.1E-08	1
10	98	11	19	12	33.00	7200	21.0	95	95	36.40	0.10	44.40	0.10	71.20	0.10	0.0		2.2E-08	1
11	98	11	19	14	31.00	7080	21.0	95	95	36.30	-0.10	44.55	0.15	71.10	0.10	20.0		2.8E-08	1
12																			
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**A zero in this column starts a series of measurements.
(Termination determined by stable Kv and low flow differential.)

*Average Kv for those rows with a 1 in the Ave. column. 2.9E-08 cm/sec

***Kv adjusted for temperature.

510104.xls

11/20/1998

RMT, Inc.

Falling Head Permeability Test

QC: AWJ

QA: 1/11

Project Name:	WEYERHAEUSER	Cell #:	4
Project #:	5101.02	USCS Description:	Clayey sand
Sample Name:	TP-13, 2-5'	USCS Classification:	SC
Visual Descript:	Clayey sand	Average Kv =	6.0E-08 cm/sec

Sample Type:	Remolded	Initial Values	Final Values			
				Maximum Proctor Density:	107.0	
				Optimum Moisture Content:	17.6	
Sample Dia. (in)		2.87	2.87	Permeant:	Water	
Sample Ht. (in)		2.29	2.28	Permeant Specific Gravity:	1.00	
Tare & Wet (g)		476.12	745.20	Sample Specific Gravity:	2.67	Est.
Tare & Dry (g)		395.77	657.50	Confining Pressure (psi):	100.0	
Tare (g)		0.00	258.84	Burette Diameter (in):	0.250	
Sample Wt. (g)		476.12	486.36	Burette Zero (cm):	100.0	
% of Proctor Density:		95.1%	96.2%			
% (+/-) of Optimum Moisture Content:		2.7%	4.4%			
Moisture (%)		20.3	22.0	Maximum Gradient:		
Wet Density (pcf)		122.4	125.6	Average Gradient:		
Dry Density (pcf)		101.8	103.0	Max. Effect. Stress (psi):	6.0	
Saturation (%)		85.1	95.0	Min. Effect. Stress (psi):	4.6	
				Ave. Effect. Stress (psi):	5.2	

	Date			Time		Run	Temp	Pressure (psi)			Cham.		Bot.		Top		Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time	C***	Bot	Top	Cham	Dif.	Bot	Dif.	Top	Dif.	Dif.%	cm/sec	0,1
1	98	11	12	4	59.00		0.0	95	95	26.80		12.15		97.20				
2	98	11	12	7	3.00	7440	21.0	95	95	28.00	1.20	16.95	4.80	92.05	5.15	-3.5	3.6E-07	
3	98	11	12	8	58.00	6900	21.5	95	95	28.60	0.60	20.70	3.75	88.50	3.55	2.7	3.2E-07	
4	98	11	12	10	58.00	7200	21.5	95	95	29.10	0.50	24.10	3.40	85.30	3.20	3.0	3.1E-07	
5	98	11	12	13	0.00	7320	21.5	95	95	29.65	0.55	27.00	2.90	82.40	2.90	0.0	2.9E-07	
6	98	11	12	14	59.00	7140	22.0	95	95	30.15	0.50	29.60	2.60	79.95	2.45	3.0	2.8E-07	
7	98	11	12	16	24.00	5100	22.0	95	95	30.30	0.15	31.30	1.70	78.30	1.65	1.5	2.8E-07	
8	98	11	13	4	49.00	44700	20.0	95	95	30.85	0.55	41.25	9.95	68.70	9.60	1.8	2.6E-07	
9	98	11	13	4	51.00		0.0	95	95	31.05		5.85		98.75				
10	98	11	13	6	49.00	7080	20.5	95	95	31.05	0.00	9.60	3.75	94.80	3.95	-2.6	2.7E-07	
11	98	11	13	9	0.00	7860	21.0	95	95	31.65	0.60	13.15	3.55	91.45	3.35	2.9	2.3E-07	
12	98	11	13	11	1.00	7260	21.0	95	95	32.20	0.55	15.95	2.80	88.80	2.65	2.8	2.1E-07	
13	98	11	13	12	53.00	6720	22.0	95	95	32.75	0.55	18.20	2.25	86.50	2.30	-1.1	2.0E-07	
14	98	11	13	16	27.00	12840	22.5	95	95	33.30	0.55	31.90	13.70	82.90	3.60	58.4	4.8E-07	
15	98	11	16	6	47.00		0.0	95	95	36.20		4.75		99.40				
16	98	11	16	8	49.00	7320	21.0	95	95	36.60	0.40	7.55	2.80	96.30	3.10	-5.1	1.9E-07	
17	98	11	16	10	18.00	5340	21.5	95	95	36.90	0.30	9.55	2.00	94.40	1.90	2.6	1.8E-07	
18	98	11	16	11	14.00		0.0	95	95	37.05		10.40		93.65				
19	98	11	16	13	15.00	7260	21.5	95	95	36.90	-0.15	13.10	2.70	90.90	2.75	-0.9	2.0E-07	
20	98	11	16	15	15.00	7200	21.5	95	95	36.95	0.05	15.65	2.55	88.40	2.50	1.0	2.0E-07	
21	98	11	16	16	54.00	5940	21.5	95	95	36.80	-0.15	17.50	1.85	86.45	1.95	-2.6	1.9E-07	
22	98	11	17	7	22.00	52080	20.5	95	95	36.90	0.10	29.75	12.25	74.30	12.15	0.4	1.8E-07	
23	98	11	17	9	26.00	7440	21.0	95	95	37.40	0.50	31.05	1.30	73.05	1.25	2.0	1.7E-07	
24	98	11	17	11	31.00	7500	21.5	95	95	37.65	0.25	32.30	1.25	71.90	1.15	4.2	1.7E-07	
25	98	11	17	13	47.00	8160	22.0	95	95	37.70	0.05	33.50	1.20	70.70	1.20	0.0	1.6E-07	
26	98	11	17	16	30.00	9780	22.0	95	95	37.60	-0.10	34.80	1.30	69.35	1.35	-1.9	1.6E-07	

**A zero in this column starts a series of measurements.

(Termination determined by stable Kv and low flow differential.)

*Average Kv for those rows with a 1 in the Ave. column.

***Kv adjusted for temperature.

RMT, Inc.

Falling Head Permeability Test

QC: [illegible]
QA: [illegible]

Project Name:	WEYERHAEUSER	Cell #:	4
Project #:	5101.02	USCS Description:	Clayey sand
Sample Name:	TP-13, 2-5'	USCS Classification:	SC
Visual Descript:	Clayey sand		

Sample Type: Remolded	Initial Values	Final Values			
			Maximum Proctor Density:	107.0	
			Optimum Moisture Content:	17.6	
Sample Dia. (in)	2.87	2.87	Permeant:	Water	
Sample Ht. (in)	2.29	2.28	Permeant Specific Gravity:	1.00	
Tare & Wet (g)	476.12	745.20	Sample Specific Gravity:	2.67	Est.
Tare & Dry (g)	395.77	657.50	Confining Pressure (psi):	100.0	
Tare (g)	0.00	258.84	Burette Diameter (in):	0.250	
Sample Wt. (g)	476.12	486.36	Burette Zero (cm):	100.0	
% of Proctor Density:	95.1%	96.2%			
% (+/-) of Optimum Moisture Content:	2.7%	4.4%			
Moisture (%)	20.3	22.0	Maximum Gradient:		
Wet Density (pcf)	122.4	125.6	Average Gradient:		
Dry Density (pcf)	101.8	103.0	Max. Effect. Stress (psi):	5.9	
Saturation (%)	85.1	95.0	Min. Effect. Stress (psi):	4.5	
			Ave. Effect. Stress (psi):	5.3	

	Date			Time		Run	Temp	Pressure (psi)		Cham.	Cham.	Bot.	Bot.	Top	Top	Flow	Ky ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time	C***	Bot	Top	Cham	Dif.	Bot	Dif.	Top	Dif.	Dif.%	cm/sec	0,1
1	98	11	17	16	30.00		0.0	95	95	37.60		34.80		69.35				
2	98	11	18	6	3.00	48780	20.5	95	95	37.50	-0.10	39.90	5.10	94.25	-24.90	-151.5	-2.0E-07	
3	98	11	18	6	4.00		0.0	95	95	37.50		39.90		99.40				
4	98	11	18	8	9.00	7500	21.0	95	95	38.10	0.60	41.40	1.50	97.55	1.85	-10.4	1.7E-07	
5	98	11	18	10	5.00	6960	21.5	95	95	38.45	0.35	42.70	1.30	96.30	1.25	2.0	1.4E-07	
6	98	11	18	12	12.00	7620	22.5	95	95	39.40	0.95	44.00	1.30	95.05	1.25	2.0	1.3E-07	
7	98	11	18	14	3.00	6660	23.5	95	95	39.70	0.30	45.10	1.10	94.00	1.05	2.3	1.3E-07	
8	98	11	18	16	15.00	7920	23.0	95	95	39.30	-0.40	46.30	1.20	92.00	2.00	-25.0	1.7E-07	
9	98	11	19	6	32.00	51420	20.5	95	95	38.30	-1.00	52.35	6.05	86.55	5.45	5.2	1.2E-07	
10	98	11	19	8	50.00	8280	21.0	95	95	38.70	0.40	53.15	0.80	85.80	0.75	3.2	1.2E-07	
11	98	11	19	10	34.00	6240	21.0	95	95	38.70	0.00	53.65	0.50	85.30	0.50	0.0	1.1E-07	
12	98	11	19	12	33.00	7140	21.0	95	95	38.80	0.10	54.25	0.60	84.75	0.55	4.3	1.1E-07	
13	98	11	19	14	32.00	7140	21.0	95	95	38.75	-0.05	54.80	0.55	84.20	0.55	0.0	1.1E-07	
14	98	11	19	16	42.00	7800	21.0	95	95	38.70	-0.05	55.35	0.55	83.70	0.50	4.8	1.0E-07	
15	98	11	20	7	20.00	52680	21.0	95	95	39.05	0.35	58.55	3.20	80.55	3.15	0.8	1.0E-07	
16	98	11	20	7	27.00		0.0	95	95	39.25		4.50		99.05				
17	98	11	20	9	28.00	7260	21.0	95	95	39.00	-0.25	6.65	2.15	97.30	1.75	10.3	1.2E-07	
18	98	11	20	11	51.00	8580	21.0	95	95	39.25	0.25	8.80	2.15	95.20	2.10	1.2	1.2E-07	
19	98	11	20	13	28.00	5820	21.0	95	95	39.30	0.05	10.30	1.50	93.80	1.40	3.4	1.3E-07	
20	98	11	20	15	28.00	7200	21.0	95	95	39.45	0.15	11.90	1.60	92.20	1.60	0.0	1.2E-07	
21	98	11	21	6	51.00	55380	20.5	95	95	39.05	-0.40	21.35	9.45	82.80	9.40	0.3	1.1E-07	
22	98	11	21	9	12.00	8460	21.0	95	95	39.05	0.00	22.45	1.10	81.80	1.00	4.8	8.8E-08	
23	98	11	23	7	15.00	165780	21.0	95	95	40.50	1.45	35.55	13.10	68.95	12.85	1.0	7.4E-08	
24	98	11	23	9	16.00	7260	21.5	95	95	41.35	0.85	35.85	0.30	68.70	0.25	9.1	4.9E-08	
25	98	11	23	11	16.00	7200	23.5	95	95	41.80	0.45	36.25	0.40	68.35	0.35	6.7	6.6E-08	
26	98	11	23	13	16.00	7200	23.5	95	95	42.50	0.70	36.60	0.35	68.00	0.35	0.0	6.3E-08	

**A zero in this column starts a series of measurements.

(Termination determined by stable Kv and low flow differential.)

*Average Kv for those rows with a 1 in the Ave. column.

***Kv adjusted for temperature.

RMT, Inc.

Falling Head Permeability Test

QC: MKL

QA: RJK

Project Name:	WEYERHAEUSER	Cell #:	4
Project #:	S101.02	USCS Description:	Clayey sand
Sample Name:	TP-13, 2-5'	USCS Classification:	SC
Visual Descript:	Clayey sand		

Sample Type: Remolded	Initial Values	Final Values			
			Maximum Proctor Density:	107.0	
			Optimum Moisture Content:	17.6	
Sample Dia. (in)	2.87	2.87	Permeant:	Water	
Sample Ht. (in)	2.29	2.28	Permeant Specific Gravity:	1.00	
Tare & Wet (g)	476.12	745.20	Sample Specific Gravity:	2.67	Est.
Tare & Dry (g)	395.77	657.50	Confining Pressure (psi):	100.0	
Tare (g)	0.00	258.84	Burette Diameter (in):	0.250	
Sample Wt. (g)	476.12	486.36	Burette Zero (cm):	100.0	
% of Proctor Density:	95.1%	96.2%			
% (+/-) of Optimum Moisture Content:	2.7%	4.4%			
Moisture (%)	20.3	22.0	Maximum Gradient:	16.3	
Wet Density (pcf)	122.4	125.6	Average Gradient:	7.8	
Dry Density (pcf)	101.8	103.0	Max. Effect. Stress (psi):	5.8	
Saturation (%)	85.1	95.0	Min. Effect. Stress (psi):	4.4	
			Ave. Effect. Stress (psi):	5.1	

	Date			Time		Run	Temp	Pressure (psi)			Chan.		Bot.		Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time	C***	Bot	Top	Chan	Dif.	Bot	Dif.	Top	Dif.	Dif.%	cm/sec	0,1
1	98	11	24	9	32.00		0.0	95	95	41.60		5.00		97.05				
2	98	11	24	11	27.00	6900	22.0	95	95	42.10	0.50	5.50	0.50	95.75	1.30	-44.4	6.0E-08	
3	98	11	24	13	26.00	7140	24.0	95	95	42.90	0.80	7.20	1.70	94.60	1.15	19.3	9.0E-08	
4	98	11	24	15	28.00	7320	24.0	95	95	42.50	-0.40	9.10	1.90	93.40	1.20	22.6	9.9E-08	
5	98	11	25	7	26.00	57480	21.0	95	95	41.30	-1.20	17.20	8.10	85.60	7.80	1.9	7.8E-08	
6	98	11	25	9	26.00	7200	21.5	95	95	42.00	0.70	18.00	0.80	84.80	0.80	0.0	7.0E-08	
7	98	11	25	12	59.00	12780	22.5	95	95	42.50	0.50	19.40	1.40	83.50	1.30	3.7	6.8E-08	
8	98	11	25	15	6.00	7620	23.5	95	95	43.15	0.65	20.30	0.90	82.80	0.70	12.5	6.8E-08	
9	98	11	26	8	20.00	62040	21.0	95	95	41.90	-1.25	25.80	5.50	77.30	5.50	0.0	6.7E-08	
10	98	11	26	10	1.00	6060	21.0	95	95	42.25	0.35	26.30	0.50	76.85	0.45	5.3	6.6E-08	
11	98	11	28	9	45.00	171840	21.0	95	95	43.75	1.50	35.90	9.60	67.70	9.15	2.4	5.8E-08	1
12	98	11	28	14	19.00	16440	22.0	95	95	44.30	0.55	36.60	0.70	67.10	0.60	7.7	5.3E-08	1
13	98	11	30	7	55.00		0.0	95	95	47.60		3.85		98.05				
14	98	11	30	9	48.00	6780	23.5	95	95	49.00	1.40	4.90	1.05	96.90	1.15	-4.5	7.1E-08	1
15	98	11	30	11	57.00	7740	23.0	95	95	48.20	-0.80	5.90	1.00	95.90	1.00	0.0	5.8E-08	1
16	98	11	30	13	48.00	6660	22.0	95	95	47.45	-0.75	6.70	0.80	95.05	0.85	-3.0	5.8E-08	1
17																		
18																		
19																		
20																		
21																		
22																		
23																		
24																		
25																		
26																		

**A zero in this column starts a series of measurements.

(Termination determined by stable Kv and low flow differential.)

*Average Kv for those rows with a 1 in the Ave. column. 6.0E-08 cm/sec

***Kv adjusted for temperature.

Appendix L
Stormwater/Erosion and Sedimentation Calculations

Attachment L1	Stormwater/Erosion and Sediment Control Design
Attachment L2	Predevelopment Stormwater Design Calculations
Attachment L3	Post Development Stormwater Design Calculations – North Area
Attachment L4	Post Development Stormwater Design Calculations – East Area
Attachment L5	Post Development Stormwater Design Calculations – West Area
Attachment L6	Post Development Stormwater Design Calculations – North West Area
Attachment L7	Box Culvert Design Calculations
Attachment L8	Articulated Block Drainage Channel Design Calculations
Attachment L9	Steep Gradient Design Calculations
Attachment L10	Sizing of Outlet Protection

Attachment L1
Stormwater/Erosion Control Design

Stormwater/Erosion and Sediment Control Design

Hydrograph Generation

1. The landfill was split into three areas (north, east, and west) for pre-development and post-development analyses. Two detention basins were designed for the north area (a north basin and a northwest basin). Each post-development area was further subdivided by establishing each terrace as a separate subwatershed (see attached figures).
2. Hydrographs for the existing terrain (pre-development) conditions for a 25-year, 24-hour storm were computed with a computer program that uses SCS TR-55 methodology.
3. A 25-year, 24-hour storm hydrograph was computed from each subwatershed area and routed together to obtain the peak flow rate into the detention basin and the amount of sediment erosion due to runoff using the Sedimot II modeling program.

Detention Basin Design

A post-development peak flow rate for each area was estimated for the 25-year, 24-hour storm event based on procedures outlined in the North Carolina Erosion and Sediment Control Planning and Design Manual (NCE&SCP&DM). The volume of runoff for the 10-year, 24-hour storm event was also estimated for each drainage basin. The peak flow rate, the runoff volume, the drainage basin area, and the recommendations provided in the NCE&SCP&DM were used to size the sediment pond, the principal spillway, and the emergency spillway for each drainage basin.

Flow above the riser was calculated with a program that uses culvert hydraulics to determine the flow rate from the principle spillway pipe. The program calculates the controlling flow in the detention basin due to the riser and principle spillway pipe.

1. Flow through the perforated riser was calculated using a "Discharge From Perforated Riser" Excel™ spreadsheet. The flow above the riser was added to the flow through the riser to obtain a total flow at each stage.
2. The following input is required by Sedimot II to begin the sedimentology analysis:
   - Specific gravity for sediment
   - Coefficient for distributing sediment load
   - Submerged bulk-specific gravity
   - Number of particle size distributions
   - Number of data values per particle size distribution
   - Particle size distribution data (mm)

- Percent finer values corresponding to the particle size values

The specific gravity used was an average specific gravity of 2.64, which is representative of the on-site soils based on data contained in the Hydrogeologic Report (Appendix B). The eroded particle size distribution data and corresponding "percent finer" values are also representative of the on-site soils. The distribution curve used may be found in the attached calculations.

The Sedimot II user's manual recommended a coefficient of between 1.0 and 2.0 for distributing sediment load equal if the concentration varies linearly with flow rate. A coefficient of 2.00 was used.

Based on recommended values and sediment size distribution, 1.35 was chosen as the submerged bulk-specific gravity.

Sedimot II has two options available to calculate sediment yield: the Modified Universal Soil Loss Equation (MUSLE) and the Soil Loss (SLOSS). The following parameters are used in both sediment yield options for each subwatershed:

- Soil erodibility factor
- Average slope length
- Average slope in percent
- Control practice factor
- Particle size distribution

A soil erodibility factor was selected using the Soil Conservation Commission Soil Survey of Washington County, North Carolina. The site, shown on sheet No. 4 of the soil survey, is comprised of Altavista, Conetoe, and Wickham soils. The majority of the soils at the site are Altavista and Wickham and have an erodibility factor of 0.20.

The average slope length and average slope is defined as the distance from the point of origin of overland flow until the flow enters a defined channel. The terrace face length and slope were used.

The control practice factor is defined as the ratio of sediment loss from an area with a given cover and conservation practice to that of a field in continuous fallow. A value of 0.4 for a condition of permanent seedlings from 0 to 60 days was considered to be a conservative situation and was used in this analysis.

Sedimot II gives the user the option of selecting different particle size distributions for each subwatershed. A particle size distribution from the Hydrogeologic Report was used. In this situation, the same distribution was utilized for all subwatershed analysis.

The MUSLE option for sediment yield was selected for each subwatershed. MUSLE calculates sediment yield, using the Williams' Modified Universal Soil Loss Equation. Eroded sediment and the combined hydrographs are routed to the "structure" (the detention basin) by travel time constants.

The outfall structure of the hydrograph was selected as a pond. The Sedimot II model predicts the performance of a user-designed sediment basin by two methods:
1) Modified Deposits Performance Of Sediments In Trap Structures (DEPOSITS); and
2) Continuous Stirred Type Reactors (CSTRs), which predicts the performance of a CSTRs. The CSTRs method was selected. This method accounts for mixing between inflow concentration once flow has entered the pond. CSTRs is more reflective of sediment basin performance than the DEPOSITS prediction. The following input is required for basin analysis using CSTRs:

- Number of continuous stirred type reactors
- Time increment of routed hydrograph
- Non-ideal settling correction factor
- Percent of pool that is dead space
- Outflow withdrawal option
- Inflow vertical concentration

Sedimot II allows for up to nine CSTRs to be used, but recommends that at least two CSTRs be used. We used three CSTRs for this analysis.

Sedimot II requires that the time increment of the routed hydrograph is an integer multiple of the inflow hydrograph time increment. The default value was selected, which will automatically set the value equal to the inflow time increment.

A non-ideal settling factor for a highly turbulent pond is greater than one. If natural or chemical flocculation occurs, the value would be less than one. The default value of one was selected.

The percent of permanent pool that is dead storage was set at 35 percent for all three ponds.

The outflow withdrawal option is used to select the percent of water (and associated sediment) that is drawn from each of four horizontal layers of the pond. This outflow withdrawal occurs at the principle and/or emergency spillway. The options are uniform, bed, surface, and input. The uniform withdrawal system assumes that the outflow concentration is equally weighted by the concentration from each layer. A bed withdrawal system uses only the concentration from the bottom most layer to determine effluent concentration. In the surface withdrawal option, the effluent concentration is equal to the concentration of the top fall depth layer. The input option is used strictly as a research tool. The surface withdrawal option was selected.

The inflow vertical concentration option, which assumed that the inflow is completely mixed, was selected.

A stage-discharge relationship was developed so that a 10-year, 24-hour storm event could be held and then released from the detention basins. The principal spillway has the capacity to carry a 25-year, 24-hour storm event without overflowing into the emergency spillway.

The emergency spillway was designed to handle the overflow of a 100-year, 24-hour storm event. Sedimot II was run to evaluate the emergency spillway for a 100-year, 24-hour storm event. Sedimot II was also run for the 2-year, the 10-year, and the 25-year, 24-hour storm events.

DESIGN SHEET

RMT 100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH, NC	DYK	6/7/99	EWT	7/8/99	05101.01

PROBLEM:

SIZE (3) SEDIMENT/EXTENDED DRY DETENTION BASINS TO MANAGE 25 YR - 24 HR STORM EVENT. DESIGN SUCH THAT DISCHARGE FLOW RATE WILL BE LESS THAN PRE-DEVELOPMENT PEAK FLOW RATE. SIZE EMERGENCY SPILLWAY TO MANAGE 100 YR-STORM EVENT. SEDIMENT BASIN ALONG WITH BEST MANAGEMENT PRACTICES (BMP'S) WILL TRAP 85% OF TOTAL SUSPENDED SOLIDS. BMP'S WILL INCLUDE GRASS SWALES AROUND THE TERRACES OF THE LANDFILL.

METHODOLOGY + REFERENCES:

- SCS SOIL SURVEY, WASHINGTON COUNTY, NC, SHEET 4
- NORTH CAROLINA EROSION + SEDIMENT CONTROL PLANNING + DESIGN MANUAL (9/1/88)
- SCS TECHNICAL RELEASE NO. 55, URBAN HYDROLOGY FOR SMALL WATERSHEDS. + GALILEO SOFTWARE
- SEDIMOT II COMPUTER PROGRAM (WILSON, BARFIELD + MOORE, 1982)

RAINFALL DATA:

2 YR - 24 HR = 4.00 IN
10 YR - 24 HR = 6.25 IN
25 YR - 24 HR = 7.25 IN
100 YR - 24 HR = 9.00 IN

SCS - TYPE III STORM (TR 55, FIG B2)

PRE-DOMINANT SOILS:

ALTAVISTA	HSG = C	K = 0.20	K ~ ERODIBILITY SOIL FACTOR
CONCOE	HSG = A	K = 0.15	$K_{AVG} \simeq 0.20$
WICKHAM	HSG = B	K = 0.15 - 0.24	

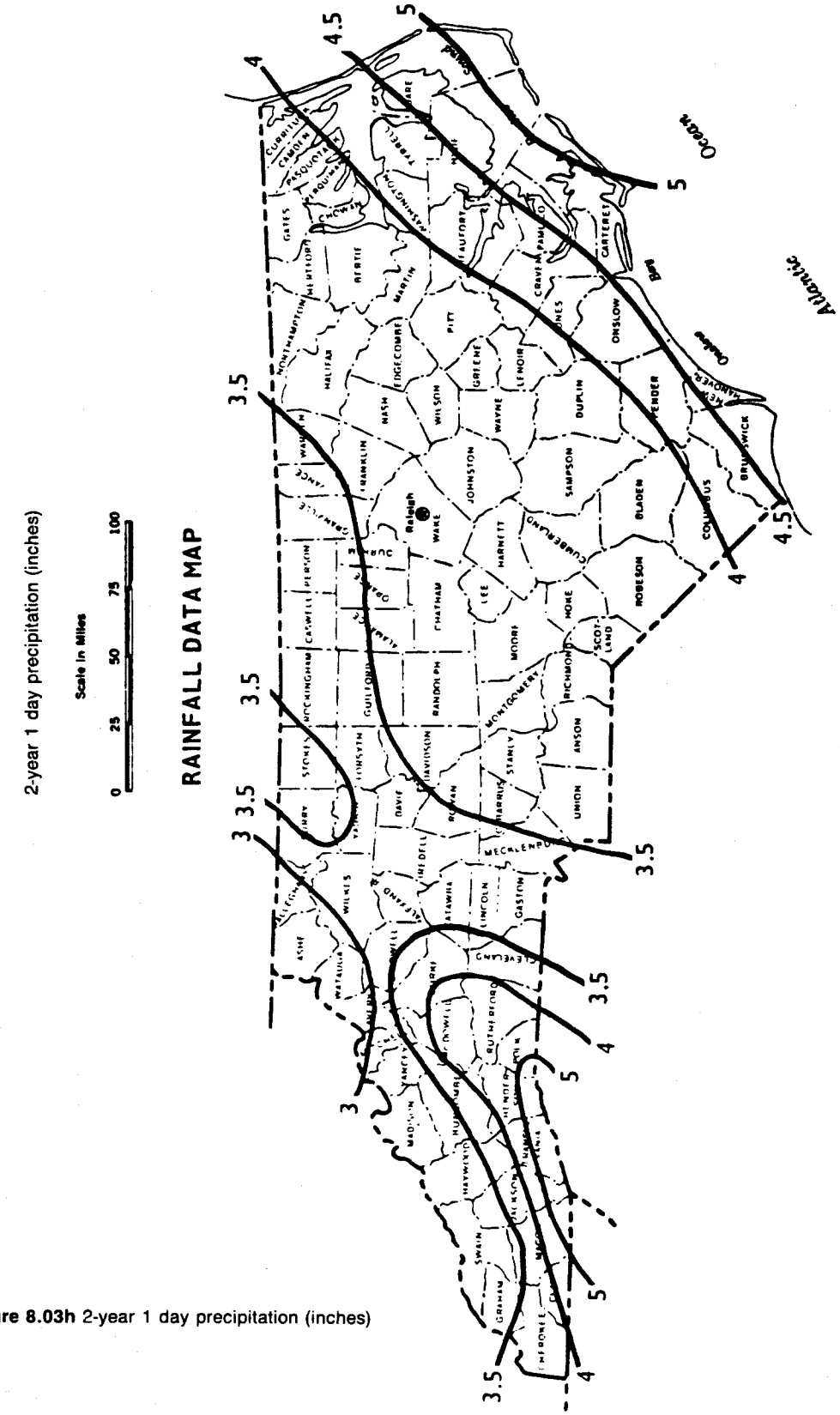

Figure 8.03h 2-year 1 day precipitation (inches)

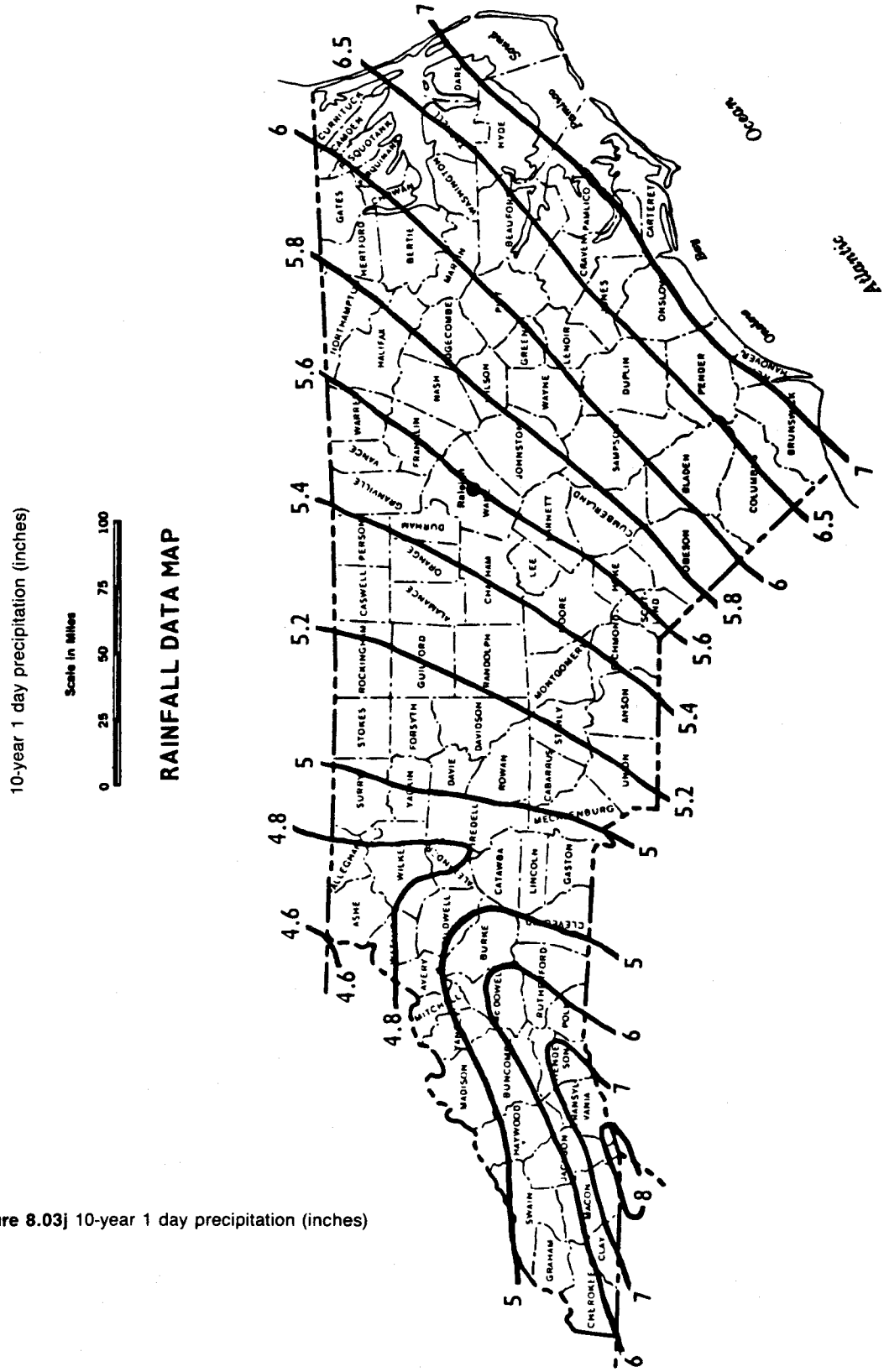

Figure 8.03j 10-year 1 day precipitation (inches)

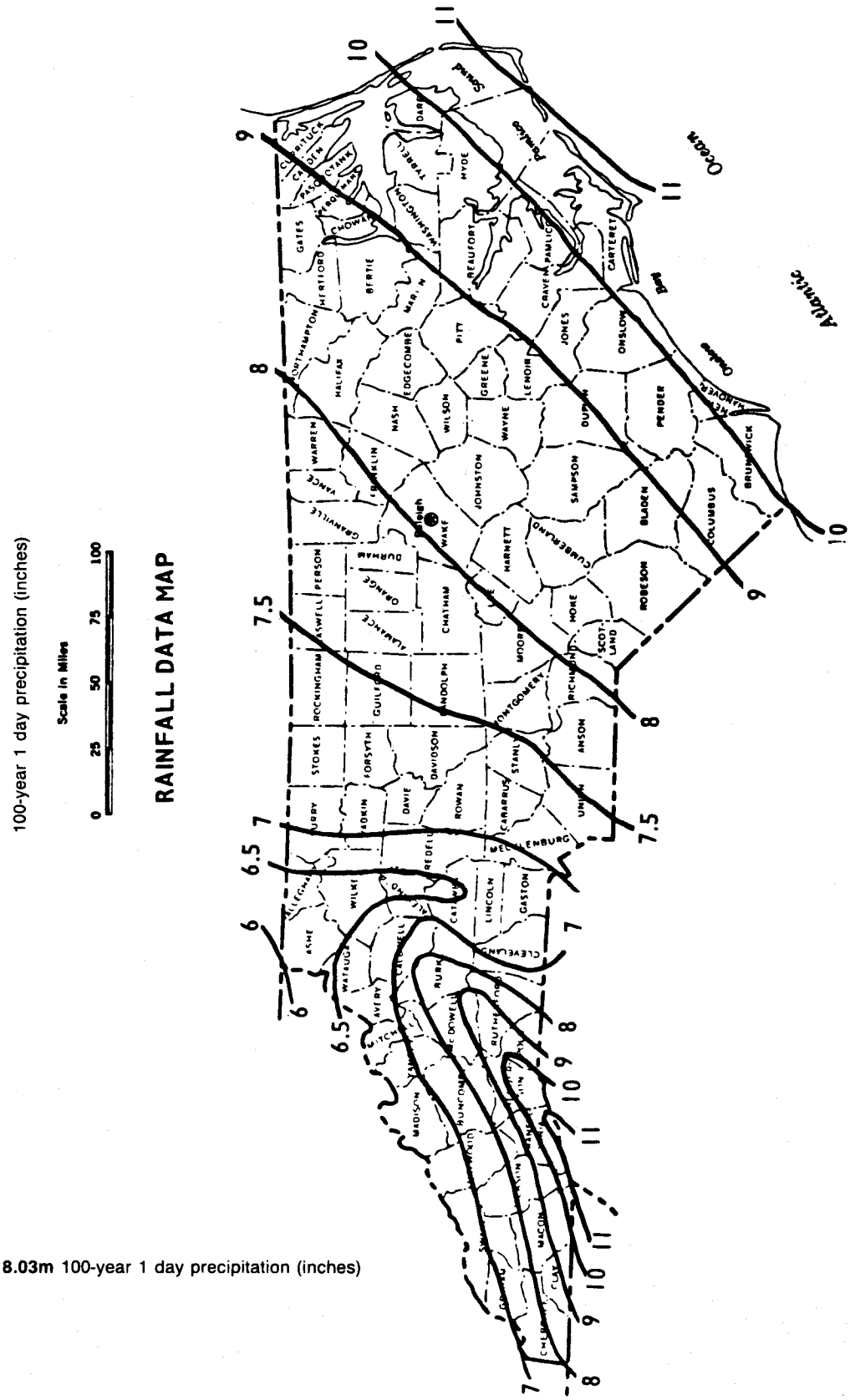

Figure 8.03m 100-year 1 day precipitation (inches)

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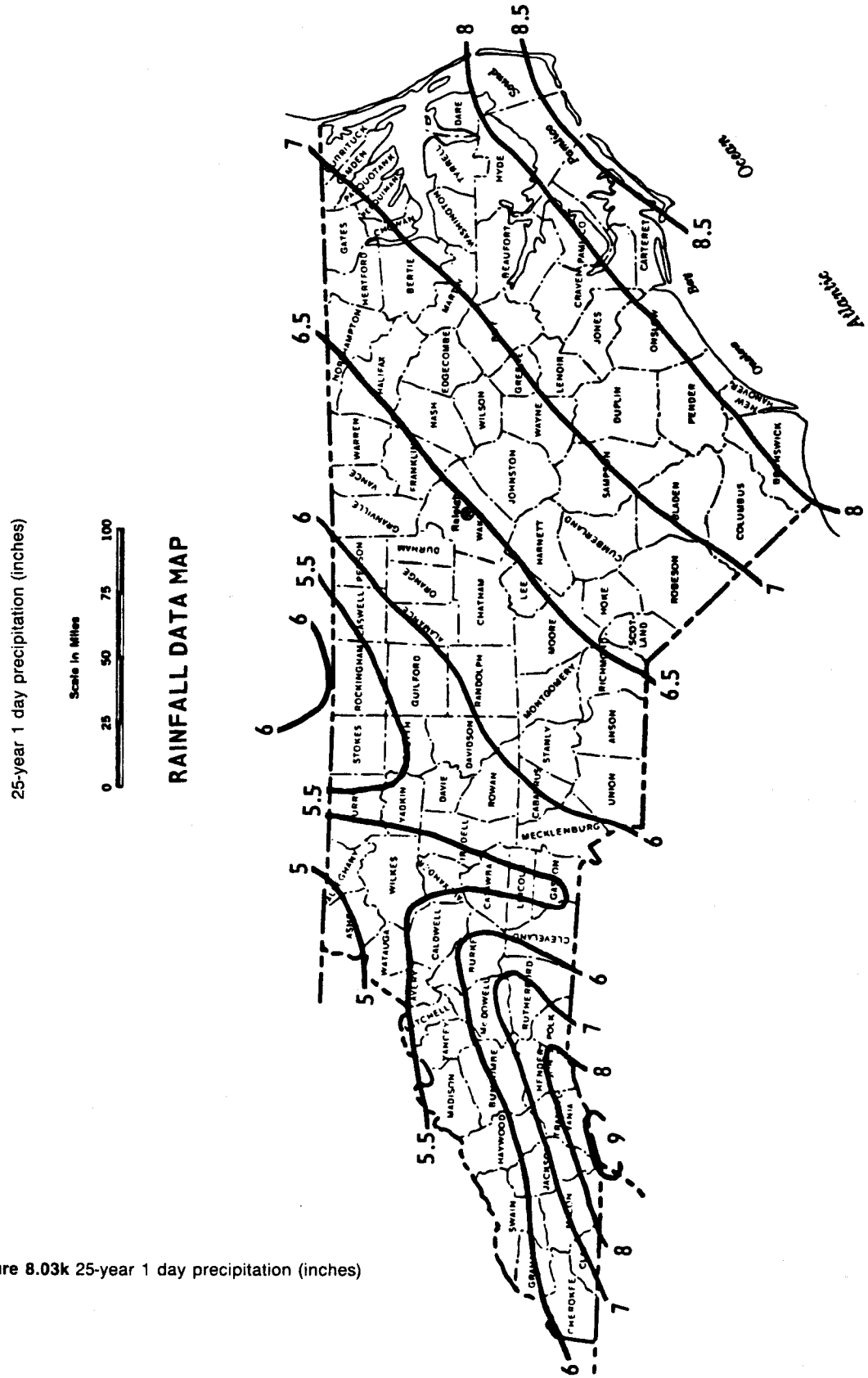

Figure 8.03k 25-year 1 day precipitation (inches)

Drawings Under Seperate Cover

Attachment L2
Predevelopment Stormwater Design Calculations

DESIGN SHEET

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PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	6/7/99	EWT	7/8/99	05101.01

DETERMINE THE PEAK FLOW RATES USING SCS TR-55 METHODOLOGY FOR PRE-DEVELOPMENT LAND USE:

NORTH AREA (#1) ≈ 22.6 ACRES ≈ 0.0353 SQ. MILES

6% WOODED : $\eta = 0.60$
94% OPEN SPACE : $\eta = 0.06$
100% TOTAL AREA : $\bar{\eta} = 0.0924$

HYDRALIC LENGTH = 1900 FT
AVG. SLOPE = 0.01895 FT/FT

EAST AREA (#2) ≈ 55.6 ACRES ≈ 0.0869 SQ. MILES

43% WOODED : $\eta = 0.60$
57% OPEN SPACE : $\eta = 0.06$
100% TOTAL AREA : $\bar{\eta} = 0.2922$

HYDRAULIC LENGTH = 2300 FT
AVG. SLOPE = 0.00956 FT/FT

WEST AREA (#3) ≈ 35.0 ACRES ≈ 0.0547 SQ. MILES

41% WOODED : $\eta = 0.60$
59% OPEN SPACE : $\eta = 0.06$
100% TOTAL AREA : $\eta = 0.2814$

HYDRAULIC LENGTH = 2200 FT
AVG SLOPE = 0.01318 FT/FT

η ~ values are derived from SCS TR-55 (Table 3.1)
RUNOFF CURVE NOS. ARE AS FOLLOWS FOR HYDROLOGIC SOIL GROUP "B"
WOODS (GOOD CONDITION) → CN=58
OPEN SPACE (POOR CONDITION - BRUSH + WEEDS) → CN=67

DESIGN SHEET

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PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	6/7/99	BNK	1/8/99	05101.01

DETERMINE PRE-DEVELOPMENT T_c + $\overline{CN}$ FOR EACH AREA:

NORTH AREA (#1):

(0'-300') $T_{t_{0-300}} = \dfrac{0.007\,(\bar{x}L)^{0.8}}{(P_2)^{0.5}\,(S)^{0.4}} = \dfrac{(0.007)\,[(0.0924)(300')]^{0.8}}{(4.0)^{0.5}\cdot(0.01895\,\frac{FT}{FT})^{0.4}}$

$T_{t_{0-300}} = 0.244$ hrs ✓

(300'-1900') VELOCITY* $\cong f(S = 0.01895\ FT/FT,\ UNPAVED) = 2.25$ FPS

$T_t = \left(\dfrac{DISTANCE}{VELOCITY}\right) = \left(\dfrac{1900' - 300'}{2.25\ FPS}\right)\left(\dfrac{1\ MIN}{60\ S}\right)\left(\dfrac{1\ HR}{60\ M}\right)$

$T_{t_{300-1900}} = 0.198$ hrs

$T_c = \sum T_t = 0.244 + 0.198$

$T_c = 0.442$ hrs

$\overline{CN} = (0.06)(58) + (0.94)(67)$

$\overline{CN} \simeq 66$

* VELOCITY FROM SCS - TR-55, FIGURE 3.1

DESIGN SHEET

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PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	6/7/99	EMT	7/8/99	05101.01

DETERMINE PRE-DEVELOPMENT T_c + CN FOR EACH AREA

EAST AREA (#2)

(0-300') $T_{t_{0-300'}} = \dfrac{0.007\,(0.2922\,(300'))^{0.8}}{(4.0)^{0.5}\cdot(0.00956)^{0.4}}$

$T_{t_{0-300'}} = 0.806$ hrs

(300'-2300') VELOCITY* = f (S = 0.00956 + FIG 3.1, UNPAVED)

VELOCITY ≅ 1.55 FPS

$T_{t_{300-2300}} = \left(\dfrac{2300'-300'}{1.55\text{ FPS}} \cdot \dfrac{1\text{ m}}{60\text{ s}} \cdot \dfrac{1\text{ h}}{60\text{ m}}\right)$

$T_{t_{300-2300}} = 0.358$ hrs

$T_c = \Sigma T_t = 0.806\text{ hrs} + 0.358\text{ hrs}$

$T_c = 1.164$ hrs

$\bar{CN} = (0.43)(58) + (0.57)(67)$

$\bar{CN} \cong 63$

* VELOCITY FROM SCS-TR-55, FIG 3.1

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PROJECT/PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SJK	6/7/99	BJT	7/8/99	05101.01

DETERMINE PRE-DEVELOPMENT T_c & CN FOR EACH AREA

WEST AREA (#3)

(0-300') $T_{t_{0-300'}} = \dfrac{(0.007)((0.2814)(300'))^{0.8}}{(4.0)^{0.5}(0.01318)^{0.4}}$ 0.2424 / 0.3540

$T_{t_{0-300'}} = 0.687$ hrs ✓

(300'-2200') VELOCITY* = f(S = 0.01318 FT/FT, UNPAVED FIG 3-1)
VELOCITY ≅ 1.85 FPS

$T_{t_{300'-2200'}} = \left(\dfrac{2200'-300'}{1.85\ \text{FPS}} \cdot \dfrac{1\ \text{M}}{60\ \text{S}} \cdot \dfrac{1\ \text{hr}}{60\ \text{M}}\right)$

$T_{t_{300'-2200'}} = 0.285$ hrs

$T_c = \sum T_t = 0.687$ hrs $+ 0.285$ hrs.

$T_c = 0.972$ hrs

$\overline{CN} = (0.41)(58) + (0.59)(67)$

$\overline{CN} \approx 63$

* VELOCITY FROM SCS-TR-55 FIG. 3.1

DESIGN SHEET

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PROJECT/PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	6/2/99			05101.01

PRE-DEVELOPMENT:

USE TR-55 BASED COMPUTER MODEL TO CALCULATE THE PRE-DEVELOPMENT FLOW RATE & RUNOFF VOLUME (SEE ATTACHED OUTPUT)

SUMMARY OF PRE-DEVELOPMENT FLOW RATES & RUNOFF VOLUMES FROM COMPUTER OUTPUT

PEAK FLOW RATES (CFS)	NORTH AREA (#1)	EAST AREA (#2)	WEST AREA (#3)
$Q_{10YR/24HR}$	40.66	52.89	37.61
$Q_{25YR/24HR}$	53.21	70.65	50.22
$Q_{100YR/24HR}$	76.20	104.00	73.63

PEAK RUNOFF VOLUME (AC-FT)	NORTH AREA (#1)	EAST AREA (#2)	WEST AREA (#3)
$\forall_{10YR/24HR}$	4.95	10.90	6.86
$\forall_{25YR/24HR}$	6.40	14.32	9.01
$\forall_{100YR/24HR}$	9.11	20.72	13.04

PRE-DEVELOPMENT

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WEYERHAEUSER PLYMOUTH - NORTH AREA 10YR/24HR STORM

DRAINAGE AREA = .0353 SQUARE MILES
TIME OF CONCENTRATION = .442 HOURS
RUNOFF CURVE NUMBER = 66
STORM DURATION = 24 HOURS
SCS TYPE 3 STORM
RAINFALL = 6.25 INCHES
RUNOFF = 2.63 INCHES = 4.95 ACRE FEET

VOLUME ADJUSTMENT FACTOR = 1.00

*** MAXIMUM FLOW = 40.66 CFS AT 12.3 HOURS ***

TIME (HOURS)	CUM. RAINFALL (INCHES)	CUM. RUNOFF (INCHES)	FLOW (CFS)
0.00	0.00	0.00	0.00
1.00	0.06	0.00	0.00
2.00	0.13	0.00	0.00
3.00	0.19	0.00	0.00
4.00	0.27	0.00	0.00
5.00	0.35	0.00	0.00
6.00	0.45	0.00	0.00
7.00	0.57	0.00	0.00
8.00	0.71	0.00	0.00
9.00	0.91	0.00	0.00
10.00	1.18	0.00	0.15
11.00	1.56	0.05	1.28
12.00	3.13	0.61	15.72
13.00	4.69	1.52	11.28
14.00	5.07	1.77	5.49
15.00	5.34	1.96	4.10
16.00	5.54	2.10	3.02
17.00	5.68	2.21	2.33
18.00	5.80	2.29	1.83
19.00	5.90	2.36	1.57
20.00	5.98	2.43	1.42
21.00	6.06	2.49	1.33
22.00	6.13	2.54	1.18
23.00	6.19	2.58	1.07
24.00	6.25	2.63	0.95
25.00	6.25	2.63	0.01

PRE-DEVELOPMENT

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WEYERHAEUSER PLYMOUTH - NORTH AREA 25YR/24HR STORM

DRAINAGE AREA = .0353 SQUARE MILES
TIME OF CONCENTRATION = .442 HOURS
RUNOFF CURVE NUMBER = 66
STORM DURATION = 24 HOURS
SCS TYPE 3 STORM
RAINFALL = 7.25 INCHES
RUNOFF = 3.40 INCHES = 6.40 ACRE FEET

VOLUME ADJUSTMENT FACTOR = 1.00

*** MAXIMUM FLOW = 53.21 CFS AT 12.3 HOURS ***

TIME (HOURS)	CUM. RAINFALL (INCHES)	CUM. RUNOFF (INCHES)	FLOW (CFS)
0.00	0.00	0.00	0.00
1.00	0.07	0.00	0.00
2.00	0.14	0.00	0.00
3.00	0.22	0.00	0.00
4.00	0.31	0.00	0.00
5.00	0.41	0.00	0.00
6.00	0.52	0.00	0.00
7.00	0.66	0.00	0.00
8.00	0.83	0.00	0.00
9.00	1.06	0.00	0.00
10.00	1.37	0.02	0.63
11.00	1.81	0.10	2.20
12.00	3.63	0.87	21.68
13.00	5.44	2.03	14.24
14.00	5.88	2.35	6.84
15.00	6.19	2.58	5.08
16.00	6.42	2.76	3.73
17.00	6.59	2.89	2.87
18.00	6.73	2.99	2.25
19.00	6.84	3.08	1.92
20.00	6.94	3.16	1.74
21.00	7.03	3.23	1.63
22.00	7.11	3.29	1.45
23.00	7.18	3.35	1.31
24.00	7.25	3.40	1.16
25.00	7.25	3.40	0.01

PRE - DEVELOPMENT

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WEYERHAEUSER PLYMOUTH - NORTH AREA 100YR/24HR STORM

DRAINAGE AREA = .0353 SQUARE MILES
TIME OF CONCENTRATION = .442 HOURS
RUNOFF CURVE NUMBER = 66
STORM DURATION = 24 HOURS
SCS TYPE 3 STORM
RAINFALL = 9 INCHES
RUNOFF = 4.84 INCHES = 9.11 ACRE FEET

VOLUME ADJUSTMENT FACTOR = 1.00

*** MAXIMUM FLOW = 76.20 CFS AT 12.3 HOURS ***

TIME (HOURS)	CUM. RAINFALL (INCHES)	CUM. RUNOFF (INCHES)	FLOW (CFS)
0.00	0.00	0.00	0.00
1.00	0.09	0.00	0.00
2.00	0.18	0.00	0.00
3.00	0.28	0.00	0.00
4.00	0.39	0.00	0.00
5.00	0.51	0.00	0.00
6.00	0.65	0.00	0.00
7.00	0.81	0.00	0.00
8.00	1.03	0.00	0.00
9.00	1.31	0.01	0.46
10.00	1.70	0.08	1.66
11.00	2.25	0.23	4.05
12.00	4.50	1.40	32.95
13.00	6.75	3.01	19.52
14.00	7.30	3.44	9.23
15.00	7.69	3.75	6.82
16.00	7.97	3.99	4.98
17.00	8.19	4.16	3.82
18.00	8.35	4.30	2.99
19.00	8.49	4.41	2.56
20.00	8.61	4.52	2.31
21.00	8.73	4.61	2.15
22.00	8.83	4.69	1.91
23.00	8.92	4.77	1.73
24.00	9.00	4.84	1.54
25.00	9.00	4.84	0.01

PRE-DEVELOPMENT

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WEYERHAEUSER PLYMOUTH - EAST AREA 10YR/24HR STORM

DRAINAGE AREA = .0869 SQUARE MILES
TIME OF CONCENTRATION = 1.164 HOURS
RUNOFF CURVE NUMBER = 63
STORM DURATION = 24 HOURS
SCS TYPE 3 STORM
RAINFALL = 6.25 INCHES
RUNOFF = 2.35 INCHES = 10.90 ACRE FEET

VOLUME ADJUSTMENT FACTOR = 1.00

*** MAXIMUM FLOW = 52.89 CFS AT 12.9 HOURS ***

TIME (HOURS)	CUM. RAINFALL (INCHES)	CUM. RUNOFF (INCHES)	FLOW (CFS)
0.00	0.00	0.00	0.00
1.00	0.06	0.00	0.00
2.00	0.13	0.00	0.00
3.00	0.19	0.00	0.00
4.00	0.27	0.00	0.00
5.00	0.35	0.00	0.00
6.00	0.45	0.00	0.00
7.00	0.57	0.00	0.00
8.00	0.71	0.00	0.00
9.00	0.91	0.00	0.00
10.00	1.18	0.00	0.00
11.00	1.56	0.02	0.56
12.00	3.13	0.49	7.20
13.00	4.69	1.31	51.20
14.00	5.07	1.55	20.70
15.00	5.34	1.73	11.98
16.00	5.54	1.86	8.59
17.00	5.68	1.96	6.33
18.00	5.80	2.04	4.98
19.00	5.90	2.10	3.99
20.00	5.98	2.16	3.52
21.00	6.06	2.22	3.19
22.00	6.13	2.27	2.90
23.00	6.19	2.31	2.65
24.00	6.25	2.35	2.38
25.00	6.25	2.35	0.85
26.00	6.25	2.35	0.10
27.00	6.25	2.35	0.01

PRE-DEVELOPMENT

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WEYERHAEUSER PLYMOUTH - EAST AREA 25YR/24HR STORM

DRAINAGE AREA = .0869 SQUARE MILES
TIME OF CONCENTRATION = 1.164 HOURS
RUNOFF CURVE NUMBER = 63
STORM DURATION = 24 HOURS
SCS TYPE 3 STORM
RAINFALL = 7.25 INCHES
RUNOFF = 3.09 INCHES = 14.32 ACRE FEET

VOLUME ADJUSTMENT FACTOR = 1.00

*** MAXIMUM FLOW = 70.65 CFS AT 12.8 HOURS ***

TIME (HOURS)	CUM. RAINFALL (INCHES)	CUM. RUNOFF (INCHES)	FLOW (CFS)
0.00	0.00	0.00	0.00
1.00	0.07	0.00	0.00
2.00	0.14	0.00	0.00
3.00	0.22	0.00	0.00
4.00	0.31	0.00	0.00
5.00	0.41	0.00	0.00
6.00	0.52	0.00	0.00
7.00	0.66	0.00	0.00
8.00	0.83	0.00	0.00
9.00	1.06	0.00	0.00
10.00	1.37	0.01	0.09
11.00	1.81	0.06	1.77
12.00	3.63	0.72	11.36
13.00	5.44	1.79	67.89
14.00	5.88	2.09	26.59
15.00	6.19	2.31	15.12
16.00	6.42	2.48	10.75
17.00	6.59	2.60	7.89
18.00	6.73	2.70	6.20
19.00	6.84	2.78	4.96
20.00	6.94	2.85	4.37
21.00	7.03	2.92	3.96
22.00	7.11	2.98	3.59
23.00	7.18	3.04	3.28
24.00	7.25	3.09	2.95
25.00	7.25	3.09	1.05
26.00	7.25	3.09	0.12
27.00	7.25	3.09	0.01

PRE - DEVELOPMENT

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EYERHAEUSER PLYMOUTH - EAST AREA 100YR/24HR STORM

DRAINAGE AREA = .0869 SQUARE MILES
TIME OF CONCENTRATION = 1.164 HOURS
RUNOFF CURVE NUMBER = 63
STORM DURATION = 24 HOURS
SCS TYPE 3 STORM
RAINFALL = 9 INCHES
RUNOFF = 4.47 INCHES = 20.72 ACRE FEET

VOLUME ADJUSTMENT FACTOR = 1.00

*** MAXIMUM FLOW = 104.00 CFS AT 12.8 HOURS ***

TIME (HOURS)	CUM. RAINFALL (INCHES)	CUM. RUNOFF (INCHES)	FLOW (CFS)
0.00	0.00	0.00	0.00
1.00	0.09	0.00	0.00
2.00	0.18	0.00	0.00
3.00	0.28	0.00	0.00
4.00	0.39	0.00	0.00
5.00	0.51	0.00	0.00
6.00	0.65	0.00	0.00
7.00	0.81	0.00	0.00
8.00	1.03	0.00	0.00
9.00	1.31	0.00	0.03
10.00	1.70	0.04	1.24
11.00	2.25	0.17	4.64
12.00	4.50	1.20	19.63
13.00	6.75	2.72	98.73
14.00	7.30	3.13	37.27
15.00	7.69	3.43	20.74
16.00	7.97	3.65	14.60
17.00	8.19	3.82	10.67
18.00	8.35	3.95	8.36
19.00	8.49	4.06	6.67
20.00	8.61	4.16	5.87
21.00	8.73	4.25	5.31
22.00	8.83	4.33	4.81
23.00	8.92	4.40	4.38
24.00	9.00	4.47	3.94
25.00	9.00	4.47	1.41
26.00	9.00	4.47	0.17
27.00	9.00	4.47	0.02

PRE-DEVELOPMENT

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WEYERHAEUSER PLYMOUTH - WEST AREA 10YR/24HR STORM

DRAINAGE AREA = .0547 SQUARE MILES
TIME OF CONCENTRATION = .963 HOURS 0.972
RUNOFF CURVE NUMBER = 63
STORM DURATION = 24 HOURS
SCS TYPE 3 STORM
RAINFALL = 6.25 INCHES
RUNOFF = 2.35 INCHES = 6.86 ACRE FEET

VOLUME ADJUSTMENT FACTOR = 1.00

*** MAXIMUM FLOW = 37.61 CFS AT 12.7 HOURS ***

TIME (HOURS)	CUM. RAINFALL (INCHES)	CUM. RUNOFF (INCHES)	FLOW (CFS)
0.00	0.00	0.00	0.00
1.00	0.06	0.00	0.00
2.00	0.13	0.00	0.00
3.00	0.19	0.00	0.00
4.00	0.27	0.00	0.00
5.00	0.35	0.00	0.00
6.00	0.45	0.00	0.00
7.00	0.57	0.00	0.00
8.00	0.71	0.00	0.00
9.00	0.91	0.00	0.00
10.00	1.18	0.00	0.00
11.00	1.56	0.02	0.50
12.00	3.13	0.49	6.28
13.00	4.69	1.31	31.14
14.00	5.07	1.55	11.07
15.00	5.34	1.73	6.88
16.00	5.54	1.86	5.11
17.00	5.68	1.96	3.79
18.00	5.80	2.04	3.00
19.00	5.90	2.10	2.43
20.00	5.98	2.16	2.18
21.00	6.06	2.22	1.98
22.00	6.13	2.27	1.79
23.00	6.19	2.31	1.64
24.00	6.25	2.35	1.47
25.00	6.25	2.35	0.33
26.00	6.25	2.35	0.02
27.00	6.25	2.35	0.00

PRE-DEVELOPMENT

13/14

SCS Hydrograph Generation Program
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WEYERHAEUSER PLYMOUTH - WEST AREA 25YR/24HR STORM

DRAINAGE AREA = .0547 SQUARE MILES
TIME OF CONCENTRATION = ~~.963~~ HOURS 0.972
RUNOFF CURVE NUMBER = 63
STORM DURATION = 24 HOURS
SCS TYPE 3 STORM
RAINFALL = 7.25 INCHES
RUNOFF = 3.09 INCHES = 9.01 ACRE FEET

VOLUME ADJUSTMENT FACTOR = 1.00

*** MAXIMUM FLOW = 50.22 CFS AT 12.7 HOURS ***

TIME (HOURS)	CUM. RAINFALL (INCHES)	CUM. RUNOFF (INCHES)	FLOW (CFS)
0.00	0.00	0.00	0.00
1.00	0.07	0.00	0.00
2.00	0.14	0.00	0.00
3.00	0.22	0.00	0.00
4.00	0.31	0.00	0.00
5.00	0.41	0.00	0.00
6.00	0.52	0.00	0.00
7.00	0.66	0.00	0.00
8.00	0.83	0.00	0.00
9.00	1.06	0.00	0.00
10.00	1.37	0.01	0.09
11.00	1.81	0.06	1.40
12.00	3.63	0.72	9.61
13.00	5.44	1.79	40.91
14.00	5.88	2.09	14.11
15.00	6.19	2.31	8.65
16.00	6.42	2.48	6.39
17.00	6.59	2.60	4.72
18.00	6.73	2.70	3.73
19.00	6.84	2.78	3.02
20.00	6.94	2.85	2.70
21.00	7.03	2.92	2.45
22.00	7.11	2.98	2.22
23.00	7.18	3.04	2.03
24.00	7.25	3.09	1.82
25.00	7.25	3.09	0.41
26.00	7.25	3.09	0.03
27.00	7.25	3.09	0.00

PRE-DEVELOPMENT

14/4

SCS Hydrograph Generation Program
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WEYERHAEUSER PLYMOUTH - WEST AREA 100YR/24HR STORM

DRAINAGE AREA = .0547 SQUARE MILES
TIME OF CONCENTRATION = ~~.963~~ HOURS 0.972
RUNOFF CURVE NUMBER = 63
STORM DURATION = 24 HOURS
SCS TYPE 3 STORM
RAINFALL = 9 INCHES
RUNOFF = 4.47 INCHES = 13.04 ACRE FEET

VOLUME ADJUSTMENT FACTOR = 1.00

*** MAXIMUM FLOW = 73.63 CFS AT 12.7 HOURS ***

TIME (HOURS)	CUM. RAINFALL (INCHES)	CUM. RUNOFF (INCHES)	FLOW (CFS)
0.00	0.00	0.00	0.00
1.00	0.09	0.00	0.00
2.00	0.18	0.00	0.00
3.00	0.28	0.00	0.00
4.00	0.39	0.00	0.00
5.00	0.51	0.00	0.00
6.00	0.65	0.00	0.00
7.00	0.81	0.00	0.00
8.00	1.03	0.00	0.00
9.00	1.31	0.00	0.03
10.00	1.70	0.04	0.99
11.00	2.25	0.17	3.41
12.00	4.50	1.20	16.18
13.00	6.75	2.72	58.88
14.00	7.30	3.13	19.60
15.00	7.69	3.43	11.81
16.00	7.97	3.65	8.66
17.00	8.19	3.82	6.38
18.00	8.35	3.95	5.03
19.00	8.49	4.06	4.06
20.00	8.61	4.16	3.62
21.00	8.73	4.25	3.29
22.00	8.83	4.33	2.97
23.00	8.92	4.40	2.71
24.00	9.00	4.47	2.43
25.00	9.00	4.47	0.54
26.00	9.00	4.47	0.04
27.00	9.00	4.47	0.00

Attachment L3
Post Development Stormwater Design Calculations – North Area

DESIGN SHEET

RMT®

SHEET 1 OF 9

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
[illegible]	[illegible]	[illegible]	AVT	7/8/99	C5101.01

POST DEVELOPMENT STORM WATER ANALYSIS;

DETERMINE: PEAK RUNOFF RATE FOR AREA 1 / NORTH BASIN USING THE SCS METHOD & 25 YR - 24 HR STORM, ($Q_{p_{25/24}}$)

GIVEN: LOCATION: PLYMOUTH, NC
HYDROLOGIC SOIL GROUP (HSG): B
TOTAL AREA OF WATERSHED: 33.09 AC
MAXIMUM HYDRAULIC LENGTH = 2890 FT
EXTERIOR FACE OF TERRACE LENGTH: 60 FT
(Up: 3:1 SLOPE 20' HIGH)
DESIGN FOR 25 YR - 24 HR STORM EVENT
FACE OF TERRACE SLOPE = 33.3 %
TOTAL HYDRAULIC LENGTH = 2890 FT

% HYDRAULIC LENGTH MODIFIED = 0
% IMPERVIOUS AREA = 0

SOLUTION:

DETERMINE: 25 yr - 24 hr STORM = 7.25 INCHES (F. 8.03 K)

DETERMINE: CN = 69 FOR FAIR CONDITION GRASS COVER ON 50 TO 75 % OF THE AREA [illegible] 5 & 3" [illegible] (T. 8.03b)

DETERMINE: RUNOFF DEPTH (INCHES) USING T. 8.03 C
7.25 INCHES OF RAINFALL & CN = 69
BY DOUBLE INTERPOLATION.

RUNOFF DEPTH = 3.73 INCHES → 25 yr Event

DESIGN SHEET

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SHEET 2 OF 3

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WEYERHAEUSER - [illegible]	SYK	5/6/99	[illegible]	[illegible]	05101.01

25yr - TOTAL RUNOFF VOLUME = (3.73 IN)(33.09 AC)(1 FT/12 IN)
= 10.3 ACRE-FT

EQUIVALENT DRAINAGE AREA = f(HYDRAULIC LENGTH = 3660')

$a = (L/209)^{1/0.6}$

$a = (2890/209)^{1.67}$

$a = 80$ ACRES

USE MAXIMUM WATERSHED SLOPE OF 33.3% AS THE AVERAGE WATERSHED SLOPE (CONSERVATIVE)

PEAK RATE OF DISCHARGE: (F. 8.03 a), 80 ACRES, N=69
PEAK RATE OF DISCHARGE = 70 CFS/IN

PEAK DISCHARGE FOR EQUIVALENT WATERSHED = (70 CFS/IN)(3.73 IN)

$Q_1 = 261.1$ CFS

PEAK DISCHARGE $Q_2 = (261.1 \text{ CFS})\left(\frac{33.09 \text{ AC}}{80 \text{ AC}}\right) = 108$ CFS

ADJUST PEAK DISCHARGE FOR AVG WATERSHED SLOPE (33.3%)
(TABLE 8.03.d)

$Q_3 = (108 \text{ AC})(1.14)$ BY DOUBLE INTERPOLATION

$Q_{P_{25,24}} = 123$ CFS

DESIGN SHEET

RMT INC
100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH, NC	SYK	5-7-99	BNT	7/8/99	05101.01

SEDIMENT BASIN DESIGN - NORTH SEDIMENT BASIN

- RUNOFF FROM AREA THAT EQUALS 33.09 ACRES WILL ENTER THE NORTH BASIN

- $Q_{25,24} = 123$ CFS

- AREA OF BASIN 2W:1L OR GREATER
- BASIN SIDE SLOPES 3H:1V
- TOP OF DIKE 8' WIDE
- BOTTOM OF DIKE ≥ 2' ABOVE HIGH GROUNDWATER TABLE

DETERMINE BASIN VOLUME:

→ $V_{MIN} = (1800\ ft^3/acre)(33.09\ acres) = 59,562\ ft^3 = 1.4\ acft$

→ MAXIMUM SIZE BASIN THE NORTH AREA WILL ACCOMMODATE

EL. 8	140' × 330' =	46,200 SF	BOTTOM OF BASIN
EL. 14	176' × 366' =	64,416 SF	TOP OF PRICIPAL SPILLWAY (RISER PIPE)
EL. 16	188' × 378' =	71,064 SF	BOTTOM OF EMERGENCY SPILLWAY
EL. 18	200' × 390' =	78,000 SF	TOP OF DIKE

10 YR, 24 HR STORM :	6.25"	RUNOFF (CN=69)	2.91" *
25 YR, 24 HR STORM :	7.25"	RUNOFF (CN=69)	3.73" *

* FROM FIG 8.03j, 8.03k T. 8.03c (by double interpolation)

→ $V_{MAX} \leq 10$ acre-ft = 435,600 cf

$$V_{El.8-18} = \frac{10}{3}\left(46{,}200 + 78{,}000 + \sqrt{(46{,}200)(78{,}000)}\right) = 614{,}100\ cf = 14.1\ ac\text{-}ft$$

$V_{El.8-18} > V_{MAX}$, therefore reduce V to V_{MAX} ∴

MINIMUM AREA OF BASIN AT PRINCIPAL SPILLWAY

$A_P \geq Q(0.01)$ TO MAXIMIZE TRAPPING EFFICIENCY

$A_P \geq (123\ cfs)(0.01) \cong 1.23$ ACRES $= 53{,}579\ ft^2$

DESIGN SHEET

RMT® 100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

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WEYERHAEUSER - PLYMOUTH	SYK	5/7/00	BNT	7/3/00	05101.01

SIZE PRINCIPAL SPILLWAY

$Q_{p_{min}} = (0.2\ CFS/AC)(\text{TOTAL AREA OF DRAINAGE BASIN})$

$Q_{p_{min}} = (0.2\ CFS/AC)(33.09\ AC$

$Q_{p_{min}} = 6.62\ CFS$

IF: $H_{min} = 4\ ft$

$D = 24\ IN$ (CMP - BARREL)

$L = 100\ ft$

THEN: $Q_{min} = (22.06\ CFS)(0.89) = 19.6\ CFS$ (T. 8.07 A).

$d_{RISER} = 30\ IN$ (CMP - PERFORATED

MINIMUM HEAD REQUIRED

$Q = 22\ CFS$
$d_{RISER} = 30\ IN$
T. 8.07b
$\Big\}\ h_{min} = 0.9\ ft$

HT OF RISER (Z): $Z = 2D = (2)(2\ ft) = 4\ ft$

HT. OF EMERGENCY SPILLWAY: $(h + Z) = 0.9' + 4' = 4.9'$ MIN

TOP OF DIKE: $(2' + Z + h) = 2' + 4' + 0.9' = 6.9'$ MIN

EMERGENCY SPILLWAY DESIGN

$Q_p = f(H = 8', D = 2', L = 100' + T.8.07A, CMP) = (31.19_{CFS})(0.89)$

$Q_p = 27.8\ CFS.$

$Q_{ES} = Q_{D_{25/24}} - Q_p = 123\ CFS - 27.8\ CFS = 95.2\ CFS.$

DESIGN SHEET

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PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	JYK	5/7/99	BWK	7/12/99	05101.01

— (E.S. DESIGN) —

DIMENSIONS FROM T. 8.07 C & Q_E = 100 CFS

STAGE = 1.13 FT

BOTTOM WIDTH = 36 FT

MAX. SLOPE = 6.1%

MIN SLOPE = 2.8 %

SPECIFY SEDIMENT CLEANOUT LEVEL TO BE MARKED ON [illegible]ER (ONE-HALF THE DESIGN SEDIMENT STORAGE VOLUME).

DESIGN SHEET

RMT®

SHEET 6 OF 9

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PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	5/12/99	[illegible]	7/6/99	05101.01

NORTH BASIN

POST DEVELOPMENT LAND USE:

- OPEN SPACE, FAIR CONDITIONS GRASS COVER ON 50 TO 75% OF SITE, HYDROLOGIC SOIL GROUP 'B'
  → USE CURVE NO. 69

- PERMANENT SEEDINGS FROM 0-60 DAYS
  → CONTROL PRACTICE FACTOR = 0.4

DETERMINING POST DEVELOPMENT PEAK FLOWRATES USING SCS METHODOLOGY & SEDIMOT II MODEL

- CALCULATE TIME OF CONCENTRATION FOR SHEET FLOW (0-60'), CHANNELIZED FLOW (ALONG BASE OF TERRACE) & CHANNELIZED FLOW ALONG BASE OF LANDFILL FROM ARTICULATED BLOCK CHANNEL (NORTHWEST) TO THE SEDIMENT BASIN. ASSUME TRAVEL TIME DOWN ARTICULATED BLOCK CHANNEL HAPPENS INSTANTANEOUS (CONSERVATIVE ASSUMPTION) AND IS ZERO.

SHEET FLOW: (0-60')

$$T_{t_{0-60'}} = \frac{0.007(nL)^{0.8}}{\sqrt{P_2} \cdot S^{0.4}} = \frac{(0.007)(0.15(60))^{0.8}}{\sqrt{4} \cdot (0.333)^{0.4}}$$

$$T_{t_{0-60'}} = 0.032 \text{ hrs}$$

where:

P_2 = 2 yr, 24 hr storm = 4 inches
S = slope = ft/3ft = 0.333
n = Manning roughness coefficient for sheet flow
n = 0.15 (short prairie grass)
L = flow length = 60 ft

DESIGN SHEET

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PROJECT/PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER DLUMOUTH	SYK	5/12/99	[illegible]	[illegible]/01	05101.01

TRAPEZOIDAL CHANNEL FLOW

$$V_{el} = \frac{1.49\, r^{2/3} \cdot S^{1/2}}{n}$$

where: n = Roughness Coeff for Channel Flow

$n = 0.035$ (earth with weeds + stone)

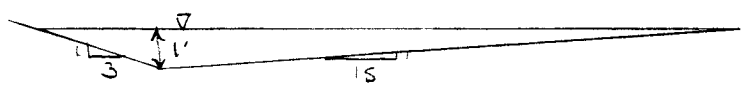
S = Slope = 0.005 ft/ft

r = hydraulic radius = a/p_w

a = cross-sectional flow area ft^2

p_w = wetted perimeter

CHANNEL ALONG BASE OF TERRACE



$a = (1)(3)(1/2) + (1)(15)(1/2) = 9.0\ ft^2$

$p_w = \left(\sqrt{1^2+3^2} + \sqrt{1^2+15^2}\right) = 18.2\ ft$

$r = a/p_w = 0.495\ ft$

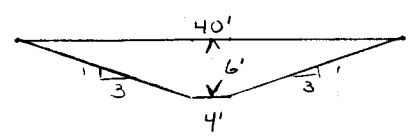
$$V_{el} = \frac{1.49\,(0.495)^{2/3} \cdot (0.005)^{1/2}}{0.035}$$

$V_{el} = 1.88\ ft/sec$

$T_t = \left(\frac{DIST}{VEL}\right) / (3600\ sec/hr)$

DIST. VARIES = MAX CHANNEL LENGTH ALONG TERRACE

CHANNEL ALONG BASE OF LANDFILL PAD



$a = \left(\frac{4'+40'}{2}\right)(6') = 132\ ft^2$

$p_w = 2\left(\sqrt{6^2+18^2}\right) + 4 = 41.95\ ft$

$r = a/p_w = \frac{132\ ft^2}{41.95\ ft} = 3.147\ ft$

$$V_{el} = \frac{1.49\,(3.147)^{2/3} \cdot (0.005)^{1/2}}{0.035}$$

$V_{el} = 6.46\ ft/sec$

$T_t = \left(\frac{DIST}{VEL}\right) / (3600\ sec/hr)$

DIST = 1680 ft

$T_t = 0.072\ hrs$

BASE CHANNEL

DESIGN SHEET

RMT®

SHEET 8 OF 9

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PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	5/12/99	[illegible]	7/6/99	05101.01

AREA 1 (NORTH BASIN)

WATERSHED #	AREA (AC)	MAX CHANNEL LENGTH ALONG TERRACE (FT)*	$T_{t_{TERRACE\ CHANNEL}}$	$T_{t_{BASE\ CHANNEL}}$	$T_{t_{SHEET\ FLOW}}$	$T_c = \sum T_t$
1	3.19	1475	0.218	—	0.032	0.250
2	4.90	1430	0.211	—	0.032	0.243
3	8.65	1360	0.201	—	0.032	0.233
4	0.52	570	0.084	0.072	0.032	0.188
5	1.50	595	0.088	0.072	0.032	0.192
6	1.86	680	0.100	0.072	0.032	0.204
7	2.07	750	0.111	0.072	0.032	0.215
8	2.33	825	0.122	0.072	0.032	0.226
9	2.15	845	0.125	0.072	0.032	0.229
10	1.88	760	0.112	0.072	0.032	0.216
11	1.62	680	0.100	0.072	0.032	0.204
12	1.31	600	0.089	0.072	0.032	0.193
13*	1.11	515	0.076	0.072	0.108	0.256

33.09 ACRES

$$T_c = T_{t_{SHEET\ FLOW}} + T_{t_{BASE\ CHANNEL}} + T_{t_{TERRACE\ CHANNEL}} + T_{t_{ARTICULATE\ BLOCK\ CHANNEL}}$$

$$T_{t_{SHEET\ FLOW}}^{*} = 0.032 + \frac{0.007(0.15(70'))^{0.8}}{\sqrt{4} \cdot (0.05)^{0.4}}$$

$$T_{t_{SF}}^{*} = 0.108\ hrs$$

** Assume $T_{t_{ARTICULATED\ BLOCK\ CHANNEL}}$ equals zero (conservative).

OUTFLOW STRUCTURE EVALUATION

RETENTION POND # **1** **(North Area)**

Weyerhaeuser No. 3 Landfill Permit Application ***RMT Job No.*** ***5101.01***

Plymouth, North Carolina

POND WIDTH	**120**	(feet)
POND LENGTH	**290**	(feet)
SIDE SLOPE	**3**	(Z:1)
DEPTH INCREMENT	**0.5**	(feet)

Depth (ft.)	Width (ft.)	Length (ft.)	Area (sq. ft.)	Area (acres)	Avg. Area (sq. ft.)	Storage (acre-ft.)
0	120	290	34,800	0.80		0
					35,420	
0.5	123	293	36,039	0.83		0.41
					36,668	
1	126	296	37,296	0.86		0.83
					37,934	
1.5	129	299	38,571	0.89		1.26
					39,218	
2	132	302	39,864	0.92		1.71
					40,520	
2.5	135	305	41,175	0.95		2.18
					41,840	
3	138	308	42,504	0.98		2.66
					43,178	
3.5	141	311	43,851	1.01		3.15
					44,534	
4	144	314	45,216	1.04		3.67
					45,908	
4.5	147	317	46,599	1.07		4.19
					47,300	
5	150	320	48,000	1.10		4.74
					48,710	
5.5	153	323	49,419	1.13		5.29
					50,138	
6	156	326	50,856	1.17		5.87
					51,584	
6.5	159	329	52,311	1.20		6.46
					53,048	
7	162	332	53,784	1.23		7.07
					54,530	
7.5	165	335	55,275	1.27		7.70
					56,030	
8	168	338	56,784	1.30		8.34
					57,548	
8.5	171	341	58,311	1.34		9.00

~(Continued)~OUTFLOW STRUCTURE EVALUATION

RETENTION POND # **1** **(North Area)**

Weyerhaeuser No. 3 Landfill Permit Application ***RMT Job No.*** ***5101.01***

Plymouth, North Carolina

Depth (ft.)	Width (ft.)	Length (ft.)	Area (sq. ft.)	Area (acres)	Avg. Area (sq. ft.)	Storage (acre-ft.)
					59,084	
9	174	344	59,856	1.37		9.68
					60,638	
9.5	177	347	61,419	1.41		10.37
					62,210	
10	180	350	63,000	1.45		11.09
					63,800	
10.5	183	353	64,599	1.48		11.82
					65,408	
11	186	356	66,216	1.52		12.57
					67,034	
11.5	189	359	67,851	1.56		13.34
					68,678	
12	192	362	69,504	1.60		14.13
					70,340	
12.5	195	365	71,175	1.63		14.94
					72,020	
13	198	368	72,864	1.67		15.76
					73,718	
13.5	201	371	74,571	1.71		16.61
					75,434	
14	204	374	76,296	1.75		17.48
					77,168	
14.5	207	377	78,039	1.79		18.36
					78,920	
15	210	380	79,800	1.83		19.27
					80,690	
15.5	213	383	81,579	1.87		20.19
					82,478	
16	216	386	83,376	1.91		21.14
					84,284	
16.5	219	389	85,191	1.96		22.11
					86,108	
17	222	392	87,024	2.00		23.10
					87,950	
17.5	225	395	88,875	2.04		24.11
					89,810	
18	228	398	90,744	2.08		25.14
					91,688	
18.5	231	401	92,631	2.13		26.19

Weyerhaeuser No. 3 Landfill Permit Application
Plymouth, North Carolina

Detention Pond # ***1***
Height of Riser (ft.) ***6***
Height of Emergency Spillway (ft.) ***8***

RMT Job No. 05101.01

HEAD	ROW																								
ELEV.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	PRIN.	EMER.	**TOTAL**
0.00	-																						0	0	**-**
0.50	0.18	-																					0	0	0.18
1.00	0.26	0.18	-																				0	0	0.44
1.50	0.32	0.26	0.18	-																			0	0	0.75
2.00	0.36	0.32	0.26	0.18	-																		0	0	1.12
2.50	0.41	0.36	0.32	0.26	0.18	-																	0	0	1.52
3.00	0.45	0.41	0.36	0.32	0.26	0.18	-																0	0	1.97
3.50	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-															0	0	2.45
4.00	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-														0	0	**2.97**
4.50	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-													0	0	**3.51**
5.00	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-												0	0	**4.09**
5.50	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-											0	0	**4.69**
6.00	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-										0	0	**5.32**
6.50	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-									9.2	0	**15.18**
7.00	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-								24.4	0	**31.06**
7.50	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-							29.9	0	**37.26**
8.00	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-						34.5	0	**42.59**
8.50	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-					38.6	34.65	**82.09**
9.00	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-				42.3	112.28	**164.19**
9.50	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-			45.7	225.57	281.67
10.00	0.81	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-		48.8	372.83	432.85
10.50	0.83	0.81	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-	51.8	553.7	617.55
11.00	0.85	0.83	0.81	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	54.6	768.7	*836.20*

TOTAL FLOW RATE PER ROW OF PERFORATED RISER PIPE USING THE ORIFICE EQUATION:

$$Q=n*C_d*A_o*(2*g*y)^{0.5}$$

WHERE:

D =	diameter of riser pipe (inches)	LET: D =	**30**	$n*C_d*A_o$ = 0.0321
s =	lateral spacing of orifice holes on riser (inches)	s ~	**4**	$(2*g)^{0.5}$ = 8.025
n =	number of holes per row =(3.14*D/s)+/-1	n =	**24**	increment= **0.5**
d =	diameter of orifice (inches)	d =	**0.500**	
A_o =	orifice area (sq. ft.) = $(3.14*(d^2/4))/144$	A_o =	0.0014	
g =	32.2 ft/sec^2	g =	32.2	
y =	elevation head (ft)	y =	(see first column in table)	
A_2 =	jet area (sq. ft.)	A_2 =	A_o	
C_v =	0.95 (sqr. edge) to 0.99 (round edge)	C_v =	**0.98**	
C_c =	A_2/A_o	C_c =	**1**	
C_d =	discharge coefficient $=C_c*C_v$	C_d =	0.98	

Normal Depth Channel Analysis Program
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WEYERHAEUSER PLYMOUTH NO. 3 LANDFILL

CHANNEL SLOPE = .005 FT/FT
MANNINGS N = .035

TRAPEZOIDAL CHANNEL OUTPUT

BOTTOM WIDTH = 36 FT
LEFT SIDE SLOPE = 4 FT/FT
RIGHT SIDE SLOPE = 4 FT/FT

DEPTH (FT)	FLOW (CFS)	AREA (SQ FT)	WP (FT)	VEL (FT/SEC)	CR. DEP. (FT)
0.50	34.65	19.00	40.12	1.82	0.30
1.00	112.28	40.00	44.25	2.81	0.65
1.50	225.57	63.00	48.37	3.58	1.03
2.00	372.83	88.00	52.49	4.24	1.41
2.50	553.74	115.00	56.62	4.82	1.81
3.00	768.65	144.00	60.74	5.34	2.22
3.50	1018.22	175.00	64.86	5.82	2.63

OUTFLOW RATING TABLE FOR FLOW ABOVE THE RISER FOR DETENTION POND NO. 1

NORTH AREA

Weyerhaeuser No. 3 Landfill Permit Application ***RMT Job No.*** ***5101.01***

Plymouth, North Carolina

RISER DIAMETER.	**2.5**	FT.
HEIGHT OF RISER	***6***	FT.
OUTFLOW PIPE DIAMETER.	***2***	FT.
OUTFLOW PIPE LENGTH.	***100***	FT.
OUTFLOW PIPE SLOPE.	***1***	%
MANNING N-VALUE.	***0.023***	(corrugated metal pipe)
ENTRANCE LOSS COEFFICIENT.	1	
BEND LOSS COEFICIENT.	1	
WEIR COEFICIENT.	***3.33***	(english units)
ORIFICE COEFFICIENT (Cd)	***0.62***	(into riser pipe)
TAILWATER DEPTH	***2.5***	FT.
THICKNESS OF WEIR.	***1***	FT.

HEAD (FT.)	FLOW (CFS)	CONTROL
0	**0**	
0.25	3.3	WEIR
0.50	**9.2**	WEIR
0.75	17.0	WEIR
1.00	**24.4**	ORIFICE
1.25	27.3	ORIFICE
1.50	**29.9**	ORIFICE
1.75	32.3	ORIFICE
2.00	**34.5**	ORIFICE
2.25	36.6	ORIFICE
2.50	**38.6**	ORIFICE
2.75	40.5	ORIFICE
3.00	**42.3**	ORIFICE
3.25	44.0	ORIFICE
3.50	**45.7**	ORIFICE
3.75	47.3	ORIFICE
4.00	**48.8**	ORIFICE
4.25	50.3	ORIFICE
4.50	**51.8**	ORIFICE
4.75	53.2	ORIFICE
5.00	**54.6**	ORIFICE

WEIR FLOW: $Q=C_w*L*H^{1.5}$ ORIFICE FLOW: $Q=C_d*A_o*(2*g*H)^{0.5}$

where: Cw = weir coefficient =3.33 (english units) Cd = C_c* C_v (or see attached sheet)

L = weir length or perimeter of riser (ft.) Ao = orifice area (sq.ft.)

H = head (feet) g = 32.2 ft/s^2

Cc = A_2/A_o (or see attached sheet) *Cv = 0.99 (rounded) to 0.95 (square) orifice*

```
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*                                        * HMVersion     :  3.20             *
*       (program description)            * Date          :  5/25/99          *
*                                        * Time          : 15:54:18          *
*                                        * Input file    : WPN1D.INP         *
*                                        * Output file   : WPN1D.OUT         *
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*                                        *                                   *
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x     x  x        x     x    x    xx   xx  x     x     x
x        x        x     x    x    x x x x  x     x     x
 xxxxx   xxxxx    x     x    x    x  x  x  x     x     x
      x  x        x     x    x    x     x  x     x     x
x     x  x        x     x    x    x     x  x     x     x
 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx      x
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:::  Full Microcomputer Implementation   :::
:::                 by                   :::
:::        Haestad Methods, Inc.         :::
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        UNIVERSITY OF KENTUCKY COMPUTER MODEL
        OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
        FOR MORE INFORMATION CONTACT THE AGRICULTURAL
        ENGINEERING DEPARTMENT

        THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
        THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
        MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

        VERSION DATE 5-25-83

        DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
        ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
        CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL


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            *********************************************
                 WATERSHED IDENTIFICATION CODE
                 -----------------------------
                 WEYERHAEUSER PLYMOUTH/NORTH AREA/290'X 120'X 6'/2YR-24HR STO
            *********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        4.00 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=====================================================================


============================  WATERSHED DATA  ============================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

1 1
3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========

========== SEDIMENTOLOGY INPUTS ==========

QUESTION NO.		
1.	SPECIFIC GRAVITY -	2.64
2.	COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -	2.00
3.	SUBMERGED BULK SPECIFIC GRAVITY -	1.35
4.	NUMBER OF PARTICLE SIZE DISTRIBUTIONS -	1
5.	NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -	11

==========

========== INPUT PARTICLE SIZE DISTRIBUTIONS ==========

VALUE NO.	SIZE, MM
1	1.0000
2	.5000
3	.2000
4	.1000
5	.0800
6	.0500
7	.0100
8	.0090
9	.0050
10	.0020
11	.0001

==========

========== PERCENT FINER DISTRIBUTIONS ==========

VALUE NO.	PARTICLE SIZE # 1
1	100.00
2	99.90
3	87.50
4	50.50
5	44.50
6	36.50
7	32.00
8	31.00
9	29.00
10	24.50
11	.00

==========

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	13
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	3.19	69.00	.250	.000	.000	.00	2.0
2	4.90	69.00	.243	.000	.000	.00	2.0
3	8.65	69.00	.233	.000	.000	.00	2.0
4	.52	69.00	.188	.000	.000	.00	2.0
5	1.50	69.00	.192	.000	.000	.00	2.0
6	1.86	69.00	.204	.000	.000	.00	2.0
7	2.07	69.00	.215	.000	.000	.00	2.0
8	2.33	69.00	.226	.000	.000	.00	2.0
9	2.15	69.00	.229	.000	.000	.00	2.0
10	1.88	69.00	.216	.000	.000	.00	2.0
11	1.62	69.00	.204	.000	.000	.00	2.0
12	1.31	69.00	.193	.000	.000	.00	2.0
13	1.11	69.00	.256	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.40	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0
10	1	.20	60.0	33.30	.400	1.0	.0
11	1	.20	60.0	33.30	.400	1.0	.0
12	1	.20	60.0	33.30	.400	1.0	.0
13	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	2.91	1.27	58.94	.057	.775	1.000
2	4.53	1.27	95.96	.058	.781	1.000
3	8.14	1.27	366.20	.059	.788	1.000
4	.53	1.27	8.22	.066	.824	1.000
5	1.52	1.27	26.79	.065	.820	1.000
6	1.83	1.27	33.61	.063	.809	1.000
7	2.01	1.27	37.52	.062	.801	1.000
8	2.22	1.27	42.41	.060	.793	1.000
9	2.04	1.27	38.65	.060	.791	1.000
10	1.82	1.27	33.65	.061	.800	1.000
11	1.60	1.27	28.79	.063	.809	1.000
12	1.32	1.27	22.99	.065	.819	1.000
13	1.00	1.27	17.96	.056	.771	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	4.00	INCHES
RUNOFF VOLUME	=	3.4927	ACRE-FT
PEAK DISCHARGE	=	31.4647	CFS
AREA	=	33.0900	ACRES
TIME OF PEAK DISCHARGE	=	12.10	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	98.49	EI UNIT
PEAK CONCENTRATION	=	398557.60	MG/L
PEAK SETTLEABLE CONCENTRATION	=	174.0493	ML/L
PEAK SETTLEABLE CONCENTRATION	=	234966.50	MG/L
TOTAL SEDIMENT YIELD	=	811.6982	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0598	MM

TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	14.10	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	66.39	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	66.39	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	18.69	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	10.98	ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	13
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	3.50
3	4.00
4	4.50
5	5.00
6	5.50
7	6.00
8	6.50
9	7.00
10	7.50
11	8.00
12	8.50
13	9.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE

1	.80
2	1.01
3	1.04
4	1.07
5	1.10
6	1.13
7	1.17
8	1.20
9	1.23
10	1.27
11	1.30
12	1.34
13	1.37

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	2.97
4	3.51
5	4.09
6	4.69
7	5.32
8	15.18
9	31.06
10	37.26
11	42.59
12	82.09
13	164.10

==========

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)

.00	.800	.00	.00	.00
3.50	1.010	3.30	.00	3.17
4.00	1.040	3.77	2.97	3.68
4.50	1.070	4.23	3.51	4.21
5.00	1.100	4.69	4.09	4.75
5.50	1.130	5.15	4.69	5.31
6.00	1.170	5.59	5.32	5.88
6.50	1.200	6.04	15.18	6.47
7.00	1.230	6.47	31.06	7.08
7.50	1.270	6.91	37.26	7.71
8.00	1.300	7.34	42.59	8.35
8.50	1.340	7.76	82.09	9.01
9.00	1.370	8.19	164.10	9.69

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	3.168	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	3.493	ACRE-FT
OUTFLOW ROUTED VOLUME	=	3.493	ACRE-FT
STORM VOLUME DISCHARGED	=	3.493	ACRE-FT
POND VOLUME AT PEAK STAGE	=	4.713	ACRE-FT
PEAK STAGE	=	4.966	FT
PEAK INFLOW RATE	=	31.465	CFS
PEAK DISCHARGE RATE	=	4.050	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	398557.60	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	48199.90	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0001	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.07	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	39767.48	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	39767.48	MG/L
BASIN TRAP EFFICIENCY	=	76.64	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	3.36	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	3.36	HRS
DETENTION TIME INCLUDING STORED FLOW	=	3.36	HRS
SEDIMENT LOAD DISCHARGED	=	189.61	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	28.30	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

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*                                        * HMVersion    :  3.20              *
*       (program description)            * Date         :  5/17/99           *
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*                                        * Output file  : WPN1A.OUT          *
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 xxxxx   xxxxx    x     x    x    x  x  x  x     x     x
      x  x        x     x    x    x     x  x     x     x
x     x  x        x     x    x    x     x  x     x     x
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:::  Full Microcomputer Implementation   :::
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37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

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*************************************************************
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        UNIVERSITY OF KENTUCKY COMPUTER MODEL
        OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
        FOR MORE INFORMATION CONTACT THE AGRICULTURAL
        ENGINEERING DEPARTMENT

        THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
        THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
        MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

        VERSION DATE 5-25-83

        DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
        ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
        CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL


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             ********************************************
                  WATERSHED IDENTIFICATION CODE
                  -----------------------------
                  WEYERHAEUSER PLYMOUTH/NORTH AREA/290'X 120'X 6'/10YR-24HR ST
             ********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        6.25 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=========================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

```
          1                 1
   3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========================================================================


========================  SEDIMENTOLOGY INPUTS  ========================

QUESTION
   NO.
    1. SPECIFIC GRAVITY -                                            2.64
    2. COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -                  2.00
    3. SUBMERGED BULK SPECIFIC GRAVITY -                             1.35
    4. NUMBER OF PARTICLE SIZE DISTRIBUTIONS -                       1
    5. NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -       11

==========================================================================


================= INPUT PARTICLE SIZE DISTRIBUTIONS ====================

                        VALUE
                         NO.        SIZE, MM

                          1           1.0000
                          2            .5000
                          3            .2000
                          4            .1000
                          5            .0800
                          6            .0500
                          7            .0100
                          8            .0090
                          9            .0050
                         10            .0020
                         11            .0001

==========================================================================


====================  PERCENT FINER DISTRIBUTIONS  =====================

VALUE                       PARTICLE SIZE #
 NO.
            1
  1    100.00
  2     99.90
  3     87.50
  4     50.50
  5     44.50
  6     36.50
  7     32.00
  8     31.00
  9     29.00
 10     24.50
 11       .00

==========================================================================
```

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	13
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	3.19	69.00	.250	.000	.000	.00	2.0
2	4.90	69.00	.243	.000	.000	.00	2.0
3	8.65	69.00	.233	.000	.000	.00	2.0
4	.52	69.00	.188	.000	.000	.00	2.0
5	1.50	69.00	.192	.000	.000	.00	2.0
6	1.86	69.00	.204	.000	.000	.00	2.0
7	2.07	69.00	.215	.000	.000	.00	2.0
8	2.33	69.00	.226	.000	.000	.00	2.0
9	2.15	69.00	.229	.000	.000	.00	2.0
10	1.88	69.00	.216	.000	.000	.00	2.0
11	1.62	69.00	.204	.000	.000	.00	2.0
12	1.31	69.00	.193	.000	.000	.00	2.0
13	1.11	69.00	.256	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.40	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0
10	1	.20	60.0	33.30	.400	1.0	.0
11	1	.20	60.0	33.30	.400	1.0	.0
12	1	.20	60.0	33.30	.400	1.0	.0
13	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	7.00	2.91	153.33	.065	.821	1.000
2	10.86	2.91	249.36	.066	.825	1.000
3	19.43	2.91	949.81	.067	.832	1.000
4	1.25	2.91	21.15	.074	.863	1.000
5	3.57	2.91	68.95	.073	.859	1.000
6	4.33	2.91	86.59	.071	.848	1.000
7	4.76	2.91	96.93	.069	.842	1.000
8	5.28	2.91	109.85	.068	.836	1.000
9	4.86	2.91	100.17	.068	.834	1.000
10	4.31	2.91	86.96	.069	.842	1.000
11	3.77	2.91	74.18	.071	.848	1.000
12	3.11	2.91	59.18	.073	.858	1.000
13	2.41	2.91	46.78	.064	.817	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	6.25	INCHES
RUNOFF VOLUME	=	8.0219	ACRE-FT
PEAK DISCHARGE	=	74.9375	CFS
AREA	=	33.0900	ACRES
TIME OF PEAK DISCHARGE	=	12.10	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	260.30	EI UNIT
PEAK CONCENTRATION	=	417561.80	MG/L
PEAK SETTLEABLE CONCENTRATION	=	188.8485	ML/L
PEAK SETTLEABLE CONCENTRATION	=	254945.40	MG/L
TOTAL SEDIMENT YIELD	=	2103.2350	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0679	MM

TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	15.90	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	76.60	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	76.60	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	17.40	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	11.52	ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	13
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	3.50
3	4.00
4	4.50
5	5.00
6	5.50
7	6.00
8	6.50
9	7.00
10	7.50
11	8.00
12	8.50
13	9.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE

1	.80
2	1.01
3	1.04
4	1.07
5	1.10
6	1.13
7	1.17
8	1.20
9	1.23
10	1.27
11	1.30
12	1.34
13	1.37

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	2.97
4	3.51
5	4.09
6	4.69
7	5.32
8	15.18
9	31.06
10	37.26
11	42.59
12	82.09
13	164.10

==========

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)

.00	.800	.00	.00	.00
3.50	1.010	3.30	.00	3.17
4.00	1.040	3.77	2.97	3.68
4.50	1.070	4.23	3.51	4.21
5.00	1.100	4.69	4.09	4.75
5.50	1.130	5.15	4.69	5.31
6.00	1.170	5.59	5.32	5.88
6.50	1.200	6.04	15.18	6.47
7.00	1.230	6.47	31.06	7.08
7.50	1.270	6.91	37.26	7.71
8.00	1.300	7.34	42.59	8.35
8.50	1.340	7.76	82.09	9.01
9.00	1.370	8.19	164.10	9.69

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	3.168	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	8.022	ACRE-FT
OUTFLOW ROUTED VOLUME	=	8.022	ACRE-FT
STORM VOLUME DISCHARGED	=	8.022	ACRE-FT
POND VOLUME AT PEAK STAGE	=	6.680	ACRE-FT
PEAK STAGE	=	6.668	FT
PEAK INFLOW RATE	=	74.937	CFS
PEAK DISCHARGE RATE	=	20.529	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	417561.80	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	77211.64	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0007	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.96	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	60364.82	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	60364.82	MG/L
BASIN TRAP EFFICIENCY	=	68.54	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	4.05	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	4.05	HRS
DETENTION TIME INCLUDING STORED FLOW	=	4.05	HRS
SEDIMENT LOAD DISCHARGED	=	661.65	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	34.10	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

*** RUN COMPLETED ****

```
*****************************************************************************
*          (program name)                * SEDIMOT S/N  :                    *
*                                        * HMVersion    :  3.20              *
*       (program description)            * Date         :  5/17/99           *
*                                        * Time         : 11:40:52           *
*                                        * Input file   : WPN1B.INP          *
*                                        * Output file  : WPN1B.OUT          *
*                                        *                                   *
*                                        *                                   *
*****************************************************************************
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```
 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx   xxxxxxx
x     x  x        x     x    x    xx   xx  x     x     x
x        x        x     x    x    x x x x  x     x     x
 xxxxx   xxxxx    x     x    x    x  x  x  x     x     x
      x  x        x     x    x    x     x  x     x     x
x     x  x        x     x    x    x     x  x     x     x
 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx      x
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::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
:::                                      :::
:::  Full Microcomputer Implementation   :::
:::                 by                   :::
:::        Haestad Methods, Inc.         :::
:::                                      :::
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37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

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             *********************************************
                  WATERSHED IDENTIFICATION CODE
                  -------------------------------
                  WEYERHAEUSER PLYMOUTH/NORTH AREA/290'X 120'X 6'/25YR-24HR ST
             *********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        7.25 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=====================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

1 1

3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========

========== SEDIMENTOLOGY INPUTS ==========

QUESTION NO.		
1.	SPECIFIC GRAVITY -	2.64
2.	COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -	2.00
3.	SUBMERGED BULK SPECIFIC GRAVITY -	1.35
4.	NUMBER OF PARTICLE SIZE DISTRIBUTIONS -	1
5.	NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -	11

==========

========== INPUT PARTICLE SIZE DISTRIBUTIONS ==========

VALUE NO.	SIZE, MM
1	1.0000
2	.5000
3	.2000
4	.1000
5	.0800
6	.0500
7	.0100
8	.0090
9	.0050
10	.0020
11	.0001

==========

========== PERCENT FINER DISTRIBUTIONS ==========

VALUE NO.	PARTICLE SIZE # 1
1	100.00
2	99.90
3	87.50
4	50.50
5	44.50
6	36.50
7	32.00
8	31.00
9	29.00
10	24.50
11	.00

==========

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	13
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	3.19	69.00	.250	.000	.000	.00	2.0
2	4.90	69.00	.243	.000	.000	.00	2.0
3	8.65	69.00	.233	.000	.000	.00	2.0
4	.52	69.00	.188	.000	.000	.00	2.0
5	1.50	69.00	.192	.000	.000	.00	2.0
6	1.86	69.00	.204	.000	.000	.00	2.0
7	2.07	69.00	.215	.000	.000	.00	2.0
8	2.33	69.00	.226	.000	.000	.00	2.0
9	2.15	69.00	.229	.000	.000	.00	2.0
10	1.88	69.00	.216	.000	.000	.00	2.0
11	1.62	69.00	.204	.000	.000	.00	2.0
12	1.31	69.00	.193	.000	.000	.00	2.0
13	1.11	69.00	.256	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.40	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0
10	1	.20	60.0	33.30	.400	1.0	.0
11	1	.20	60.0	33.30	.400	1.0	.0
12	1	.20	60.0	33.30	.400	1.0	.0
13	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	8.99	3.72	202.44	.068	.832	1.000
2	13.94	3.72	329.20	.068	.837	1.000
3	24.95	3.72	1253.79	.070	.843	1.000
4	1.59	3.72	27.83	.076	.872	1.000
5	4.56	3.72	90.73	.075	.868	1.000
6	5.55	3.72	114.27	.073	.860	1.000
7	6.10	3.72	127.93	.072	.854	1.000
8	6.78	3.72	145.00	.071	.847	1.000
9	6.23	3.72	132.23	.070	.846	1.000
10	5.54	3.72	114.78	.072	.853	1.000
11	4.84	3.72	97.89	.073	.860	1.000
12	3.97	3.72	77.88	.075	.867	1.000
13	3.10	3.72	61.76	.067	.828	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	7.25	INCHES
RUNOFF VOLUME	=	10.2580	ACRE-FT
PEAK DISCHARGE	=	94.9414	CFS
AREA	=	33.0900	ACRES
TIME OF PEAK DISCHARGE	=	12.10	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	359.62	EI UNIT
PEAK CONCENTRATION	=	423574.00	MG/L
PEAK SETTLEABLE CONCENTRATION	=	193.2118	ML/L
PEAK SETTLEABLE CONCENTRATION	=	260835.90	MG/L
TOTAL SEDIMENT YIELD	=	2775.7090	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0702	MM

TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	16.70	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	79.45	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	79.45	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	17.05	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	11.87	ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	13
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	3.50
3	4.00
4	4.50
5	5.00
6	5.50
7	6.00
8	6.50
9	7.00
10	7.50
11	8.00
12	8.50
13	9.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE

1	.80
2	1.01
3	1.04
4	1.07
5	1.10
6	1.13
7	1.17
8	1.20
9	1.23
10	1.27
11	1.30
12	1.34
13	1.37

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	2.97
4	3.51
5	4.09
6	4.69
7	5.32
8	15.18
9	31.06
10	37.26
11	42.59
12	82.09
13	164.10

==========

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)

.00	.800	.00	.00	.00
3.50	1.010	3.30	.00	3.17
4.00	1.040	3.77	2.97	3.68
4.50	1.070	4.23	3.51	4.21
5.00	1.100	4.69	4.09	4.75
5.50	1.130	5.15	4.69	5.31
6.00	1.170	5.59	5.32	5.88
6.50	1.200	6.04	15.18	6.47
7.00	1.230	6.47	31.06	7.08
7.50	1.270	6.91	37.26	7.71
8.00	1.300	7.34	42.59	8.35
8.50	1.340	7.76	82.09	9.01
9.00	1.370	8.19	164.10	9.69

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	3.168	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	10.258	ACRE-FT
OUTFLOW ROUTED VOLUME	=	10.258	ACRE-FT
STORM VOLUME DISCHARGED	=	10.258	ACRE-FT
POND VOLUME AT PEAK STAGE	=	7.252	ACRE-FT
PEAK STAGE	=	7.136	FT
PEAK INFLOW RATE	=	94.941	CFS
PEAK DISCHARGE RATE	=	32.746	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	423574.00	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	89965.98	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0059	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	7.94	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	65774.48	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	65774.48	MG/L
BASIN TRAP EFFICIENCY	=	66.78	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	3.58	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	3.58	HRS
DETENTION TIME INCLUDING STORED FLOW	=	3.58	HRS
SEDIMENT LOAD DISCHARGED	=	922.07	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	35.60	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

```
*****************************************************************************
*          (program name)                * SEDIMOT S/N   :                   *
*                                        * HMVersion     :  3.20             *
*       (program description)            * Date          :  5/17/99          *
*                                        * Time          : 11:43:04          *
*                                        * Input file    : WPN1C.INP         *
*                                        * Output file   : WPN1C.OUT         *
*                                        *                                   *
*                                        *                                   *
*****************************************************************************
```

```
 XXXXX   XXXXXXX  XXXXXX   XXXXX  X     X   XXXXX   XXXXXXX
X     X  X        X     X    X    XX   XX  X     X     X
X        X        X     X    X    X X X X  X     X     X
 XXXXX   XXXXX    X     X    X    X  X  X  X     X     X
      X  X        X     X    X    X     X  X     X     X
X     X  X        X     X    X    X     X  X     X     X
 XXXXX   XXXXXXX  XXXXXX   XXXXX  X     X   XXXXX      X
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::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
:::                                      :::
:::  Full Microcomputer Implementation   :::
:::                 by                   :::
:::        Haestad Methods, Inc.         :::
:::                                      :::
::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

```
*************************************************************
*************************************************************

      UNIVERSITY OF KENTUCKY COMPUTER MODEL
      OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
      FOR MORE INFORMATION CONTACT THE AGRICULTURAL
      ENGINEERING DEPARTMENT

      THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
      THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
      MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

      VERSION DATE 5-25-83

      DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
      ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
      CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL


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


            ********************************************
                 WATERSHED IDENTIFICATION CODE
                 -----------------------------
                 WEYERHAEUSER PLYMOUTH/NORTH AREA/290'X 120'X 6'/100YR-24HR S
            ********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        9.00 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=========================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

```
          1                 1
   3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========================================================================


========================  SEDIMENTOLOGY INPUTS  ========================

QUESTION
   NO.
    1. SPECIFIC GRAVITY -                                            2.64
    2. COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -                  2.00
    3. SUBMERGED BULK SPECIFIC GRAVITY -                             1.35
    4. NUMBER OF PARTICLE SIZE DISTRIBUTIONS -                       1
    5. NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -       11

==========================================================================


================= INPUT PARTICLE SIZE DISTRIBUTIONS ===================

                        VALUE
                         NO.        SIZE, MM

                          1            1.0000
                          2             .5000
                          3             .2000
                          4             .1000
                          5             .0800
                          6             .0500
                          7             .0100
                          8             .0090
                          9             .0050
                         10             .0020
                         11             .0001

==========================================================================


===================  PERCENT FINER DISTRIBUTIONS  =====================

VALUE                       PARTICLE SIZE #
 NO.
            1
  1    100.00
  2     99.90
  3     87.50
  4     50.50
  5     44.50
  6     36.50
  7     32.00
  8     31.00
  9     29.00
 10     24.50
 11       .00

==========================================================================
```

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	13
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	3.19	69.00	.250	.000	.000	.00	2.0
2	4.90	69.00	.243	.000	.000	.00	2.0
3	8.65	69.00	.233	.000	.000	.00	2.0
4	.52	69.00	.188	.000	.000	.00	2.0
5	1.50	69.00	.192	.000	.000	.00	2.0
6	1.86	69.00	.204	.000	.000	.00	2.0
7	2.07	69.00	.215	.000	.000	.00	2.0
8	2.33	69.00	.226	.000	.000	.00	2.0
9	2.15	69.00	.229	.000	.000	.00	2.0
10	1.88	69.00	.216	.000	.000	.00	2.0
11	1.62	69.00	.204	.000	.000	.00	2.0
12	1.31	69.00	.193	.000	.000	.00	2.0
13	1.11	69.00	.256	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.40	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0
10	1	.20	60.0	33.30	.400	1.0	.0
11	1	.20	60.0	33.30	.400	1.0	.0
12	1	.20	60.0	33.30	.400	1.0	.0
13	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	12.59	5.21	295.30	.070	.847	1.000
2	19.53	5.21	480.18	.071	.851	1.000
3	34.94	5.21	1828.67	.073	.858	1.000
4	2.23	5.21	40.51	.079	.886	1.000
5	6.38	5.21	132.25	.078	.883	1.000
6	7.77	5.21	166.60	.076	.874	1.000
7	8.54	5.21	186.55	.075	.868	1.000
8	9.50	5.21	211.46	.074	.862	1.000
9	8.73	5.21	192.85	.073	.860	1.000
10	7.75	5.21	167.38	.075	.867	1.000
11	6.77	5.21	142.72	.076	.874	1.000
12	5.56	5.21	113.53	.078	.882	1.000
13	4.34	5.21	90.09	.070	.842	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	9.00	INCHES
RUNOFF VOLUME	=	14.3704	ACRE-FT
PEAK DISCHARGE	=	132.0035	CFS
AREA	=	33.0900	ACRES
TIME OF PEAK DISCHARGE	=	12.10	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	575.89	EI UNIT
PEAK CONCENTRATION	=	434191.70	MG/L
PEAK SETTLEABLE CONCENTRATION	=	200.1067	ML/L
PEAK SETTLEABLE CONCENTRATION	=	270144.00	MG/L
TOTAL SEDIMENT YIELD	=	4048.0960	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0732	MM

TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	17.80	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	83.15	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	83.15	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	16.68	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	12.37	ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	13
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	3.50
3	4.00
4	4.50
5	5.00
6	5.50
7	6.00
8	6.50
9	7.00
10	7.50
11	8.00
12	8.50
13	9.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE

1	.80
2	1.01
3	1.04
4	1.07
5	1.10
6	1.13
7	1.17
8	1.20
9	1.23
10	1.27
11	1.30
12	1.34
13	1.37

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	2.97
4	3.51
5	4.09
6	4.69
7	5.32
8	15.18
9	31.06
10	37.26
11	42.59
12	82.09
13	164.10

==========

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)

.00	.800	.00	.00	.00
3.50	1.010	3.30	.00	3.17
4.00	1.040	3.77	2.97	3.68
4.50	1.070	4.23	3.51	4.21
5.00	1.100	4.69	4.09	4.75
5.50	1.130	5.15	4.69	5.31
6.00	1.170	5.59	5.32	5.88
6.50	1.200	6.04	15.18	6.47
7.00	1.230	6.47	31.06	7.08
7.50	1.270	6.91	37.26	7.71
8.00	1.300	7.34	42.59	8.35
8.50	1.340	7.76	82.09	9.01
9.00	1.370	8.19	164.10	9.69

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	3.168	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	14.370	ACRE-FT
OUTFLOW ROUTED VOLUME	=	14.370	ACRE-FT
STORM VOLUME DISCHARGED	=	14.370	ACRE-FT
POND VOLUME AT PEAK STAGE	=	8.547	ACRE-FT
PEAK STAGE	=	8.149	FT
PEAK INFLOW RATE	=	132.003	CFS
PEAK DISCHARGE RATE	=	54.369	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	434191.70	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	103556.70	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0268	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	36.21	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	71573.78	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	71573.78	MG/L
BASIN TRAP EFFICIENCY	=	65.28	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	3.08	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	3.08	HRS
DETENTION TIME INCLUDING STORED FLOW	=	3.08	HRS
SEDIMENT LOAD DISCHARGED	=	1405.65	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	37.90	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.02	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.02	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.01	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.01	ML/L

DESIGN SHEET

RMT®

SHEET 1 OF 1

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	JYK	6/17/99	SWT	7/6/09	05101.01

SUMMARY OF NORTH AREA SEDIMENT BASIN DESIGN

BASIN DIMENSIONS: BASE AREA → 120' x 290'
SIDE SLOPES → 3H : 1V

PRINCIPAL SPILLWAY: 30" CMP RISER DIAM.
24" CMP BARREL DIAM.
0.5" DIAMETER PERFORATIONS
→ 4" O.C. HORIZONTALLY
→ 6" O.C VERTICALLY
6 FEET FROM POND BOTTOM TO TOP OF RISER
100 FEET LONG
1% SLOPE

EMERGENCY SPILLWAY: BASE WIDTH → 36 FEET
SIDE SLOPES: 4H:1V
8 FEET FROM POND BOTTOM TO BASE OF EMERGENCY SPILLWAY
2-FOOT DEEP

	POST-DEVELOPMENT			PRE-DEVELOPMENT		
$Q_{POND,10Y}$	= 20.5	CFS	<	40.7	CFS	✓
$Q_{POND,25Y}$	= 32.7	CFS	<	53.2	CFS	✓
$Q_{POND,100Y}$	= 54.3	CFS	<	76.2	CFS	✓

TE_{2YR} = 76.6% > 70% ✓ (≥70% FOR HIGH QUALITY WATERS FOR 2YR EVENT)
TE_{10YR} = 68.5% > 60% ✓
TE_{25YR} = 66.8% > 60% ✓
TE_{100YR} = 65.2% > 60% ✓

Attachment L4
Post Development Stormwater Design Calculations – East Area

DESIGN SHEET

RMT®

SHEET 1 OF 2

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	5/17/99	[illegible]	[illegible]	05101.01

POST DEVELOPMENT STORM WATER ANALYSIS

DETERMINE: PEAK RUNOFF RATE FOR AREA 2 / EAST BASIN USING SCS METHOD & 25 YR - 24 HR STORM ($Q_{p_{25,24}}$)

GIVEN:

LOCATION - PLYMOUTH, NC
HYDROLOGIC SOIL GROUP (HSG) = B
TOTAL AREA OF WATERSHED = 30.80 AC
MAXIMUM HYDRAULIC LENGTH = 2160 ft
MAXIMUM SLOPE: (3:1, H:V) ≈ 33.3%
DESIGN EVENT: 25 YR - 24 HR STORM = 7.25 INCHES
% HYDRALIC LENGTH MODIFICATION = 0 %
% IMPERVIOUS AREA = 0 %

DETERMINE: CN = 69 FOR FAIR CONDITIONS GRASS COVER ON 50-75% OF THE AREA & HSG = B. [T. 8.03 b]. ASSUME MAPPING & VEGETATION PROGRESS WITH LANDFILL CONSTRUCTION

RUNOFF DEPTH = 3.73" FROM TABLE 8.03c FOR 7.25" EVENT & CN=69, BY DOUBLE INTERPOLATION

25 YR - TOTAL RUNOFF VOL = (3.73")(1/12)(30.8 AC)
= 9.57 ac-ft

EQUIVALENT DRAINAGE AREA, a = f(HYDRAULIC LENGTH, L=2220)

$a = (L/209)^{(1/0.6)}$

$a = (2160/209)^{(1/0.6)}$

a = 49.0 ac

DESIGN SHEET

RMT®
100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER PLYMOUTH	SYK	5/17/99			05101.01

EAST BASIN

DETERMINE: PEAK RATE OF DISCHARGE, USING THE MAXIMUM WATERSHED SLOPE OF 33.3% AS THE AVERAGE WATERSHED SLOPE (CONSERVATIVE), F. 8.03a, CN=69, a: 49.0 acres.

PEAK RATE OF DISCHARGE ≈ 48.0 CFS/IN OF RUNOFF

PEAK DISCHARGE FOR EQUIVALENT WATERSHED $Q_1 = (48 \text{ CFS/IN})(3.73 \text{ IN}) = 179$ CFS

PEAK DISCHARGE, $Q_2 = (179 \text{ CFS})\left(\frac{30.80 \text{ AC}}{49.00 \text{ AC}}\right) = 113$ CFS

ADJUST Q_2 FOR SLOPE (33.3%) FROM T. 8.03 d & DOUBLE INTERPOLATION

$Q_3 = (113 \text{ CFS})(1.15)$

$Q_3 = 130$ CFS

$Q_{D_{25,24}} = 130$ CFS

DESIGN SHEET

RMT®

SHEET 3 OF 1

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	7/17/99	[illegible]	7/3/99	

SEDIMENT BASIN DESIGN - EAST BASIN

GIVEN: DRAINAGE BASIN TOTAL AREA = 30.8 AC
$Q_{25,24}$ = 130 CFS
BOTTOM OF BASIN EL ≥ 2' + EL. HIGH GWT.
TOP OF DIKE WIDTH = 8' TO 10'
SIDE SLOPES 3:1 (H:V)
POND LENGTH TO WIDTH RATIO ~ 2:1 OR GREATER

DETERMINE BASIN VOLUME

MIN VOLUME = (1800 ft³/acre)(30.8 acres) = 55,440 ft³
= 1.27 acre-ft

RECOMMENDED AREA OF BASIN AT PRINCIPLE SPILLWAY EL.

$A_p \geq Q(0.01) = (130\text{cfs})(0.01) = 1.30\text{acres} = 56{,}628\ ft^2$

DESIGN SHEET

RMT®
100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYCRHAEUSER - PLYMOUTH	SJK	5/24/99	FLH	7/16/99	05101.01

EAST BASIN

RECOMMENDED AREA @ PRINCIPAL SPILLWAY IS
56,628 SF ≈ 1.3 ACRES

SIDE SLOPES 3:1 (H:V)
TOP OF DIKE EL 38 (MAX)
BOTTOM OF POND EL 28 TO 27

IF TOP OF DIKE = EL 36
BOTTOM OF POND = EL 28
EMERGENCY SPILLWAY (ES) = EL 34
PRINCIPAL SPILLWAY (PS) = EL 32
POND L:W RATIO @ P.S. ~ 2:1 OR GREATER.

RECTANGULAR BASIN - SIZE

$W_P = \sqrt{56628/2} = 168$ ft
$L_P = 2W_P = 337$ ft

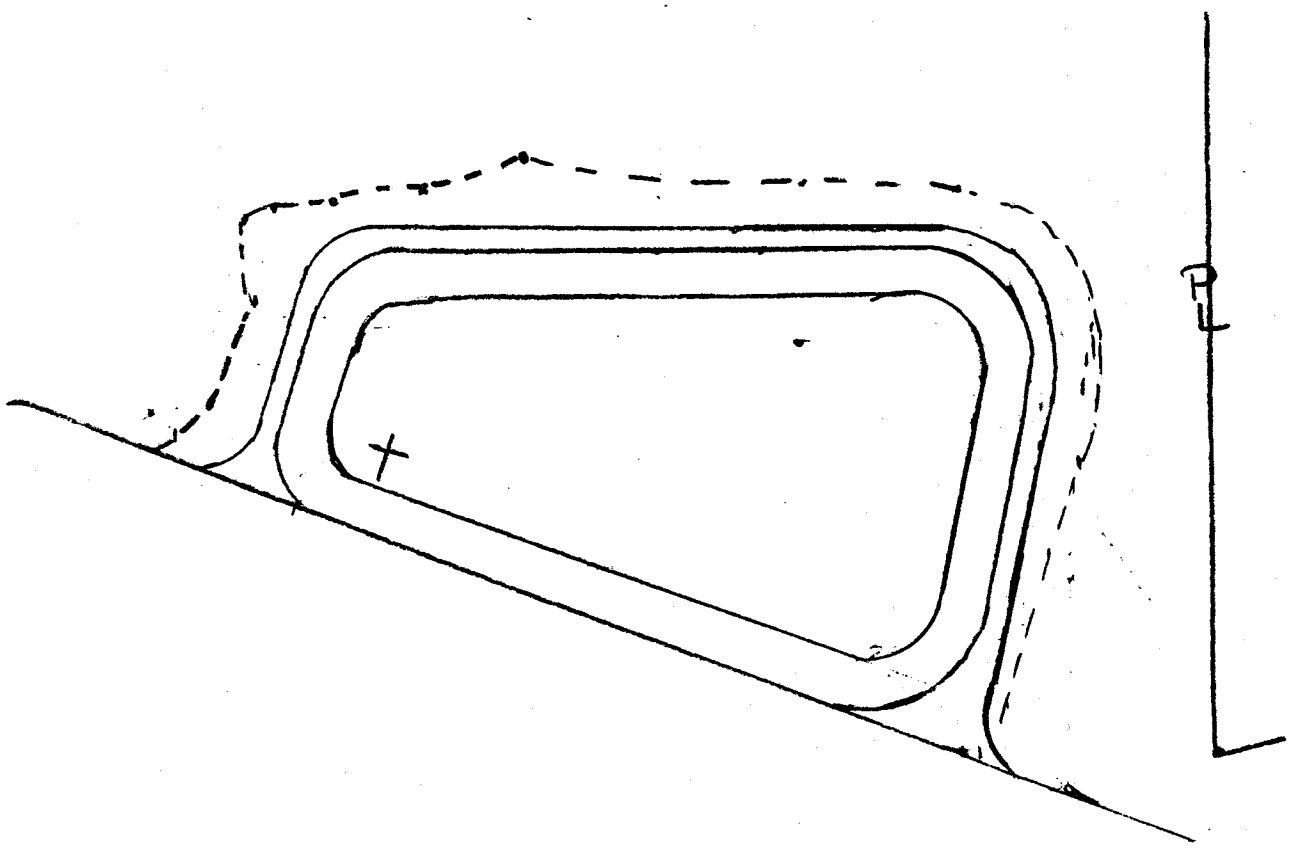
$W_B = 168 - (2 \cdot 3 \cdot (32' - 28')) = 144'$
$L_B = 337 - (2 \cdot 3 \cdot (32' - 28')) = 313'$

HOWEVER AREA WILL ONLY ACCOMODATE RECTANGULAR BASIN OF ABOUT 350' X 90', THEREFORE TRY A NON-RECTANGULAR SHAPED BASIN TO MAXIMIZE POND SIZE IN LIMITED IRREGULAR SHAPE AREA. (SEE ATTACHED SKETCH AND AREA/VOLUME CALCULATIONS

AT TOP OF PRINCIPAL SPILLWAY RISER AT 4 FT, THE BASIN AREA IS 1.35 ACRES WHICH IS GREATER THAN THE RECOMMENDED 1.3 ACRES. THE TOTAL VOLUME AT 6 FT IS 7.66 AC-FT WHICH IS LESS THAN 10 ACRE-FT [illegible].

EAST BASIN

5/26/99



EL 28 ~ 1.07 acres
El 36. ~ 1.62 acres.

DESIGN SHEET

RMT
100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
[illegible]	[illegible]	[illegible]	[illegible]	7/8/99	05101.01

EAST BASIN

LET BOTTOM OF POND = 0' (EL. 28)
TOP OF RISER = 4' (EL. 32)
EMERGENCY SPILLWAY = 6' (EL. 34)
TOP OF DIKE = 8' (EL. 36)

SIZE PRINCIPAL SPILLWAY, $Q_{P_{MIN}} = (0.2\,CFS/AC)(30.8\,AC)$
$Q_{P_{MIN}} = 6.2\,CFS$

LET PRINCIPAL SPILLWAY RISER DIAMETER = 30" = d
THEN PRINCIPAL SPILLWAY BARREL DIAMETER = 24" = D

HT OF RISER ≈ 2D = (2)(2 ft) = 4 ft (MIN)

IF H_{MIN} = 4 FT & L = 70 FT FOR 24" CMP
PERFORATED RISER, THEN Q = 22 CFS (T.8.07A)

MIN. HEAD(h) SLUICE FOR Q = 22 CFS, d = 30 IN
→ 0.63 ft (FIG. 8.07.B)

MIN. HT. OF EMERGENCY SPILLWAY = 0.63 ft + 4 ft
= 4.63 FT

EMERGENCY SPILLWAY

$Q_P = f(H = 6', D = 2', L = 70', T.8.07A, CMP)$
$Q_P = 27.0\,CFS$

$Q_{ES} = Q_{P_{25/24}} - Q_P = 130\,CFS - 27\,CFS = 103\,CFS$

[illegible] T.8.07B & Q = 120 CFS [illegible] = 36" [illegible] .75 to .8", [illegible] SIDE SLOPES

DESIGN SHEET

RMT 100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	3/12/99	[illegible]	7/9/99	05101.01

POST DEVELOPMENT LAND USE:

- OPEN SPACE, FAIR CONDITIONS GRASS COVER ON 50 TO 75% OF SITE, HYDROLOGIC SOIL GROUP "B"
  ↳ USE CURVE NO. 69

- PERMANENT SEEDINGS FROM 0-60 DAYS
  ↳ CONTROL PRACTICE FACTOR = 0.4

DETERMINE POST DEVELOPMENT PEAK FLOWRATES USING SCS METHODOLOGY & SEDIMOT II MODEL

- CALCULATE TIME OF CONCENTRATION FOR SHEET FLOW (0-60'), CHANNELIZED FLOW (ALONG BASE OF TERRACE) & CHANNELIZED FLOW ALONG BASE OF LANDFILL FROM ARTICULATED BLOCK CHANNEL (NORTHWEST) TO THE SEDIMENT BASIN. ASSUME TRAVEL TIME DOWN ARTICULATED BLOCK CHANNEL HAPPENS INSTANTANEOUS (CONSERVATIVE ASSUMPTION) AND IS ZERO.

SHEET FLOW: (0-60')

$$T_{t_{0\text{-}60'}} = \frac{0.007(nL)^{0.8}}{\sqrt{P_2} \cdot S^{0.4}} = \frac{(0.007)(0.15(60))^{0.8}}{\sqrt{4} \cdot (0.333)^{0.4}}$$

$$T_{t_{0\text{-}60'}} = 0.032 \text{ hrs}$$

where:
P_2 = 2 yr, 24 hr storm = 4 inches
S = slope = 1ft/3ft = 0.333
n = Manning's roughness coefficient for Sheet Flow
n = 0.15 (short prairie grass)
L = flow length = 60 ft

DESIGN SHEET

RMT 100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER PLYMOUTH	SYK	5/12/99	[illegible]	7/6/99	05101.01

TRAPEZOIDAL CHANNEL FLOW

$$V_{el} = \frac{1.49\, r^{2/3} \cdot S^{1/2}}{n}$$

where: n = Manning Roughness Coeff for Channel Flow

$n = 0.035$ (earth with weeds + stone)

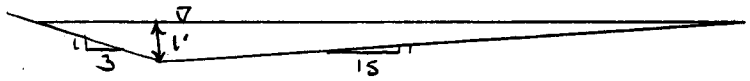
S = slope = 0.005 ft/ft

r = hydraulic radius = a/p_w

a = cross-sectional flow area, ft^2

p_w = wetted perimeter

CHANNEL ALONG BASE OF TERRACE



$a = (1)(3)(1/2) + (1)(15)(1/2) = 9.0\ ft^2$

$p_w = \left(\sqrt{1^2+3^2} + \sqrt{1^2+15^2}\right) = 18.2\ ft$

$r = a/p_w = 0.495\ ft$

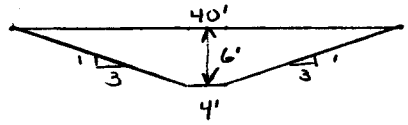
$$V_{el} = \frac{1.49\,(0.495)^{2/3} \cdot (0.005)^{1/2}}{0.035}$$

$V_{el} = 1.88$ ft/sec

$T_t = \left(\frac{DIST}{VEL}\right) / (3600\ sec/HR)$

DIST. VARIES = MAX CHANNEL LENGTH ALONG TERRACE

CHANNEL ALONG BASE OF LANDFILL CAP



$a = \left(\frac{4' + 40'}{2}\right)(6') = 132\ ft^2$

$p_w = 2\left(\sqrt{6^2 + 18^2}\right) + 4 = 41.95\ ft$

$r = a/p_w = \frac{132\ ft^2}{41.95\ ft} = 3.147\ ft$

$$V_{el} = \frac{1.49\,(3.147)^{2/3} \cdot (0.005)^{1/2}}{0.035}$$

$V_{el} = 6.46$ ft/sec

$T_t = \left(\frac{DIST}{VEL}\right) / (3600\ sec/HR)$

DIST = 1680 ft

$T_t = 0.072$ hrs

BASE CHANNEL

DESIGN SHEET

RMT®

SHEET 9 OF 0

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER	JJK	5/20/99	[illegible]	[illegible]	05101.01

AREA 2 (EAST BASIN)

WATERSHED #	AREA (AC)	MAX CHANNEL LENGTH ALONG TERRACE (FT)	$T_{t\ TERRACE\ CHANNEL}$	$T_{t\ BASE\ CHANNEL}$	$T_{SHEET\ FLOW}$	$T_c = \sum T_T$
1	5.03	2100	0.310	—	0.032	0.342
2	4.64	1850	0.273	—	0.032	0.305
3	4.44	1740	0.257	—	0.032	0.289
4	3.58	1585	0.234	—	0.032	0.266
5	3.16	1420	0.210	—	0.032	0.242
6	2.74	1245	0.184	—	0.032	0.216
7	2.63	1110	0.164	—	0.032	0.196
8	1.47	635	0.094	—	[illegible]	0.126
[illegible]	3.11	470	0.069	—	0.187	0.256
	30.80					

$$T_c = T_{t_{SHEET\ FLOW}} + T_{t_{BASE\ CHANNEL}} + T_{t_{TERRACE\ CHANNEL}} + T_{t_{ARTICULATE\ BLOCK\ CHANNEL}}$$

$$T_{t_{TC}} = \left(\frac{DIST}{1.88 + 1/S}\right) / (3600\ \text{[illegible]})$$

* Assume $T_{t\ BASE\ CHANNEL}$ equals zero (conservative).

** Assume $T_{t\ ART\ BLOCK\ CHANNEL}$ equals zero (conservative).

$$T_{t_{SF}} = 0.032 + \frac{0.007\,(0.15(170'))^{0.8}}{\sqrt{4} \cdot (0.05)^{0.4}}$$

$$T_{t_{SF}} = 0.187$$

OUTFLOW STRUCTURE EVALUATION

RETENTION POND # **3** **(East Area)**

Weyerhaeuser No. 3 Landfill Permit Application ***RMT Job No. 5101.01***

Plymouth, North Carolina

DEPTH INCREMENT **0.5** (feet)

Depth (ft.)	Area (acres)	Avg. Area (sq. ft.)	Storage (acre-ft.)
0	1.07		0
		1.09	
0.5	1.10		0.54
		1.12	
1	1.14		1.10
		1.16	
1.5	1.17		1.68
		1.19	
2	1.21		2.28
		1.22	
2.5	1.24		2.89
		1.26	
3	1.28		3.52
		1.29	
3.5	1.31		4.17
		1.33	
4	1.35		4.83
		1.36	
4.5	1.38		5.51
		1.40	
5	1.41		6.21
		1.43	
5.5	1.45		6.92
		1.47	
6	1.48		7.66
		1.50	
6.5	1.52		8.41
		1.53	
7	1.55		9.17
		1.57	
7.5	1.59		9.96
		1.60	
8	1.62		10.76

Weyerhaeuser No. 3 Landfill Permit Application
Plymouth, North Carolina

Detention Pond # **2**
Height of Riser (ft.) **4**
Height of Emergency Spillway (ft.) **6**

RMT Job No. 05101.01

HEAD	ROW																								
ELEV.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	PRIN.	EMER.	**TOTAL**
0.00	-																						0	0	**-**
0.50	0.18	-																					0	0	0.18
1.00	0.26	0.18	-																				0	0	0.44
1.50	0.32	0.26	0.18	-																			0	0	0.75
2.00	0.36	0.32	0.26	0.18	-																		0	0	1.12
2.50	0.41	0.36	0.32	0.26	0.18	-																	0	0	**1.52**
3.00	0.45	0.41	0.36	0.32	0.26	0.18	-																0	0	**1.97**
3.50	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-															0	0	**2.45**
4.00	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-														0	0	**2.97**
4.50	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-													9.2	0	**12.71**
5.00	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-												24.4	0	**28.49**
5.50	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-											29.9	0	**34.59**
6.00	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-										34.5	0	**39.82**
6.50	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-									38.6	34.65	**79.23**
7.00	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-								42.3	112.28	**161.24**
7.50	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-							45.7	225.57	278.63
8.00	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-						48.8	372.83	429.72
8.50	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-					51.8	553.74	614.38
9.00	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-				54.6	0	64.21
9.50	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-			0	0	10.40
10.00	0.81	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-		0	0	11.22
10.50	0.83	0.81	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-	0	0	12.05
11.00	0.85	0.83	0.81	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	0	0	12.9

TOTAL FLOW RATE PER ROW OF PERFORATED RISER PIPE USING THE ORIFICE EQUATION:

$$Q=n*C_d*A_o*(2*g*y)^{0.5}$$

WHERE:

D =	diameter of riser pipe (inches)	LET: D =	**30**	$n*C_d*A_o$ = 0.0321
s =	lateral spacing of orifice holes on riser (inches)	s ~	**4**	$(2*g)^{0.5}$ = 8.025
n =	number of holes per row =(3.14*D/s)+/-1	n =	**24**	increment= **0.5**
d =	diameter of orifice (inches)	d =	**0.500**	
A_o =	orifice area (sq. ft.) = $(3.14*(d^2/4))/144$	A_o =	0.0014	
g =	32.2 ft/sec^2	g =	32.2	
y =	elevation head (ft)	y =	(see first column in table)	
A_2 =	jet area (sq. ft.)	A_2 =	A_o	
C_v =	0.95 (sqr. edge) to 0.99 (round edge)	C_v =	**0.98**	
C_c =	A_2/A_o	C_c =	**1**	
C_d =	discharge coefficient $=C_c*C_v$	C_d =	0.98	

Normal Depth Channel Analysis Program
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WEYERHAEUSER PLYMOUTH\EAST BASIN

CHANNEL SLOPE = .005 FT/FT
MANNINGS N = .035

TRAPEZOIDAL CHANNEL OUTPUT

BOTTOM WIDTH = 36 FT
LEFT SIDE SLOPE = 4 FT/FT
RIGHT SIDE SLOPE = 4 FT/FT

DEPTH (FT)	FLOW (CFS)	AREA (SQ FT)	WP (FT)	VEL (FT/SEC)	CR. DEP. (FT)
0.25	10.81	9.25	38.06	1.17	0.14
0.50	34.65	19.00	40.12	1.82	0.30
0.75	68.79	29.25	42.18	2.35	0.48
1.00	112.28	40.00	44.25	2.81	0.65
1.25	164.62	51.25	46.31	3.21	0.84
1.50	225.57	63.00	48.37	3.58	1.03
1.75	295.00	75.25	50.43	3.92	1.22
2.00	372.83	88.00	52.49	4.24	1.41
2.25	459.07	101.25	54.55	4.53	1.61
2.50	553.74	115.00	56.62	4.82	1.81

OUTFLOW RATING TABLE FOR FLOW ABOVE THE RISER FOR DETENTION POND NO. **2**

EAST AREA

Weyerhaeuser No. 3 Landfill Permit Application ***RMT Job No.*** ***5101.01***

Plymouth, North Carolina

RISER DIAMETER.	**2.5**	FT.
HEIGHT OF RISER	***4***	FT.
OUTFLOW PIPE DIAMETER.	***2***	FT.
OUTFLOW PIPE LENGTH.	***70***	FT.
OUTFLOW PIPE SLOPE.	***1***	%
MANNING N-VALUE.	***0.023***	(corrugated metal pipe)
ENTRANCE LOSS COEFFICIENT.	1	
BEND LOSS COEFICIENT.	1	
WEIR COEFICIENT.	***3.33***	(english units)
ORIFICE COEFFICIENT (Cd)	***0.62***	(into riser pipe)
TAILWATER DEPTH	***2.5***	FT.
THICKNESS OF WEIR.	***1***	FT.

HEAD (FT.)	FLOW (CFS)	CONTROL
0	**0**	
0.25	3.3	WEIR
0.50	**9.2**	WEIR
0.75	17.0	WEIR
1.00	**24.4**	ORIFICE
1.25	27.3	ORIFICE
1.50	**29.9**	ORIFICE
1.75	32.3	ORIFICE
2.00	**34.5**	ORIFICE
2.25	36.6	ORIFICE
2.50	**38.6**	ORIFICE
2.75	40.5	ORIFICE
3.00	**42.3**	ORIFICE
3.25	44.0	ORIFICE
3.50	**45.7**	ORIFICE
3.75	47.3	ORIFICE
4.00	**48.8**	ORIFICE
4.25	50.3	ORIFICE
4.50	**51.8**	ORIFICE
4.75	53.2	ORIFICE
5.00	**54.6**	ORIFICE

WEIR FLOW: $Q=C_w*L*H^{1.5}$ ORIFICE FLOW: $Q=C_d*A_o*(2*g*H)^{0.5}$

where:	Cw = weir coefficient =3.33 (english units)	Cd = C_c* C_v (or see attached sheet)
	L = weir length or perimeter of riser (ft.)	Ao = orifice area (sq.ft.)
	H = head (feet)	g = 32.2 ft/s^2
	Cc = A_2/A_o (or see attached sheet)	*Cv = 0.99 (rounded) to 0.95 (square) orifice*

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        UNIVERSITY OF KENTUCKY COMPUTER MODEL
        OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
        FOR MORE INFORMATION CONTACT THE AGRICULTURAL
        ENGINEERING DEPARTMENT

        THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
        THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
        MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

        VERSION DATE 5-25-83

        DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
        ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
        CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL


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            *********************************************
                 WATERSHED IDENTIFICATION CODE
                 -----------------------------
                 WEYERHAEUSER PLYMOUTH/EAST BASIN/1.10 ACRES X 4'/2YR-24HR ST
            *********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        4.00 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=====================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

1 1
3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========

========== SEDIMENTOLOGY INPUTS ==========

QUESTION NO.		
1.	SPECIFIC GRAVITY -	2.64
2.	COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -	2.00
3.	SUBMERGED BULK SPECIFIC GRAVITY -	1.35
4.	NUMBER OF PARTICLE SIZE DISTRIBUTIONS -	1
5.	NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -	11

==========

========== INPUT PARTICLE SIZE DISTRIBUTIONS ==========

VALUE NO.	SIZE, MM
1	1.0000
2	.5000
3	.2000
4	.1000
5	.0800
6	.0500
7	.0100
8	.0090
9	.0050
10	.0020
11	.0001

==========

========== PERCENT FINER DISTRIBUTIONS ==========

VALUE NO.	PARTICLE SIZE # 1
1	100.00
2	99.90
3	87.50
4	50.50
5	44.50
6	36.50
7	32.00
8	31.00
9	29.00
10	24.50
11	.00

==========

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	9
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *

JUNCTION 1, BRANCH 1, STRUCTURE 1

* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	5.03	69.00	.342	.000	.000	.00	2.0
2	4.64	69.00	.305	.000	.000	.00	2.0
3	4.44	69.00	.289	.000	.000	.00	2.0
4	3.58	69.00	.266	.000	.000	.00	2.0
5	3.16	69.00	.242	.000	.000	.00	2.0
6	2.74	69.00	.216	.000	.000	.00	2.0
7	2.63	69.00	.196	.000	.000	.00	2.0
8	1.47	69.00	.126	.000	.000	.00	2.0
9	3.11	69.00	.256	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER	SEG	SOIL	LENGTH	SLOPE	CP	PART	SURF

SHED	NUM	K	FEET	PCT	VALUE	OPT	COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.20	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	4.04	1.27	91.25	.042	.721	1.000
2	3.90	1.27	85.59	.052	.740	1.000
3	3.82	1.27	82.50	.053	.749	1.000
4	3.19	1.27	66.07	.055	.764	1.000
5	2.93	1.27	58.77	.058	.781	1.000
6	2.65	1.27	51.32	.061	.800	1.000
7	2.64	1.27	49.99	.064	.816	1.000
8	1.57	1.27	26.99	.070	.846	1.000
9	2.81	1.27	56.95	.056	.771	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	4.00	INCHES
RUNOFF VOLUME	=	3.2510	ACRE-FT
PEAK DISCHARGE	=	27.5333	CFS
AREA	=	30.8000	ACRES
TIME OF PEAK DISCHARGE	=	12.10	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	98.49	EI UNIT
PEAK CONCENTRATION	=	308964.80	MG/L
PEAK SETTLEABLE CONCENTRATION	=	131.6135	ML/L
PEAK SETTLEABLE CONCENTRATION	=	177678.20	MG/L
TOTAL SEDIMENT YIELD	=	569.4261	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0553	MM
TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	14.30	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	50.20	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	50.20	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	14.40	ML/L

ARITHMETIC AVERAGE SETTLEABLE
CONCENTRATION DURING PEAK 24 HOUR
PERIOD = 8.58 ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	12
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	2.00
3	2.50
4	3.00
5	3.50
6	4.00
7	4.50
8	5.00
9	5.50
10	6.00
11	6.50
12	7.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE
1	1.07
2	1.21
3	1.24
4	1.28
5	1.31
6	1.35
7	1.38
8	1.41
9	1.45
10	1.48
11	1.52
12	1.55

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	1.52
4	1.97
5	2.45
6	2.97
7	12.71
8	28.49
9	34.59
10	39.80
11	79.23
12	161.24

==========

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	1.070	.00	.00	.00
2.00	1.210	1.94	.00	2.28
2.50	1.240	2.42	1.52	2.89
3.00	1.280	2.90	1.97	3.52
3.50	1.310	3.37	2.45	4.17
4.00	1.350	3.84	2.97	4.84
4.50	1.380	4.30	12.71	5.52
5.00	1.410	4.76	28.49	6.22
5.50	1.450	5.22	34.59	6.93
6.00	1.480	5.67	39.80	7.66
6.50	1.520	6.12	79.23	8.41
7.00	1.550	6.57	161.24	9.18

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	2.280	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	3.251	ACRE-FT
OUTFLOW ROUTED VOLUME	=	3.244	ACRE-FT
STORM VOLUME DISCHARGED	=	3.244	ACRE-FT
POND VOLUME AT PEAK STAGE	=	3.981	ACRE-FT
PEAK STAGE	=	3.354	FT
PEAK INFLOW RATE	=	27.533	CFS
PEAK DISCHARGE RATE	=	2.310	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	308964.80	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	37195.80	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0000	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.06	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	32499.58	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	32499.58	MG/L
BASIN TRAP EFFICIENCY	=	74.75	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	7.23	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	7.23	HRS
DETENTION TIME INCLUDING STORED FLOW	=	7.23	HRS
SEDIMENT LOAD DISCHARGED	=	143.79	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	38.40	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

*** RUN COMPLETED ****

```
*****************************************************************************
*          (program name)                * SEDIMOT S/N   :                   *
*                                        * HMVersion     :  3.20             *
*       (program description)            * Date          :  5/26/99          *
*                                        * Time          : 10:57:02          *
*                                        * Input file    : wpn2a.inp         *
*                                        * Output file   : wpn2a.out         *
*                                        *                                   *
*                                        *                                   *
*****************************************************************************
```

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 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx   xxxxxxx
x     x  x        x     x    x    xx   xx  x     x     x
x        x        x     x    x    x x x x  x     x     x
 xxxxx   xxxxx    x     x    x    x  x  x  x     x     x
      x  x        x     x    x    x     x  x     x     x
x     x  x        x     x    x    x     x  x     x     x
 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx      x
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::::::::::::::::::::::::::::::::::::::::::::
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:::                                      :::
:::  Full Microcomputer Implementation   :::
:::                by                    :::
:::        Haestad Methods, Inc.         :::
:::                                      :::
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37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

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        VERSION DATE 5-25-83

        DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
        ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
        CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL


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            ********************************************
                 WATERSHED IDENTIFICATION CODE
                 -----------------------------
                 WEYERHAEUSER PLYMOUTH/EAST BASIN/1.10 ACRES X 4'/10YR-24HR S
            ********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        6.25 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=====================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

1 1
3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========

========== SEDIMENTOLOGY INPUTS ==========

QUESTION NO.		
1.	SPECIFIC GRAVITY -	2.64
2.	COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -	2.00
3.	SUBMERGED BULK SPECIFIC GRAVITY -	1.35
4.	NUMBER OF PARTICLE SIZE DISTRIBUTIONS -	1
5.	NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -	11

==========

========== INPUT PARTICLE SIZE DISTRIBUTIONS ==========

VALUE NO.	SIZE, MM
1	1.0000
2	.5000
3	.2000
4	.1000
5	.0800
6	.0500
7	.0100
8	.0090
9	.0050
10	.0020
11	.0001

==========

========== PERCENT FINER DISTRIBUTIONS ==========

VALUE NO.	PARTICLE SIZE # 1
1	100.00
2	99.90
3	87.50
4	50.50
5	44.50
6	36.50
7	32.00
8	31.00
9	29.00
10	24.50
11	.00

==========

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	9
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	5.03	69.00	.342	.000	.000	.00	2.0
2	4.64	69.00	.305	.000	.000	.00	2.0
3	4.44	69.00	.289	.000	.000	.00	2.0
4	3.58	69.00	.266	.000	.000	.00	2.0
5	3.16	69.00	.242	.000	.000	.00	2.0
6	2.74	69.00	.216	.000	.000	.00	2.0
7	2.63	69.00	.196	.000	.000	.00	2.0
8	1.47	69.00	.126	.000	.000	.00	2.0
9	3.11	69.00	.256	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER	SEG	SOIL	LENGTH	SLOPE	CP	PART	SURF

SHED	NUM	K	FEET	PCT	VALUE	OPT	COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.20	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	9.85	2.91	239.61	.056	.770	1.000
2	9.49	2.91	224.28	.059	.789	1.000
3	9.26	2.91	215.85	.061	.798	1.000
4	7.68	2.91	172.33	.063	.811	1.000
5	7.01	2.91	152.69	.066	.826	1.000
6	6.29	2.91	132.61	.069	.842	1.000
7	6.21	2.91	128.71	.072	.855	1.000
8	3.68	2.91	69.36	.079	.884	1.000
9	6.76	2.91	148.30	.064	.817	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	6.25	INCHES
RUNOFF VOLUME	=	7.4668	ACRE-FT
PEAK DISCHARGE	=	66.2382	CFS
AREA	=	30.8000	ACRES
TIME OF PEAK DISCHARGE	=	12.10	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	260.30	EI UNIT
PEAK CONCENTRATION	=	328773.10	MG/L
PEAK SETTLEABLE CONCENTRATION	=	145.8929	ML/L
PEAK SETTLEABLE CONCENTRATION	=	196955.40	MG/L
TOTAL SEDIMENT YIELD	=	1483.7380	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0633	MM
TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	16.20	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	58.71	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	58.71	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	13.51	ML/L

ARITHMETIC AVERAGE SETTLEABLE
CONCENTRATION DURING PEAK 24 HOUR
PERIOD = 9.12 ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	12
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	2.00
3	2.50
4	3.00
5	3.50
6	4.00
7	4.50
8	5.00
9	5.50
10	6.00
11	6.50
12	7.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE
1	1.07
2	1.21
3	1.24
4	1.28
5	1.31
6	1.35
7	1.38
8	1.41
9	1.45
10	1.48
11	1.52
12	1.55

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	1.52
4	1.97
5	2.45
6	2.97
7	12.71
8	28.49
9	34.59
10	39.80
11	79.23
12	161.24

==========

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	1.070	.00	.00	.00
2.00	1.210	1.94	.00	2.28
2.50	1.240	2.42	1.52	2.89
3.00	1.280	2.90	1.97	3.52
3.50	1.310	3.37	2.45	4.17
4.00	1.350	3.84	2.97	4.84
4.50	1.380	4.30	12.71	5.52
5.00	1.410	4.76	28.49	6.22
5.50	1.450	5.22	34.59	6.93
6.00	1.480	5.67	39.80	7.66
6.50	1.520	6.12	79.23	8.41
7.00	1.550	6.57	161.24	9.18

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	2.280	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	7.467	ACRE-FT
OUTFLOW ROUTED VOLUME	=	7.445	ACRE-FT
STORM VOLUME DISCHARGED	=	7.445	ACRE-FT
POND VOLUME AT PEAK STAGE	=	5.706	ACRE-FT
PEAK STAGE	=	4.635	FT
PEAK INFLOW RATE	=	66.238	CFS
PEAK DISCHARGE RATE	=	16.984	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	328773.10	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	62607.61	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0005	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.65	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	47175.07	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	47175.07	MG/L
BASIN TRAP EFFICIENCY	=	67.71	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	6.32	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	6.32	HRS
DETENTION TIME INCLUDING STORED FLOW	=	6.32	HRS
SEDIMENT LOAD DISCHARGED	=	479.12	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	39.80	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

*** RUN COMPLETED ****

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*************************************************************
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*************************************************************
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            ********************************************
                 WATERSHED IDENTIFICATION CODE
                 -----------------------------
                 WEYERHAEUSER PLYMOUTH/EAST BASIN/1.10 ACRES X 4'/25YR-24HR S
            ********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        7.25 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=========================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

1 1
3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========

========== SEDIMENTOLOGY INPUTS ==========

QUESTION NO.		
1.	SPECIFIC GRAVITY -	2.64
2.	COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -	2.00
3.	SUBMERGED BULK SPECIFIC GRAVITY -	1.35
4.	NUMBER OF PARTICLE SIZE DISTRIBUTIONS -	1
5.	NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -	11

==========

========== INPUT PARTICLE SIZE DISTRIBUTIONS ==========

VALUE NO.	SIZE, MM
1	1.0000
2	.5000
3	.2000
4	.1000
5	.0800
6	.0500
7	.0100
8	.0090
9	.0050
10	.0020
11	.0001

==========

========== PERCENT FINER DISTRIBUTIONS ==========

VALUE NO.	PARTICLE SIZE # 1
1	100.00
2	99.90
3	87.50
4	50.50
5	44.50
6	36.50
7	32.00
8	31.00
9	29.00
10	24.50
11	.00

==========

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	9
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	5.03	69.00	.342	.000	.000	.00	2.0
2	4.64	69.00	.305	.000	.000	.00	2.0
3	4.44	69.00	.289	.000	.000	.00	2.0
4	3.58	69.00	.266	.000	.000	.00	2.0
5	3.16	69.00	.242	.000	.000	.00	2.0
6	2.74	69.00	.216	.000	.000	.00	2.0
7	2.63	69.00	.196	.000	.000	.00	2.0
8	1.47	69.00	.126	.000	.000	.00	2.0
9	3.11	69.00	.256	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER	SEG	SOIL	LENGTH	SLOPE	CP	PART	SURF

SHED	NUM	K	FEET	PCT	VALUE	OPT	COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.20	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	12.68	3.72	316.69	.058	.782	1.000
2	12.20	3.72	296.29	.062	.801	1.000
3	11.90	3.72	285.10	.063	.809	1.000
4	9.87	3.72	227.55	.066	.822	1.000
5	9.00	3.72	201.57	.069	.837	1.000
6	8.07	3.72	175.02	.072	.853	1.000
7	7.94	3.72	169.52	.074	.865	1.000
8	4.70	3.72	91.24	.080	.893	1.000
9	8.69	3.72	195.80	.067	.828	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	7.25	INCHES
RUNOFF VOLUME	=	9.5481	ACRE-FT
PEAK DISCHARGE	=	84.3912	CFS
AREA	=	30.8000	ACRES
TIME OF PEAK DISCHARGE	=	12.10	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	359.62	EI UNIT
PEAK CONCENTRATION	=	333143.80	MG/L
PEAK SETTLEABLE CONCENTRATION	=	149.1958	ML/L
PEAK SETTLEABLE CONCENTRATION	=	201414.30	MG/L
TOTAL SEDIMENT YIELD	=	1958.7900	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0654	MM
TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	17.00	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	61.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	61.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	13.27	ML/L

ARITHMETIC AVERAGE SETTLEABLE
CONCENTRATION DURING PEAK 24 HOUR
PERIOD = 9.40 ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	12
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	2.00
3	2.50
4	3.00
5	3.50
6	4.00
7	4.50
8	5.00
9	5.50
10	6.00
11	6.50
12	7.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE
1	1.07
2	1.21
3	1.24
4	1.28
5	1.31
6	1.35
7	1.38
8	1.41
9	1.45
10	1.48
11	1.52
12	1.55

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	1.52
4	1.97
5	2.45
6	2.97
7	12.71
8	28.49
9	34.59
10	39.80
11	79.23
12	161.24

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****

CAUTION: THE STAGE OF YOUR PRINCIPLE SPILLWAY MAY CAUSE BED SCOUR. SEDIMOT II DOES NOT CONSIDER POSSIBLE BED SCOUR; HENCE, YOUR OBSERVED EFFLUENT MAY NOT MEET THE DESIRED EFFLUENT STANDARD. INCREASE THE STAGE OF YOUR PRINCIPAL SPILLWAY.

****
****

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	1.070	.00	.00	.00

2.00	1.210	1.94	.00	2.28
2.50	1.240	2.42	1.52	2.89
3.00	1.280	2.90	1.97	3.52
3.50	1.310	3.37	2.45	4.17
4.00	1.350	3.84	2.97	4.84
4.50	1.380	4.30	12.71	5.52
5.00	1.410	4.76	28.49	6.22
5.50	1.450	5.22	34.59	6.93
6.00	1.480	5.67	39.80	7.66
6.50	1.520	6.12	79.23	8.41
7.00	1.550	6.57	161.24	9.18

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	2.280	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	9.548	ACRE-FT
OUTFLOW ROUTED VOLUME	=	9.522	ACRE-FT
STORM VOLUME DISCHARGED	=	9.522	ACRE-FT
POND VOLUME AT PEAK STAGE	=	6.238	ACRE-FT
PEAK STAGE	=	5.016	FT
PEAK INFLOW RATE	=	84.391	CFS
PEAK DISCHARGE RATE	=	28.690	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	333143.80	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	72181.22	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0042	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	5.63	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	51148.39	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	51148.39	MG/L
BASIN TRAP EFFICIENCY	=	66.08	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	5.33	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	5.33	HRS
DETENTION TIME INCLUDING STORED FLOW	=	5.33	HRS
SEDIMENT LOAD DISCHARGED	=	664.52	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	40.50	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

```
*****************************************************************************
*          (program name)                * SEDIMOT S/N  :                    *
*                                        * HMVersion    :  3.20              *
*       (program description)            * Date         :  5/26/99           *
*                                        * Time         : 10:46:32           *
*                                        * Input file   : wpn2c.inp          *
*                                        * Output file  : wpn2c.out          *
*                                        *                                   *
*                                        *                                   *
*****************************************************************************
```

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 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx   xxxxxxx
x     x  x        x     x    x    xx   xx  x     x     x
x        x        x     x    x    x x x x  x     x     x
 xxxxx   xxxxx    x     x    x    x  x  x  x     x     x
      x  x        x     x    x    x     x  x     x     x
x     x  x        x     x    x    x     x  x     x     x
 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx      x
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:::                                      :::
:::  Full Microcomputer Implementation   :::
:::                 by                   :::
:::        Haestad Methods, Inc.         :::
:::                                      :::
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37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

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

        UNIVERSITY OF KENTUCKY COMPUTER MODEL
        OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
        FOR MORE INFORMATION CONTACT THE AGRICULTURAL
        ENGINEERING DEPARTMENT

        THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
        THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
        MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

        VERSION DATE 5-25-83

        DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
        ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
        CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL


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


            *********************************************
                 WATERSHED IDENTIFICATION CODE
                 -----------------------------
                 WEYERHAEUSER PLYMOUTH/EAST BASIN/1.10 ACRES X 4'/100YR-24HR
            *********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        9.00 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=========================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

1 1
3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========

========== SEDIMENTOLOGY INPUTS ==========

QUESTION NO.		
1.	SPECIFIC GRAVITY -	2.64
2.	COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -	2.00
3.	SUBMERGED BULK SPECIFIC GRAVITY -	1.35
4.	NUMBER OF PARTICLE SIZE DISTRIBUTIONS -	1
5.	NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -	11

==========

========== INPUT PARTICLE SIZE DISTRIBUTIONS ==========

VALUE NO.	SIZE, MM
1	1.0000
2	.5000
3	.2000
4	.1000
5	.0800
6	.0500
7	.0100
8	.0090
9	.0050
10	.0020
11	.0001

==========

========== PERCENT FINER DISTRIBUTIONS ==========

VALUE NO.	PARTICLE SIZE # 1
1	100.00
2	99.90
3	87.50
4	50.50
5	44.50
6	36.50
7	32.00
8	31.00
9	29.00
10	24.50
11	.00

==========

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	9
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	5.03	69.00	.342	.000	.000	.00	2.0
2	4.64	69.00	.305	.000	.000	.00	2.0
3	4.44	69.00	.289	.000	.000	.00	2.0
4	3.58	69.00	.266	.000	.000	.00	2.0
5	3.16	69.00	.242	.000	.000	.00	2.0
6	2.74	69.00	.216	.000	.000	.00	2.0
7	2.63	69.00	.196	.000	.000	.00	2.0
8	1.47	69.00	.126	.000	.000	.00	2.0
9	3.11	69.00	.256	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER	SEG	SOIL	LENGTH	SLOPE	CP	PART	SURF

SHED	NUM	K	FEET	PCT	VALUE	OPT	COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.20	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	17.80	5.21	462.61	.061	.796	1.000
2	17.12	5.21	432.56	.064	.815	1.000
3	16.69	5.21	416.13	.066	.824	1.000
4	13.83	5.21	332.00	.068	.836	1.000
5	12.61	5.21	294.02	.072	.852	1.000
6	11.30	5.21	255.22	.075	.867	1.000
7	11.11	5.21	247.14	.078	.879	1.000
8	6.53	5.21	132.52	.082	.905	1.000
9	12.17	5.21	285.64	.070	.842	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	9.00	INCHES
RUNOFF VOLUME	=	13.3759	ACRE-FT
PEAK DISCHARGE	=	118.1525	CFS
AREA	=	30.8000	ACRES
TIME OF PEAK DISCHARGE	=	12.10	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	575.89	EI UNIT
PEAK CONCENTRATION	=	342665.90	MG/L
PEAK SETTLEABLE CONCENTRATION	=	155.1650	ML/L
PEAK SETTLEABLE CONCENTRATION	=	209472.80	MG/L
TOTAL SEDIMENT YIELD	=	2857.8310	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0682	MM
TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	18.10	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	63.98	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	63.98	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	12.99	ML/L

ARITHMETIC AVERAGE SETTLEABLE
CONCENTRATION DURING PEAK 24 HOUR
PERIOD = 9.80 ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	12
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	2.00
3	2.50
4	3.00
5	3.50
6	4.00
7	4.50
8	5.00
9	5.50
10	6.00
11	6.50
12	7.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE
1	1.07
2	1.21
3	1.24
4	1.28
5	1.31
6	1.35
7	1.38
8	1.41
9	1.45
10	1.48
11	1.52
12	1.55

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	1.52
4	1.97
5	2.45
6	2.97
7	12.71
8	28.49
9	34.59
10	39.80
11	79.23
12	161.24

==========

****
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CAUTION: THE STAGE OF YOUR PRINCIPLE SPILLWAY MAY CAUSE BED SCOUR. SEDIMOT II DOES NOT CONSIDER POSSIBLE BED SCOUR; HENCE, YOUR OBSERVED EFFLUENT MAY NOT MEET THE DESIRED EFFLUENT STANDARD. INCREASE THE STAGE OF YOUR PRINCIPAL SPILLWAY.

****
****

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	1.070	.00	.00	.00

2.00	1.210	1.94	.00	2.28
2.50	1.240	2.42	1.52	2.89
3.00	1.280	2.90	1.97	3.52
3.50	1.310	3.37	2.45	4.17
4.00	1.350	3.84	2.97	4.84
4.50	1.380	4.30	12.71	5.52
5.00	1.410	4.76	28.49	6.22
5.50	1.450	5.22	34.59	6.93
6.00	1.480	5.67	39.80	7.66
6.50	1.520	6.12	79.23	8.41
7.00	1.550	6.57	161.24	9.18

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	2.280	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	13.376	ACRE-FT
OUTFLOW ROUTED VOLUME	=	13.345	ACRE-FT
STORM VOLUME DISCHARGED	=	13.345	ACRE-FT
POND VOLUME AT PEAK STAGE	=	7.636	ACRE-FT
PEAK STAGE	=	5.982	FT
PEAK INFLOW RATE	=	118.152	CFS
PEAK DISCHARGE RATE	=	39.608	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	342665.90	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	81014.13	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0126	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	17.06	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	55250.30	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	55250.30	MG/L
BASIN TRAP EFFICIENCY	=	64.80	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	4.25	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	4.25	HRS
DETENTION TIME INCLUDING STORED FLOW	=	4.25	HRS
SEDIMENT LOAD DISCHARGED	=	1006.00	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	41.50	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.01	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.01	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.01	ML/L

DESIGN SHEET

RMT®

SHEET _____ OF _____

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	JJK	6/17/99			05101.01

SUMMARY OF EAST AREA SEDIMENT BASIN DESIGN

BASIN DIMENSIONS: BASE AREA → 1.10 ACRES (IRREGULAR SHAPE)
SIDE SLOPES → 3H:1V

PRINCIPAL SPILLWAY: 30" CMP RISER DIAM.
24" CMP BARREL DIAM.
0.5" DIAMETER PERFORATIONS
→ 4" O.C. HORIZONTALLY
→ 6" O.C. VERTICALLY
4 FEET FROM POND BOTTOM TO TOP OF RISER
70 FEET LONG
1% SLOPE

EMERGENCY SPILLWAY: BASE WIDTH → 44 FEET
SIDE SLOPES 4H:1V
6 FEET FROM POND BOTTOM TO BASE OF EMERGENCY SPILLWAY
2-FOOT DEEP

	POST-DEVELOPMENT		PRE-DEVELOPMENT	
$Q_{POND,10Y}$ =	17.0 CFS	<	52.9 CFS	✓
$Q_{POND,25Y}$ =	28.7 CFS	<	70.7 CFS	✓
$Q_{POND,100Y}$ =	39.6 CFS	<	104.0 CFS	✓

TE_{2YR} =	74.8 %	>	70%	(≥70% RQD FOR HQWs FOR 2YR EVENT) ✓
TE_{10YR} =	67.7%	>	60%	
TE_{25YR} =	66.1%	>	60%	✓
TE_{100YR} =	64.8%	>	60%	✓

Attachment L5
Post Development Stormwater Design Calculations – West Area

DESIGN SHEET

RMT®
100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	5/19/99	[illegible]	[illegible]	05101.01

POST DEVELOPMENT STORMWATER ANALYSIS -

DETERMINE: PEAK RUNOFF RATE FOR AREA 3 / "WEST BASIN" USING SCS METHOD & 25 YR - 24 HR STORM ($Q_{P_{25/24}}$)

GIVEN: LOCATION - PLYMOUTH NC
HSG = B
TOTAL AREA OF WATERSHED = 40.51 ACRES
MAXIMUM HYDRAULIC LENGTH = 2040 FT
MAXIMUM SLOPE: 33.3% (3H:1V)
DESIGN EVENT: 25 YR - 24 HR STORM = 7.25 INCHES
% HYDRAULIC LENGTH MODIFIED = 0%
% IMPERVIOUS AREA = 0%

DETERMINE: CN = 69 FOR FAIR CONDITIONS GRASS COVER ON 50-75% OF THE AREA & HSG "B" [T. 8.03b]. ASSUME CAPPING + RESTATION PROGRESS WITH LANDFILL CONSTRUCTION

RUNOFF DEPTH = 3.73" FROM TABLE 8.03c FOR 7.25" EVENT BY DOUBLE INTERPOLATION FOR CN = 69.

25-YR TOTAL RUNOFF = (3.73")(1/12")(40.51 AC)
= 12.6 AC-FT

EQUIVALENT DRAINAGE AREA, a, = f(HYDRAULIC LENGTH, L = 2040)
$a = (2040'/209)^{(1/0.6)}$
a = 44.58 AC.

DESIGN SHEET

RMT

SHEET 2 OF 7

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	5/24/99	BMT	9/8/99	05101.01

WEST BASIN

DETERMINE: PEAK RATE OF DISCHARGE, USING MAXIMUM WATERSHED SLOPE OF 33.3% AS AN AVG. WATERSHED SLOPE (CONSERVATIVE)
F. 8.03g, CN = 69, a = 44.58 ac

PEAK RATE OF DISCHARGE ≅ 45 CFS/IN OF RUNOFF

PK. DISCHARGE FOR EQUIVALENT WATERSHED $= Q_1 = \left(45 \frac{cfs}{IN}\right)(3.73\ IN) = 168\ cfs$

PK. DISCHARGE $= Q_2 = (168\ cfs)\left(\frac{40.51\ ac}{44.58\ ac}\right) = 153\ cfs$

ADJUST Q_2 FOR (33.3% SLOPE) FROM T. 8.03d
& DOUBLE INTERPOLATION

$Q_3 = (153\ cfs)(1.15) = 176\ cfs$

$Q_{P_{25/24}} = 176\ cfs$

DESIGN SHEET

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PROJECT/PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	YK	5/20/99	[illegible]	7/6/99	05101.01

SEDIMENT BASIN DESIGN - WEST BASIN

GIVEN: DRAINAGE BASIN TOTAL AREA = 40.51 ACRES

$Q_{p\,25/24} = 176$ CFS

BOTTOM OF BASIN EL ≥ 2' + EL. HIGH GWT

TOP OF DIKE WIDTH = 8' TO 10'

SIDE SLOPES : (3:1) HORIZONTAL TO VERTICAL

POND LENGTH TO WIDTH RATO ~ 2:1 OR GREATER.

DETERMINE BASIN VOLUME

MIN VOLUME = $(1800\ \frac{ft^3}{ac})(40.51\ ac) = 72{,}918\ ft^3 = 1.67$ ac-ft.

RECOMMENDED AREA AT PRINCIPAL SPILLWAY, $A_p \geq Q_p(0.01)$

$A_p \geq (176\ cfs)(0.01) = 1.76$ acres $= 76{,}666\ ft^2$

LET $2W = L$, THEN $W_p = \sqrt{76{,}666/2} = 196$ ft

$L_p = 2W_p = 392$ ft

TOTAL VOLUME OF RUNOFF FROM THE 10YR-24HR EVENT

6.25 IN = 10YR-24HR EVENT

2.91 IN RUNOFF FROM T. 8.03.C + CN=69 & DOUBLE INFILTRATION

$V_{10,24} = (2.91\ in)(1/12)(40.51\ acres) = 9.82$ ac-ft

SIZE PRINCIPAL SPILLWAY, $Q_{p\,min} = (0.2\ cfs/ac)(40.51\ ac) = 8.1$ CFS.

LET PRINCIPAL SPILLWAY BARREL = 30" MAY = D

Ht of Riser = 2D = 2(2.5') = 5 FT. (MIN)

DESIGN SHEET

RMT

SHEET 4 OF 7

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SJL	5/25/99	[illegible]	7/6/00	05101.01

WEST BASIN

IF: $D_{BARREL} = 2.5'$ & $d_{RISER} = 2.0'$

$H = 4.0$ ft.

$L = 70$ ft

RISER IS CMP - PERFORATED

THEN $Q = 22.06$ CFS (T. 8.07 A) $= f(d = 24'' + H = 4' + L = 70$ FT$)$

MIN. HEAD RQD FOR $(Q = 22$ CFS, $d_{riser} = 30'')$ — F. 8.07 B.
$(h) \approx 0.63$ ft.

HT OF EMERGENCY SPILLWAY $\geq 2D + h = (2)(2') + 0.63'$
≥ 4.63 FT.

LET BASIN BOTTOM = 0
TOP OF RISER = 4 (PS)
TOP OF ES = 6'
TOP OF DIKE = 8'
$A_B = 170' \times 320 = 1.44$ AC
$A_P = 194' \times 394' \cong 1.75$ AC ✓

EMERGENCY SPILLWAY

$Q_P = f(H = 6$ FT, $D = 2$ FT, $L = 70'$, T. 8.07A CMP)
$Q_P = 27.01$ CFS

$Q_E = Q_{P\,25/24} - Q_P = 176$ CFS $- 27$ CFS $= 149$ CFS

FROM T. 8.07C & $Q = 160$ CFS, USE BOTTOM WIDTH = 44'
SLOPES 2.7 TO 4.3 (MIN TO MAX) & 4:1 (H:V) SIDE SLOPES

DESIGN SHEET

RMT 100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	3/12/99	BNT	7/8/99	05101.01

WEST-BASIN

POST DEVELOPMENT LAND USE:

- OPEN SPACE, FAIR CONDITIONS GRASS COVER ON 50 TO 75% OF SITE, HYDROLOGIC SOIL GROUP "B"
  ↳ USE CURVE NO. 69

- PERMANENT SEEDINGS FROM 0-60 DAYS
  ↳ CONTROL PRACTICE FACTOR = 0.4

DETERMINE POST DEVELOPMENT PEAK FLOWRATES USING SCS METHODOLOGY & SEDIMOT II MODEL

- CALCULATE TIME OF CONCENTRATION FOR SHEET FLOW (0-60'), CHANNELIZED FLOW (ALONG BASE OF TERRACE) & CHANNELIZED FLOW ALONG BASE OF LANDFILL FROM ARTICULATED BLOCK CHANNEL (NORTHWEST) TO THE SEDIMENT BASIN. ASSUME TRAVEL TIME DOWN ARTICULATED BLOCK CHANNEL HAPPENS INSTANTANEOUS (CONSERVATIVE ASSUMPTION) AND IS ZERO.

SHEET FLOW: (0-60')

$$T_{t_{0-60'}} = \frac{0.007(nL)^{0.8}}{\sqrt{P_2} \cdot S^{0.4}} = \frac{(0.007)(0.15(60))^{0.8}}{\sqrt{4} \cdot (0.333)^{0.4}}$$

$$T_{t_{0-60'}} = 0.032 \text{ hrs}$$

where:

P_2 = 2 yr, 24 hr storm = 4 inches
S = slope = 1ft/3ft = 0.333
n = Manning's Roughness Coefficient for Sheet Flow
n = 0.15 (short prairie grass)
L = flow length = 60 ft

DESIGN SHEET

RMT 100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER PLYMOUTH	SYK	5/12/99	[illegible]	7/8/99	05101.01

TRAPEZOIDAL CHANNEL FLOW

$$V_{el} = \frac{1.49\, r^{2/3} \cdot S^{1/2}}{n}$$

where: n = Manning Roughness Coeff for Channel Flow

$n = 0.035$ (earth with weeds + stone)

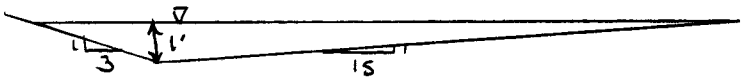
S = slope = 0.005 ft/ft

r = hydraulic radius = a/p_w

a = cross-sectional flow area, ft^2

p_w = wetted perimeter

CHANNEL ALONG BASE OF TERRACE



$a = (1)(3)(1/2) + (1)(15)(1/2) = 9.0\ ft^2$

$p_w = \left(\sqrt{1^2+3^2} + \sqrt{1^2+15^2}\right) = 18.2\ ft$

$r = a/p_w = 0.495\ ft$

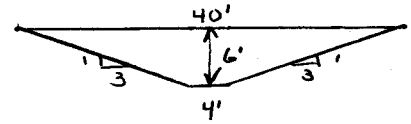
$$V_{el} = \frac{1.49\,(0.495)^{2/3} \cdot (0.005)^{1/2}}{0.035}$$

$V_{el} = 1.88$ ft/sec

$T_t = \left(\frac{DIST}{VEL}\right) / (3600\ sec/HR)$

DIST. VARIES = MAX CHANNEL LENGTH ALONG TERRACE

CHANNEL ALONG BASE OF LANDFILL CAP



$a = \left(\frac{4'+40'}{2}\right)(6') = 132\ ft^2$

$p_w = 2\left(\sqrt{6^2+18^2}\right) + 4 = 41.95\ ft$

$r = a/p_w = \frac{132\ ft^2}{41.95\ ft} = 3.147\ ft$

$$V_{el} = \frac{1.49\,(3.147)^{2/3} \cdot (0.005)^{1/2}}{0.035}$$

$V_{el} = 6.46$ ft/sec

$T_t = \left(\frac{DIST}{VEL}\right) / (3600\ sec/HR)$

DIST = 1680 ft

$T_t = 0.072$ hrs

BASE CHANNEL

DESIGN SHEET

RMT®

SHEET 7 OF 7

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	5/20/99			05101.01

AREA 3 (WEST BASIN)

WATERSHED #	AREA (ACRES)	MAX CHANNEL LENGTH ALONG TERRACE (FT)	T_t TERRACE CHANNEL	$T_{SHEET\ FLOW}$	$T_c = \Sigma T_t$
1	3.25	1862	0.275	—	0.275
2	3.62	1980	0.293	0.032	0.325
3	4.30	1915	0.283	0.032	0.315
4	4.31	1855	0.274	0.032	0.306
5	4.31	1735	0.256	0.032	0.288
6	4.39	1630	0.241	0.032	0.273
7	3.96	1400	0.207	0.032	0.239
8	4.01	1035	0.153	0.165 * (L=140')	0.318
9	2.80	1000	0.148	0.032	0.180
10	5.56	640	0.095	0.183 * (L=165)	0.278
TOTAL AREA =	40.51				

$$T_c = T_{t_{SF}} + T_{t_{BC}} + T_{t_{TC}} + T_{t_{ABC}}$$

let $T_{t_{BC}} + T_{t_{ABC}} = 0$ (conservative)

$$* \; T_{t_{SF}} = 0.032 + \frac{0.007(0.15(L))^{0.8}}{\sqrt{4} \cdot (0.05)^{0.4}}$$

CN = 69

$$T_{t_{TC}} = \left(\frac{DIST}{1.88\,ft/s}\right)\left(3600\,s/H\right) =$$

OUTFLOW STRUCTURE EVALUATION

RETENTION POND # **3** **(West Area)**

Weyerhaeuser No. 3 Landfill Permit Application ***RMT Job No.*** ***5101.01***

Plymouth, North Carolina

POND WIDTH	**170**	(feet)
POND LENGTH	**370**	(feet)
SIDE SLOPE	**3**	(Z:1)
DEPTH INCREMENT	**0.5**	(feet)

Depth (ft.)	Width (ft.)	Length (ft.)	Area (sq. ft.)	Area (acres)	Avg. Area (sq. ft.)	Storage (acre-ft.)
0	170	370	62,900	1.44		0
					63,715	
0.5	173	373	64,529	1.48		0.73
					65,353	
1	176	376	66,176	1.52		1.48
					67,009	
1.5	179	379	67,841	1.56		2.25
					68,683	
2	182	382	69,524	1.60		3.04
					70,375	
2.5	185	385	71,225	1.64		3.85
					72,085	
3	188	388	72,944	1.67		4.67
					73,813	
3.5	191	391	74,681	1.71		5.52
					75,559	
4	194	394	76,436	1.75		6.39
					77,323	
4.5	197	397	78,209	1.80		7.28
					79,105	
5	200	400	80,000	1.84		8.18
					80,905	
5.5	203	403	81,809	1.88		9.11
					82,723	
6	206	406	83,636	1.92		10.06
					84,559	
6.5	209	409	85,481	1.96		11.03
					86,413	
7	212	412	87,344	2.01		12.02
					88,285	
7.5	215	415	89,225	2.05		13.04
					90,175	
8	218	418	91,124	2.09		14.07
					92,083	
8.5	221	421	93,041	2.14		15.13

Normal Depth Channel Analysis Program
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WEYERHAEUSER PLYMOUTH WEST BASIN

CHANNEL SLOPE = .005 FT/FT
MANNINGS N = .035

TRAPEZOIDAL CHANNEL OUTPUT

BOTTOM WIDTH = 44 FT
LEFT SIDE SLOPE = 4 FT/FT
RIGHT SIDE SLOPE = 4 FT/FT

DEPTH (FT)	FLOW (CFS)	AREA (SQ FT)	WP (FT)	VEL (FT/SEC)	CR. DEP. (FT)
0.25	13.20	11.25	46.06	1.17	0.14
0.50	42.21	23.00	48.12	1.84	0.30
0.75	83.62	35.25	50.18	2.37	0.48
1.00	136.19	48.00	52.25	2.84	0.65
1.25	199.24	61.25	54.31	3.25	0.84
1.50	272.38	75.00	56.37	3.63	1.03
1.75	355.38	89.25	58.43	3.98	1.22
2.00	448.08	104.00	60.49	4.31	1.41
2.25	550.42	119.25	62.55	4.62	1.61

OUTFLOW RATING TABLE FOR FLOW ABOVE THE RISER FOR DETENTION POND NO. 3

WEST AREA

Weyerhaeuser No. 3 Landfill Permit Application ***RMT Job No.*** ***5101.01***

Plymouth, North Carolina

RISER DIAMETER.	**2.5**	FT.
HEIGHT OF RISER	***4***	FT.
OUTFLOW PIPE DIAMETER.	***2***	FT.
OUTFLOW PIPE LENGTH.	***70***	FT.
OUTFLOW PIPE SLOPE.	***1***	%
MANNING N-VALUE.	***0.023***	(corrugated metal pipe)
ENTRANCE LOSS COEFFICIENT.	1	
BEND LOSS COEFICIENT.	1	
WEIR COEFICIENT.	***3.33***	(english units)
ORIFICE COEFFICIENT (Cd)	***0.62***	(into riser pipe)
TAILWATER DEPTH	***2.5***	FT.
THICKNESS OF WEIR.	***1***	FT.

HEAD (FT.)	FLOW (CFS)	CONTROL
0	**0**	
0.25	3.3	WEIR
0.50	**9.2**	WEIR
0.75	17.0	WEIR
1.00	**24.4**	ORIFICE
1.25	27.3	ORIFICE
1.50	**29.9**	ORIFICE
1.75	32.3	ORIFICE
2.00	**34.5**	ORIFICE
2.25	36.6	ORIFICE
2.50	**38.6**	ORIFICE
2.75	40.5	ORIFICE
3.00	**42.3**	ORIFICE
3.25	44.0	ORIFICE
3.50	**45.7**	ORIFICE
3.75	47.3	ORIFICE
4.00	**48.8**	ORIFICE
4.25	50.3	ORIFICE
4.50	**51.8**	ORIFICE
4.75	53.2	ORIFICE
5.00	**54.6**	ORIFICE

WEIR FLOW: $Q=C_w*L*H^{1.5}$ ORIFICE FLOW: $Q=C_d*A_o*(2*g*H)^{0.5}$

where: Cw = weir coefficient =3.33 (english units) Cd = C_c* C_v (or see attached sheet)

L = weir length or perimeter of riser (ft.) Ao = orifice area (sq.ft.)

H = head (feet) g = 32.2 ft/s^2

Cc = A_2/A_o (or see attached sheet) *Cv = 0.99 (rounded) to 0.95 (square) orifice*

Weyerhaeuser No. 3 Landfill Permit Application
Plymouth, North Carolina

Detention Pond # ***3***
Height of Riser (ft.) ***4***
Height of Emergency Spillway (ft.) ***6***

RMT Job No. 05101.01

HEAD	ROW																								
ELEV.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	PRIN.	EMER.	**TOTAL**
0.00	-																						0	0	**-**
0.50	0.18	-																					0	0	0.18
1.00	0.26	0.18	-																				0	0	0.44
1.50	0.32	0.26	0.18	-																			0	0	0.75
2.00	0.36	0.32	0.26	0.18	-																		0	0	1.12
2.50	0.41	0.36	0.32	0.26	0.18	-																	0	0	1.52
3.00	0.45	0.41	0.36	0.32	0.26	0.18	-																0	0	**1.97**
3.50	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-															0	0	**2.45**
4.00	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-														0	0	**2.97**
4.50	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-													9.2	0	**12.71**
5.00	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-												24.4	0	**28.49**
5.50	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-											29.9	0	**34.59**
6.00	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-										34.5	0	**39.82**
6.50	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-									38.6	42.21	**86.79**
7.00	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-								42.3	136.19	**185.15**
7.50	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-							45.7	272.38	325.44
8.00	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-						48.8	448.08	504.97
8.50	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-					51.8	0	60.64
9.00	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-				54.6	0	64.21
9.50	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-			0	0	10.40
10.00	0.81	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18			0	0	11.22
10.50	0.83	0.81	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18		0	0	12.05
11.00	0.85	0.83	0.81	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	0	0	12.9

TOTAL FLOW RATE PER ROW OF PERFORATED RISER PIPE USING THE ORIFICE EQUATION:

$$Q=n*C_d*A_o*(2*g*y)^{0.5}$$

WHERE:

- D = diameter of riser pipe (inches)
- s = lateral spacing of orifice holes on riser (inches)
- n = number of holes per row =(3.14*D/s)+/-1
- d = diameter of orifice (inches)
- A_o = orifice area (sq. ft.) = $(3.14*(d^2/4))/144$
- g = 32.2 ft/sec^2
- y = elevation head (ft)
- A_2 = jet area (sq. ft.)
- C_v = 0.95 (sqr. edge) to 0.99 (round edge)
- C_c = A_2/A_o
- C_d = discharge coefficient =C_c*C_v

LET:

D =	**30**
s ~	**4**
n =	**24**
d =	**0.500**
A_o =	0.0014
g =	32.2
y =	(see first column in table)
A_2 =	A_o
C_v =	**0.98**
C_c =	**1**
C_d =	0.98

$n*C_d*A_o$ =	0.0321
$(2*g)^{0.5}$ =	8.025
increment=	**0.5**

```
*****************************************************************************
*          (program name)                * SEDIMOT S/N  :                    *
*                                        * HMVersion    :  3.20              *
*       (program description)            * Date         :  5/25/99           *
*                                        * Time         : 10:59:28           *
*                                        * Input file   : wpn3d.inp          *
*                                        * Output file  : wpn3d.out          *
*                                        *                                   *
*                                        *                                   *
*****************************************************************************
```

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x     x  x        x     x    x    xx   xx  x     x     x
x        x        x     x    x    x x x x  x     x     x
 xxxxx   xxxxx    x     x    x    x  x  x  x     x     x
      x  x        x     x    x    x     x  x     x     x
x     x  x        x     x    x    x     x  x     x     x
 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx      x
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:::                 by                   :::
:::        Haestad Methods, Inc.         :::
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              *********************************************
                   WATERSHED IDENTIFICATION CODE
                   -----------------------------
                   WEYERHAEUSER PLYMOUTH/WEST AREA/170'X370'X4'/2YR-24HR STORM
              *********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        4.00 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=====================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

1 1
3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========

========== SEDIMENTOLOGY INPUTS ==========

QUESTION NO.		
1.	SPECIFIC GRAVITY -	2.64
2.	COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -	2.00
3.	SUBMERGED BULK SPECIFIC GRAVITY -	1.35
4.	NUMBER OF PARTICLE SIZE DISTRIBUTIONS -	1
5.	NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -	11

==========

========== INPUT PARTICLE SIZE DISTRIBUTIONS ==========

VALUE NO.	SIZE, MM
1	1.0000
2	.5000
3	.2000
4	.1000
5	.0800
6	.0500
7	.0100
8	.0090
9	.0050
10	.0020
11	.0001

==========

========== PERCENT FINER DISTRIBUTIONS ==========

VALUE NO.	PARTICLE SIZE # 1
1	100.00
2	99.90
3	87.50
4	50.50
5	44.50
6	36.50
7	32.00
8	31.00
9	29.00
10	24.50
11	.00

==========

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	10
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	3.25	69.00	.275	.000	.000	.00	2.0
2	3.62	69.00	.325	.000	.000	.00	2.0
3	4.30	69.00	.315	.000	.000	.00	2.0
4	4.31	69.00	.306	.000	.000	.00	2.0
5	4.31	69.00	.288	.000	.000	.00	2.0
6	4.39	69.00	.273	.000	.000	.00	2.0
7	3.96	69.00	.239	.000	.000	.00	2.0
8	4.01	69.00	.318	.000	.000	.00	2.0
9	2.80	69.00	.180	.000	.000	.00	2.0
10	5.56	69.00	.278	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.20	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0
10	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	2.85	1.27	58.85	.054	.758	1.000
2	2.96	1.27	63.87	.049	.729	1.000
3	3.57	1.27	78.02	.051	.735	1.000
4	3.62	1.27	78.75	.051	.740	1.000
5	3.71	1.27	79.86	.053	.750	1.000
6	3.87	1.27	82.55	.055	.760	1.000
7	3.69	1.27	75.89	.059	.784	1.000
8	3.31	1.27	71.99	.050	.733	1.000
9	2.91	1.27	54.68	.068	.833	1.000
10	4.86	1.27	107.12	.054	.756	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	4.00	INCHES
RUNOFF VOLUME	=	4.2759	ACRE-FT
PEAK DISCHARGE	=	35.3521	CFS
AREA	=	40.5100	ACRES
TIME OF PEAK DISCHARGE	=	12.10	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	98.49	EI UNIT
PEAK CONCENTRATION	=	307986.60	MG/L
PEAK SETTLEABLE CONCENTRATION	=	130.0334	ML/L
PEAK SETTLEABLE CONCENTRATION	=	175545.00	MG/L
TOTAL SEDIMENT YIELD	=	751.5802	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0538	MM
TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	14.40	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	49.94	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	49.94	ML/L

ARITHMETIC AVERAGE SETTLEABLE
CONCENTRATION DURING PERIOD OF
SIGNIFICANT CONCENTRATION = 14.42 ML/L
ARITHMETIC AVERAGE SETTLEABLE
CONCENTRATION DURING PEAK 24 HOUR
PERIOD = 8.65 ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	11
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	2.50
3	3.00
4	3.50
5	4.00
6	4.50
7	5.00
8	5.50
9	6.00
10	6.50
11	7.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE
1	1.44
2	1.64
3	1.67
4	1.71
5	1.75
6	1.80
7	1.84
8	1.88
9	1.92
10	1.96

POND DISCHARGE DATA

DISCHARGE POINT	VALUE
1	.00
2	.00
3	1.97
4	2.45
5	2.97
6	12.71
7	28.49
8	34.59
9	39.82
10	86.79
11	185.15

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	1.440	.00	.00	.00
2.50	1.640	2.42	.00	3.85
3.00	1.670	2.90	1.97	4.68
3.50	1.710	3.38	2.45	5.52
4.00	1.750	3.86	2.97	6.39
4.50	1.800	4.32	12.71	7.27
5.00	1.840	4.79	28.49	8.18
5.50	1.880	5.25	34.59	9.11
6.00	1.920	5.70	39.82	10.06
6.50	1.960	6.16	86.79	11.03
7.00	2.010	6.61	185.15	12.03

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	3.850	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	4.276	ACRE-FT
OUTFLOW ROUTED VOLUME	=	4.264	ACRE-FT
STORM VOLUME DISCHARGED	=	4.264	ACRE-FT
POND VOLUME AT PEAK STAGE	=	6.142	ACRE-FT
PEAK STAGE	=	3.858	FT
PEAK INFLOW RATE	=	35.352	CFS
PEAK DISCHARGE RATE	=	2.822	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	307986.60	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	33125.20	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0000	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.05	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	28748.06	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	28748.06	MG/L
BASIN TRAP EFFICIENCY	=	77.76	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	7.80	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	7.80	HRS
DETENTION TIME INCLUDING STORED FLOW	=	7.80	HRS
SEDIMENT LOAD DISCHARGED	=	167.12	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	38.40	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

*** RUN COMPLETED ****

```
*****************************************************************************
*          (program name)                * SEDIMOT S/N   :                  *
*                                        * HMVersion     :  3.20            *
*       (program description)            * Date          :  5/25/99         *
*                                        * Time          : 10:46:54         *
*                                        * Input file    : wpn3a.inp        *
*                                        * Output file   : wpn3a.out        *
*                                        *                                  *
*                                        *                                  *
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x     x  x        x     x    x    xx   xx  x     x     x
x        x        x     x    x    x x x x  x     x     x
 xxxxx   xxxxx    x     x    x    x  x  x  x     x     x
      x  x        x     x    x    x     x  x     x     x
x     x  x        x     x    x    x     x  x     x     x
 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx      x
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::::::::::::::::::::::::::::::::::::::::::::
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:::                                      :::
:::  Full Microcomputer Implementation   :::
:::                 by                   :::
:::        Haestad Methods, Inc.         :::
:::                                      :::
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```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

```
*************************************************************
*************************************************************

        UNIVERSITY OF KENTUCKY COMPUTER MODEL
        OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
        FOR MORE INFORMATION CONTACT THE AGRICULTURAL
        ENGINEERING DEPARTMENT

        THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
        THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
        MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

        VERSION DATE 5-25-83

        DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
        ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
        CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL


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              ********************************************
                   WATERSHED IDENTIFICATION CODE
                   -----------------------------
                   WEYERHAEUSER PLYMOUTH/WEST AREA/170'X370'X4'/10YR-24HR STORM
              ********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        6.25 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=========================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

1 1
3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========

========== SEDIMENTOLOGY INPUTS ==========

QUESTION NO.		
1.	SPECIFIC GRAVITY -	2.64
2.	COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -	2.00
3.	SUBMERGED BULK SPECIFIC GRAVITY -	1.35
4.	NUMBER OF PARTICLE SIZE DISTRIBUTIONS -	1
5.	NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -	11

==========

========== INPUT PARTICLE SIZE DISTRIBUTIONS ==========

VALUE NO.	SIZE, MM
1	1.0000
2	.5000
3	.2000
4	.1000
5	.0800
6	.0500
7	.0100
8	.0090
9	.0050
10	.0020
11	.0001

==========

========== PERCENT FINER DISTRIBUTIONS ==========

VALUE NO.	PARTICLE SIZE # 1
1	100.00
2	99.90
3	87.50
4	50.50
5	44.50
6	36.50
7	32.00
8	31.00
9	29.00
10	24.50
11	.00

==========

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	10
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *

JUNCTION 1, BRANCH 1, STRUCTURE 1

* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	3.25	69.00	.275	.000	.000	.00	2.0
2	3.62	69.00	.325	.000	.000	.00	2.0
3	4.30	69.00	.315	.000	.000	.00	2.0
4	4.31	69.00	.306	.000	.000	.00	2.0
5	4.31	69.00	.288	.000	.000	.00	2.0
6	4.39	69.00	.273	.000	.000	.00	2.0
7	3.96	69.00	.239	.000	.000	.00	2.0
8	4.01	69.00	.318	.000	.000	.00	2.0
9	2.80	69.00	.180	.000	.000	.00	2.0
10	5.56	69.00	.278	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.20	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0
10	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	6.90	2.91	153.71	.062	.806	1.000
2	7.22	2.91	167.51	.058	.778	1.000
3	8.68	2.91	204.51	.059	.783	1.000
4	8.80	2.91	206.35	.059	.788	1.000
5	9.00	2.91	208.93	.061	.798	1.000
6	9.34	2.91	215.55	.063	.807	1.000
7	8.82	2.91	197.05	.067	.828	1.000
8	8.07	2.91	188.72	.058	.782	1.000
9	6.83	2.91	140.65	.076	.871	1.000
10	11.76	2.91	279.87	.062	.804	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	6.25	INCHES
RUNOFF VOLUME	=	9.8207	ACRE-FT
PEAK DISCHARGE	=	85.4372	CFS
AREA	=	40.5100	ACRES
TIME OF PEAK DISCHARGE	=	12.10	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	260.30	EI UNIT
PEAK CONCENTRATION	=	329941.80	MG/L
PEAK SETTLEABLE CONCENTRATION	=	145.4608	ML/L
PEAK SETTLEABLE CONCENTRATION	=	196372.10	MG/L
TOTAL SEDIMENT YIELD	=	1962.8640	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0618	MM
TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	16.20	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	58.67	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	58.67	ML/L

ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION = 13.67 ML/L

ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD = 9.22 ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	11
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	2.50
3	3.00
4	3.50
5	4.00
6	4.50
7	5.00
8	5.50
9	6.00
10	6.50
11	7.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE
1	1.44
2	1.64
3	1.67
4	1.71
5	1.75
6	1.80
7	1.84
8	1.88
9	1.92
10	1.96

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	1.97
4	2.45
5	2.97
6	12.71
7	28.49
8	34.59
9	39.82
10	86.79
11	185.15

==========

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	1.440	.00	.00	.00
2.50	1.640	2.42	.00	3.85
3.00	1.670	2.90	1.97	4.68
3.50	1.710	3.38	2.45	5.52
4.00	1.750	3.86	2.97	6.39
4.50	1.800	4.32	12.71	7.27
5.00	1.840	4.79	28.49	8.18
5.50	1.880	5.25	34.59	9.11
6.00	1.920	5.70	39.82	10.06
6.50	1.960	6.16	86.79	11.03
7.00	2.010	6.61	185.15	12.03

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	3.850	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	9.821	ACRE-FT
OUTFLOW ROUTED VOLUME	=	9.795	ACRE-FT
STORM VOLUME DISCHARGED	=	9.795	ACRE-FT
POND VOLUME AT PEAK STAGE	=	8.013	ACRE-FT
PEAK STAGE	=	4.906	FT
PEAK INFLOW RATE	=	85.437	CFS
PEAK DISCHARGE RATE	=	25.514	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	329941.80	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	61465.19	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0002	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.22	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	47206.12	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	47206.12	MG/L
BASIN TRAP EFFICIENCY	=	67.87	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	5.24	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	5.24	HRS
DETENTION TIME INCLUDING STORED FLOW	=	5.24	HRS
SEDIMENT LOAD DISCHARGED	=	630.61	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	39.70	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

*** RUN COMPLETED ****

```
*****************************************************************************
*          (program name)                * SEDIMOT S/N   :                   *
*                                        * HMVersion     :  3.20             *
*       (program description)            * Date          :  5/25/99          *
*                                        * Time          : 10:55:43          *
*                                        * Input file    : wpn3b.inp         *
*                                        * Output file   : wpn3b.out         *
*                                        *                                   *
*                                        *                                   *
*****************************************************************************
```

```
 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx   xxxxxxx
x     x  x        x     x    x    xx   xx  x     x     x
x        x        x     x    x    x x x x  x     x     x
 xxxxx   xxxxx    x     x    x    x  x  x  x     x     x
      x  x        x     x    x    x     x  x     x     x
x     x  x        x     x    x    x     x  x     x     x
 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx      x
```

```
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:::                                      :::
:::  Full Microcomputer Implementation   :::
:::                 by                   :::
:::        Haestad Methods, Inc.         :::
:::                                      :::
::::::::::::::::::::::::::::::::::::::::::::
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```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

```
*************************************************************
*************************************************************

      UNIVERSITY OF KENTUCKY COMPUTER MODEL
      OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
      FOR MORE INFORMATION CONTACT THE AGRICULTURAL
      ENGINEERING DEPARTMENT

      THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
      THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
      MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

      VERSION DATE 5-25-83

      DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
      ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
      CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL


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


            *********************************************
                 WATERSHED IDENTIFICATION CODE
                 -----------------------------
                 WEYERHAEUSER PLYMOUTH/WEST AREA/170'X370'X4'/25YR-24HR STORM
            *********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        7.25 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=====================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

1 1
3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========

========== SEDIMENTOLOGY INPUTS ==========

QUESTION NO.		
1.	SPECIFIC GRAVITY -	2.64
2.	COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -	2.00
3.	SUBMERGED BULK SPECIFIC GRAVITY -	1.35
4.	NUMBER OF PARTICLE SIZE DISTRIBUTIONS -	1
5.	NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -	11

==========

========== INPUT PARTICLE SIZE DISTRIBUTIONS ==========

VALUE NO.	SIZE, MM
1	1.0000
2	.5000
3	.2000
4	.1000
5	.0800
6	.0500
7	.0100
8	.0090
9	.0050
10	.0020
11	.0001

==========

========== PERCENT FINER DISTRIBUTIONS ==========

VALUE NO.	PARTICLE SIZE # 1
1	100.00
2	99.90
3	87.50
4	50.50
5	44.50
6	36.50
7	32.00
8	31.00
9	29.00
10	24.50
11	.00

==========

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	10
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	3.25	69.00	.275	.000	.000	.00	2.0
2	3.62	69.00	.325	.000	.000	.00	2.0
3	4.30	69.00	.315	.000	.000	.00	2.0
4	4.31	69.00	.306	.000	.000	.00	2.0
5	4.31	69.00	.288	.000	.000	.00	2.0
6	4.39	69.00	.273	.000	.000	.00	2.0
7	3.96	69.00	.239	.000	.000	.00	2.0
8	4.01	69.00	.318	.000	.000	.00	2.0
9	2.80	69.00	.180	.000	.000	.00	2.0
10	5.56	69.00	.278	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.20	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0
10	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	8.87	3.72	202.99	.065	.817	1.000
2	9.29	3.72	221.34	.060	.790	1.000
3	11.17	3.72	270.20	.061	.795	1.000
4	11.32	3.72	272.61	.061	.800	1.000
5	11.57	3.72	275.97	.063	.810	1.000
6	12.00	3.72	284.64	.065	.818	1.000
7	11.33	3.72	260.14	.069	.839	1.000
8	10.37	3.72	249.35	.060	.793	1.000
9	8.72	3.72	185.06	.078	.880	1.000
10	15.11	3.72	369.62	.064	.816	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	7.25	INCHES
RUNOFF VOLUME	=	12.5582	ACRE-FT
PEAK DISCHARGE	=	109.7541	CFS
AREA	=	40.5100	ACRES
TIME OF PEAK DISCHARGE	=	12.10	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	359.62	EI UNIT
PEAK CONCENTRATION	=	336918.40	MG/L
PEAK SETTLEABLE CONCENTRATION	=	149.9510	ML/L
PEAK SETTLEABLE CONCENTRATION	=	202433.90	MG/L
TOTAL SEDIMENT YIELD	=	2591.9030	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0639	MM
TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	16.90	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	60.98	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	60.98	ML/L

ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION = 13.46 ML/L

ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD = 9.48 ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	11
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	2.50
3	3.00
4	3.50
5	4.00
6	4.50
7	5.00
8	5.50
9	6.00
10	6.50
11	7.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE
1	1.44
2	1.64
3	1.67
4	1.71
5	1.75
6	1.80
7	1.84
8	1.88
9	1.92
10	1.96

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	1.97
4	2.45
5	2.97
6	12.71
7	28.49
8	34.59
9	39.82
10	86.79
11	185.15

==========

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	1.440	.00	.00	.00
2.50	1.640	2.42	.00	3.85
3.00	1.670	2.90	1.97	4.68
3.50	1.710	3.38	2.45	5.52
4.00	1.750	3.86	2.97	6.39
4.50	1.800	4.32	12.71	7.27
5.00	1.840	4.79	28.49	8.18
5.50	1.880	5.25	34.59	9.11
6.00	1.920	5.70	39.82	10.06
6.50	1.960	6.16	86.79	11.03
7.00	2.010	6.61	185.15	12.03

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	3.850	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	12.558	ACRE-FT
OUTFLOW ROUTED VOLUME	=	12.529	ACRE-FT
STORM VOLUME DISCHARGED	=	12.529	ACRE-FT
POND VOLUME AT PEAK STAGE	=	8.966	ACRE-FT
PEAK STAGE	=	5.420	FT
PEAK INFLOW RATE	=	109.754	CFS
PEAK DISCHARGE RATE	=	33.610	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	336918.40	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	69899.31	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0034	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	4.57	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	51434.64	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	51434.64	MG/L
BASIN TRAP EFFICIENCY	=	66.09	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	4.45	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	4.45	HRS
DETENTION TIME INCLUDING STORED FLOW	=	4.45	HRS
SEDIMENT LOAD DISCHARGED	=	878.91	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	40.40	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

*** RUN COMPLETED ****

```
*****************************************************************************
*          (program name)                * SEDIMOT S/N   :                  *
*                                        * HMVersion     :  3.20            *
*       (program description)            * Date          :  5/25/99         *
*                                        * Time          : 10:53:33         *
*                                        * Input file    : wpn3c.inp        *
*                                        * Output file   : wpn3c.out        *
*                                        *                                  *
*                                        *                                  *
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 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx   xxxxxxx
x     x  x        x     x    x    xx   xx  x     x     x
x        x        x     x    x    x x x x  x     x     x
 xxxxx   xxxxx    x     x    x    x  x  x  x     x     x
      x  x        x     x    x    x     x  x     x     x
x     x  x        x     x    x    x     x  x     x     x
 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx      x
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:::  Full Microcomputer Implementation   :::
:::                 by                   :::
:::        Haestad Methods, Inc.         :::
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*************************************************************
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              *********************************************
                   WATERSHED IDENTIFICATION CODE
                   -----------------------------
                   WEYERHAEUSER PLYMOUTH/WEST AREA/170'X370'X4'/100YR-24HR STOR
              *********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        9.00 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=========================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

1 1
3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========

========== SEDIMENTOLOGY INPUTS ==========

QUESTION NO.		
1.	SPECIFIC GRAVITY -	2.64
2.	COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -	2.00
3.	SUBMERGED BULK SPECIFIC GRAVITY -	1.35
4.	NUMBER OF PARTICLE SIZE DISTRIBUTIONS -	1
5.	NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -	11

==========

========== INPUT PARTICLE SIZE DISTRIBUTIONS ==========

VALUE NO.	SIZE, MM
1	1.0000
2	.5000
3	.2000
4	.1000
5	.0800
6	.0500
7	.0100
8	.0090
9	.0050
10	.0020
11	.0001

==========

========== PERCENT FINER DISTRIBUTIONS ==========

VALUE NO.	PARTICLE SIZE # 1
1	100.00
2	99.90
3	87.50
4	50.50
5	44.50
6	36.50
7	32.00
8	31.00
9	29.00
10	24.50
11	.00

==========

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	10
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	3.25	69.00	.275	.000	.000	.00	2.0
2	3.62	69.00	.325	.000	.000	.00	2.0
3	4.30	69.00	.315	.000	.000	.00	2.0
4	4.31	69.00	.306	.000	.000	.00	2.0
5	4.31	69.00	.288	.000	.000	.00	2.0
6	4.39	69.00	.273	.000	.000	.00	2.0
7	3.96	69.00	.239	.000	.000	.00	2.0
8	4.01	69.00	.318	.000	.000	.00	2.0
9	2.80	69.00	.180	.000	.000	.00	2.0
10	5.56	69.00	.278	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.20	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0
10	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	12.43	5.21	296.21	.067	.832	1.000
2	13.04	5.21	323.21	.062	.804	1.000
3	15.67	5.21	394.50	.063	.809	1.000
4	15.88	5.21	397.98	.064	.814	1.000
5	16.22	5.21	402.79	.066	.824	1.000
6	16.83	5.21	415.36	.068	.833	1.000
7	15.87	5.21	379.43	.072	.854	1.000
8	14.56	5.21	364.08	.063	.808	1.000
9	12.13	5.21	268.85	.080	.892	1.000
10	21.19	5.21	539.40	.067	.830	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	9.00	INCHES
RUNOFF VOLUME	=	17.5928	ACRE-FT
PEAK DISCHARGE	=	153.8100	CFS
AREA	=	40.5100	ACRES
TIME OF PEAK DISCHARGE	=	12.10	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	575.89	EI UNIT
PEAK CONCENTRATION	=	346764.10	MG/L
PEAK SETTLEABLE CONCENTRATION	=	156.0820	ML/L
PEAK SETTLEABLE CONCENTRATION	=	210710.70	MG/L
TOTAL SEDIMENT YIELD	=	3781.8120	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0667	MM
TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	18.00	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	63.97	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	63.97	ML/L

ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION = 13.19 ML/L

ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD = 9.89 ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	11
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	2.50
3	3.00
4	3.50
5	4.00
6	4.50
7	5.00
8	5.50
9	6.00
10	6.50
11	7.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE
1	1.44
2	1.64
3	1.67
4	1.71
5	1.75
6	1.80
7	1.84
8	1.88
9	1.92
10	1.96

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	1.97
4	2.45
5	2.97
6	12.71
7	28.49
8	34.59
9	39.82
10	86.79
11	185.15

==========

****
****

CAUTION: THE STAGE OF YOUR PRINCIPLE SPILLWAY MAY CAUSE BED SCOUR. SEDIMOT II DOES NOT CONSIDER POSSIBLE BED SCOUR; HENCE, YOUR OBSERVED EFFLUENT MAY NOT MEET THE DESIRED EFFLUENT STANDARD. INCREASE THE STAGE OF YOUR PRINCIPAL SPILLWAY.

****
****

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	1.440	.00	.00	.00

2.50	1.640	2.42	.00	3.85
3.00	1.670	2.90	1.97	4.68
3.50	1.710	3.38	2.45	5.52
4.00	1.750	3.86	2.97	6.39
4.50	1.800	4.32	12.71	7.27
5.00	1.840	4.79	28.49	8.18
5.50	1.880	5.25	34.59	9.11
6.00	1.920	5.70	39.82	10.06
6.50	1.960	6.16	86.79	11.03
7.00	2.010	6.61	185.15	12.03

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	3.850	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	17.593	ACRE-FT
OUTFLOW ROUTED VOLUME	=	17.562	ACRE-FT
STORM VOLUME DISCHARGED	=	17.562	ACRE-FT
POND VOLUME AT PEAK STAGE	=	10.564	ACRE-FT
PEAK STAGE	=	6.257	FT
PEAK INFLOW RATE	=	153.810	CFS
PEAK DISCHARGE RATE	=	64.004	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	346764.10	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	79668.38	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0113	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	15.30	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	55952.21	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	55952.21	MG/L
BASIN TRAP EFFICIENCY	=	64.56	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	3.55	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	3.55	HRS
DETENTION TIME INCLUDING STORED FLOW	=	3.55	HRS
SEDIMENT LOAD DISCHARGED	=	1340.18	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	41.40	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.01	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.01	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.01	ML/L

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SHEET _____ OF _____

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	JYK	6/17/99	EWT	7/8/99	05101.01

SUMMARY OF WEST AREA SEDIMENT BASIN DESIGN

BASIN DIMENSIONS: BASE AREA → 170' x 370'
SIDESLOPES → 3H:1V

PRINCIPAL SPILLWAY: 30" CMP RISER DIAM.
24" CMP BARREL DIAM.
0.5" PERFORATIONS DIAM.
→ 4" O.C. HORIZONTALLY
→ 6" O.C. VERTICALLY
4 FEET FROM POND BOTTOM TO TOP OF RISER.
70 FEET LONG
1% SLOPE

EMERGENCY SPILLWAY: BASE WIDTH → 44 FEET
SIDESLOPES → 4H:1V.
6 FEET FROM BOTTOM OF POND TO BASE OF EMERGENCY SPILLWAY
2-FOOT DEEP

	POST-DEVELOPMENT		PRE-DEVELOPMENT
$Q_{POND,10Y}$ =	25.5 CFS	<	37.6 CFS
$Q_{POND,25Y}$ =	33.6 CFS	<	50.2 CFS
$Q_{POND,100Y}$ =	64.0 CFS	<	73.6 CFS

TE_{2YR} =	77.6 %	>	70%	(≥70% REQ FOR HQW'S FOR 2YR EVENT) ✓
TE_{10YR} =	67.9 %	>	60%	✓
TE_{25YR} =	66.0 %	>	60%	✓
TE_{100YR} =	64.6 %	>	60%	✓

Attachment L6
Post Development Stormwater Design Calculations – North West Area

DESIGN SHEET

SHEET 1 OF

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER PLYMOUTH	SYK	8/13/99	[illegible]	9/13/99	05101.01

POST DEVELOPMENT STORM WATER ANALYSIS; NORTHWEST BASIN

DETERMINE: PEAK RUNOFF RATE FOR AREA 1A (NORTWEST BASIN) USING THE SCS METHOD & 25 YR-24 HR STORM $Q_{P_{25,24}}$

GIVEN:

LOCATION: PLYMOUTH, NC
HYDROGEOLOGIC SOIL GROUP (HSG) "B"
TOTAL AREA OF WATERSHED = 16.35 ACRES
MAXIMUM HYDRAULIC LENGTH = 1370
EXTERIOR FACE OF TERRACE LENGTH = 60'
(I.E. 3H:1V SLOPE, 20' HIGH)
DESIGN FOR 25 YR, 24 HR STORM EVENT
FACE OF TERRACE SLOPE = 33.3%

% HYDRAULIC LENGTH MODIFIED = 0
% IMPERVIOUS AREA = 0

SOLUTION:

FROM FIGURE 8.03K, 25 YR-24 HR STORM = 7.25 INCHES

FROM TABLE 8.03b, CN = 69 FOR FAIR CONDITION GRASS COVERAGE ON 50 TO 75% OF THE AREA (ASSUME CAPPING & VEGETATION PROGRESS WITH LANDFILL CONSTRUCTION)

FROM TABLE 8.03c, 7.25 INCHES OF RUNOFF, CN = 69, DOUBLE INTERPOLATION
RUNOFF DEPTH = 3.73 INCHES

FOR (25 YR, 24 HR EVENT

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SHEET 2 OF

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER-PLYMOUTH	[illegible]	8/13/99	[illegible]	9/13/99	05101.01

25 YEAR TOTAL RUNOFF VOLUME $= (3.73\ IN)(16.35)(1'/12'') = 5.1$ AC-FT

10 YR TOTAL RUNOFF VOL. $= (2.91\ IN)(16.35)(1/12'') = 4.0$ AC-FT

EQUIVALENT DRAINAGE AREA, $a = f(HL = 1370\ ft)$

$$a = [(HL)/209]^{1/0.6} = [1370/209]^{1/0.6}$$

$$a = 23 \text{ ACRES}$$

USE 27% FOR AVG WATERSHED SLOPE.

RATE OF DISCHARGE: F. 8.03a, 23 ACRES, CN=69, S=33%, TYPE II STORM

PEAK RATE OF DISCHARGE = 29 CFS/IN

PEAK DISCHARGE FOR EQUIVALENT WATERSHE = $(29\ CFS/IN)(3.73\ IN)$

$$Q_1 = 108.2 \text{ CFS}$$

PEAK DISCHARGE, $Q_2 = (108.2\ CFS)\left(\frac{16.35}{23.00}\right) = 76.9\ CFS$

ADJUST PEAK DISCHARGE FOR AVG WATERSHED SLOPE (27%) + AREA = 16.35 AC BY DOUBLE INTERPOLATION OF DATA FROM T. 8.03 d.

$$Q_3 = (76.9\ CFS)(1.085) = 83.4\ CFS$$

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SHEET 3 OF

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PROJECT/PROPOSAL NAME	PREPARED		CHECKED		PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	By: SMK	Date: 8/16/99	By: BJD	Date: 9/15/99	05101.01

SEDIMENT BASIN DESIGN

V_{min} = MIN VOL = $(1800\ ft^3/ac)(16.35\ ac) = 29{,}430\ ft^3 = 0.68\ ac\text{-}ft$

MIN. AREA OF BASIN @ PRINCIPAL SPILLWAY $= A_{PS} \geq 0.01\ (Q)$

$A_{PS} \geq 0.01\ (83.4\ cfs) = 0.83$ acres

$A_{PS} \geq 36{,}329\ ft^2$

SIZE BASIN:

3H:1V SIDESLOPES
EL 32 TOP OF DIKE
EL. 24 TO 26 BOTTOM OF POND.
EL 30 EMERGENCY SPILLWAY
EL 28 PRINCIPAL SPILLWAY

SIZE PRINCIPAL SPILLWAY

$Q_{P_{min}} = (0.2\ cfs/ac)(16.35\ ac) = 3.27\ cfs.$

LET PRINCIPAL SPILLWAY RISER DIAMETER = 30" = d
LET PRINCIPAL SPILLWAY BARREL DIAMETER = 24" = D
HEIGHT OF RISER = 2D = 48" = 4' MIN

IF H_{min} = 4 FT & L_{min} = 80 ft FOR 24" CMP PERFORATED RISER,
THEN Q = 22.06 (0.96) = 21.2 CFS (T. 8.07 A)

MIN. HEAD RQDn FOR Q = 21 cfs & d = 30 in (T. 8.07 B) = 0.87 ft
MIN. HT. OF EMERGENCY SPILLWAY = 0.87 ft + 4' = 4.87 ft

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WEYERHAEUSER – PLYMOUTH	SJK	9/6/09	[illegible]	[illegible]	05101.01

ESTIMATE AREA OF BASIN

$A_{PS} \geq 36,329$

Let $A_{PS} = 37,000$ SF $L = 2W$

$W = \sqrt{37,000/2} = 136$

$L = 2W = 272$

A_{PS} 4' BELOW TOP OF BERM & 3H:1V SIDE SLOPES

A_{BERM} (INTER) $\approx W: 136 + (4')(2)(3) = 160'$

$\approx L: 272 + (4')(2)(3) = 296'$

$\hookrightarrow 47,360$

LET $W_{BERM} = 150$ F, THEN $L \approx 315$ FT

SIZE TOP OF BERM 150' x 335'

Area Elevation	Width	Length	Area (Ac)
32	150	335	1.153
31	144	329	1.088
30	138	323	1.023
29	132	317	0.960
28	126	311	0.899 ✓
27	120	305	0.840
26	114	299	0.782
25	*	*	0.208
24	*	*	0.040

* triangular shape area

b. Determine runoff depth (in inches) from the curve number and rainfall depth using Table 8.03c.

Table 8.03c Runoff Depth

Rainfall (inches)	Curve Number (CN)[1]							
	60	65	70	75	80	85	90	95
1.0	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56
1.2	0.00	0.00	0.03	0.07	0.15	0.28	0.46	0.74
1.4	0.00	0.02	0.06	0.13	0.24	0.39	0.61	0.92
1.6	0.01	0.05	0.11	0.20	0.34	0.52	0.76	1.11
1.8	0.03	0.09	0.17	0.29	0.44	0.65	0.93	1.30
2.0	0.06	0.14	0.24	0.38	0.56	0.80	1.09	1.48
2.5	0.17	0.30	0.46	0.65	0.89	1.18	1.53	1.97
3.0	0.33	0.51	0.72	0.96	1.25	1.59	1.98	2.44
4.0	0.76	1.03	1.33	1.67	2.04	2.46	2.92	3.42
5.0	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.41
6.0	1.92	2.35	2.80	3.28	3.78	4.31	4.85	5.40
7.0	2.60	3.10	3.62	4.15	4.69	5.26	5.82	6.40
8.0	3.33	3.90	4.47	5.04	5.62	6.22	6.81	7.39
9.0	4.10	4.72	5.34	5.95	6.57	7.19	7.79	8.39
10.0	4.90	5.57	6.23	6.88	7.52	8.16	8.78	9.39
11.0	5.72	6.44	7.13	7.82	8.48	9.14	9.77	10.39
12.0	6.56	7.32	8.05	8.76	9.45	10.12	10.76	11.39

[1] To obtain runoff depths for CN's and other rainfall amounts not shown in this table, use an arithmetic interpolation.

The volume of runoff from the site can be calculated by multiplying the area of the site by the runoff depth.

Step 4. Determine the peak rate of runoff for the design storm by adjusting for watershed shape as follows:

a. Determine an "equivalent drainage area" from the hydraulic length of the watershed using Figure 8.03n. Hydraulic length is the length of the flow path from the most remote point in the watershed to the point of discharge.

b. Determine the discharge (cfs/inch of runoff) for the equivalent drainage area from Figure 8.03o through 8.03q:

Figure 8.03o - for average watershed slopes 0-3%
Figure 8.03p - for average watershed slopes 3-7%
Figure 8.03q - for average watershed slopes 8-50%

Calculate the peak discharge, Q_1, of the equivalent watershed by multiplying equivalent watershed area by runoff from Table 8.03c in Step 3b.

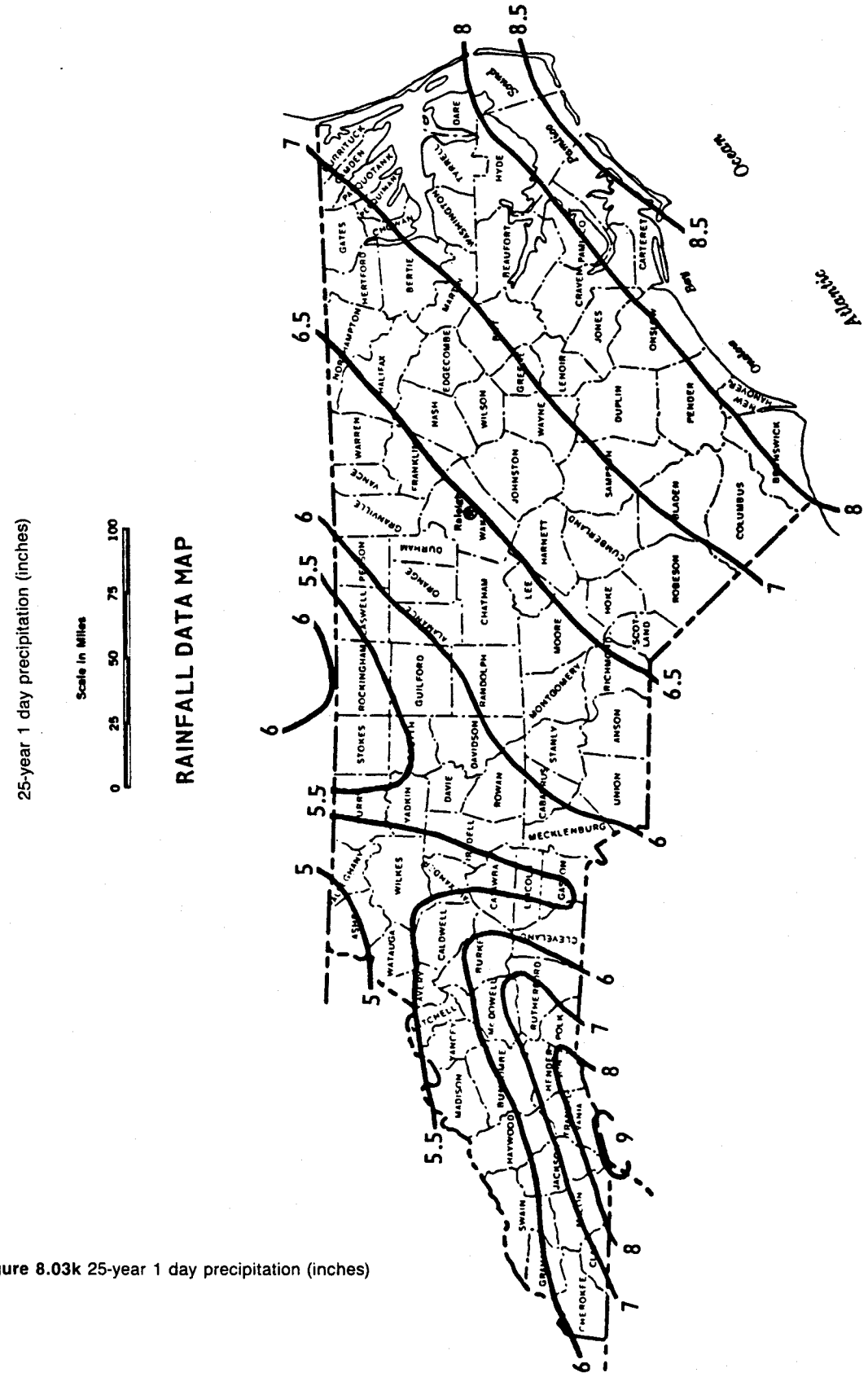


Figure 8.03k 25-year 1 day precipitation (inches)

Table 8.03b
Runoff Curve Numbers (CN)

Land Use/Cover		Hydrologic Soil Group A	B	C	D
Cultivated land					
without conservation		72	81	88	91
with conservation		62	71	78	81
Pasture land					
poor condition		68	79	86	89
fair condition		49	69	79	84
good condition		39	61	74	80
Meadow					
good condition		30	58	71	78
Wood or forest land					
Thin stand - poor cover, no mulch		45	66	77	83
Good stand - good cover		25	55	70	77
Open spaces, lawns, parks, golf courses, cemeteries, etc.					
good condition: grass cover on 75% or more of the area		39	61	74	80
fair condition: grass cover on 50 to 75% of the area		49	69	79	84
Commercial and business areas (85% impervious)		89	92	94	95
Industrial districts (72% impervious)		81	88	91	93
Residential:[1] Development completed and vegetation established					
Average lot size	Average % Impervious				
1/8 acre or less	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acre	15	47	66	77	81
Paved parking lots, roofs, driveways, etc.		98	98	98	98
Streets and roads paved with curbs and storm sewers		98	98	98	98
gravel		76	85	89	91
dirt		72	82	87	89
Newly graded area		81	89	93	95
Residential: Development underway and no vegetation					
Lot sizes of 1/4 acre		88	93	95	97
Lot sizes of 1/2 acre		85	91	94	96
Lot sizes of 1 acre		82	90	93	95
Lot sizes of 2 acres		81	89	92	94

[1]Curve numbers are computed assuming the runoff from the house and driveway is directed toward the street.

source: USDA-SCS

Table 8.03d
Slope Adjustment Factors

	Slope (percent)	10 acres	20 acres	50 acres	100 acres	200 acres
Flat	0.1	0.49	0.47	0.44	0.43	0.42
	0.2	0.61	0.59	0.56	0.55	0.54
	0.3	0.69	0.67	0.65	0.64	0.63
	0.4	0.76	0.74	0.72	0.71	0.70
	0.5	0.82	0.80	0.78	0.77	0.77
	0.7	0.90	0.89	0.88	0.87	0.87
	1.0	1.00	1.00	1.00	1.00	1.00
	1.5	1.13	1.14	1.14	1.15	1.16
Moderate	3	0.93	0.92	0.91	0.90	0.90
	4	1.00	1.00	1.00	1.00	1.00
	5	1.04	1.05	1.07	1.08	1.08
	6	1.07	1.10	1.12	1.14	1.15
	7	1.09	1.13	1.18	1.21	1.22
Steep	8	0.92	0.88	0.84	0.81	0.80
	9	0.94	0.90	0.86	0.84	0.83
	10	0.96	0.92	0.88	0.87	0.86
	11	0.96	0.94	0.91	0.90	0.89
	12	0.97	0.95	0.93	0.92	0.91
	13	0.97	0.97	0.95	0.94	0.94
	14	0.98	0.98	0.97	0.96	0.96
	15	0.99	0.99	0.99	0.98	0.98
	16	1.00	1.00	1.00	1.00	1.00
	20	1.03	1.04	1.05	1.06	1.07
	25	1.06	1.08	1.12	1.14	1.15
	30	1.09	1.11	1.14	1.17	1.20
	40	1.12	1.16	1.20	1.24	1.29
	50	1.17	1.21	1.25	1.29	1.34

source: USDA-SCS

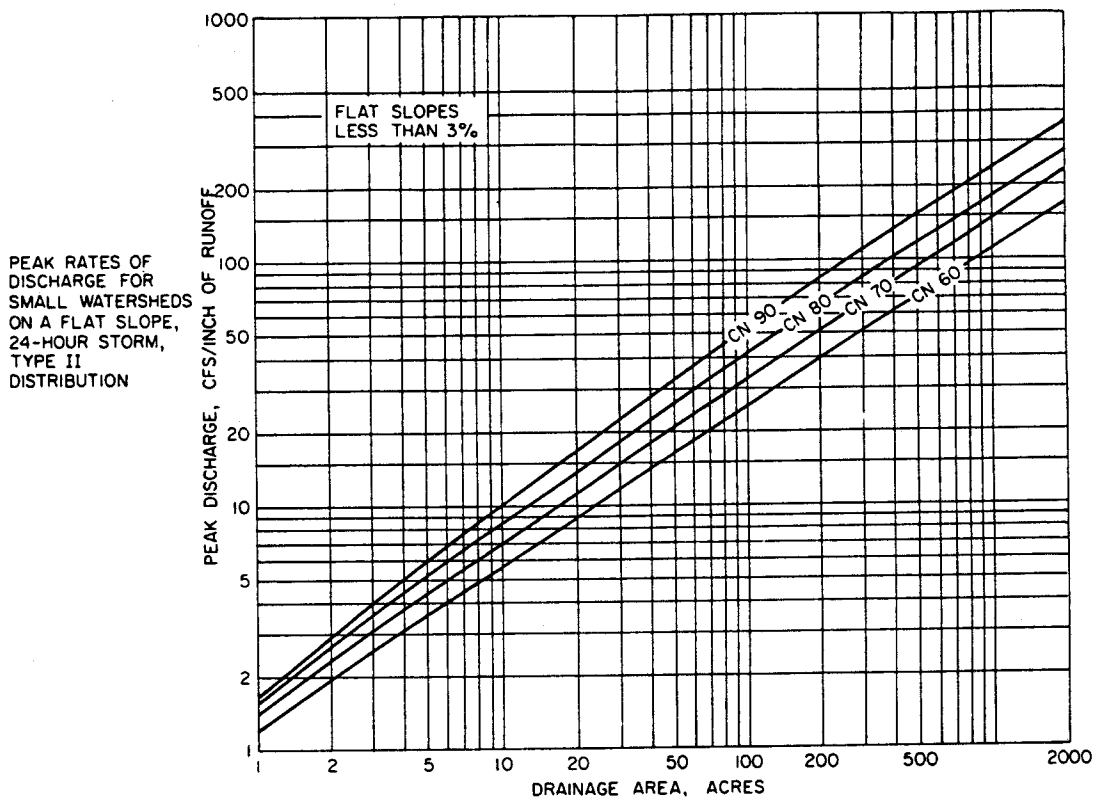


Figure 8.03o Discharge vs equivalent drainage area for average watershed slopes 0 - 3%.

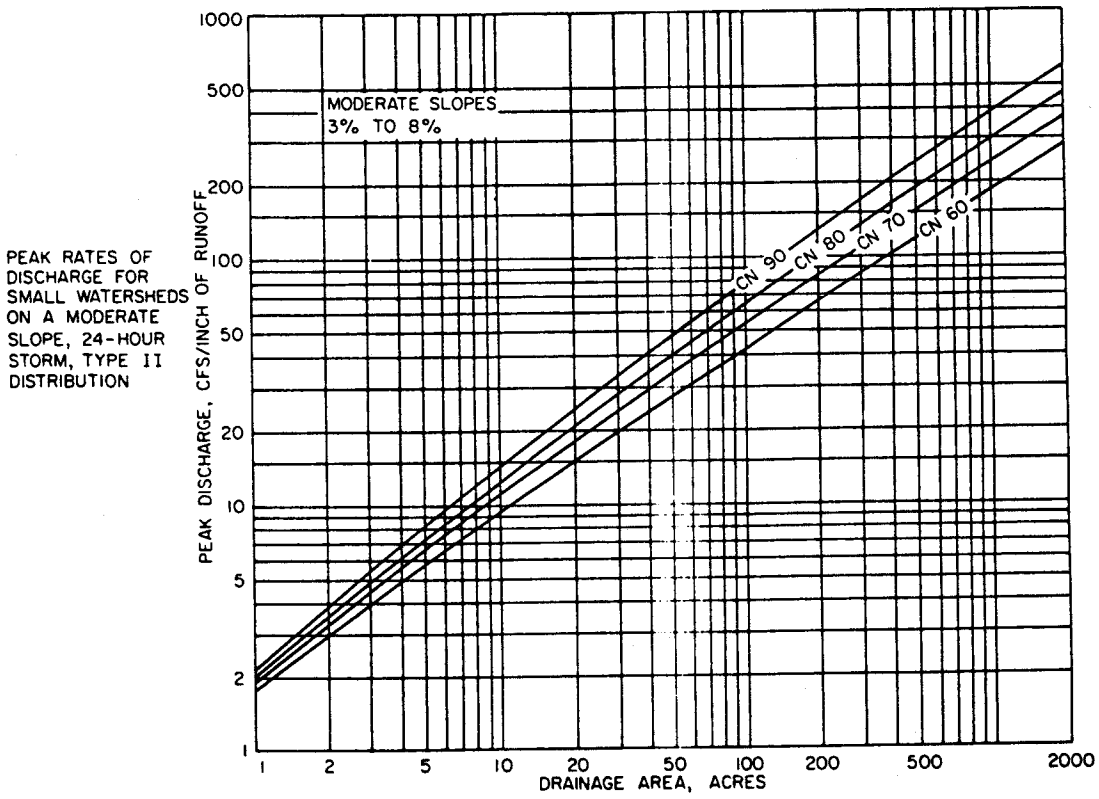
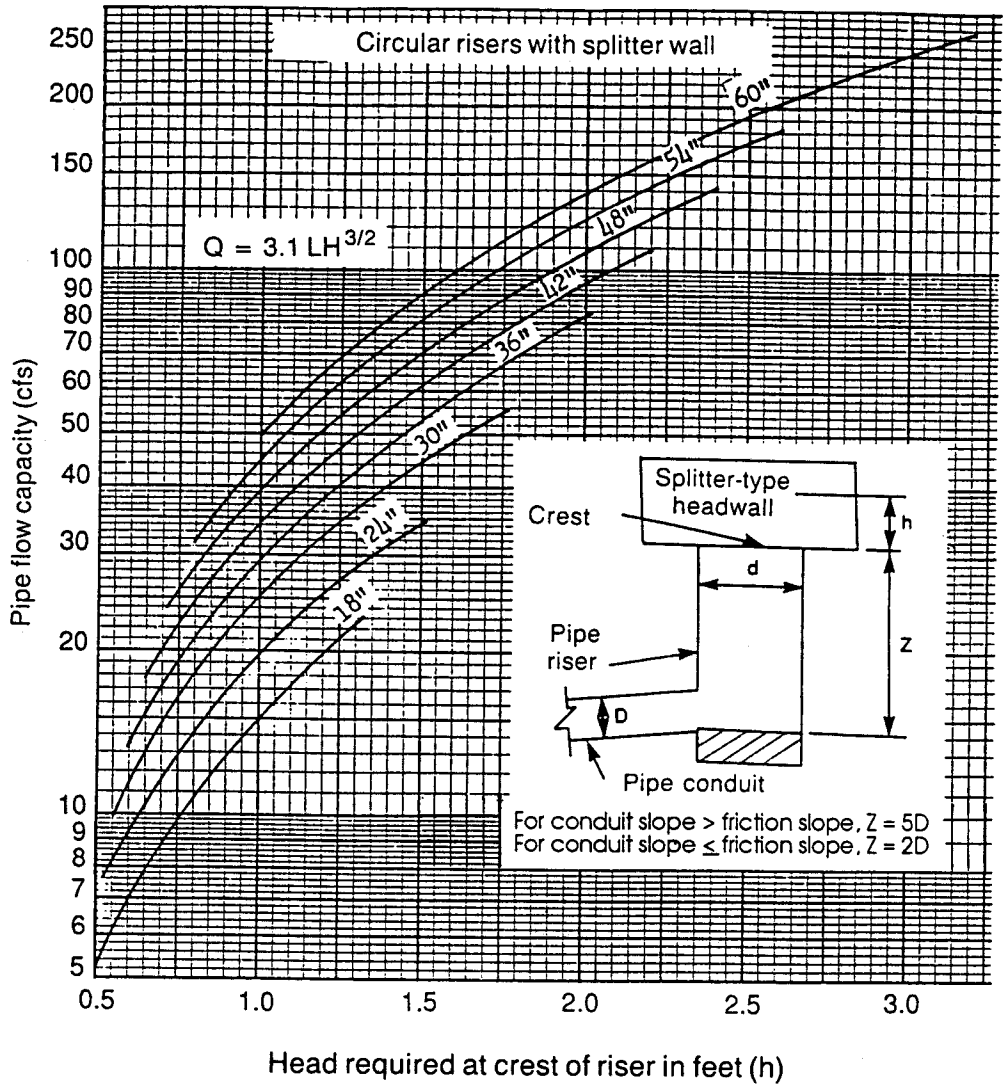


Figure 8.03p Discharge vs equivalent drainage area for average watershed 3 - 8%.



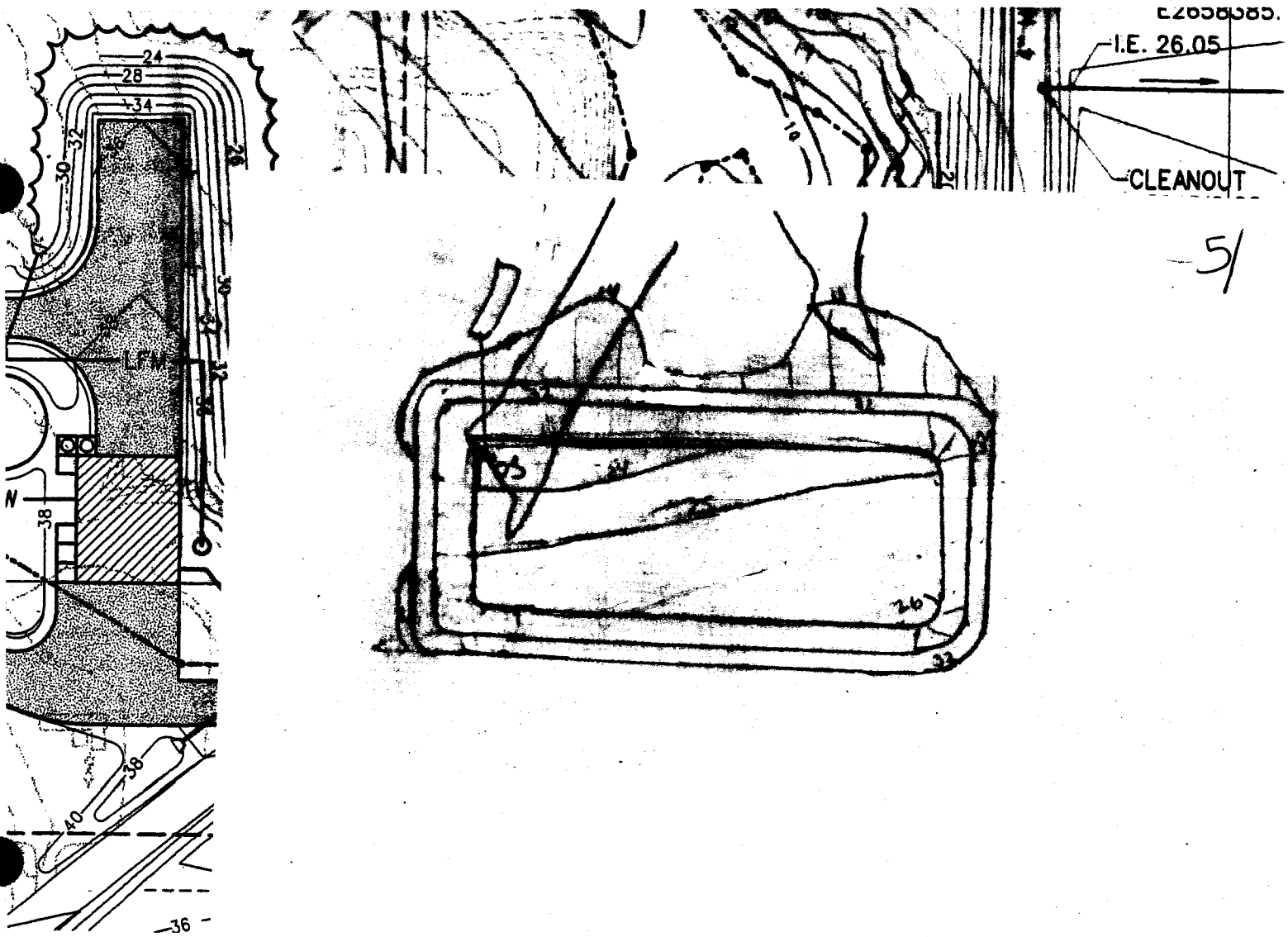
Inlet Proportions	
Pipe Conduit (D) - in	Pipe Riser (d) - in
8-12	18
15	21
18	24
21	30
24	30
30	36
36	48
42	54
48	60

Pipe drop inlet spillway design:

For a given Q and H, refer to Table 8.07a or 8.07b for conduit size. Then determine the riser diameter (d) from the Inlet Proportions Table on this figure. Next, refer to the above curves, using the conduit capacity and riser diameter, and find the head (h) required above the crest of the riser. The height of the riser should not be less than 5D - h, except as noted in the above sketch.

Example - Given: CMP; Q = 20 cfs; H = 14 ft, h max. 1.0 ft; L = 70 ft. From Table 8.07a find conduit size (D) = 18 inches. From Inlet Proportions Table, riser size = 24 inches. Head (h) required for Q = 20 and d = 24 is 1.0 ft.

Figure 8.07b Design chart for riser outlet.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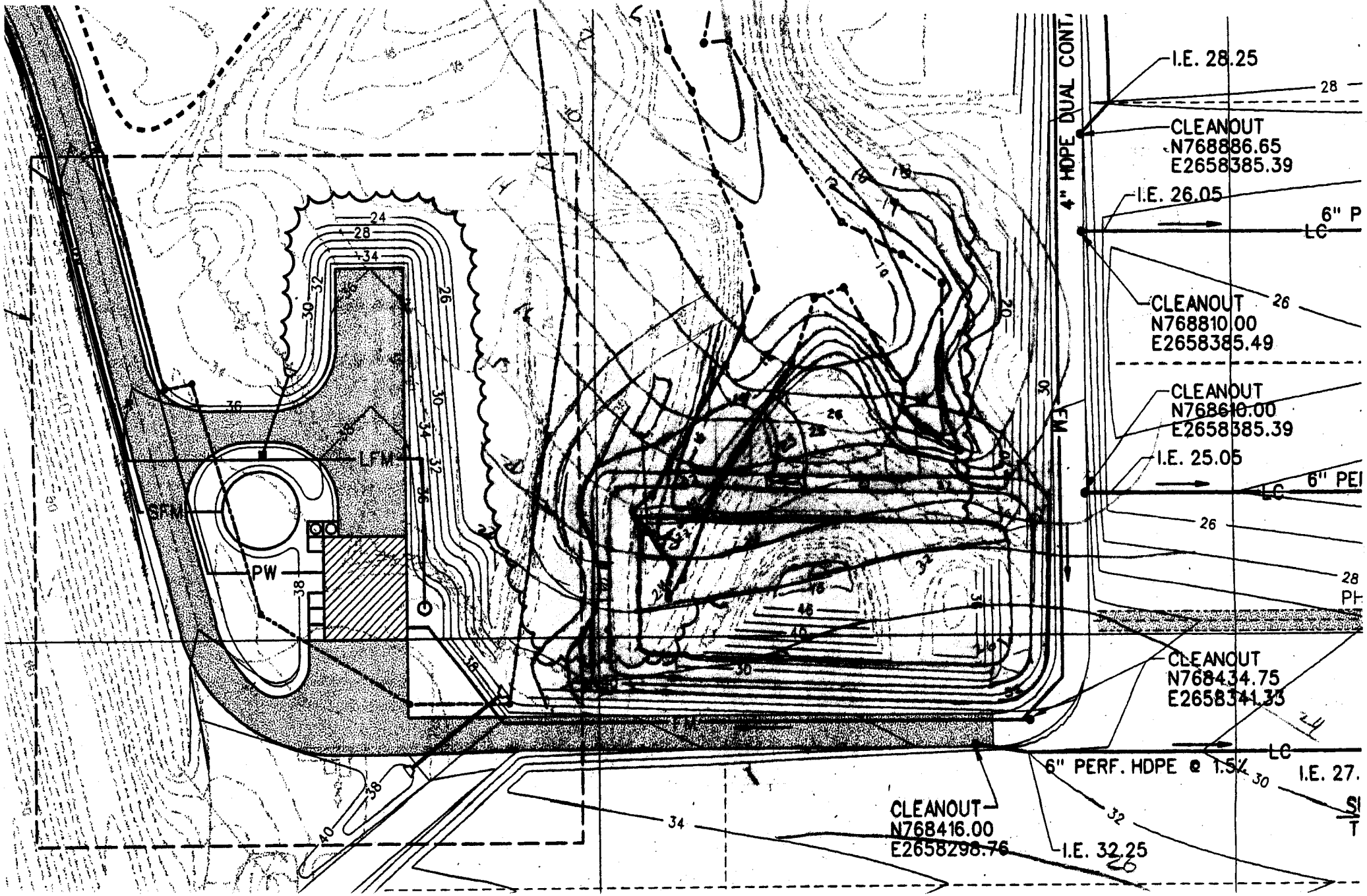
I.E. 26.05
CLEANOUT
5
24
28
34
32
30
26
LFM
N
38
40
36


I.E. 28.25
CLEANOUT
N768886.65
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I.E. 26.05
6" P
LC
CLEANOUT
N768810.00
E2658385.49
CLEANOUT
N768610.00
E2658385.39
I.E. 25.05
6" PE
LC
CLEANOUT
N768434.75
E2658341.33
LC
6" PERF. HDPE @ 1.5%
I.E. 27.
CLEANOUT
N768416.00
E2658298.76
I.E. 32.25
4" HDPE DUAL CONT.
LFM
SFM
PW

DESIGN SHEET

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WEYERHAEUSER-PLYMOUTH	[illegible]	8/17/99	[illegible]	9/13/99	05101.01

EMERGENCY SPILLWAY DESIGN

$Q_P = f(H=6\text{ ft}, D=2\text{ ft}, L=80\text{ ft}$ & T. 8.07 A CMP)

$Q_P = (27.01_{CFS})(0.96) = 25.93$ CFS

$Q_{ES} = Q_{P_{25/24}} - Q_P = 83.4_{CFS} - 25.93_{CFS}$

$Q_{ES} = 57.47$ CFS

FROM T. 8.07c, Q=60 CFS → 28 FT WIDE
3% to 8.6 % SLOPE RANGE
4H:1V SIDE SLOPES

MIN HT OF ES = 4.9'

SET IT @ 6.0' OR EL. 30.
USE 8.6% EXIT SLOPE
B = 28' WIDE

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WEYERHAEUSER - PLYMOUTH	SJL	8/18/98			05101.01

POST DEVELOPMENT LAND USE:

- OPEN SPACE, FAIR CONDITIONS, GRASS COVER ON 50 TO 75% OF SITE HYDROGEOLOGIC SOIL GROUP "B" → USE CURVE 69

- PERMANENT SEEDINGS FROM 0-60 DAYS
  → CONTROL PRACTICE FACTOR = 0.4.

DETERMINE POST-DEVELOPMENT PEAK FLOW RATES USING SCS METHODOLOGY & SEDIMOT II MODEL

CALCULATE TIME OF CONCENTRATION FOR SHEET FLOW DOWN THE SIDE OF THE TERRACE (0-60') AND CHANNELIZE FLOW ALONG BASE OF TERRACE TO ARTICULATED BLOCK CHANNEL.

ASSUME TRAVEL TIME DOWN ARTICULATED BLOCK CHANNEL APPROACHES INSTANTANEOUSLY (CONSERVATIVE ASSUMPTION) AND IS ZERO

SHEET FLOW (0-60'): $T_{t_{0-60'}} = \frac{0.007\,(n \cdot L)^{0.8}}{\sqrt{P_2} \cdot S^{0.4}} = \frac{0.007\,(0.15(60))^{0.8}}{\sqrt{4} \cdot (0.333)^{0.4}}$

$T_{0-60'} = 0.032$ hrs

where: P_2 = 2yr, 24 hr storm = 4 in
S = slope = 1/3' = 0.333
n = Manning's Roughness Coefficient for Sheet Flow = 0.15 (short prairie grass)
L = flow length = 60 ft

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SHEET 9 OF

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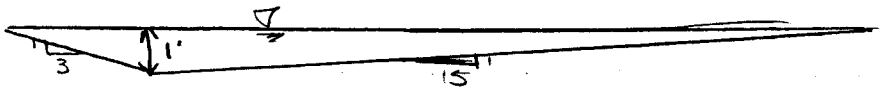
PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
Weyerhaeuser Plymouth	SJK	8/10/99	[illegible]	9/9/99	05101.01

Trapezoidal Channel Flow

$$Vel = \frac{1.49\, r^{2/3} \cdot S^{1/2}}{\eta}$$

where: η = Manning Roughness Coef for Channel Flow
$\eta = 0.035$ (earth w/ weeds + stone)
S = Slope = 0.005 ft/ft
r = hydraulic radius = a/p_w
p_w = wetted perimeter.

CHANNEL ALONG BASE OF TERRACE



$$a = (1)(3)(1/2) + (1)(15)(1/2) = 9.0\ ft^2$$

$$p_w = \left(\sqrt{1^2+3^2}\right) + \left(\sqrt{1^2+15^2}\right) = 18.2\ ft$$

$$r = a/p_w = 9/18.2 = 0.495\ ft$$

$$Vel = \frac{1.49\,(0.495)^{2/3} \cdot (0.005)^{1/2}}{0.035}$$

$$Vel = 1.58\ fps$$

$$T_t = \left(\frac{DIST}{VEL}\right) / (3600\ sec/hr)$$

terrace channel.

DIST = MAX CHANNEL LENGTH ALONG TERRACE

DESIGN SHEET

RMT®

SHEET 10 OF

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SJK	8/18/09	dwz	9/9/09	05101.01

AREA 1A (NORTH WEST BASIN)

WATERSHED #	AREA (AC)	MAX CHANNEL LENGTH ALONG TERRACE	T_t (secs) TERRACE CHANNEL	T_t (secs) SHEET FLOW	$T_c = \Sigma T_t$
* 1	0.52	570	0.084	0.0181	0.102
2	1.50	595	0.088	0.032	0.120
3	1.56	680	0.100	0.032	0.132
4	2.07	750	0.111	0.032	0.143
5	2.33	825	0.122	0.032	0.154
6	2.15	845	0.125	0.032	0.157
7	1.88	760	0.112	0.032	0.144
8	1.62	680	0.100	0.032	0.132
9	1.31	[illegible]	0.089	0.032	0.121
10 **	1.11	515	0.076	0.108**	0.184

** $T_{t_{SF}} = 0.032 + \frac{0.007\,(0.15(70'))^{0.8}}{\sqrt{4'} \cdot (0.05)^{0.4}} = 0.108$

* $T_{t_{SF}} = \frac{0.007\,(0.15(30'))^{0.8}}{\sqrt{4} \cdot (0.333)^{0.4}} = 0.018$

DESIGN SHEET

RMT®

SHEET 11 OF

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAESER - PLYMOUTH	[illegible]	8/18/98	[illegible]	9/9/99	05101.01

At Emergency Spillway Elevation 30 (6')

Volume of Sedimentation Basin = 4.22 AC-FT

ASSUME DISCHARGE THROUGH RISER STARTS @ 2.0 FT

	STAGE	AREA	DISCHARGE
1	0	0.040	0
2	1	0.208	0
3	2	0.782	1.12
4	3.5	0.871	2.45
5	4	0.899	2.97
6	4.5	0.929	12.71
7	5.0	0.960	28.49
8	5.5	0.991	34.59
9	6.0	1.023	39.82
10	6.5	1.055	71.68
11	7.0	1.088	137.37

2 yr STORM	TE = 72.2%	PK STG = 2.4 FT	ok
10 yr STORM	TE = 71.92%	PK STAGE = 4.0 FT	✓
25 yr STORM	TE = 70.86%	PK STG = 4.4 FT	✓
100 yr STORM	TE 69.4%	PK STG = 4.9 FT	✓

OUTFLOW STRUCTURE EVALUATION

RETENTION POND # **1A** **(Northwest Area)**

Weyerhaeuser No. 3 Landfill ***RMT Job No. 5101.01***

Plymouth, North Carolina

DEPTH INCREMENT **1** (feet)

Depth (ft.)	Area (acres)	Avg. Area (sq. ft.)	Storage (acre-ft.)
0	0.0400		0
		0.124	
1	0.2080		0.12
		0.495	
2	0.7820		0.62
		0.811	
3	0.8400		1.43
		0.870	
4	0.8990		2.30
		0.930	
5	0.9600		3.23
		0.992	
6	1.0230		4.22
		1.056	
7	1.0880		5.28
		1.121	
8	1.1530		6.40

Weyerhaeuser No. 3 Landfill
Plymouth, North Carolina

Detention Pond # ***1***
Height of Riser (ft.) ***4***
Height of Emergency Spillway (ft.) ***6***

RMT Job No. 05101.01

HEAD	ROW																								
ELEV.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	PRIN.	EMER.	**TOTAL**
0.00	-																						0	0	**-**
0.50	0.18	-																					0	0	0.18
1.00	0.26	0.18	-																				0	0	**0.44**
1.50	0.32	0.26	0.18	-																			0	0	0.75
2.00	0.36	0.32	0.26	0.18	-																		0	0	**1.12**
2.50	0.41	0.36	0.32	0.26	0.18	-																	0	0	1.52
3.00	0.45	0.41	0.36	0.32	0.26	0.18	-																0	0	**1.97**
3.50	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-															0	0	2.45
4.00	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-														0	0	**2.97**
4.50	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-													9.2	0	**12.71**
5.00	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-												24.4	0	**28.49**
5.50	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-											29.9	0	**34.59**
6.00	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-										34.5	0	**39.82**
6.50	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-									38.6	27.1	**71.68**
7.00	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-								42.3	88.41	**137.37**
7.50	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-							45.7	178.93	231.99
8.00	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-						48.8	297.94	354.83
8.50	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-					51.8	445.78	506.42
9.00	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-				54.6	623.24	687.45
9.50	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-			0	831.29	841.69
10.00	0.81	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-		0	0	11.22
10.50	0.83	0.81	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	-	0	0	12.05
11.00	0.85	0.83	0.81	0.79	0.77	0.75	0.73	0.70	0.68	0.66	0.63	0.60	0.58	0.55	0.51	0.48	0.45	0.41	0.36	0.32	0.26	0.18	0	0	12.90

TOTAL FLOW RATE PER ROW OF PERFORATED RISER PIPE USING THE ORIFICE EQUATION:

$$Q=n*C_d*A_o*(2*g*y)^{0.5}$$

WHERE:

D =	diameter of riser pipe (inches)	LET: D =	**30**	$n*C_d*A_o$ = 0.0321
s =	lateral spacing of orifice holes on riser (inches)	s ~	**4**	$(2*g)^{0.5}$ = 8.025
n =	number of holes per row =(3.14*D/s)+/-1	n =	**24**	increment= **0.5**
d =	diameter of orifice (inches)	d =	**0.500**	
A_o =	orifice area (sq. ft.) = $(3.14*(d^2/4))/144$	A_o =	0.0014	
g =	32.2 ft/sec^2	g =	32.2	
y =	elevation head (ft)	y =	(see first column in table)	
A_2 =	jet area (sq. ft.)	A_2 =	A_o	
C_v =	0.95 (sqr. edge) to 0.99 (round edge)	C_v =	**0.98**	
C_c =	A_2/A_o	C_c =	**1**	
C_d =	discharge coefficient $=C_c*C_v$	C_d =	0.98	

Normal Depth Channel Analysis Program
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WEYERHAEUSER PLYMOUTH NORTHWEST BASIN

CHANNEL SLOPE = .005 FT/FT
MANNINGS N = .035

TRAPEZOIDAL CHANNEL OUTPUT

BOTTOM WIDTH = 28 FT
LEFT SIDE SLOPE = 4 FT/FT
RIGHT SIDE SLOPE = 4 FT/FT

DEPTH (FT)	FLOW (CFS)	AREA (SQ FT)	WP (FT)	VEL (FT/SEC)	CR. DEP. (FT)
0.50	27.10	15.00	32.12	1.81	0.30
1.00	88.41	32.00	36.25	2.76	0.65
1.50	178.93	51.00	40.37	3.51	1.03
2.00	297.94	72.00	44.49	4.14	1.42
2.50	445.78	95.00	48.62	4.69	1.82
3.00	623.24	120.00	52.74	5.19	2.22
3.50	831.29	147.00	56.86	5.66	2.64

OUTFLOW RATING TABLE FOR FLOW ABOVE THE RISER FOR DETENTION POND NO. **1A**

Northwest Area

Weyerhaeuser No. 3 Landfill ***RMT Job No.*** ***5101.01***

Plymouth, North Carolina

RISER DIAMETER.	**2.5**	FT.
HEIGHT OF RISER	***4***	FT.
OUTFLOW PIPE DIAMETER.	***2***	FT.
OUTFLOW PIPE LENGTH.	***100***	FT.
OUTFLOW PIPE SLOPE.	***2***	%
MANNING N-VALUE.	***0.023***	(corrugated metal pipe)
ENTRANCE LOSS COEFFICIENT.	1	
BEND LOSS COEFICIENT.	1	
WEIR COEFICIENT.	***3.33***	(english units)
ORIFICE COEFFICIENT (Cd)	***0.62***	(into riser pipe)
TAILWATER DEPTH	***2.5***	FT.
THICKNESS OF WEIR.	***1***	FT.

HEAD (FT.)	FLOW (CFS)	CONTROL
0	**0**	
0.25	3.3	WEIR
0.50	**9.2**	WEIR
0.75	17.0	WEIR
1.00	**24.4**	ORIFICE
1.25	27.3	ORIFICE
1.50	**29.9**	ORIFICE
1.75	32.3	ORIFICE
2.00	**34.5**	ORIFICE
2.25	36.6	ORIFICE
2.50	**38.6**	ORIFICE
2.75	40.5	ORIFICE
3.00	**42.3**	ORIFICE
3.25	44.0	ORIFICE
3.50	**45.7**	ORIFICE
3.75	47.3	ORIFICE
4.00	**48.8**	ORIFICE
4.25	50.3	ORIFICE
4.50	**51.8**	ORIFICE
4.75	53.2	ORIFICE
5.00	**54.6**	ORIFICE

WEIR FLOW: $Q=C_w*L*H^{1.5}$ ORIFICE FLOW: $Q=C_d*A_o*(2*g*H)^{0.5}$

where: Cw = weir coefficient =3.33 (english units) Cd = C_c* C_v (or see attached sheet)

L = weir length or perimeter of riser (ft.) Ao = orifice area (sq.ft.)

H = head (feet) g = 32.2 ft/s^2

Cc = A_2/A_o (or see attached sheet) *Cv = 0.99 (rounded) to 0.95 (square) orifice*

```
*****************************************************************************
*          (program name)                * SEDIMOT S/N  :                    *
*                                        * HMVersion    :  3.20              *
*       (program description)            * Date         :  8/18/99           *
*                                        * Time         : 16:00:44           *
*                                        * Input file   : WPN4A.INP          *
*                                        * Output file  : WPN4A.OUT          *
*                                        *                                   *
*                                        *                                   *
*****************************************************************************
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 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx   xxxxxxx
x     x  x        x     x    x    xx   xx  x     x     x
x        x        x     x    x    x x x x  x     x     x
 xxxxx   xxxxx    x     x    x    x  x  x  x     x     x
      x  x        x     x    x    x     x  x     x     x
x     x  x        x     x    x    x     x  x     x     x
 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx      x
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:::                                      :::
:::  Full Microcomputer Implementation   :::
:::                 by                   :::
:::        Haestad Methods, Inc.         :::
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37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

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*************************************************************
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        UNIVERSITY OF KENTUCKY COMPUTER MODEL
        OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
        FOR MORE INFORMATION CONTACT THE AGRICULTURAL
        ENGINEERING DEPARTMENT

        THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
        THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
        MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

        VERSION DATE 5-25-83

        DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
        ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
        CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL


*************************************************************
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              *********************************************
                   WATERSHED IDENTIFICATION CODE
                   -----------------------------
                   WEYERHAEUSER PLYMOUTH/NORTHWEST BASIN/0.8 ACRES X 4'/10YR-24
              *********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        6.25 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=====================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

1 1
3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========

========== SEDIMENTOLOGY INPUTS ==========

QUESTION NO.		
1.	SPECIFIC GRAVITY -	2.64
2.	COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -	2.00
3.	SUBMERGED BULK SPECIFIC GRAVITY -	1.35
4.	NUMBER OF PARTICLE SIZE DISTRIBUTIONS -	1
5.	NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -	11

==========

========== INPUT PARTICLE SIZE DISTRIBUTIONS ==========

VALUE NO.	SIZE, MM
1	1.0000
2	.5000
3	.2000
4	.1000
5	.0800
6	.0500
7	.0100
8	.0090
9	.0050
10	.0020
11	.0001

==========

========== PERCENT FINER DISTRIBUTIONS ==========

VALUE NO.	PARTICLE SIZE # 1
1	100.00
2	99.90
3	87.50
4	50.50
5	44.50
6	36.50
7	32.00
8	31.00
9	29.00
10	24.50
11	.00

==========

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	10
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	.52	69.00	.102	.000	.000	.00	.0
2	1.50	69.00	.120	.000	.000	.00	.0
3	1.86	69.00	.132	.000	.000	.00	2.0
4	2.07	69.00	.143	.000	.000	.00	2.0
5	2.33	69.00	.154	.000	.000	.00	2.0
6	2.15	69.00	.157	.000	.000	.00	2.0
7	1.88	69.00	.144	.000	.000	.00	2.0
8	1.62	69.00	.132	.000	.000	.00	2.0
9	1.31	69.00	.121	.000	.000	.00	.0
10	1.11	69.00	.184	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.20	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0
10	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	1.60	2.91	24.26	.098	1.000	1.000
2	4.60	2.91	79.47	.098	1.000	1.000
3	4.66	2.91	90.28	.079	.884	1.000
4	5.19	2.91	101.77	.079	.884	1.000
5	5.84	2.91	116.19	.079	.884	1.000
6	5.39	2.91	106.18	.079	.884	1.000
7	4.71	2.91	91.36	.079	.884	1.000
8	4.06	2.91	77.33	.079	.884	1.000
9	4.02	2.91	68.29	.098	1.000	1.000
10	2.69	2.91	49.67	.075	.867	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	6.25	INCHES
RUNOFF VOLUME	=	3.9637	ACRE-FT
PEAK DISCHARGE	=	39.8126	CFS
AREA	=	16.3500	ACRES
TIME OF PEAK DISCHARGE	=	12.00	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	260.30	EI UNIT
PEAK CONCENTRATION	=	323124.60	MG/L
PEAK SETTLEABLE CONCENTRATION	=	153.4626	ML/L
PEAK SETTLEABLE CONCENTRATION	=	207174.50	MG/L
TOTAL SEDIMENT YIELD	=	804.7990	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0823	MM
TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	15.50	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	63.61	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	63.61	ML/L

ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION = 13.67 ML/L

ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD = 8.83 ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	11
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	1.00
3	2.00
4	3.50
5	4.00
6	4.50
7	5.00
8	5.50
9	6.00
10	6.50
11	7.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE
1	.04
2	.21
3	.78
4	.87
5	.90
6	.93
7	.96
8	.99
9	1.02
10	1.05

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	1.12
4	2.45
5	2.97
6	12.71
7	28.49
8	34.59
9	39.82
10	71.68
11	137.37

==========

****
****

CAUTION: THE STAGE OF YOUR PRINCIPLE SPILLWAY MAY CAUSE BED SCOUR. SEDIMOT II DOES NOT CONSIDER POSSIBLE BED SCOUR; HENCE, YOUR OBSERVED EFFLUENT MAY NOT MEET THE DESIRED EFFLUENT STANDARD. INCREASE THE STAGE OF YOUR PRINCIPAL SPILLWAY.

****
****

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	.040	.00	.00	.00

1.00	.208	.66	.00	.12
2.00	.782	1.10	1.12	.62
3.50	.871	2.34	2.45	1.86
4.00	.899	2.79	2.97	2.30
4.50	.929	3.25	12.71	2.76
5.00	.960	3.70	28.49	3.23
5.50	.991	4.15	34.59	3.72
6.00	1.023	4.59	39.82	4.22
6.50	1.055	5.03	71.68	4.74
7.00	1.088	5.47	137.37	5.28

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	.124	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	3.964	ACRE-FT
OUTFLOW ROUTED VOLUME	=	3.950	ACRE-FT
STORM VOLUME DISCHARGED	=	3.950	ACRE-FT
POND VOLUME AT PEAK STAGE	=	2.340	ACRE-FT
PEAK STAGE	=	4.042	FT
PEAK INFLOW RATE	=	39.813	CFS
PEAK DISCHARGE RATE	=	3.795	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	323124.60	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	71420.45	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0001	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.20	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	41696.29	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	41696.29	MG/L
BASIN TRAP EFFICIENCY	=	71.92	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	7.58	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	7.58	HRS
DETENTION TIME INCLUDING STORED FLOW	=	7.58	HRS
SEDIMENT LOAD DISCHARGED	=	226.02	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	40.40	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

```
*****************************************************************************
*          (program name)                * SEDIMOT S/N   :                   *
*                                        * HMVersion     :  3.20             *
*       (program description)            * Date          :  8/18/99          *
*                                        * Time          : 16:08:16          *
*                                        * Input file    : WPN4B.INP         *
*                                        * Output file   : WPN4B.OUT         *
*                                        *                                   *
*                                        *                                   *
*****************************************************************************
```

```
 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx   xxxxxxx
x     x  x        x     x    x    xx   xx  x     x     x
x        x        x     x    x    x x x x  x     x     x
 xxxxx   xxxxx    x     x    x    x  x  x  x     x     x
      x  x        x     x    x    x     x  x     x     x
x     x  x        x     x    x    x     x  x     x     x
 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx      x
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```
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::::::::::::::::::::::::::::::::::::::::::::
:::                                      :::
:::  Full Microcomputer Implementation   :::
:::                 by                   :::
:::        Haestad Methods, Inc.         :::
:::                                      :::
::::::::::::::::::::::::::::::::::::::::::::
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37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

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*************************************************************
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      UNIVERSITY OF KENTUCKY COMPUTER MODEL
      OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
      FOR MORE INFORMATION CONTACT THE AGRICULTURAL
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      VERSION DATE 5-25-83

      DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
      ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
      CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL


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


            ********************************************
                 WATERSHED IDENTIFICATION CODE
                 -----------------------------
                 WEYERHAEUSER PLYMOUTH/NORTHWEST BASIN/0.8 ACRES X 4'/25YR-24
            ********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        7.25 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=====================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

1 1
3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========

========== SEDIMENTOLOGY INPUTS ==========

QUESTION NO.		
1.	SPECIFIC GRAVITY -	2.64
2.	COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -	2.00
3.	SUBMERGED BULK SPECIFIC GRAVITY -	1.35
4.	NUMBER OF PARTICLE SIZE DISTRIBUTIONS -	1
5.	NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -	11

==========

========== INPUT PARTICLE SIZE DISTRIBUTIONS ==========

VALUE NO.	SIZE, MM
1	1.0000
2	.5000
3	.2000
4	.1000
5	.0800
6	.0500
7	.0100
8	.0090
9	.0050
10	.0020
11	.0001

==========

========== PERCENT FINER DISTRIBUTIONS ==========

VALUE NO.	PARTICLE SIZE # 1
1	100.00
2	99.90
3	87.50
4	50.50
5	44.50
6	36.50
7	32.00
8	31.00
9	29.00
10	24.50
11	.00

==========

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	10
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	.52	69.00	.102	.000	.000	.00	.0
2	1.50	69.00	.120	.000	.000	.00	.0
3	1.86	69.00	.132	.000	.000	.00	2.0
4	2.07	69.00	.143	.000	.000	.00	2.0
5	2.33	69.00	.154	.000	.000	.00	2.0
6	2.15	69.00	.157	.000	.000	.00	2.0
7	1.88	69.00	.144	.000	.000	.00	2.0
8	1.62	69.00	.132	.000	.000	.00	2.0
9	1.31	69.00	.121	.000	.000	.00	.0
10	1.11	69.00	.184	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.20	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0
10	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	2.00	3.72	31.64	.098	1.000	1.000
2	5.78	3.72	103.63	.098	1.000	1.000
3	5.95	3.72	118.75	.080	.893	1.000
4	6.62	3.72	133.87	.080	.893	1.000
5	7.45	3.72	152.84	.080	.893	1.000
6	6.87	3.72	139.67	.080	.893	1.000
7	6.01	3.72	120.18	.080	.893	1.000
8	5.18	3.72	101.73	.080	.893	1.000
9	5.05	3.72	89.04	.098	1.000	1.000
10	3.43	3.72	65.36	.077	.876	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	7.25	INCHES
RUNOFF VOLUME	=	5.0686	ACRE-FT
PEAK DISCHARGE	=	51.0742	CFS
AREA	=	16.3500	ACRES
TIME OF PEAK DISCHARGE	=	12.00	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	359.62	EI UNIT
PEAK CONCENTRATION	=	327132.20	MG/L
PEAK SETTLEABLE CONCENTRATION	=	156.0727	ML/L
PEAK SETTLEABLE CONCENTRATION	=	210698.10	MG/L
TOTAL SEDIMENT YIELD	=	1056.7030	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0835	MM
TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	16.30	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	65.45	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	65.45	ML/L

ARITHMETIC AVERAGE SETTLEABLE
CONCENTRATION DURING PERIOD OF
SIGNIFICANT CONCENTRATION = 13.22 ML/L
ARITHMETIC AVERAGE SETTLEABLE
CONCENTRATION DURING PEAK 24 HOUR
PERIOD = 8.98 ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	11
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	1.00
3	2.00
4	3.50
5	4.00
6	4.50
7	5.00
8	5.50
9	6.00
10	6.50
11	7.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE
1	.04
2	.21
3	.78
4	.87
5	.90
6	.93
7	.96
8	.99
9	1.02
10	1.05

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	1.12
4	2.45
5	2.97
6	12.71
7	28.49
8	34.59
9	39.82
10	71.68
11	137.37

==========

****
****

CAUTION: THE STAGE OF YOUR PRINCIPLE SPILLWAY
MAY CAUSE BED SCOUR. SEDIMOT II DOES NOT CONSIDER
POSSIBLE BED SCOUR; HENCE, YOUR OBSERVED EFFLUENT
MAY NOT MEET THE DESIRED EFFLUENT STANDARD. INCREASE
THE STAGE OF YOUR PRINCIPAL SPILLWAY.
****
****

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	.040	.00	.00	.00

1.00	.208	.66	.00	.12
2.00	.782	1.10	1.12	.62
3.50	.871	2.34	2.45	1.86
4.00	.899	2.79	2.97	2.30
4.50	.929	3.25	12.71	2.76
5.00	.960	3.70	28.49	3.23
5.50	.991	4.15	34.59	3.72
6.00	1.023	4.59	39.82	4.22
6.50	1.055	5.03	71.68	4.74
7.00	1.088	5.47	137.37	5.28

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	.124	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	5.069	ACRE-FT
OUTFLOW ROUTED VOLUME	=	5.053	ACRE-FT
STORM VOLUME DISCHARGED	=	5.053	ACRE-FT
POND VOLUME AT PEAK STAGE	=	2.658	ACRE-FT
PEAK STAGE	=	4.390	FT
PEAK INFLOW RATE	=	51.074	CFS
PEAK DISCHARGE RATE	=	10.567	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	327132.20	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	75453.61	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0013	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	1.79	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	44404.16	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	44404.16	MG/L
BASIN TRAP EFFICIENCY	=	70.86	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	6.55	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	6.55	HRS
DETENTION TIME INCLUDING STORED FLOW	=	6.55	HRS
SEDIMENT LOAD DISCHARGED	=	307.93	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	41.10	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

```
*****************************************************************************
*          (program name)                * SEDIMOT S/N  :                    *
*                                        * HMVersion    :  3.20              *
*       (program description)            * Date         :  8/18/99           *
*                                        * Time         : 16:10:52           *
*                                        * Input file   : WPN4C.INP          *
*                                        * Output file  : WPN4C.OUT          *
*                                        *                                   *
*                                        *                                   *
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 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx   xxxxxxx
x     x  x        x     x    x    xx   xx  x     x     x
x        x        x     x    x    x x x x  x     x     x
 xxxxx   xxxxx    x     x    x    x  x  x  x     x     x
      x  x        x     x    x    x     x  x     x     x
x     x  x        x     x    x    x     x  x     x     x
 xxxxx   xxxxxxx  xxxxxx   xxxxx  x     x   xxxxx      x
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:::                                      :::
:::  Full Microcomputer Implementation   :::
:::                 by                   :::
:::        Haestad Methods, Inc.         :::
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*************************************************************
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        VERSION DATE 5-25-83

        DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
        ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
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*************************************************************
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             ********************************************
                  WATERSHED IDENTIFICATION CODE
                  -----------------------------
                  WEYERHAEUSER PLYMOUTH/NORTHWEST BASIN/0.8 AC X 4'/100YR-24
             ********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        9.00 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=====================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

```
          1                 1
   3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========================================================================


========================  SEDIMENTOLOGY INPUTS  ========================

QUESTION
   NO.
    1. SPECIFIC GRAVITY -                                              2.64
    2. COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -                    2.00
    3. SUBMERGED BULK SPECIFIC GRAVITY -                               1.35
    4. NUMBER OF PARTICLE SIZE DISTRIBUTIONS -                         1
    5. NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -         11

==========================================================================


================= INPUT PARTICLE SIZE DISTRIBUTIONS ===================

                        VALUE
                         NO.        SIZE, MM

                          1           1.0000
                          2            .5000
                          3            .2000
                          4            .1000
                          5            .0800
                          6            .0500
                          7            .0100
                          8            .0090
                          9            .0050
                         10            .0020
                         11            .0001

==========================================================================


===================  PERCENT FINER DISTRIBUTIONS  =====================

VALUE                       PARTICLE SIZE #
 NO.
            1
  1    100.00
  2     99.90
  3     87.50
  4     50.50
  5     44.50
  6     36.50
  7     32.00
  8     31.00
  9     29.00
 10     24.50
 11       .00

==========================================================================
```

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	10
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	.52	69.00	.102	.000	.000	.00	.0
2	1.50	69.00	.120	.000	.000	.00	.0
3	1.86	69.00	.132	.000	.000	.00	2.0
4	2.07	69.00	.143	.000	.000	.00	2.0
5	2.33	69.00	.154	.000	.000	.00	2.0
6	2.15	69.00	.157	.000	.000	.00	2.0
7	1.88	69.00	.144	.000	.000	.00	2.0
8	1.62	69.00	.132	.000	.000	.00	2.0
9	1.31	69.00	.121	.000	.000	.00	.0
10	1.11	69.00	.184	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.20	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0
10	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	2.73	5.21	45.45	.098	1.000	1.000
2	7.88	5.21	148.89	.098	1.000	1.000
3	8.27	5.21	172.48	.082	.905	1.000
4	9.20	5.21	194.43	.082	.905	1.000
5	10.36	5.21	221.98	.082	.905	1.000
6	9.56	5.21	202.86	.082	.905	1.000
7	8.36	5.21	174.55	.082	.905	1.000
8	7.20	5.21	147.75	.082	.905	1.000
9	6.88	5.21	127.93	.098	1.000	1.000
10	4.78	5.21	95.04	.080	.889	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	9.00	INCHES
RUNOFF VOLUME	=	7.1005	ACRE-FT
PEAK DISCHARGE	=	71.7318	CFS
AREA	=	16.3500	ACRES
TIME OF PEAK DISCHARGE	=	12.00	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	575.89	EI UNIT
PEAK CONCENTRATION	=	331508.70	MG/L
PEAK SETTLEABLE CONCENTRATION	=	159.0372	ML/L
PEAK SETTLEABLE CONCENTRATION	=	214700.30	MG/L
TOTAL SEDIMENT YIELD	=	1531.3720	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0849	MM
TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	17.30	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	67.85	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	67.85	ML/L

ARITHMETIC AVERAGE SETTLEABLE
CONCENTRATION DURING PERIOD OF
SIGNIFICANT CONCENTRATION = 12.81 ML/L
ARITHMETIC AVERAGE SETTLEABLE
CONCENTRATION DURING PEAK 24 HOUR
PERIOD = 9.24 ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	11
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	1.00
3	2.00
4	3.50
5	4.00
6	4.50
7	5.00
8	5.50
9	6.00
10	6.50
11	7.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE
1	.04
2	.21
3	.78
4	.87
5	.90
6	.93
7	.96
8	.99
9	1.02
10	1.05

11 1.09

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	1.12
4	2.45
5	2.97
6	12.71
7	28.49
8	34.59
9	39.82
10	71.68
11	137.37

==========

****
****

CAUTION: THE STAGE OF YOUR PRINCIPLE SPILLWAY MAY CAUSE BED SCOUR. SEDIMOT II DOES NOT CONSIDER POSSIBLE BED SCOUR; HENCE, YOUR OBSERVED EFFLUENT MAY NOT MEET THE DESIRED EFFLUENT STANDARD. INCREASE THE STAGE OF YOUR PRINCIPAL SPILLWAY.

****
****

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	.040	.00	.00	.00

1.00	.208	.66	.00	.12
2.00	.782	1.10	1.12	.62
3.50	.871	2.34	2.45	1.86
4.00	.899	2.79	2.97	2.30
4.50	.929	3.25	12.71	2.76
5.00	.960	3.70	28.49	3.23
5.50	.991	4.15	34.59	3.72
6.00	1.023	4.59	39.82	4.22
6.50	1.055	5.03	71.68	4.74
7.00	1.088	5.47	137.37	5.28

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	.124	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	7.101	ACRE-FT
OUTFLOW ROUTED VOLUME	=	7.081	ACRE-FT
STORM VOLUME DISCHARGED	=	7.081	ACRE-FT
POND VOLUME AT PEAK STAGE	=	3.164	ACRE-FT
PEAK STAGE	=	4.929	FT
PEAK INFLOW RATE	=	71.732	CFS
PEAK DISCHARGE RATE	=	26.255	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	331508.70	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	83405.70	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0059	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	7.90	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	48222.98	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	48222.98	MG/L
BASIN TRAP EFFICIENCY	=	69.39	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	5.26	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	5.26	HRS
DETENTION TIME INCLUDING STORED FLOW	=	5.26	HRS
SEDIMENT LOAD DISCHARGED	=	468.75	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	42.20	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

```
*****************************************************************************
*          (program name)                * SEDIMOT S/N  :                    *
*                                        * HMVersion    :  3.20              *
*       (program description)            * Date         :  8/18/99           *
*                                        * Time         : 16:13:37           *
*                                        * Input file   : WPN4D.INP          *
*                                        * Output file  : WPN4D.OUT          *
*                                        *                                   *
*                                        *                                   *
*****************************************************************************
```

```
 XXXXX   XXXXXXX  XXXXXX   XXXXX  X     X   XXXXX   XXXXXXX
X     X  X        X     X    X    XX   XX  X     X     X
X        X        X     X    X    X X X X  X     X     X
 XXXXX   XXXXX    X     X    X    X  X  X  X     X     X
      X  X        X     X    X    X     X  X     X     X
X     X  X        X     X    X    X     X  X     X     X
 XXXXX   XXXXXXX  XXXXXX   XXXXX  X     X   XXXXX      X
```

```
::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
:::                                      :::
:::  Full Microcomputer Implementation   :::
:::                 by                   :::
:::        Haestad Methods, Inc.         :::
:::                                      :::
::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

```
*************************************************************
*************************************************************

        UNIVERSITY OF KENTUCKY COMPUTER MODEL
        OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
        FOR MORE INFORMATION CONTACT THE AGRICULTURAL
        ENGINEERING DEPARTMENT

        THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
        THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
        MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

        VERSION DATE 5-25-83

        DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
        ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
        CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL


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


             *********************************************
                  WATERSHED IDENTIFICATION CODE
                  -----------------------------
                  WEYERHAEUSER PLYMOUTH/NORTHWEST BASIN/0.8 AC X 4'/2YR-24
             *********************************************


============================  STORM  INPUT  ============================

QUESTION
   NO.

    1. STORM TYPE -                                          SCS'S TYPE 2
    2. RAINFALL DEPTH -                                        4.00 INCHES
    3. STORM DURATION -                                       24.00 HOURS
    4. TIME INCREMENT -                                         .10 HOURS

=======================================================================


===========================  WATERSHED DATA  ==========================

QUESTION
   NO.
    1. NUMBER OF JUNCTIONS - 1
    2. JUNCTION     NUMBER OF BRANCHES
```

1 1
3. COMPUTATION - BOTH HYDROLOGY AND SEDIMENTOLOGY

==========

========== SEDIMENTOLOGY INPUTS ==========

QUESTION NO.		
1.	SPECIFIC GRAVITY -	2.64
2.	COEFFICIENT FOR DISTRIBUTING SEDIMENT LOAD -	2.00
3.	SUBMERGED BULK SPECIFIC GRAVITY -	1.35
4.	NUMBER OF PARTICLE SIZE DISTRIBUTIONS -	1
5.	NUMBER OF DATA VALUES PER PARTICLE SIZE DISTRIBUTION -	11

==========

========== INPUT PARTICLE SIZE DISTRIBUTIONS ==========

VALUE NO.	SIZE, MM
1	1.0000
2	.5000
3	.2000
4	.1000
5	.0800
6	.0500
7	.0100
8	.0090
9	.0050
10	.0020
11	.0001

==========

========== PERCENT FINER DISTRIBUTIONS ==========

VALUE NO.	PARTICLE SIZE # 1
1	100.00
2	99.90
3	87.50
4	50.50
5	44.50
6	36.50
7	32.00
8	31.00
9	29.00
10	24.50
11	.00

==========

========== STRUCTURE INPUT FOR JUNCTION #1 ==========

BRANCH	NUMBER OF STRUCTURES
1	1

==========

========== BETWEEN STRUCTURE ROUTING PARAMETERS ==========

BRANCH NO.	BETWEEN	PARAMETERS 1 TIME	2 MUSK. K	3 MUSK. X,
1	PRIOR J OR S TO STRUCTURE 1	.00	.00	.00

==========

========== STRUCTURE DATA FOR JUNCTION #1 ==========

QUESTION NO.		
1.	NUMBER OF SUBWATERSHEDS -	10
2.	TYPE OF SEDIMENT CONTROL STRUCTURE -	POND

==========

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X,	UNIT HYDRO
1	.52	69.00	.102	.000	.000	.00	.0
2	1.50	69.00	.120	.000	.000	.00	.0
3	1.86	69.00	.132	.000	.000	.00	2.0
4	2.07	69.00	.143	.000	.000	.00	2.0
5	2.33	69.00	.154	.000	.000	.00	2.0
6	2.15	69.00	.157	.000	.000	.00	2.0
7	1.88	69.00	.144	.000	.000	.00	2.0
8	1.62	69.00	.132	.000	.000	.00	2.0
9	1.31	69.00	.121	.000	.000	.00	.0
10	1.11	69.00	.184	.000	.000	.00	2.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.20	60.0	33.30	.400	1.0	.0
2	1	.20	60.0	33.30	.400	1.0	.0
3	1	.20	60.0	33.30	.400	1.0	.0
4	1	.20	60.0	33.30	.400	1.0	.0
5	1	.20	60.0	33.30	.400	1.0	.0
6	1	.20	60.0	33.30	.400	1.0	.0
7	1	.20	60.0	33.30	.400	1.0	.0
8	1	.20	60.0	33.30	.400	1.0	.0
9	1	.20	60.0	33.30	.400	1.0	.0
10	1	.20	60.0	33.30	.400	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	.73	1.27	9.81	.098	1.000	1.000
2	2.10	1.27	32.12	.098	1.000	1.000
3	1.98	1.27	35.13	.070	.846	1.000
4	2.21	1.27	39.60	.070	.846	1.000
5	2.49	1.27	45.21	.070	.846	1.000
6	2.29	1.27	41.32	.070	.846	1.000
7	2.01	1.27	35.55	.070	.846	1.000
8	1.73	1.27	30.09	.070	.846	1.000
9	1.83	1.27	27.60	.098	1.000	1.000
10	1.14	1.27	19.31	.067	.829	1.000

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	4.00	INCHES
RUNOFF VOLUME	=	1.7258	ACRE-FT
PEAK DISCHARGE	=	16.5374	CFS
AREA	=	16.3500	ACRES
TIME OF PEAK DISCHARGE	=	12.00	HRS
LOAD RATE EXPONENT FACTOR	=	2.00	
BETA	=	1.0000	
SUBMERGE BULK SPECIFIC GRAVITY	=	1.35	
RAINFALL EROSITIVITY FACTOR	=	98.49	EI UNIT
PEAK CONCENTRATION	=	312196.20	MG/L
PEAK SETTLEABLE CONCENTRATION	=	145.3194	ML/L
PEAK SETTLEABLE CONCENTRATION	=	196181.20	MG/L
TOTAL SEDIMENT YIELD	=	315.7376	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0764	MM
TIME OF PEAK CONCENTRATION	=	12.10	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	13.80	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	56.60	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	56.60	ML/L

ARITHMETIC AVERAGE SETTLEABLE
CONCENTRATION DURING PERIOD OF
SIGNIFICANT CONCENTRATION = 15.02 ML/L
ARITHMETIC AVERAGE SETTLEABLE
CONCENTRATION DURING PEAK 24 HOUR
PERIOD = 8.64 ML/L

========== POND INPUT ==========

QUESTION NO.		
1.	TIME INCREMENT OF THE ROUTED HYDROGRAPH -	.10 HOURS
2.	NON-IDEAL SETTLING CORRECTION FACTOR -	1.00
3.	PERCENT OF PERMANENT POOL THAT IS DEAD SPACE -	35.00
4.	OUTFLOW WITHDRAWAL OPTION -	SURFACE
5.	INFLOW VERTICAL CONCENTRATION -	COMP. MIXED
6.	NUMBER OF STAGE POINTS -	11
7.	NUMBER OF ROUTED HYDROGRAPH POINTS -	500
8.	STAGE-DISCHARGE OPTION -	INPUT
9.	OUTPUT OPTION -	SUM. TABLES
10.	NUMBER OF CONTINUOUS STIRRED REACTORS	3

==========

========== POND STAGE DATA ==========

STAGE POINT	VALUE
1	.00
2	1.00
3	2.00
4	3.50
5	4.00
6	4.50
7	5.00
8	5.50
9	6.00
10	6.50
11	7.00

==========

========== POND AREA DATA ==========

AREA POINT	VALUE
1	.04
2	.21
3	.78
4	.87
5	.90
6	.93
7	.96
8	.99
9	1.02
10	1.05

11 1.09

==========

========== POND DISCHARGE DATA ==========

DISCHARGE POINT	VALUE
1	.00
2	.00
3	1.12
4	2.45
5	2.97
6	12.71
7	28.49
8	34.59
9	39.82
10	71.68
11	137.37

==========

* *

POND RESULTS

* *

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	.040	.00	.00	.00
1.00	.208	.66	.00	.12
2.00	.782	1.10	1.12	.62
3.50	.871	2.34	2.45	1.86
4.00	.899	2.79	2.97	2.30
4.50	.929	3.25	12.71	2.76
5.00	.960	3.70	28.49	3.23
5.50	.991	4.15	34.59	3.72
6.00	1.023	4.59	39.82	4.22
6.50	1.055	5.03	71.68	4.74
7.00	1.088	5.47	137.37	5.28

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	.124	ACRE-FT
DEAD STORAGE	=	35.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	1.726	ACRE-FT
OUTFLOW ROUTED VOLUME	=	1.722	ACRE-FT
STORM VOLUME DISCHARGED	=	1.722	ACRE-FT
POND VOLUME AT PEAK STAGE	=	.990	ACRE-FT
PEAK STAGE	=	2.449	FT
PEAK INFLOW RATE	=	16.537	CFS
PEAK DISCHARGE RATE	=	1.518	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	312196.20	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	67670.43	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0001	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.10	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	37160.52	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	37160.52	MG/L
BASIN TRAP EFFICIENCY	=	72.19	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	5.97	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	5.97	HRS
DETENTION TIME INCLUDING STORED FLOW	=	5.97	HRS
SEDIMENT LOAD DISCHARGED	=	87.80	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	38.70	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

*** RUN COMPLETED ****

DESIGN SHEET

RMT®

SHEET ____ OF ____

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	8/18/99	[illegible]	9/10/99	05101.01

SUMMARY OF NORTHWEST BASIN DESIGN

BASIN DIMENSIONS: SEE SHEET 5

EL. 24 A ~ 0.04 AC
25 A ~ 0.21 AC
26 (114' x 299')
32 (150' x 335')

(SIDE SLOPE → 3H:1V)

PRINCIPAL SPILLWAY: (P.S.)
30" CMP RISER DIAMETER
24" CMP BARREL DIAMETER
0.5" PERFORATIONS DIAMETER
→ 4" O.C. HORIZONTALLY
→ 6" O.C. VERTICALLY
30 FT LONG
1% SLOPE

EMERGENCY SPILLWAY: (E.S.)
BASE WIDTH → 28 FT
SIDESLOPES 4H:1V
6 FT FROM POND BOTTOM (EL 30) TO BASE OF E.S.
2 FT DEEP

		POST-DEV		PRE-DEV
$Q_{POND(10y)}$	=	3.8	<	40.7 ✓
$Q_{POND(25y)}$	=	10.6	<	53.2 ✓
$Q_{POND(100y)}$	=	26.2	<	76.2 ✓

TE_{2yr} = 72 > 70% ✓ (FOR HQW)
TE_{10yr} = 71.9 > 60% ✓
TE_{25yr} = 70.9 > 60% ✓
TE_{100yr} = 69.4 > 60% ✓

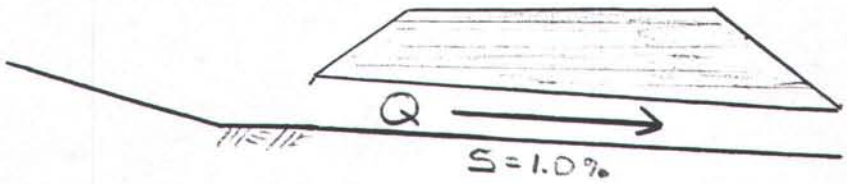
Attachment L7
Box Culvert Design Calculations

DESIGN SHEET

RMT® 100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	6/2/99	BW	7/7/99	05101.01

BOX CULVERT DESIGN



REINFORCED CONCRETE BOX CULVERT

PROBLEM:

SIZE A BOX CULVERT WHICH WILL CONVEY THE PEAK FLOWRATE (25 YR-24 HR) FROM EACH DRAINAGE AREA TO THE APPROPRIATE SEDIMENT POND. FROM THE SEDIMOT MODEL, $Q_{25,24}$ FROM EACH DRAINAGE AREA IS AS FOLLOWS:

NORTH AREA (NO. 1) = 95 CFS

EAST AREA (NO. 2) = 85 CFS

WEST AREA (NO. 3) = 110 CFS

NORTHWEST AREA (NO. 1A) = 52 CFS

DESIGN SHEET

RMT® 100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	6/2/99	RMT	7/7/99	05101.01

SOLUTION

SINCE THE ARTICULATED BLOCK CHANNEL IS 10 FT WIDE, USE THIS DIMENSION AS THE WIDTH, USE NOMOGRAPH DEVELOPED BY BUREAU OF PUBLIC ROADS TO SIZE THE BOX CULVERT WITH INLET CONTROL (SOURCE: USDOT - FHA - HYDRAULIC ENGINEERING CIRCULAR NO. 5)

NORTH AREA (#1)

Q = 95 CFS.
Q/B = 95 CFS/10 FT = 9.5 SFS
ASSUME HEADWALL @ 30° TO 75°
TRY 30 INCHES DEPTH. Hw/D TO BE < 1

FROM NOMOGRAPH, Hw/D = 0.88 (SEE ATTACHED)
HW = (30 IN)(0.88) = 26.4 IN < 30 IN

USE 30" (D) X 10' (L)

EAST AREA

Q = 85 CFS
Q/B = 85/10 = 8.5 SFS
ASSUME HEADWALL @ 30° TO 75°
TRY 30 INCHES DEPTH. Hw/D TO BE < 1

FROM NOMOGRAPH, Hw/D = 0.81 (SEE ATTACHED)
HW = (30 IN)(0.81) = 24.3 IN < 30 IN

USE 30"(D) x 10' (L)

DESIGN SHEET

RMT

SHEET 3 OF 4

100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	6/2/99	EWT	7/7/99	05101.01

WEST AREA

Q = 110 CFS
Q/B = 110/10 = 11 SFS
ASSUME HEADWALL @ 30° TO 75°
TRY 30 INCHES DEPTH. H_w/D TO BE < 1

FROM NOMOGRAPH, $H_w/D = 0.96$ (SEE ATTACHED)
$HW = (30\ IN)(0.96) = 28.8\ IN < 30.0\ IN$

USE 30" (D) x 10' (L)

NORTHWEST AREA

Q = 52 CFS
Q/B = 52 CFS / 10 FT = 5.2 SFS
ASSUME HEADWALL @ 30° TO 75°
TRY 30 INCHES DEPTH, $H_w/D = 0.575$ (SEE ATTACHED FIGURE)
$HW = (30\ IN)(0.575) = 17.3\ IN < 30\ IN$

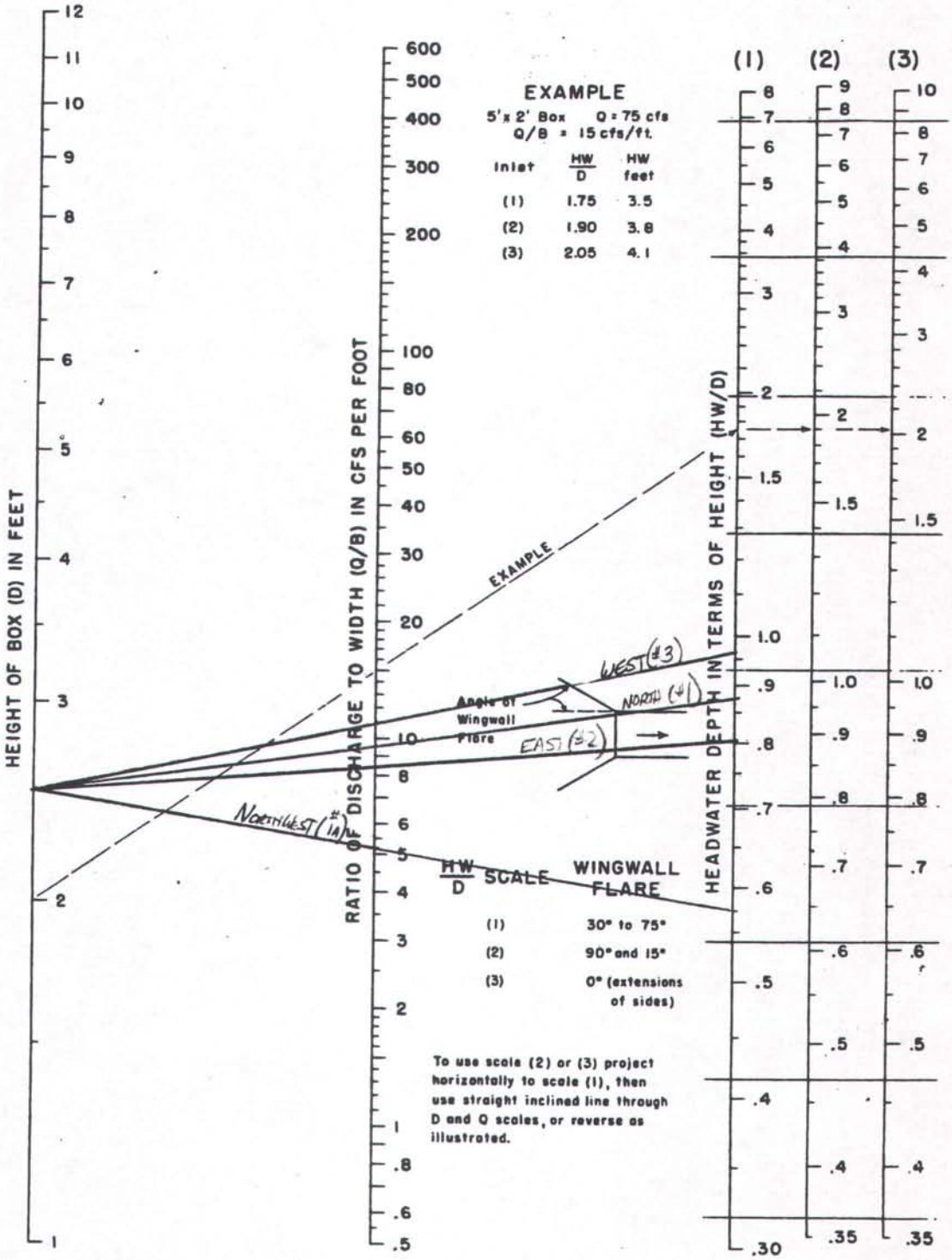
USE 30" (D) x 10' (L)

SUMMARY:

		D		L
NORTH AREA	(#1)	30 IN	x	10'
EAST AREA	(#2)	30 IN	x	10'
WEST AREA	(#3)	30 IN	x	10'
NORTHWEST AREA	(#1A)	30 IN	x	10'

* ASSUME CULVERTS DESIGNED WITH 30° TO 75° HEADWALLS

CHART I



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

Attachment L8
Articulated Block Drainage Channel Design Calculations

DESIGN SHEET

RMT®
100 Verdae Boulevard P.O. Box 16778 Greenville, SC 29607-3825 Phone: 864-281-0030 FAX: 864-281-0288

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER PLYMOUTH	SYK	6/3/99	EMT	6/7/99	05101.01

ARTICULATED BLOCK DRAINAGE CHANNEL DESIGN

PROBLEM: DETERMINE THE CAPACITY OF THE PROPOSED ARTICULATED BLOCK DRAINAGE CHANNELS

TRAPEZOIDAL CHANNELS
$Z = 4:1$
BASE = 10 FT WIDE
$n = 0.034$ (MANNING'S ROUGHNESS COEFFICIENT
$S = 0.27$ (AVG) $\rightsquigarrow [20' = (V) / (60' + 15')$ Horiz. Terrace
MAX. DEPTH = 1.5 FT

BASED ON SEDIMOT II CALCS. Q_{DESIGN} (25 YR/24 HR) FOR EACH DRAINAGE AREA IS AS FOLLOWS.

NORTH AREA (#1) = 95 CFS
EAST AREA (#2) = 85 CFS
WEST AREA (#3) = 110 CFS
NORTHWEST AREA (#1A) = 52 CFS

USING THE FLOWMASTER PROGRAM, EVALUATE THE CHANNEL FOR THE GIVEN CONDITION AT 0.75 FEET DEPTH

FROM FLOWMASTER

Q_{MAX} @ 0.75' = 157.9 CFS > Q_{DESIGN} (25 y/24 h) = 95 CFS, 85 CFS, 110 CFS, 52 CFS (RESPECTIVELY)

CHANNELS ARE SATISFACTORY

2/2

WEYERHAEUSER PLYMOUTH - NO. 3 LANDFILL
Worksheet for Trapezoidal Channel

Project Description	
Project File	h:\data\common\civil\fmaster\wo_abdc.fm2
Worksheet	ARTICULATED BLOCK CHANNEL
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.034	
Channel Slope	0.270000	ft/ft
Depth	0.75	ft
Left Side Slope	4.00	H : V
Right Side Slope	4.00	H : V
Bottom Width	10.00	ft

Results		
Discharge	157.93	ft^3/s
Flow Area	9.75	ft^2
Wetted Perimeter	16.18	ft
Top Width	16.00	ft
Critical Depth	1.59	ft
Critical Slope	0.016472	ft/ft
Velocity	16.20	ft/s
Velocity Head	4.08	ft
Specific Energy	4.83	ft
Froude Number	3.66	
Flow is supercritical.		

Attachment L9
Steep Gradient Design Calculations

DESIGN SHEET

RMT®
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PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	6/3/99	EWT	7/7/99	05101.01

STEEP GRADIENT DESIGN OF ARTICULATED BLOCK DRAINAGE CHANNELS
(NICOLON - ARMORFLEX® DESIGN MANUAL)

MANNING'S RESISTANCE COEF, $n = 0.0369(q)^{0.305} \cdot (S)^{0.488}$

where: q = unit discharge per foot width, (Q/b)
S = slope of channel in direction of flow
$S = 0.333$ (MAX)
let channel base, b = 10-foot width
Q_{DESIGN} = 95 CFS, 85 CFS, 110 CFS, 52 CFS respectively
25/24
for the North, East, West + North West Area.

$q = \frac{Q_{DESIGN}}{b}$ = 9.5 SFS, 8.5 SFS, 11.0 SFS 5.2 SFS
respectively for north, east west & north west areas.

then: $n_N = 0.043$

$n_E = 0.041$

$n_W = 0.045$

$n_{NW} = 0.036$

DEPTH OF UNIFORM FLOW, $y_0 = [q \cdot n / (1.49 S^{0.5})]^{0.6}$

$y_{0(N)} = [(9.5\,SFS)(0.043)/(1.49 \cdot (0.333)^{0.5})]^{0.6} \cong 0.64$ ft

$y_{0(E)} = [(8.5\,SFS)(0.041)/(1.49 \cdot (0.333)^{0.5})]^{0.6} \cong 0.59$ ft

$y_{0(W)} = [(11.0\,SFS)(0.045)/(1.49 \cdot (0.333)^{0.5})]^{0.6} \cong 0.72$ ft

$y_{0(NW)} = [(5.2\,SFS)(0.036)/((1.49)(0.333)^{0.5})]^{0.6} \cong 0.45$ ft

DESIGN SHEET

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PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER - PLYMOUTH	SYK	6/3/99			05101.01

VELOCITY OF UNIFORM FLOW, $V = q/y_o$:

$V_{(NW)} = (5.2 \text{ SFS} / 0.45 \text{ ft}) = 11.5$ FPS

$V_{(N)} = (9.5 \text{ SFS} / 0.64 \text{ ft}) = 14.9$ FPS

$V_{(E)} = (8.5 \text{ SFS} / 0.59 \text{ ft}) = 14.5$ FPS

$V_{(W)} = (11 \text{ SFS} / 0.72 \text{ ft}) = 15.4$ FPS

NOTE:

FREEBOARD ALLOWANCE SHALL EQUAL OR EXCEED THE MEAN DEPTH OF FLOW SINCE THE WAVE HEIGHT WILL REACH APPROXIMATELY TWICE THE MEAN DEPTH. BOTH FLOW DEPTH AND FREEBOARD ARE TAKEN NORMAL TO THE PLANE OF THE CHANNEL BOTTOM

FOR SIDE SLOPES OF 4 HORIZONTAL TO 1 VERTICAL, CHANNEL SLOPE OF 0.333 FT/FT AND $q = 5.2; 9.5; 8.5;$ & 11.0 SFS (RESPECTIVELY) & CHART 4.3

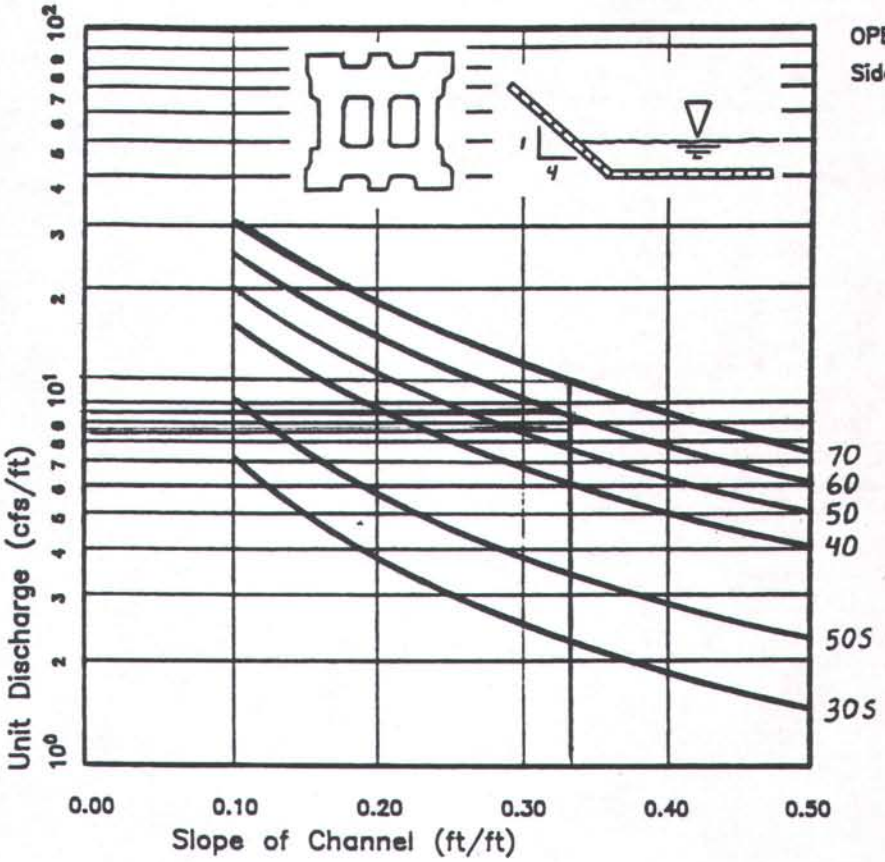
RECOMMEND USING THE FOLLOWING:

NORTH WEST AREA (#1A) – CLASS 45 - CLOSED CELL
CLASS 40 - OPEN CELL

NORTH AREA (#1) – CLASS 55 - CLOSED CELL OR
CLASS 60 - OPEN CELL

EAST AREA (#2) – CLASS 55 - CLOSED CELL OR
CLASS 60 - OPEN CELL

WEST AREA (#3) – CLASS 75 - CLOSED CELL OR
CLASS 70 - OPEN CELL


OPEN-CELL ARMORFLEX
Side Slope z = 4:1
1
4
70
60
50
40
50S
30S
Unit Discharge (cfs/ft)
Slope of Channel (ft/ft)
0.00
0.10
0.20
0.30
0.40
0.50

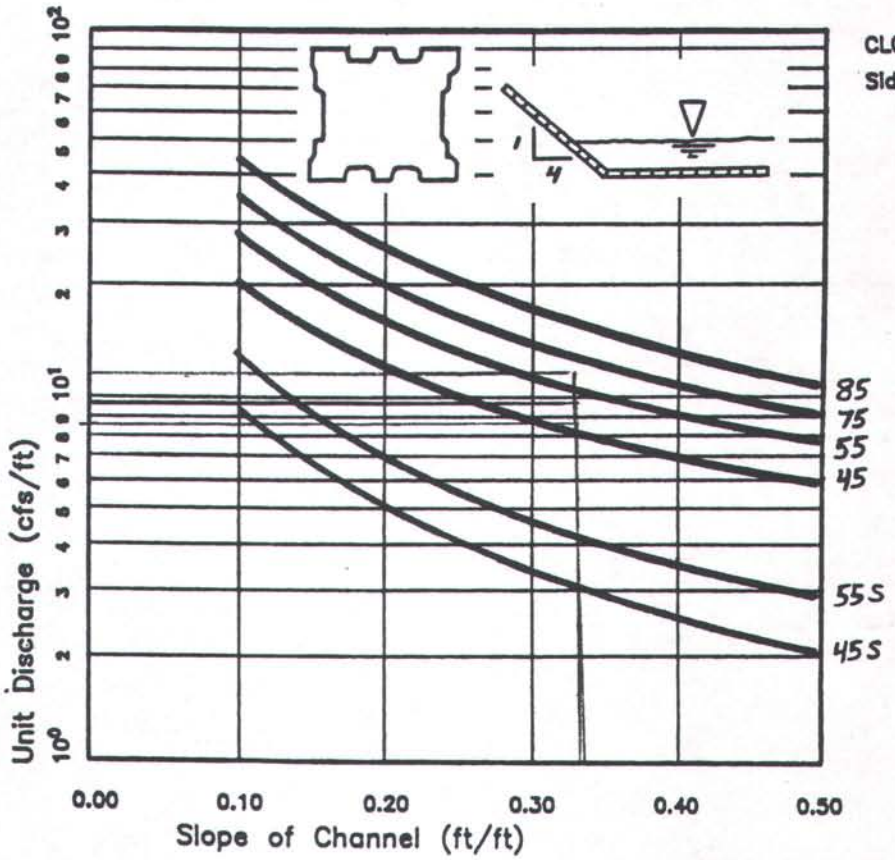

CLOSED-CELL ARMORFLEX
Side Slope z = 4:1
1
4
85
75
55
45
55S
45S
Unit Discharge (cfs/ft)
Slope of Channel (ft/ft)
0.00
0.10
0.20
0.30
0.40
0.50

CHART 4.3

Attachment L10
Sizing of Outlet Protection

DESIGN SHEET

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PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYERHAEUSER PLYMOUTH	JJC	9/22/99	RKN	9/22/99	05101.01

FROM NCDENR "EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL":

DESIGN RIPRAP OUTLET PROTECTION FOR OUTFALL CULVERT FOR EACH SEDIMENT BASIN

Q_{DESIGN} = DISCHARGE FLOW RATE WHEN THE WATER LEVEL IN THE BASIN REACHES THE BOTTOM OF THE EMERGENCY SPILLWAY

$d = D_o$ = DIAMETER OF THE PRINCIPAL SPILLWAY BARREL/OUTLET PIPE DIAMETER

ASSUME MAXIMUM TAILWATER CONDITION ($T_W \geq 0.5 D_o$)
THEREFORE USE FIGURE 8.06b

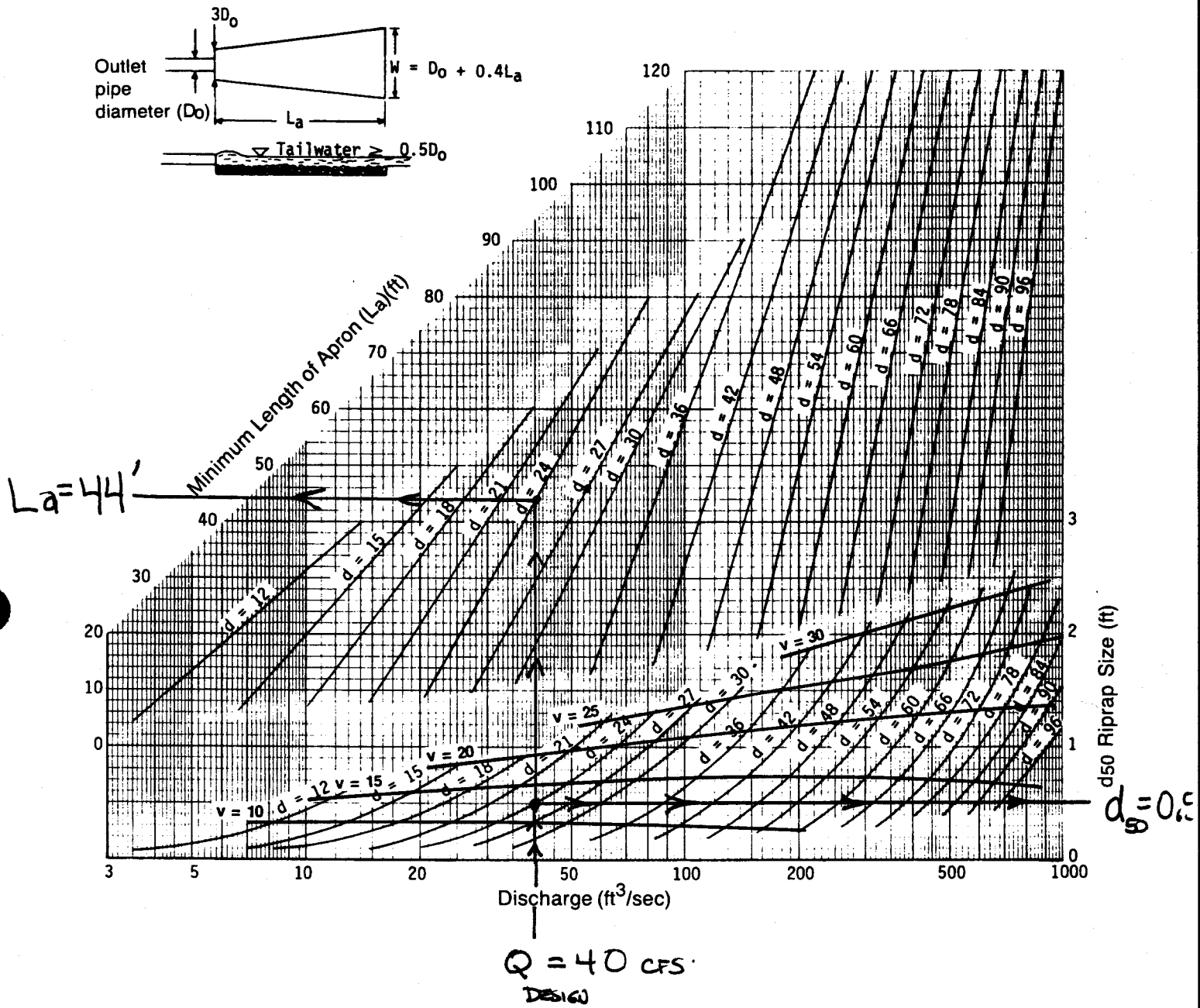
SEDIMENT BASIN OUTFALL	Q_{DESIGN} (CFS)	D_o (INCHES)	(MIN) $3D_o$ (FT)	(MIN) RIPRAP, d_{50} (INCHES)	(MIN) L_a (FT)	(MIN) $W = D_o + 0.4L_a$ (FT)
NORTH (#1)	43	24	6	7	48'	21.2
EAST (#2)	40	24	6	6	44'	19.6
WEST (#3)	43	24	6	7	48'	21.2
NORTHWEST (#1A)	40	24	6	6	44'	19.6

MAX. STONE DIAMETER = $1.5 \times d_{50}$ = 9 INCHES TO 10.5 INCHES = d_{MAX}

APRON THICKNESS = $1.5 \times d_{MAX}$ = 13.5 INCHES TO 15.75 INCHES

05101.01

2/4



Curves may not be extrapolated.

Figure 8.06b Design of outlet protection from a round pipe flowing full, maximum tailwater condition ($T_w \geq 0.5$ diameter).

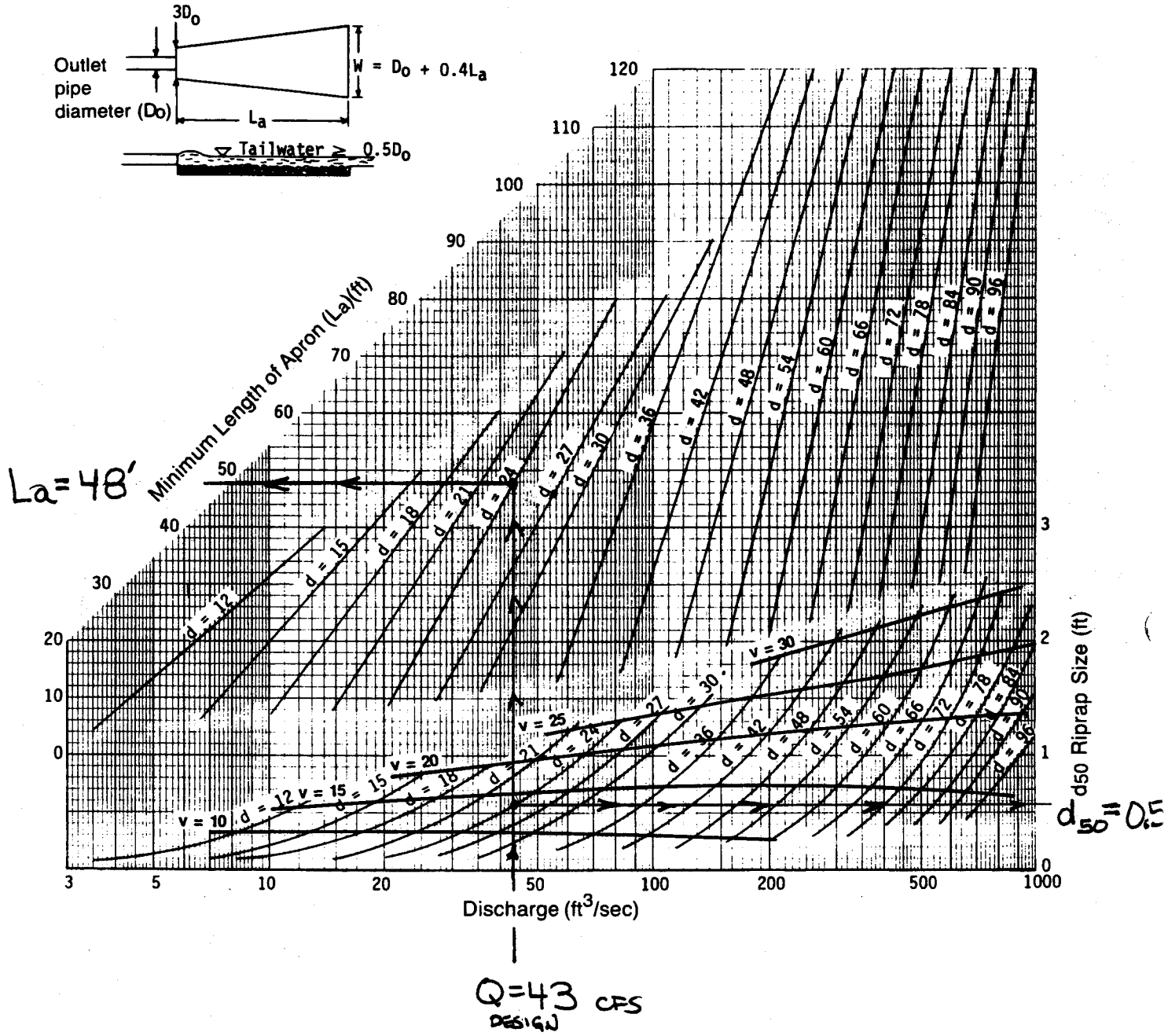
WEYERHAEUSER - PLYMOUTH NO. 3 LANDFILL
EAST (#2) AND NORTHWEST (#1A) SEDIMENT BASIN OUTFALLS

Q_{DESIGN} = 40 CFS

D_o = 2 FT

La = 44 FT (MIN)

d_{50} RIPRAP = 6 INCHES (MIN)



Curves may not be extrapolated.

Figure 8.06b Design of outlet protection from a round pipe flowing full, maximum tailwater condition ($T_w \geq 0.5$ diameter).

WEYERHAEUSER PLYMOUTH NO. 3 LANDFILL

NORTH (#1) AND WEST (#3) SEDIMENT BASIN OUTFALLS

Q_{DESIGN} = 43 CFS L_a = 48 FT (MIN)

D_o = 2 FT d_{50} = 7 INCHES (MIN)

RIPRAP

DESIGN SHEET

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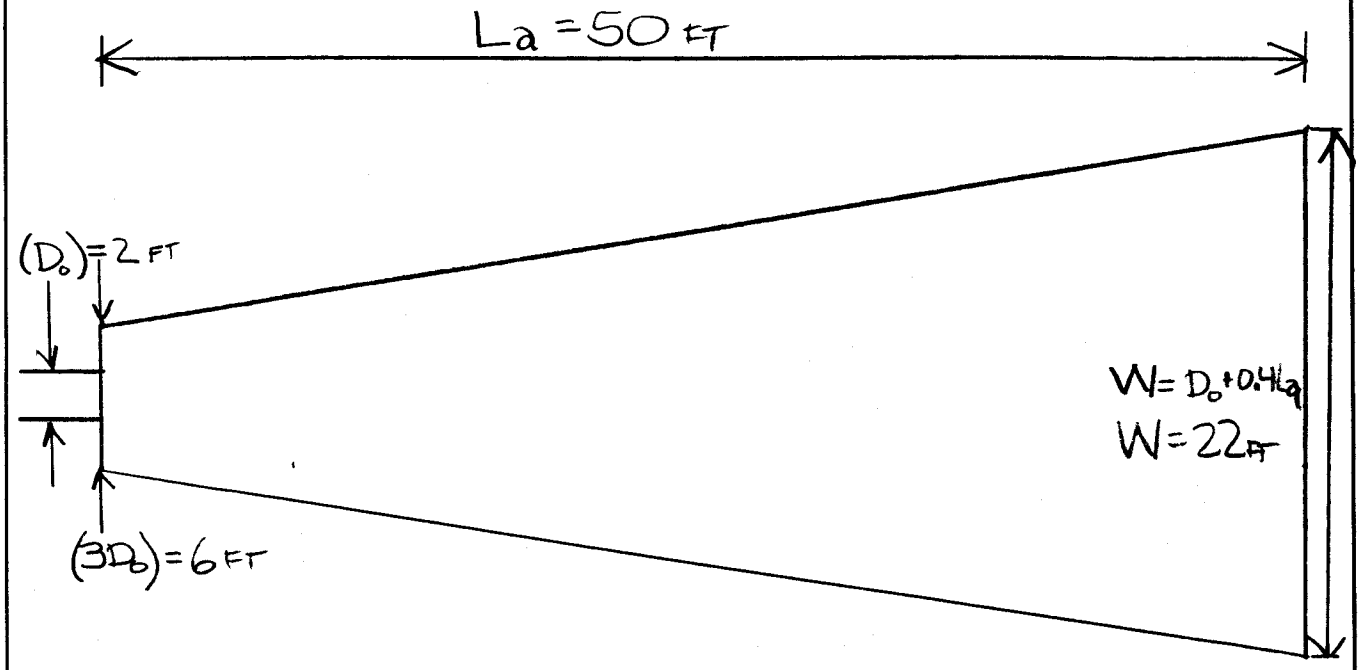
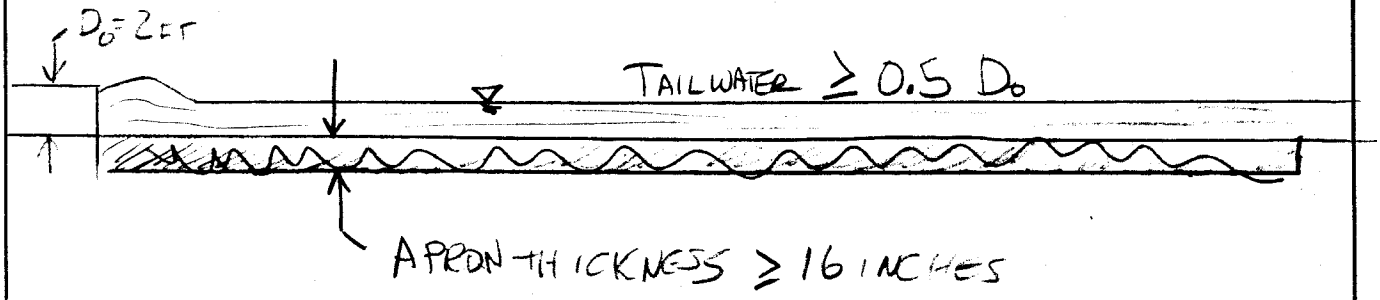
PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
WEYER HAEUSER PLYMOUTH	CWH	9/22/99	RKN	9/22/99	05101.01

SINCE ALL FOUR OUTFALL CULVERT REQUIRE SIMILAR SIZE RIP RAP OUTLET PROTECTION THE FOLLOWING DIMENSIONS ARE RECOMMENDED FOR OUTFALL PROTECTION FOR ALL FOUR BASINS





RIPRAP d_{50} = 7 INCHES
RIPRAP d_{MAX} = 12.5 INCHES

Appendix M
Operations Plan

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Section 1
Overview

Landfill No. 3 will be operated as an area fill. An operating area will be established on the waste surface where loads of waste will be dumped from transport and conveyor equipment. Landfill operating equipment will spread and compact waste materials into a working face that will slope downward from the operating area into the open cell bottom. The landfill operations described in the following sections will be conducted to accomplish the following objectives:

- Compact waste materials into a stable fill mass.
- Cover paper wastes that might present a blowing litter problem with soil-like waste materials such as dewatered wastewater treatment solids (fiber sludge), boiler ash, and woodyard waste (bark, grit, and reject wood chips).
- Grade all waste surfaces to promote drainage to the leachate collection drainage layer on the bottom and sides of the landfill.
- Maintain as small an operating area as possible.
- Minimize the area of operation generating leachate by using stormwater diversion berms and redirecting non-contact stormwater directly to surface drainage systems.

In addition, operations will be conducted in compliance with the provisions of NC DENR regulations Section .1626. Asbestos waste will be placed in the asbestos landfill located east of Landfill No. 2 and west of Phase 1 of Landfill No. 3.

Section 2
General Operating Requirements

Landfill operations will be conducted by a Weyerhaeuser employee or a contract operator to Weyerhaeuser.

Site control will be maintained at all times by a security fence and a manned guard station at the entrance to the Weyerhaeuser mill. The landfill area will be accessible only to landfill operations personnel, Weyerhaeuser supervisory personnel, and authorized visitors. The following activities are prohibited:

- Scavenging of waste materials
- Feeding of farm or domestic animals
- Waste fill in standing water
- Open burning

Access to the disposal area of the landfill will be established using temporary culverts and soil, ash waste or gravel as appropriate to construct ramps off the perimeter dike road into the lined fill area. Runon and runoff from waste-filled areas will be controlled at all times by the leachate collection system and the perimeter berm. Stormwater within open areas of the cell will be controlled by means of temporary stormwater diversion berms, which will allow stormwater to be discharged to the perimeter ditching rather than treated as leachate. Waste will be placed from the perimeter inward so that the side slopes may be capped as they reach final grades.

Salvage operations will not occur on a routine basis. Infrequently, the interior of the landfill might be used to store materials for recovery and use at a later date. Such materials include bark and wood waste, waste lime to be used for agricultural purposes, or dewatered fiber wastewater solids to be used as a soil amendment or other application. No hazardous wastes will be stored in the landfill. Recoverable materials will be segregated from the active waste disposal operation to the extent possible.

Daily inspections should also be performed to evaluate leachate levels within the landfill. Impermeable waste streams, such as ash, should be concentrated within the cell as much as possible to allow direct runoff into the leachate collection layer. Care should be taken to place various waste streams in appropriate locations that assist the operation of the leachate system as well as the evolution of the cell. This includes leaving some freeboard along the edge of the perimeter berms. Waste should not be placed in such a manner as to spill on to the tops of these

berms. The free board will leave access to the drainage layer against the wall of the berm allowing leachate runoff access to the collection system below.

Working faces should be kept as small as possible, and areas should be capped as they are completed to the designed grades. Placing waste from the edge of the cell inward will afford the opportunity to cap sections sooner. Stormwater that flows off the capped sections will be diverted to the perimeter drainage ditches and will not be collected as leachate. These common landfill operational practices will compliment a stormwater control berm.

The design features and operating procedures described in this application have been developed to minimize the potential for slope failure. However, the slope stability analysis has revealed that the potential for slope failure at this site increases under the following conditions:

- Steeper slopes than planned
- Waste placed much looser or wetter than in the existing landfill or that which was tested.
- Soil or waste not compacted as recommended
- A rise in the groundwater table
- Leachate not able to adequately drain
- Shear strength parameters less than those used in the analysis
- Subgrade soils destabilized due to poor drainage or construction equipment traffic

To minimize the potential occurrence of these conditions, the following operational procedures are recommended:

- Have the subgrade soils observed by a qualified geotechnical engineer immediately prior to construction of the liner to confirm that the subgrades are suitable for construction of the landfill.
- Have qualified geotechnical personnel monitor placement and test compaction of all controlled fill soil used to construct the landfill and sediment basins to verify that the recommended compaction has been attained.
- Control the equipment traffic and drainage throughout construction (especially during rainy weather) to prevent destabilization of the subgrade soils.
- Place soil used in construction of the sediment basins, perimeter dikes, or grading of the site in lifts no more than 8 inches thick (loose). Compact these soil to at least 95 percent of the Standard Proctor (ASTM D 698) maximum dry density at ±3 percent of the optimum moisture content.
- Dewater all dredge wastewater solids by plate and frame press immediately prior to placement in landfill.
- Place and compact the waste material in lifts no more than 3 feet thick. Waste material placed in the facility should be compacted by repeated passes of the bulldozer until firm.

- Keep all waste material well drained by sloping the surface of the waste material to allow for stormwater drainage.
- Conduct additional testing and slope stability analyses if there is a change in the waste material placed or the quality of waste material placed in the landfill.
- Maintain adequate drainage of any leachate generated during waste placement operations. RMT recommends that no more than 1 foot of head be allowed to build up within the solid waste facility.
- Construct side slopes no steeper than 3 horizontal to 1 vertical to a height not greater than 214 feet. Bench exterior side slopes inward 15 feet for every 20 feet rise in height.

In the event dewatered wastewater solids are subjected to precipitation prior to placement, blend it with ash to improve its shear strength and compaction. The shear strength of 60/40 dewatered wastewater solids to ash blend is significantly higher than for dewatered wastewater solids alone.

Section 3
Operating Equipment

Landfill No. 3 will be operated with a mid-size bulldozer. Support equipment will consist of over-the-road transport vehicles, including standard dump trucks and rolloff container trucks. A motor-grader will be used for road maintenance, but will not necessarily be dedicated to the landfill operations.

A conveyor system will be used to transport dewatered wastewater solids. This material will be conveyed from the dewatering press building to a mobile conveyor tower located on the perimeter berm.

In general, a bulldozer will be used to spread waste and compact the working face. The bulldozer will be used to maintain access from the perimeter road to the operating area, and to spread soil-like waste materials over blowing waste.

Hauling equipment operating outside the landfill area will be washed in a wash down area located at the dewatering press building. Wash water will be collected and treated with the landfill leachate and the dewatering press filtrate.

Operating equipment will be included in Weyerhaeuser's preventative maintenance program. Routine maintenance, such as oil and filter changes, as well as sampling and analysis of lubricating and hydraulic oils will be conducted on schedules set in the program. Spare parts will be carried in inventory. If extended service should be required on the landfill bulldozer, a substitute bulldozer will be provided by other operations at the Weyerhaeuser mill or leased from a local contractor to ensure continuous operations.

Section 4
Pumps

Redundant submersible pump systems remove leachate from the bottom of the landfill and transfer it by force main to the storage tank/sump of the leachate transfer station, then to the mill wastewater treatment system. Maintenance of the pumps will be conducted in accordance with manufacturer's recommendations.

Maintaining a strict set of operational checks and balances is crucial to the success of all landfill operations. A daily record of flow rates and total volumes will be used in troubleshooting the system. If flow is lower than anticipated, the system should be thoroughly inspected and any problems should be repaired - a pump may be down, the line may be clogged, or the leachate collection layer may be impeded by an impermeable waste stream. The flow meter should be routinely monitored and placed on a preventative maintenance (PM) schedule. The pumps should also be placed on a PM schedule. This will allow water to be removed as designed and the overall storage capacity of the cell for the major storm events to be maintained.

Section 5
Dust Control

Due to the frequent use of ash as daily cover and the potential for dusting, dust control equipment will be used at the Landfill. This equipment will consist of a pump and piping system tied to the leachate transfer station storage tank or wet well. Leachate will be pumped from the storage tank or wet well to mobile sprinkler units located within the Landfill.

Section 6
Litter Control

A portion of the waste disposed of in the landfill will be compacted and uncompacted paper from the Weyerhaeuser Complex paper manufacturing operations. This waste type will be dumped at the edge of the operating area. The waste material will be compacted by repeated passes of the compactor or bulldozer. Each day, or more frequently if required by weather conditions, blowing waste will be covered with soil-like waste materials or soil if suitable wastes are unavailable. Cover material will be available from a stockpile area. If necessary, litter-control fencing will be used to prevent litter from blowing beyond the landfill area.

Section 7
Stormwater Controls

Landfill operations will be conducted in a manner to minimize infiltration into the waste fill for two reasons:

- Excess moisture will reduce the stability of the fill by lowering the shear strength of the waste materials.
- Excess moisture will result in the generation of unnecessary quantities of leachate and increase the hydraulic head on the landfill liner.

Surface water runon will be prevented by the perimeter ditch and berm around the landfill, and by the cell delineation berms at the south end of each construction stage. The waste fill will be graded to minimize infiltration of contact rainwater. The operating area must be nearly level to function as a turnaround and dumping area for waste transport vehicles. The working face and operating area will be kept as small as practical, and will be sloped or crowned so that water drains from the surface to the leachate collection sand layer at the toe of the waste fill. Ponding of water will not be allowed. Depressions in the operating area will be filled with waste materials to promote runoff. The working face of the fill will be maintained at a slope of 3 horizontal to 1 vertical up to 5 horizontal to 1 vertical to promote runoff to the leachate collection sand layer at the toe of the slope.

Temporary stormwater control berms will be constructed in unfilled areas of the active cell to divert clean stormwater away from the leachate collection system. The berm will be located to provide adequate storage space for waste as well as temporary storage of runoff from the working face. It will also be sited to maximize segregation of stormwater and leachate.

Leachate will be collected in a series of sumps equipped with both primary and secondary submersible pumps. It is anticipated that during normal landfill operations the pumps will cycle to minimize pump burnout. In the event of an extraordinary rainfall event, primary and secondary pumps will be active thereby minimizing the amount and holding time of leachate within the landfill.

The following stormwater and leachate management practices will be maintained at the landfill:

- Diversion of non-contact stormwater away from the leachate system and removal of surface water discharge outside the landfill boundary. This can be accomplished via temporary internal diversion berms within the landfill and the use of portable pumps, if necessary. Internal berms are most important in the initial time period after the landfill is opened because extreme leachate generation rates are more likely. Although, the landfill system

with internal stormwater diversion berms will allow for temporary storage/handling of the leachate generated from a 25-year, 24-hour storm event, it is crucial to separate and discharge non-contact stormwater before it is considered leachate. The pumps are sized to take up to 6 days to discharge leachate generated from the 25-year, 24-hour storm event.

- Limitation of the active filling area of the landfill to a small area to minimize the volume of leachate generated. This area is typically 5 acres or less depending on specific site conditions.
- Maintenance of a filling sequence that reaches final waste grades as soon as possible so that final cover soils can be placed to further divert surface water.
- Proper maintenance, operation, and monitoring of the leachate pumps, pump controls, discharge piping, leachate collection piping, and clean-outs.

Section 8
Site Facilities

Telephone, potable water, and toilets will be available in the dewatering press building. Back-up communication to and from the site will be provided by radio or cellular telephone. Since the dewatering press building is located in the area set aside for asbestos waste disposal, it will ultimately be demolished at closure of the landfill when it is no longer needed.

Section 9
Final Cover

Final cover will be progressively placed on areas of the landfill that have been graded to final contours. Cap construction will typically be performed in areas of 5 acres or less. Final grading and cap construction will proceed from north to south and west, as the fill reaches final grades. The cap for the Landfill includes GCL and a VFPE liner. These materials will be protected from the elements and operating equipment by a vegetative soil layer. Maintenance of the vegetative layer is critical to protect the integrity of the landfill cap system.

The cap will be sown according to approved seeding specifications for perennial vegetation. Vegetated cap areas will be mowed at least annually using equipment that will not damage the integrity of the soil cover layer. Vegetated areas will be inspected during the course of landfill operations. Conditions that may require repair include the following:

- Sparse or unhealthy vegetation
- Improper vegetation, such as trees or woody shrubs
- Erosion of the soil cover layer
- Slope failures, such as soil creep and sloughing
- Rutting from vehicular traffic or equipment operation

Damaged areas will be repaired as weather permits.

Section 10
Inspections

The landfill operator or designated inspector will conduct inspections of all landfill operating systems on a routine basis. Inspections will be conducted and documented using an inspection log. A typical example is included as Table 10-1.

Table 10-1
Sample Landfill Inspection Checklist

INSPECTION CHECKLIST	INSPECTION	INITIAL AND DATE THE APPROPRIATE BOX									
		S	M	T	W	T	F	S	STORMS	MONTHLY	QUARTERLY
Pumps											
1	Daily - check flashing light and standing water. Weekly - switch on and check current.										
2											
3											
4											
Ditches	Inspect monthly and after storms.										
Sediment Basin	Inspect monthly and after storms.										
Dikes and Berms	Inspect monthly and after storms.										
Fence and Gates											

Comments:

Work Orders Placed:

DATE	ORDER NUMBER	DESCRIPTION OF REQUEST

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Closure/Post Closure

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Section 1
Introduction

This technical narrative addresses the closure and post-closure care requirements as identified in the NC DENR Solid Waste Management Rules, Section .1629 as related to closure/post closure activities for the Weyerhaeuser Landfill No. 3 in Plymouth, North Carolina. The requirements have been addressed in the format suggested in Section .1629.

1.1 Related Documents

This closure plan and cost estimate are included as an appendix to the Construction Plan Application for On-site Industrial Process Waste Landfill No. 3. It is to be used in conjunction with the following:

- CQA Plan (Appendix Q)
- Drawing No. 510101-C12 and Drawing No. 510101-C13, Final Grading Plan
- Drawing No. 510101-C14, Phase Progression Plan
- Drawing No. 510101-C17 and Drawing No. 510101-C18, Leachate Collection and Removal System Details
- Drawing No. 510101-C22, Sediment Pond Details
- Construction Specifications (to be issued immediately prior to cap construction)

Section 2
Background and Location

Industrial solid waste generated from manufacturing operations at the Weyerhaeuser Plymouth Complex will be disposed of in the landfill. The waste streams include, but are not limited to, boiler ash, grits, liquor dregs, lime mud, wood wastes, paper wastes, pulp rejects, general mill trash, and dewatered wastewater treatment plant solids. Off-site waste material will likely be accepted from other Weyerhaeuser mills only. Waste streams from these mills will be limited to those listed above.

The proposed 95-acre site is located approximately 2 miles south of the Weyerhaeuser Complex as shown on Drawing No. 510101-C01. The site is generally located west of Ken Trowbridge Road; south of the Weyerhaeuser Complex and the Roanoke River; east of Welch Creek; and north of Highway 64.

Section 3
Final Cover Design and Construction

Closure activities for the Weyerhaeuser landfill will include the following items:

- Installation of intermediate cover
- Installation of the cap system
- Establishment of the vegetative cover

3.1 Permitted Final Cover Design

3.1.1 Installation of Intermediate Cover

Intermediate cover will consist of 12 inches of select waste (ash). This layer will serve as a smooth support layer for the GCL. The intermediate cover will be placed at Weyerhaeuser's discretion on the waste in areas that have reached final grade elevations, and may be removed and stockpiled for future use before capping activities begin.

3.1.2 Installation of the Cap System

The largest area of the landfill requiring cover at any time during the life of the landfill is for a premature closure condition and is estimated to be approximately 14.6 acres. The estimated total volume of the landfill is 11 million cubic yards. Prior to beginning closure of the landfill, a notice of intent to close the unit will be submitted to NC DENR and placed in the site operating record.

The proposed cap system for final cover will consist of the following components (top to bottom) as shown on Drawing No. 510101-C19, Drawing No. 510101-C20, and Drawing No. 510101-C21:

- 6-inch vegetative layer
- 12-inch vegetative support layer
- Geotextile/geonet/geotextile composite (drainage layer)
- 40-mil VFPE geomembrane
- GCL

The minimum slope of the final cap will be 5 percent. The maximum slope of the final cap will be 33 percent. Benches, 15 feet in width, will be graded into the final cap slope at vertical intervals of 20 feet. The benches will have a minimum slope of 0.5 percent to collect storm water from the cap and to provide equipment access along the face of the landfill for maintenance and inspections.

Prior to beginning capping activities, any remaining fine grading of the intermediate cover will be conducted. Gas collection trenches and vents will be placed at the crest of the landfill. Next, the GCL will be placed to provide an impermeable layer that will reduce storm water infiltration into the waste and thereby reduce leachate production.

A 40-mil VFPE textured liner will be placed on the GCL to enhance the barrier layer. Refer to the CQA Plan for VFPE acceptance specifications (see Appendix Q). A drainage composite consisting of a geotextile/geonet/geotextile will be placed over the textured membrane. Refer to the CQA Plan for geonet and geotextile acceptance specifications. This drainage layer will collect infiltration and divert water to the drainage terraces.

The final component of the cover system will consist of general fill and topsoil. The general fill layer will consist of 12 inches of soil or a mixture of dewatered wastewater solids and ash, as previously approved by NC DENR. The topsoil will consist of 6 inches of soil capable of sustaining vegetative growth. The sedimentation pond will be cleaned of sediment build-up and the sediment, consisting of material eroded from the existing cover, may be blended into the vegetative layer. Final grading of this layer will be accomplished with tracked equipment.

Within 90 days after completion of final grading requirements of the landfill unit, a seed bed will be prepared in the vegetative layer prior to applying seed and mulch. The seed bed will be prepared with a disc harrow penetrating to a minimum depth of 2 inches. Large clods, rocks, or other foreign material brought to the surface during preparation of the seed bed will be removed prior to the application of fertilizer, seed, and mulch. Fertilizer will be evenly spread over the surface of the prepared seed bed and worked into the soil with one final light pass with a disk harrow or a chain harrow. Lime will be applied, if necessary, to enhance growth.

Permanent vegetation will be established by spreading seed with a mechanical device that ensures an even application rate of the seed mixture. The vegetative components may be applied simultaneously with a hydroseeder.

The following method is suggested for establishing the permanent vegetation:

1. Apply liming agent at recommended rate.
2. Apply fertilizer (10-10-10) at recommended rate.
3. Work lime and fertilizer into the soil.
4. Apply seed mixture at recommended rates.
5. Apply mulch to the seeded surface.
6. If final grading and surface preparation are delayed due to inclement weather, appropriate measures will be taken to remedy any effects of erosion.
7. Maintenance measures will be performed as necessary to achieve a thorough coverage of vegetation.

3.2 Construction Specifications

Prior to the commencement of closure activities, applicable construction specifications will be issued for NC DENR review. In the interim, the CQA Plan located in Appendix Q of the Permit Application will provide any necessary information regarding the cap components and their required properties.

3.3 Quality Assurance/Quality Control

Construction quality assurance and quality control during all landfill closure activities will be performed according to the CQA Plan (Appendix Q of the Permit Application). The CQA Plan was written in accordance with Section .1621 of the NC DENR regulations and will form part of this document as referenced. Prior to closure, the CQA Plan will be reviewed and modified as necessary and attached to this closure plan and cost estimate.

3.4 Erosion Control Measures

State and federal erosion control regulations will be followed during closure activities. Prior to establishing vegetation, areas left disturbed for a period greater than 14 days will be covered with jute mesh, temporary vegetation, or an equivalent cover. Other standard management practices for erosion control such as silt fencing, hay bale barriers, etc., will be employed as necessary. In addition, storm water from the cap areas will be routed through the sediment ponds located around the landfill, which will serve to remove suspended sediment.

Section 4
Closure Scenarios

4.1 Routine and Premature Closure

The disposal site will be developed in 18 phases as shown on Drawing No. 510101-C14. This operating scenario shown is based on utilizing the working face method of fill and allows for the lateral expansion of the facility in the future. As waste is placed in the active stage, it will be graded, spread, and compacted along the working face. As final subgrade elevations are reached, the working face will move to the south into the next lined phase. The finished areas will then be covered with either a temporary cover, which will minimize the generation of leachate, or a final cover will be constructed.

With the exception of Phase 1 and Phase 2, which each occupy a footprint area of approximately 15 acres, each of the landfill's 18 phases covers approximately 2 to 5 acres. Each landfill phase is estimated to have a life expectancy of approximately 5 to 6 years.

Final cap construction will proceed from phase to phase. As Phase 1 nears capacity, the Phase 2 cell will be constructed. Phase 1 will then be capped as filling begins on Phase 2. Construction will proceed in this manner through the life of the landfill. Prior to construction of the final cap, surface water that comes into contact with waste will be managed as leachate. Surface water runoff from areas of vegetated intermediate cap will be discharged through appropriate sedimentation controls.

Due to the landfill geometry, the scenario for both the worst-case routine and premature closure condition will exist when Phase 1 reaches its final elevations and expansion begins toward the south into Phase 2. Worst-case routine and premature closure will therefore require the construction of final cover for approximately 14.6 acres.

4.2 Closure Cost Estimate

For purposes of meeting NC DENR financial assurance requirements, the cost to close the initial 14.6-acre cell was calculated to be approximately $1.8 million (Attachment 1). This estimate includes the estimated cost for NC DENR to hire an independent third party as general contractor (not a corporate subsidiary or parent, or affiliate of the permittee) to perform each task, including the costs of preparing and executing bid documents for the selection of a general contractor and supervising the general contractor's performance.

Unit costs are based on information from contractors in the southeastern United States, vendor estimates, published costs, or engineering estimates. Costs reflect a discount rate of 5 percent and an inflation rate of 3 percent. Specific cost allowances are not included for interest during construction, legal fees, financial consultants, debt service, or equipment depreciation. Closure costs include an administrative allowance of 20 percent of the capital cost plus a general contingency of 15 percent.

The following is a description of those closure items in Attachment 1 that may require explanation.

4.2.1 Control Grading

This item includes relocating waste, surface preparation, and obtaining proper surface elevations. Erosion control measures are shown as separate line items.

4.2.2 Geosynthetic Clay Liner

This item includes placing GCL for the low permeability layer of the final cover.

4.2.3 40-mil Textured VFPE Geomembrane

This item includes obtaining and installing 40-mil textured VFPE geomembrane for the final cover.

4.2.4 Geonet Drainage Composite

This item includes obtaining and installing geonet drainage composite for the final cover.

4.2.5 Vegetative Support Layer

This item includes placing fill material for the vegetative support layer and assumes that all necessary material will be available from an on-site stockpile. The cost for this item is based on in-place volumes.

4.2.6 Topsoil

This item includes placing topsoil for the final cover and assumes that all necessary material will be available from an on-site stockpile. The cost for this item is based on in-place volumes.

4.2.7 Vegetation

Establishing a vegetative cover includes the following items:

- Soil Testing
- Amending soil with lime, fertilizer, and organic matter
- Incorporating soil amendments, including disking, harrowing, sprigging, and herbicide application
- Spreading and disking surface thatch

4.2.8 Closure Survey

This item includes survey of the entire closure area to determine final elevations of the cap. The cost to prepare a drawing of the final elevations showing contour intervals at 2-foot contours is included as a separate item.

4.2.9 Administrative Costs

Administrative costs shown as 20 percent of the total capital cost include the following items:

- Redesigning final closure, if necessary, in accordance with existing site conditions and applicable regulations
- Contracting for technical consulting services
- Providing administrative overhead for oversight
- Preparing final closure certification
- The costs for an independent third party consultant for all services associated with preparing and executing bid documents, selection of an independent third party construction contractor, and supervision of the contractor's general performance

4.3 Maximum Waste Inventory

It is expected that over the entire life of the facility, the maximum waste inventory will be approximately 11 million cubic yards.

Section 5
Closure Schedule

It is expected that closure for this scenario would not require longer than 180 days. However, if the project were to exceed this duration, Weyerhaeuser would take the steps necessary to prevent threats to human health and the environment from the unclosed landfill unit. The closure period would be extended only with NC DENR approval. In addition, closure activities for the landfill unit would be completed in accordance with this plan.

Section 6
Closure Certification and Deed Notation

Following closure of the landfill unit, Weyerhaeuser will submit to NC DENR a certification, signed by an independent registered professional engineer verifying that closure has been completed in accordance with the closure plan, and a copy placed in the site operating record. In addition, within 90 days after closure activities are complete, Weyerhaeuser will record a notation onto the land deed and/or some other legal instrument that is normally examined during a title search stating that the property has been used as a solid waste disposal facility landfill unit. The notation will include the following information:

- The land has been used as a solid waste disposal facility landfill unit.
- The land use is restricted to ensure that the cap system integrity or other containment components are not compromised, and monitoring systems are not disturbed.
- That any re-use of the property will not increase the potential threat to human health or the environment.
- The name of the permittee, the type of disposal facility, and the beginning and closure dates of the disposal activities will be included.
- The locations and dimensions of the landfill unit with respect to permanently surveyed benchmarks and section corners on a plat prepared and sealed by a land surveyor will be included.
- The notation will be certified by an Engineer or Land Surveyor stating that all closure requirements have been completed as determined necessary by the Department.

Weyerhaeuser will submit a certified copy of the recording instrument to NC DENR and place a copy in the operating record within 120 days after permit expiration, revocation, or as otherwise directed by NC DENR.

Section 7
Post-Closure Monitoring/Maintenance

7.1 Final Cover Maintenance/Inspection Schedule

The finished cap and perimeter berm will receive a visual inspection periodically to check for and document evidence of settling, subsidence, erosion, and other potential failures of the final cover. These inspections will also encompass the perimeter berm, ditches, channels, and sediment basin to ensure storm water runoff and runon are being properly routed. These inspections, along with any repairs that were required, will be documented and maintained on file by Weyerhaeuser.

In addition, the landfill will be mowed at least once per growing season, and fertilized and reseeded as necessary. This will protect the final cover against erosion and decrease the potential for leachate generation. Vegetation that poses a threat to the integrity of the final cover, such as deep-rooted shrubs and trees, will be removed.

7.2 Leachate Collection System/Miscellaneous Maintenance

Weyerhaeuser will perform the following maintenance activities for the duration of the post-closure care period:

- **Pumps**. Proper maintenance of this equipment is critical to the operation of the leachate collection and transfer system. The manufacturer's recommendation for routine inspection and cleaning intervals will be followed for pumps and pump controls. In addition, all valves and flow measurement devices will be inspected and cleaned as necessary on a regular basis.
- **Leachate Treatment**. Leachate collected in the wet well of the leachate transfer station will continue to be treated in the mill wastewater treatment system for the duration of the post-closure period. Leachate collection may be discontinued if testing establishes that leachate treatment is no longer necessary and upon approval of NC DENR (see Subsection 5.6.2 of the Permit Application).
- **Access Control**. Access to the landfill facility will be controlled by secure fencing for the duration of the post-closure period.

7.3 Groundwater Monitoring System

Groundwater will continue to be monitored as described in Subsection 5.6.1 and in Appendix O, Sampling and Analysis Procedures for Groundwater, of the Permit Application for the duration of the post-closure period.

7.4 Gas Monitoring

Gas monitoring at the site will not be performed at the landfill due to the predominantly inorganic nature of the wastes, as discussed in Subsection 5.6.3 of the landfill Permit Application document.

Section 8
Post-Closure Cost Estimate

The post-closure cost estimate was based on monitoring and maintaining Phase 1 of the disposal facility for a period of 30 years after final closure. This estimate is included as Attachment 2. Unit costs are based on information from contractors in the southeastern United States, vendor estimates, published costs, or engineering estimates. Costs reflect current pricing. The present value of post-closure care for Phase 1 is estimated to be $1.3 million, assuming a 9-year life for Phase 1, a 30-year post-closure care duration, 3 percent inflation, and 5 percent interest. Specific cost allowances are not included for interest during construction, legal fees, financial consultants, debt service, or equipment depreciation. Post-closure costs include an administrative allowance of 20 percent of the capital cost plus a general contingency of 15 percent.

8.1 Routine Inspection

This item is for inspecting the site twice each year for 2 years to determine the necessary maintenance required.

8.2 Maintenance of On-site Improvements

This item is for repair and maintenance of all on-site permanent improvements and equipment including signs, gates, fences, roads, or other structures necessary to maintain closure of the site.

8.3 Maintaining Vegetation

The cost is included to mow the site two times per year, reseeding as necessary, and applying weed control measures.

8.4 Repair of Final Cover

This item is for controlling erosion, settlement, and ponding on the final cover.

8.5 Maintaining Surface Drainage Features

This item includes the cost of repairing erosion for 10 percent of the total ditch length per year.

8.6 Groundwater Monitoring Well Sampling

The cost is included to sample and analyze one sample per year for each of the 11 monitoring wells in accordance with the Groundwater Monitoring, Sampling, and Analysis Plan for the duration of the post-closure period.

8.7 Leachate Collection System Maintenance

The cost is included to maintain the six leachate pumps in Phase 1 in accordance with manufacturer's recommendations. This cost was derived by multiplying the capital cost of the pumps by 10 percent representing the depreciation of each pump over its useful life.

8.8 Administrative Costs

Administrative costs shown as 20 percent of the total capital cost include the following items:

- Record keeping
- Contracting for technical consulting services
- Administrative overhead for oversight
- Preparing post-closure certification
- The costs for an independent third party consultant for all services associated with preparing and executing bid documents, selection of an independent third party construction contractor, and supervision of the contractor's general performance

8.9 Post-Closure Costs Not Included

No allowance has been made for the following items:

- Air sampling
- Soil sampling
- Surface water sampling
- Gas sampling
- Monitoring well abandonment
- Leachate treatment

Section 9
Contact Persons

The following office can be contacted during the post-closure period:

Director of Environmental Affairs
Weyerhaeuser Company
Plymouth Mill
West Main Street Extension
PO Box 787
Plymouth, North Carolina 27962
(252) 793-8111

Section 10
Landfill Property Use

Currently, there are no planned uses of the property during the post-closure period. In the event a use is realized, NC DENR will be contacted for approval. All proposed activities will be restricted to prevent damage to the integrity of the final cover, liner, and all other components of the containment system.

Section 11
Post-Closure Certification

Following completion of post-closure care, Weyerhaeuser will notify NC DENR that a certification, signed by a registered profession engineer, and verifying that post-closure care has been completed in accordance with this post-closure plan, has been placed in the operating record.

Attachment 1
Opinion of Probable Costs
Landfill No. 3 Closure,
Phase 1 Cost Estimate

OPINION OF PROBABLE COSTS

LANDFILL # 3 CLOSURE — By: EWT

WEYERHAEUSER PLYMOUTH, NORTH CAROLINA — Checked: RKN

RMT PROJECT NO. 5101.01 — Date: 9/22/99

Footprint (acres):	14.60	Disposal Rate (cyds/year):	71,000
Volume (cyds):	611,800	Cut (cyds):	58,000
Waste Unit Weight (lbs/cf):	70	General Fill Borrow (cyds):	7,500
Phase Operations (years):	9	Post-Closure Care (years):	30
Discount Rate:	5%	Inflation:	3%

DESCRIPTION: Closure of Phase 1 (approximately 29 acres)

ITEM NUMBER	*ITEM DESCRIPTION*	*UNITS*	*UNIT COST*	*QUANTITY*	*TOTAL COSTS*
1.00	**MOBILIZATION**	LS	$ 25,000.00	1	$ 25,000
2.00	**CONSTRUCT MULTILAYERED CAP**				
2.01	CONTROL GRADING	SY	$ 1.80	70,664	$ 127,195
2.02	COARSE AGGREGATE LAYER	CY	$ 26.00	-	$ -
2.03	GEOTEXTILE	SY	$ 1.75	-	$ -
2.04	GCL	SF	$ 0.46	635,976	$ 292,549
2.05	40-MIL TEXTURED VFPE MEMBRANE	SF	$ 0.40	635,976	$ 254,390
2.06	GEONET COMPOSITE	SF	$ 0.68	635,976	$ 432,464
2.07	PASSIVE GAS SYSTEM	EACH	$ 15,000.00	1	$ 15,000
2.08	VEGETATIVE SUPPORT LAYER	CY	$ 2.50	23,555	$ 58,887
2.09	TOPSOIL	CY	$ 2.50	11,777	$ 29,443
2.10	FINAL GRADING	SY	$ 1.30	70,664	$ 91,863
2.11	VEGETATION	ACRE	$ 3,000.00	15	$ 43,800
3.00	**EROSION CONTROL**				
3.01	SILT FENCING	LF	$ 2.25	3,000	$ 6,750
3.02	SEDIMENT TRAPS	EA	$ 1,500.00	1	$ 1,500
3.03	HAY BALE BARRIERS (QUANTITY ALLOWANCE)	TON	$ 500.00	3	$ 1,500
3.04	TEMPORARY DIVERSION DITCHES (QUANTITY ALLOWANCE)	LF	$ 2.00	1,000	$ 2,000
3.05	RIP RAP (QUANTITY ALLOWANCE)	TON	$ 24.00	250	$ 6,000
4.00	**DEMOBILIZATION**	LS	$ 10,000.00	1	$ 10,000
5.00	**SURVEYING**				
5.01	SURVEYING	ACRE	$ 5,000.00	15	$ 73,000
6.00	**CONSTRUCTION MANAGEMENT**				
6.01	ON-SITE CONSTRUCTION MANAGEMENT ($5,000/wk x 15 wks)	LS	$ 75,000.00	1	$ 75,000
6.02	GEOSYNTHETIC FIELD & LABORATORY TESTING	SF	$ 0.05	635,976	$ 31,799
7.00	SUBTOTAL				$ 1,578,140
8.00	ADMINISTRATIVE (20% OF CAPITAL COSTS)				$ 315,628
9.00	CONTINGENCY (15% OF CAPITAL COSTS)				$ 236,721
10.00	**TOTAL CLOSURE CAPITAL COST ESTIMATE**				**$ 2,130,489**

10.01	TOTAL CLOSURE CAPITAL COST ESTIMATE PER ACRE				$	145,924
11.00	**CLOSURE ESTIMATE PRESENT VALUE**				**$**	**1,796,274**

Attachment 2
Opinion of Probable Costs
Landfill No. 3 Post-Closure,
Phase 1 Cost Estimate

OPINION OF PROBABLE COSTS

LANDFILL # 3 POST-CLOSURE — By: EWT

WEYERHAEUSER PLYMOUTH, NORTH CAROLINA — Checked: RKN

RMT PROJECT NO. 5101.01 — Date: 9/22/99

Footprint (acres):	14.60	Disposal Rate (cyds/year):	71,000
Volume (cyds):	611,800	Cut (cyds):	58,000
Waste Unit Weight (lbs/cf):	70	General Fill Borrow (cyds):	7,500
Phase Operations (years):	9	Post-Closure Care (years):	30
Discount Rate:	5%	Inflation:	3%

DESCRIPTION: Post-closure of Phase 1 (approximately 29 acres)

ITEM NUMBER	*ITEM DESCRIPTION*	*UNITS*	*UNIT COST*	*QUANTITY*	*TOTAL COSTS*
1.00	**ROUTINE INSPECTION (2 TRIPS PER YEAR)**	EACH	$ 3,000.00	2	$ 6,000
2.00	**MAINTENANCE OF ON-SITE IMPROVEMENTS**	YEAR	$ 7,500.00	1	$ 7,500
3.00	**MONITORING WELL ABANDONMENT**	EACH	$ 1,000.00	-	$ -
4.00	**MAINTAIN VEGETATION (29 ACRES AT $300/ACRE/YEAR)**	ACRE	$ 300.00	15	$ 4,380
5.00	**REPAIR FINAL COVER**	YEAR	$ 3,000.00	1	$ 3,000
6.00	**MAINTAIN SURFACE DRAINAGE FEATURES (1000 FT AT $4/LF/YR)**	YEAR	$ 4,000.00	1	$ 4,000
7.00	**MAINTAIN LEACHATE COLLECTION**				
7.01	MAINTENANCE OF LEACHATE PUMPS (10% OF CAPITAL COST/PUMP/YEAR)	PUMP	$ 400.00	6	$ 2,400
8.00	**GROUNDWATER SAMPLE ANALYSIS (1/YEAR/PHASE FOR 11 WELLS)**	EACH	$ 2,000.00	11	$ 22,000
9.00	**GROUNDWATER SAMPLE COLLECTION**	TRIP	$ 2,500.00	1	$ 2,500
10.00	SUBTOTAL				$ 51,780
11.00	ADMINISTRATIVE (20% OF CAPITAL COSTS)				$ 10,356
12.00	CONTINGENCY (15% OF CAPITAL COSTS)				$ 7,767
13.00	**TOTAL POST-CLOSURE CAPITAL COST ESTIMATE PER YEAR**				**$ 69,903**
13.01	TOTAL POST-CLOSURE CAPITAL COST ESTIMATE PER ACRE				$ 4,788
14.00	**POST-CLOSURE ESTIMATE PRESENT VALUE**				**$ 1,319,983**

Appendix O
Sampling and Analysis Procedures for Groundwater

Sampling and Analysis Procedures for Groundwater

General Information

Sample bottles will be shipped to the site in sturdy, durable shipping coolers.

Type 1 reagent grade water will be used that meets ASTM, CAP, and NCCLS standards.

Field activities will be documented in a bound field book or on a field collection sheet. The following information will appear on each page: project, date, time, sampler's initials, site contact, conductivity, well depth, temperature, water level, gallons purged, and pH.

Monitoring wells will be fitted with dedicated QED low flow purge system bladder sampling pumps and water level meters (or equivalent). The dedicated pumps will be used to purge well volumes and collect groundwater samples. The following wells will be fitted with dedicated QED sampling pumps (or equivalent) and electric water level meters: MW-1, MW-1A, MW-2, MW-3, MW-4, MW-5, MW-6, MW-6A, MW-7, MW-8, MW-9, MW-10, MW-11, and MW-12.

In most cases, a field team will consist of two technicians. The field team will check equipment before departing for the site. Water extracted from the wells that is not used for sample volume will be discarded on the land surface in the vicinity of the well.

Equipment Decontamination

Dedicated QED sampling pumps and water level meters (or equivalent) will remain in the wells. No equipment will require removal prior to measuring water levels and sampling. This equipment will be shipped to the site pre-cleaned. Therefore, decontamination of pump equipment at the site will not be necessary.

Though the wells are to be equipped with dedicated pumps, it may be necessary at times to use nondedicated equipment (for example, dedicated pumps out of service) to purge and sample wells. Such groundwater sampling equipment that will come into contact with the sample will be cleaned according to a specific procedure. Equipment will be washed with laboratory detergent and water, followed by a tap water rinse. Stiff brushes may be used to remove gross debris. Cleaning procedures may be augmented with the use of a high-pressure sprayer to remove debris, assist with the detergent wash, and perform the tap water rinse. The equipment will then be rinsed three times with deionized, organic free (*i.e.*, Type 1 reagent grade) water, and allowed to air dry. After rinses with deionized, organic free water, equipment will be rinsed with isopropanol, and allowed to air dry. The isopropanol application will be followed by a final deionized, organic-free water rinse. The equipment will again be allowed to air dry.

Any equipment that is not to be used immediately after decontamination will be wrapped in aluminum foil, then stored in a manner and location that minimizes the risk of contamination.

Teflon Bailer Cleaning Procedure

(This procedure is approved for use under both Solid Waste Section and Groundwater Section rules.)

1. Disassemble the bailers, and tap water rinse the parts. Place the end caps and ball in a phosphate-free soap solution to soak.
2. Wash the bailer tubes with phosphate-free soap. Use a brush to scrub the insides of each tube.
3. Rinse all bailer parts with deionized water and reassemble.
4. Rinse the inside and outside of each bailer with a 10 percent solution of hydrochloric acid in deionized water.
5. Rinse bailers with deionized water.
6. Rinse the inside and outside of each bailer with methanol.
7. Let bailers air dry for 24 hours on shelf.
8. Rinse again the inside and outside of each bailer with methanol.
9. Rinse bailers with deionized water and air dry for 24 hours on shelf.
10. Wrap completely in aluminum foil (shiny side out).
11. Place foil-wrapped bailer in plastic sleeve, and seal with tape.

Water Levels

A procedure for obtaining water levels that maximizes accuracy of measurement, reduces the risk of exposure to potentially contaminated groundwater, and reduces the potential for cross contamination will be used. The well cap will be removed and the well allowed to vent. Tightly sealed wells will not respond well to variation in the water table due to a "straw effect" caused by air trapped in the well casing. Venting the well will allow the water level in the well to equilibrate and become representative of the piezometric surface. Measurements will be made to the nearest hundredth of a foot.

The wells will be equipped with dedicated water level indicators. In the event that the dedicated water level indicator can not be used, a portable water level indicator will be used. The operation of the portable electric water level indicator will be checked before introducing it into the well. The probe will be lowered slowly into the well until the buzzer sounds or a light illuminates to indicate the probe is in the water. Depth to water will be measured from the point on the cable touching the surveyed measuring point at the top of the well casing.

To reduce the possibility of cross contamination, the portable water level indicator probe and any cable that entered the well must be decontaminated as indicated by site specific requirements before the next water level will be taken.

Pressure transducers and data loggers may also be used to record water levels over extended periods of time.

Purging Wells

Water that has remained in a well casing for a period of time may not be representative of the water contained in the surrounding formation that the well is intended to sample. In order to obtain samples that are representative of water in the formation, wells will be purged of the water in the casing and surrounding sand pack to allow water from the formation to enter the well casing for sampling. The wells will be purged slowly to reduce turbidity and the potential for suspended sediment in the sample.

Water will be purged slowly from a well until specific conductance, pH and temperature stabilize. A minimum of three well volumes will be purged from the well unless the well is bailed dry. In the latter case, no further purging is necessary. A "well volume" is the volume of water contained in the well at the time of sampling. A well volume will be purged using the dedicated sampling pump. As an alternative, the wells may be purged using a peristaltic pump with flexible tubing, or Groundfos® sampling pump (or equivalent), or using a clean bailer and cord. Unless otherwise specified, dedicated QED sampling pumps (or equivalent) will be used. The pump will be started at a low flow rate and the outflow will be directed into a bucket of known volume. The purpose of the low flow rate during well purging is to reduce turbidity resulting from disturbing sediment that may be present in the bottom of the well. Purge water will be measured based on the known volume of the bailer used or by pouring the contents into a container of known volume. Purge water will be discarded on the ground adjacent to the well.

As a second alternative to purging with the dedicated sampling pump, a bottom-filling Teflon bailer may be used to purge the well. The bailer and cord should only touch the inside of the well or a clean surface provided specifically for that bailer and cord. Bailers will be gently lowered to the top of the water column and then gently removed to reduce turbidity.

The color, odor, turbidity, and any other comments pertaining to the purge water will be documented in the field log. After each well volume of water has been removed from the well, specific conductance, pH, and temperature of the water will be determined and recorded in the field log. After specific conductance, pH and temperature have stabilized, sample collection may begin.

Sampling of Wells

Existing monitoring wells MW-1, MW-1A, and MW-8 and new monitoring wells MW-9, MW-10, MW-11 and MW-12 will be sampled quarterly for four consecutive quarters beginning after the new wells have been installed. Following the fourth quarter, these wells will be sampled semiannually. Monitoring wells MW-2 through MW-6 and MW-6A and MW-7 will continue to be sampled at the frequency established for the Landfill No. 2.

Wells will be sampled using dedicated QED sampling pumps (or equivalent). The samples will be discharged directly to the sample containers. The sample bottles will be labeled with sample identification, date, and project number. Preservative will be added to the bottle prior to collecting the sample. Samples will be collected in the following order unless otherwise specified: volatile and organics; metals; sulfate and chloride; turbidity; and nitrate. This sequence is based on the preferred collection order listed in RCRA Groundwater Monitoring Technical Enforcement Guidance Document, September, 1986.

In bottles where caustic preservative will be required (*i.e.*, samples for cyanide analysis), pH will be verified in the field by pouring some of the preserved sample over pH paper. If the proper pH has not been attained, more preservative will be added in the field. Samples requiring acid preservative will be checked with pH paper to determine if sufficient preservative has been added. More preservative will be added to the sample if necessary.

Well sampling sequence will be determined based upon available information about the site. The sequence will generally begin with background wells and wells upgradient of active and completed landfill phases, followed by wells downgradient of active or completed phases.

Sample Handling and Shipping

Immediately after sample collection, the sampler will check the label for completeness. Glass sample bottles will be wrapped in bubble wrap packaging to minimize the possibility of breakage. Samples will then be placed into a cooler containing ice. The chain of custody form will then be completed and stored with the samples inside the cooler in a plastic bag. Custody will be maintained by the sampler until the coolers are prepared for transport. The cooler will be filled with ice, sealed with tape, and shipped via overnight air freight or courier, or it will be delivered to the lab by field technicians.

References

Bouwer, H. and Rice, R. C., 1988, A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers With Completely or Partially Penetrating Wells, Water Resources Research, vol. 12, no. 3, pages 423-428.

National Water Well Association. "RCRA Groundwater Monitoring Technical Enforcement Guidance Document (TEGD): September, 1986."

U.S. Environmental Protection Agency, Office of Research and Development. "Groundwater Handbook," EPA/625/6-87/016, March, 1987.

U.S. Environmental Protection Agency, Region IV. "Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual (ECBSOPQAM): February 1, 1991."

Appendix P
Monitoring Well
Installation Specifications

Monitoring Well
Installation Specifications

Documentation

Field activity involving drilling and well installation will be observed and documented by a hydrogeologist under the supervision of a North Carolina licensed professional geologist. Field observations will be documented chronologically in a bound field book, dedicated to the project. Typical items included in the documentation are: personnel on site, drilling and sampling techniques, description of material encountered, well installation (*i.e.*, materials, as-built information, and development), and other information pertinent to the groundwater monitoring plan. Standard forms used to document drilling and well installation activity are included in the Typical Forms Section included at the end of this Appendix.

Drilling Methods and Procedures

The primary drilling method will be hollow stem auger. However, the use of the hollow stem auger method for proper monitoring well installation is occasionally inhibited by the sandy soils of the Coastal Plain. If the drilling and well installation cannot be properly completed using the hollow stem auger method, mud rotary drilling will be the alternate drilling method.

Drilling and well installation will be completed by a well driller certified by the State of North Carolina. The Certified Well Driller will be responsible for notifying the State of North Carolina of the well installation, upon completion, as required by North Carolina law. Lubricants or glue that might possibly contaminate samples, boreholes, or monitoring wells, will not be used in any manner. Boreholes in which no well is installed, will be grouted from the bottom of the borehole to within 2 feet of the land surface in accordance with the *North Carolina Well Construction Standards* (NCAC Title 15A, Subchapter 2C, Section .0100).

Hollow Stem Auger

When using the hollow stem auger method, drilling will be done with continuous flight hollow stem augers. Wells will be installed with augers with a minimum of 10-inch outer diameter and 6¼-inch inner diameter.

Mud Rotary

If mud rotary is used, the drilling fluid will consist of clean, potable water and bentonite powder. Borehole diameter, when using mud rotary methods for well installation, will be at least 6 inches. The settling pit (*i.e.*, "mud tub," "sump," etc.) will be covered during drilling operations to reduce the possibility of contaminating the drilling fluid.

Equipment, such as hoses or tools, will not be placed in the settling pit if it may introduce contaminants into the drilling fluid.

Soil Sampling

Subsurface soil samples will be collected using a split barrel sampler in general accordance with ASTM D-1586. Samples from borings in which wells are to be installed will be collected at 5-foot depth intervals. Augers or borehole will be cleanly open to those depths.

Soil samples may also be collected using a thin-walled tube sampler (*i.e.*, a "Shelby Tube") in general accordance with ASTM D-1587. Samples will be collected from predetermined depths. Augers or borehole will be cleanly open to those depths. In general, soil samples will be collected at 5-foot intervals beginning at the land surface. The sample and tube will be sealed in microcrystalline wax upon removal from the borehole.

Grouting

Grouting will be done with a Portland cement slurry containing approximately 5 percent powdered bentonite. The grout slurry will be mixed by pump recirculation or other acceptable methods. When thoroughly mixed, the slurry will be pumped into the borehole or annulus via a rigid tremie.

Monitoring Well Installation

After each borehole has been advanced to the desired depth, a groundwater monitoring well will be installed. Monitoring wells will be constructed in accordance with NCAC Title 15, Subchapter 2C, Section .0100. The actual well construction details will be determined by the hydrogeologist in the field at the time of drilling, based on field conditions. In general, wells will be installed as outlined in this Section and in Table 1. As-built well construction and development will be documented on forms shown in the Typical Forms Section.

Construction Materials

The monitoring wells will be constructed of 2-inch I.D. schedule 40 PVC casing and screen with threaded, flush joints. The screened section will be 10 feet in length. Well screens will be machine slotted with 0.010-inch openings. Filter sand will be Foster-Dixiana FX-50 or an equivalent. Downhole well seals will consist of bentonite pellets.

Installation Procedure

Wells will be installed through the hollow stem augers as they are withdrawn from the borehole or in a clean open borehole. Augers or borehole will be clean and open over their entire length prior to beginning well installation.

After drilling is complete, well screen and casing will be placed to the desired depth. Once the screen is correctly placed, the annular space around the screen will be packed with filter sand. The sand pack will extend approximately 2 feet above the top of the screen. The upper surface of the sand pack will then be sealed with bentonite pellets. The bentonite seal will be approximately 2 feet thick. The bentonite pellets will be allowed to hydrate for at least 30 minutes before introducing grout into the borehole. The annular space above the bentonite seal will be grouted to the land surface.

A steel protective cover with a lockable cap will be placed over each completed well and secured in the grout column. Locks will be provided for each well. A concrete pad (2 feet x 2 feet x 4 inches) will be framed and poured around each well. The concrete pad will extend 6 inches below the ground surface within 6 inches of the borehole. Weep holes will be drilled in each protective casing, just above the level of the concrete pad. A permanent identification plate will be affixed to each completed well. The information on the identification plate will include drilling contractor name and registration number, completion date, well construction information, and a warning that the well is not a water supply well. A typical monitoring well schematic is included as Figure 1.

Well Development

Monitoring wells will be developed by pumping with a positive displacement PVC pump, or other acceptable pump, until discharge is relatively clear and free of sediment. Well casing and screen and all development equipment will be decontaminated by steam cleaning before use. When installation and development are complete, each well will be located vertically and horizontally by a registered land surveyor. Well development will be documented in the field on forms shown in the Typical Forms Section.

Single well hydraulic conductivity tests will be conducted on each of the newly installed wells using a programmable data logger and a pressure transducer. Before beginning the test, the static water level and the total depth of the well will be measured. The pressure transducer will be placed in the well and the height of the water column above the transducer will be recorded. Following this, a PVC slug will be placed into the well. After the water level returns to static conditions, the PVC slug will be removed and the

change in water level will be automatically recorded. The test will be terminated when the observed water level in the well has returned to near static conditions. This procedure will be performed once in each well. The data collected will be used to estimate hydraulic conductivity according to the Bouwer and Rice method (Bouwer, H. and Rice, R. C., 1988).

Decontamination

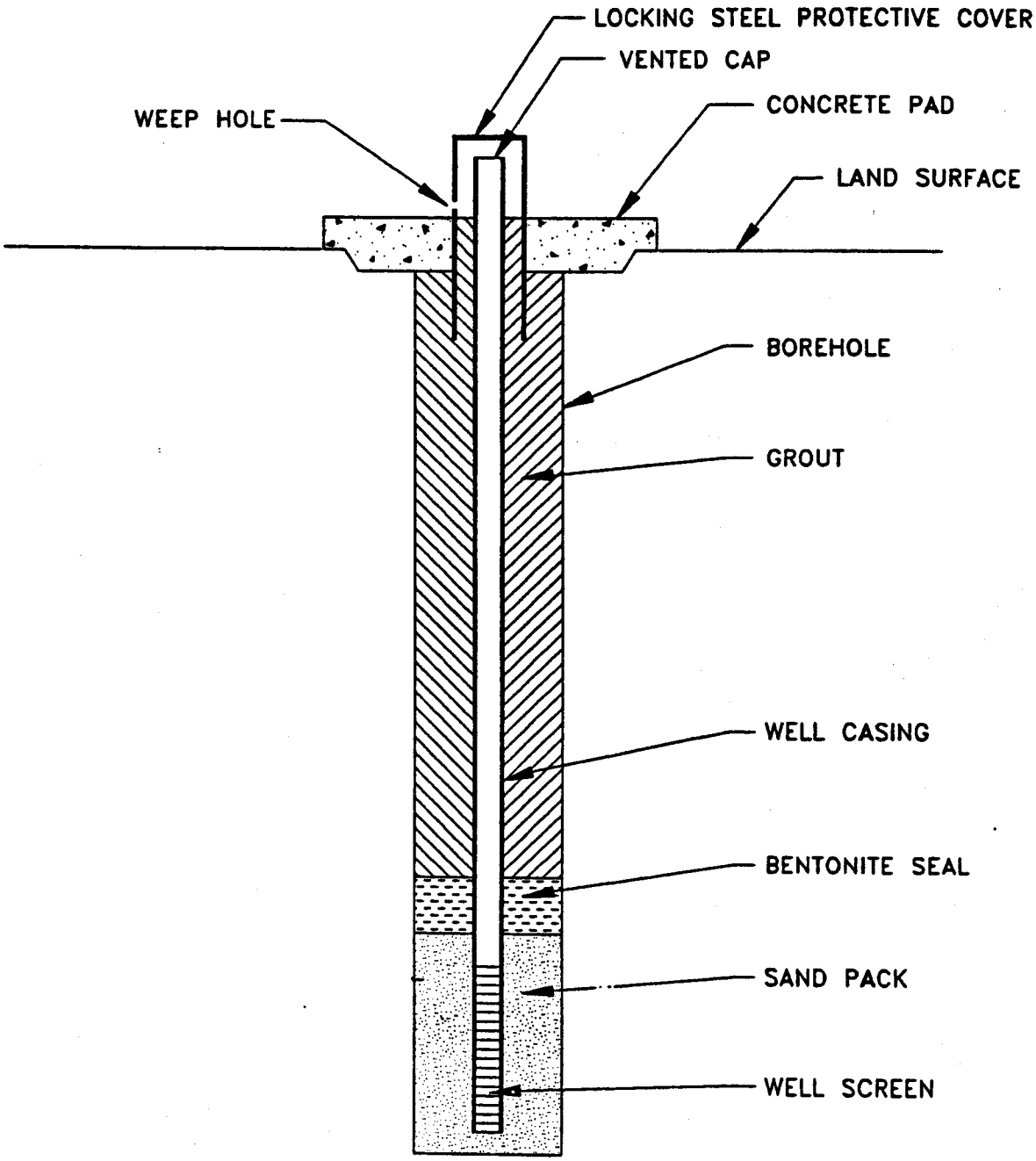
Decontamination of downhole tools and well materials will be accomplished by steam cleaning before drilling each borehole. Clean tools and equipment will be placed on and covered by clean plastic sheeting (or wrapped in aluminum foil) during transportation and storage. Downhole tools or equipment that contact possibly contaminated surfaces will be decontaminated before further use.

Table P-1
Drilling, Sampling, and Well Construction Information

BORING NUMBER	ESTIMATE DEPTH (feet)	SAMPLING INTERVAL (feet)	BOREHOLE DIAMETER (inches)	SCREEN SLOT SIZE (inches)	SCREEN LENGTH (feet)	WELL CONSTRUCTION MATERIALS
MW-9	25	5	10 (1)	0.01	10	2″ PVC
MW-10	15	5	10 (1)	0.01	10	2″ PVC
MW-11	25	5	10 (1)	0.01	10	2″ PVC
MW-12	25	5	10 (1)	0.01	10	2″ PVC
MW-13	15	5	10 (1)	0.01	10	2″ PVC
MW-14	20	5	10 (1)	0.01	10	2″ PVC
MW-15	15	5	10 (1)	0.01	10	2″ PVC
MW-16	15	5	10 (1)	0.01	10	2″PVC

(1) Borehole diameter will be 10 inches if drilled using hollow stem augers. The borehole diameter will be a minimum of 6 inches if drilled using mud rotary.

/WEL-DIA/MW000005



MONITORING WELL SCHEMATIC

Not To Scale

RMT INC.

LOG OF TEST BORING

F-203 (R 01-87)

BORING NO. _____

SHEET NO. _____ OF _____

PROJECT NAME _____ PROJECT NO. _____

LOCATION _____ INSTALLATION _____

CONTRACTOR _____ SURFACE ELEV. _____

DRILLING METHOD _____ BOREHOLE DIA. _____

SAMPLING NOTES						VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
INTERVAL		RECOVERY	MOISTURE			
NO.	TYPE	N			DEPTH	
					5	
					10	
					15	

GENERAL NOTES

DATE STARTED _____

DATE COMPLETED _____

RIG _____

CREW CHIEF _____

LOGGED _____ CHECKED _____

WATER LEVEL OBSERVATIONS

WHILE DRILLING ▽ _____

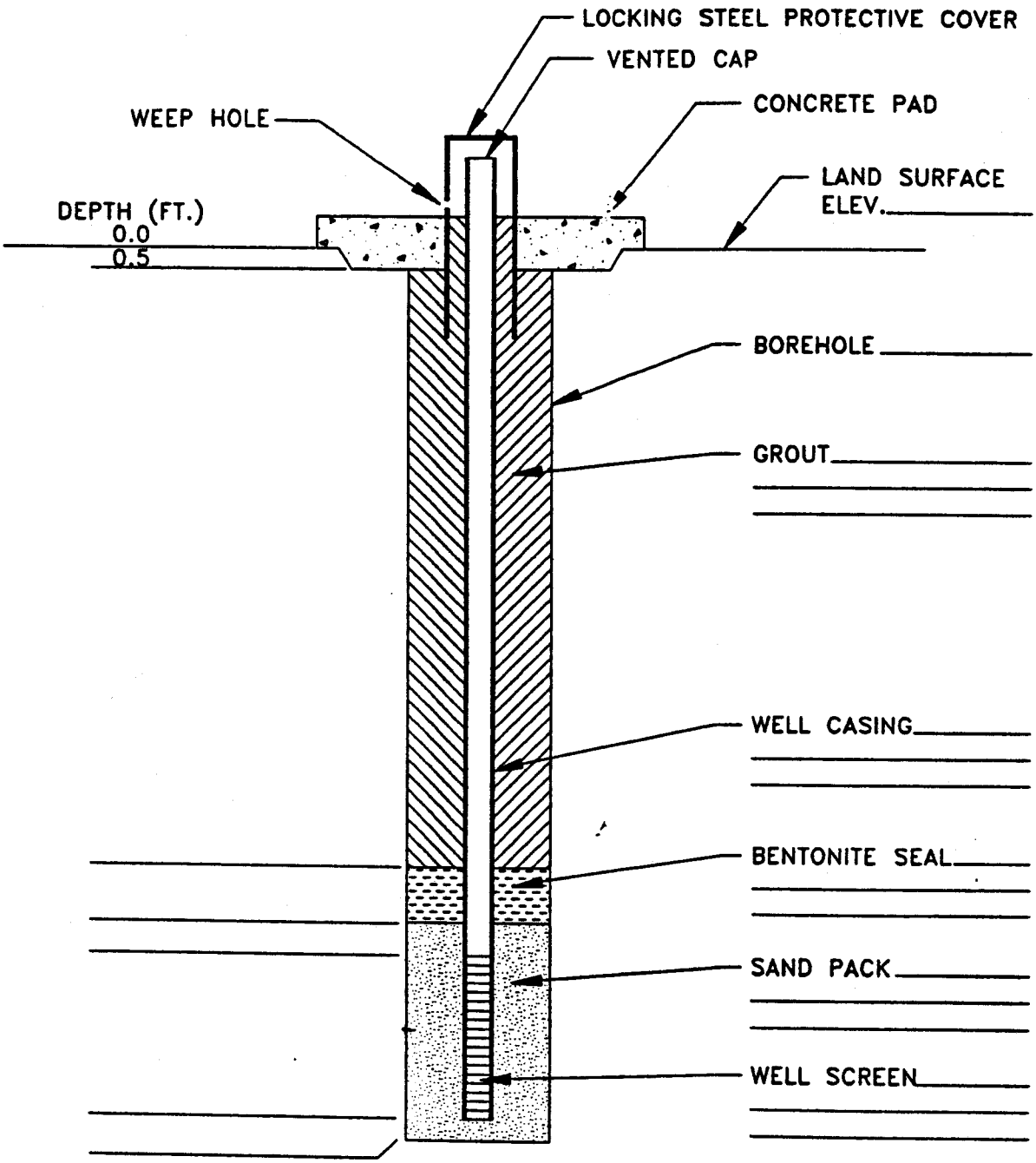
AT COMPLETION ▼ _____

AFTER DRILLING

CAVE-IN: DATE/TIME _____ DEPTH _____

WATER: DATE/TIME _____ DEPTH _____

/WEL-DIA/MW00000C



WELL CONSTRUCTION DIAGRAM

Not To Scale

PROJECT _____

PROJECT NO. _____

WELL NO. _____

DATE INSTALLED _____

DRILLING CONTRACTOR _____

RMT GEOLOGIST _____

RMT INC.

RMT INC.

100 Verdae Boulevard P.O. Box 16779 Greenville, SC 29606 Phone: 803-281-0030 FAX: 803-281-0288

SHEET _____ OF _____

RECORD OF WELL DEVELOPMENT

PROJECT AND NUMBER: _____

DATE: _____

DEVELOPMENT PERFORMED BY: _____

WELL NUMBER: _____

METHOD OF DEVELOPMENT: _____

ESTIMATED RATE OF FLOW: _____

DEVELOPMENT TIME

START: _____ FINISH: _____ TOTAL TIME: _____

TOTAL VOLUME OF WATER REMOVED: _____

COMMENTS: _____

_____

_____

_____

Appendix Q
Construction Quality Assurance Plan
Phase 1 Construction – Landfill No. 3

RMT

MAY 2000
Received
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Section 1
Introduction

1.1 Project Background

This report presents the CQA Plan for specific components of the composite liner and final cover for the Weyerhaeuser Plymouth Landfill. The liner and cover area cover approximately 95 acres and will be developed on Weyerhaeuser property located in Plymouth, North Carolina.

This plan addresses CQA requirements for modified liner and cover components of the landfill. Design-related aspects of the components mentioned above are addressed in the Construction Plan Application. This CQA Plan is a "working" document, which will be updated as necessary to reflect changes in specific materials used, in installation practices, or in tests and test methods.

1.2 Purpose and Scope

The purpose of this CQA Plan is to provide procedures that will confirm that the landfill liner and cover are constructed and documented consistent with the Construction Plan Application approved by NC DENR, and the Construction Drawings and Specifications.

The scope of this report includes general CQA requirements concerning roles, responsibilities, and qualifications of parties involved; the preconstruction meeting; and general inspection and documentation procedures. Specific CQA requirements for each liner component address construction procedures and observation, field and laboratory testing frequency and methods, and acceptance criteria. Geomembrane testing and acceptance criteria are based on the National Sanitation Foundation Standard Number 54 (NSF 54) *Flexible Membrane Liners*, and the Geosynthetics Research Institute (GRI).

The general CQA requirements (Sections 2, 3, and 4) pertain to all liner components. The following report sections pertain to the landfill components as shown:

REPORT SECTION		LANDFILL COMPONENT
Section 5	Compacted Select Clay Fill	Clay soil liner (sump areas)
Section 6	Granular Materials	Leachate drainage blanket Pipe bedding material
Section 7	Geotextiles and Geocushion	Leachate collection bedding cushion Component of Geocomposites

REPORT SECTION		LANDFILL COMPONENT
Section 8	Geomembranes	Geomembrane liner (landfill base and cap)
Section 9	Geonets	Component of Geocomposite
Section 10	Geosynthetic Clay Liner	GCL liner (landfill base)
Section 11	Geocomposites	Drainage layer (final cover)
Section 12	Select Ash Fill	Protection layer (landfill base) Levelling course (final cover)
Section 13	Piping	Leachate collection and transfer piping Gas Collection piping
Section 14	Compacted Prepared Subgrade Fill	Prepared subgrade for landfill base liner

Section 2
Roles, Responsibilities, and Qualifications

2.1 CQA Officer

The CQA Officer shall supervise and be responsible for all inspections, testing, and related construction documentation as described in this CQA Plan. The CQA Officer will be responsible for preparation of the construction documentation report to certify substantial compliance with the engineering design. The CQA Officer shall be a North Carolina Registered Professional Engineer.

The CQA Officer may delegate daily inspection, testing, and sampling duties to a qualified technician with experience in the assigned aspect of construction who will serve as the Resident Project Representative (RPR). Although these duties may be delegated, the CQA Officer will retain the responsibility for these activities.

When an RPR is designated, the CQA Officer shall visit the construction site biweekly (every 2 weeks) at a minimum during active periods of construction to personally observe the construction and documentation procedures. Also, at a minimum, the CQA Officer shall personally observe, on at least one occasion, each of the major elements of construction including the prepared subgrade, the GCL, the geomembrane liner, and the leachate drainage layer. The CQA Officer shall be readily available for consultation, as needed.

2.2 Resident Project Representative

The RPR will carry out daily inspection, testing, and sampling duties under the direct supervision of the CQA Officer. The RPR shall be a qualified technician with experience in the assigned aspect of construction. The RPR will observe and document construction and installation procedures. The RPR will prepare daily summary and inspection reports and transmit these routinely to the CQA Officer. The RPR will immediately notify the CQA Officer of problems or deviations from the CQA Plan or design plans and specifications. Reporting, documentation, and resolution of problems and deficiencies shall be carried out as described in Subsection 4.3. The RPR will ***not*** have authority to approve design or specification changes without the consent of the CQA Officer.

2.3 Soils Testing Laboratory

The Soils Testing Laboratory retained will be experienced in landfill construction soils testing in accordance with the American Society of Testing and Materials (ASTM) Standards and other applicable standards. The selected laboratory will be required to be responsive to the project needs by providing test results within reasonable time frames. This shall include providing verbal communication on the status of ongoing tests and immediate communication of test results as needed to facilitate ongoing construction. Such information may include hydraulic conductivity test data, proctor values, and borrow source characterization data. Final laboratory reports will be certified by the soils testing laboratory and submitted to the CQA Officer.

2.4 Geosynthetics Testing Laboratory

The Geosynthetics Testing Laboratory will have experience in testing geosynthetics in accordance with standards developed by ASTM, National Sanitation Foundation (NSF), Geosynthetic Research Institute (GRI), and other applicable test standards. The selected laboratory will be required to be responsive to the project needs by providing test results within reasonable time frames. Final laboratory reports will be certified by the geosynthetics testing laboratory and submitted to the CQA Officer.

2.5 Construction Contractor

The Construction Contractor's role will be performed by a construction firm retained by the Owner to furnish earthwork and piping construction. The Construction Contractor will be experienced in solid waste landfill construction, knowledgeable about clay liner construction techniques, and familiar with geosynthetic construction.

2.6 Geosynthetic Installers

The Geosynthetic Installers are the companies hired by the Contractor to install the geosynthetic components referenced in this manual and to perform the nondestructive seam testing of the geomembranes required by this plan. The term "Installer" is used throughout this plan when reference is made to the tasks and responsibilities of a Geosynthetic Installer.

The Installer will be trained and qualified to install the various geosynthetic components covered by this plan. The Installer of the geomembranes will be approved and/or licensed by the Manufacturer. A copy of the approval letter or license will be submitted by the Installer to the CQA Officer.

Prior to confirmation of any contractual agreements, the Contractor shall obtain from the Installer of the geomembrane the following written information, which must be approved by the CQA Officer:

1. Corporate background and information
2. Installation capabilities
   - Information on equipment and personnel
   - Daily anticipated production
   - Quality control (QC) manual for installation
   - Samples of field seams and certified test results
3. A list of at least 10 completed facilities, totalling a minimum of 2,000,000 ft^2 for which the Installer has completed the installation of a polyethylene geomembrane.

For each installation, the following information will be provided:

1. Name and purpose of facility, its location, and date of installation
2. Name of owner, project manager, designer, manufacturer, and fabricator (if any)
3. Name and qualifications of the supervisor(s) of the Installer's crew(s)
4. Thickness of the geomembrane and the surface area of the installed geomembrane
5. Type of seaming and type of seaming apparatus used

All personnel performing geomembrane seaming operations will be qualified by experience or by successfully passing seaming tests for the seaming methods to be used. At least one seamer will have experience seaming a minimum of 1,000,000 ft^2 of polyethylene geomembrane using the same type of seaming apparatus in use at the site. The most experienced seamer, the "master seamer," will provide direct supervision, as required, over less experienced seamers. No field seaming will take place without an experienced seamer (meeting the seaming criteria stated above) being present.

The Contractor shall require the Installer to provide a list of proposed seaming personnel and their professional records. This document will be reviewed by the CQA Officer. Any proposed seaming personnel deemed insufficiently experienced will not be accepted by the CQA Officer or will be asked to pass a seaming test. Any changes in the list of seaming personnel shall be brought to the attention of the CQA Officer.

The Installer will designate one representative as the Superintendent, who will represent the Installer at all site meetings and be responsible for acting as the Installer's spokesperson on site. This superintendent should be pre-qualified for this role, on the basis of experience, management ability, and authority. The appointment must be approved by the CQA Officer.

Section 3
Preconstruction

3.1 Preconstruction Meeting

Prior to construction commencing at the landfill facility, a preconstruction meeting shall be held. This meeting will include the parties involved in the construction, including the CQA Officer, RPR, Construction and/or Installation Contractor, and Owner.

The objectives of this meeting include construction planning and coordination of tasks; identification of potential problems that might cause difficulties and delays in construction; and proper interpretation of design intent by contractor(s). It is important that the rules regarding testing, repair, etc., be known and accepted by each party to this plan.

Specific topics considered for this meeting include the following:

- Review general safety requirements of the Owner and specific safety issues associated with the construction activities.
- Review critical design details of the project, including the plans and specifications.
- Review measures for surface water runoff and runon diversion control including sump locations, siltation control, and pumping requirements.
- Make appropriate modifications to the CQA Plan; develop project-specific addendums (if necessary).
- Review the responsibilities of each party.
- Review lines of authority and communication.
- Review methods for documenting and reporting and for distributing documents and reports.
- Review requirements of the Soils Testing Laboratory and the Geosynthetics Testing Laboratory regarding sample sizes, methods of collection, and shipment. Also review turnaround times for sample data and implications on construction schedule pending receipt of acceptance data.
- Review the number and locations of the testing requirements for soils and geosynthetic components.
- Review precautions to be taken to maximize bonding between lifts of compacted clay.
- Review the method for splicing segments of compacted clay soil liner.
- Review precautions to be taken to minimize desiccation of clay soil surfaces.

- Review methods of subgrade surface preparation and approval prior to geosynthetic placement.
- Establish rules for writing on the geomembrane (*i.e.*, who is authorized to write, what can be written, and in which color); outline procedures for packaging and storing archive samples.
- Review the time schedule for all operations and workforce logistical issues.
- Establish procedures for deployment of materials over completed geomembranes emphasizing protection of the membrane. Specific discussion shall address deployment of select granular fill on sidewalls.
- Observe where the site survey benchmarks are located, and review methods for maintaining vertical and horizontal control.
- Review permit documentation requirements.
- Review the survey documentation tables and plans that identify the locations where survey documentation information is required.
- Conduct a site walk-around to review material storage locations and general conditions relative to construction.
- Review geomembrane panel and seam layout drawings and numbering systems.
- Establish procedures for use of the geomembrane welding apparatus, if applicable.
- Establish appropriate intervals for seamers to record operating and ambient data.
- Finalize field cutout sample sizes.
- Review liner penetration procedures.
- Review repair procedures.

The meeting will be documented by the CQA Officer, and minutes will be distributed to all parties involved in the construction project.

Section 4
General Construction Inspection and Documentation

This section describes general documentation procedures to be implemented including use of forms, identification and resolution of problems or deficiencies, and photographic documentation.

4.1 Daily Reports

A daily summary report shall be prepared by the CQA Officer or the RPR under direct supervision of the CQA Officer, for each day of activity containing the following information:

1. Date, project name, location, and report preparer's name. Name of RPR on site performing CQA under the supervision of the CQA Officer.
2. Time work starts and ends each construction work day. Also, the duration and reason for work stoppages (*i.e.*, weather delay, equipment shortage, labor shortage, unanticipated conditions encountered, *etc.*).
3. Data on weather conditions including temperature, humidity, wind speed and direction, cloud cover, and precipitation.
4. Construction Contractor's work force, equipment in use, and materials delivered to or removed from job site.
5. Chronological description of work in progress including locations and type of work performed.
6. Summary of meetings held and attendees.
7. A description of materials used, and references or results of testing and documentation.
8. Discussion of problems/deficiencies identified and corrective actions taken as described in Subsection 4.3 (Problem/Deficiency Identification and Corrective Action).
9. Identification/list of laboratory samples collected, marked, and delivered to laboratories, or clear reference to the document containing such information if samples were obtained.
10. An accurate record of calibrations, recalibrations, or standardizations performed on field testing equipment, including actions taken as a result of recalibrations. In addition, the results of other data recording such as geomembrane seam barrel temperature, or a clear reference to the document containing such information, if applicable.
11. Copies of each RPR's daily field data sheets.

Field data sheets shall be prepared for each work day by each RPR containing the following information:

1. Test or sample location and elevation.
2. Type of inspection.
3. The procedures used.
4. Test data (*i.e.*, proctor value, *etc.*).
5. Results.
6. Personnel involved in the inspection and sampling activities.
7. Signature of the RPR.

4.2 Forms, Checklists, and Data Sheets

Additional forms may be developed during the course of the project to provide specific needs such as geomembrane inspections or simply to improve efficiency of data collection. New forms shall be approved by the CQA Officer prior to their use.

4.3 Problem/Deficiency Identification and Corrective Action

Problem or deficiency identification and corrective action will be documented in the Daily Summary Report when a construction material or activity is observed or tested that does not meet the requirements set forth in this plan and in the construction specifications. The Summary Report should clearly reference other reports, photographs, or forms that contain data or observations leading to the determination of a problem or deficiency. Problem/deficiency identification and corrective action documentation may include the following information:

1. A description of the problem or deficiency, including reference to supplemental data or observations responsible for determining the problem or deficiency.
2. Location of the problem or deficiency, including how and when the problem or deficiency was discovered. In addition, an estimate of how long the problem or deficiency has existed.
3. An opinion as to the probable cause of the problem or deficiency.
4. A recommended corrective action for resolving the problem or deficiency. If the corrective action has already been implemented, then the observations and documentation to show that the problem or deficiency has been resolved. If the problem or deficiency has not been resolved by the end of the day upon which it was discovered, then the report will clearly state that it is an unresolved problem or deficiency. Subsequent Daily Reports shall indicate the status of problems or deficiencies until resolved.

If the problem or deficiency has not been resolved, the CQA Officer and the preparer will discuss the necessary corrective actions. The CQA Officer will work with the Owner and Construction Contractor to implement actions as necessary to resolve the problem or deficiency. A description of such problems or deficiencies and corrective actions implemented shall be provided in the Construction Documentation Report.

The CQA Officer, working with the Owner and Construction Contractor, will determine if the problem or deficiency is an indication of a situation that might require changes to the plans and specifications and/or the CQA Plan. Revisions to the plans or specifications or the CQA Plan must be approved by the CQA Officer and the site Owner after consultation with NC DENR. Documentation of the Department's concurrence and/or conditions regarding proposed changes shall be incorporated into the Construction Documentation Report.

4.4 Photographic Documentation

Photographs will be taken to document observations, problems, deficiencies, corrective actions, and work in progress. Photographs will be in 35-mm print format and will be filed in chronological order in a permanent protective file by the CQA Officer, or the RPR.

The following information should be documented in the daily report or a log book for each photograph:

1. Date and time.
2. Location where photograph was taken, including information regarding the orientation of the photograph itself for proper viewing (*i.e.*, looking south).
3. Description of the subject matter.
4. Unique identifying number for reference in other reports.
5. Name and signature of photographer.

4.5 Surveying

Surveying documentation requirements for each liner component are described in their respective plan sections. Required surveying will be performed by a North Carolina registered surveyor experienced in construction surveying. Surveying will be conducted under the supervision of the CQA Officer. Surveys will be based on survey control monuments shown on the drawings prepared as part of the Construction Plan Application. Elevations will be based on MSL datum, and coordinates will be based on the North Carolina State Plane Coordinate System. The location of field tests and samples will be recorded. Generally, these locations can be determined by reference to nearby construction stakes or markings; however, if such

convenient reference is not readily available, the CQA Officer or the designated RPR is responsible to provide or request survey control.

Section 5
Compacted Select Clay Fill

Select clay fill refers to the compacted clay in the leachate sump area beneath the composite liner. The select clay fill shall be either bentonite-amended soil or a natural clay that can be compacted to a permeability of 1.0×10^{-7} cm/s or less. On-site clay soils are proposed. A clay borrow investigation report will be made available to the Contractor. If clay soil from the on-site borrow source is not used, a bentonite-amended soil is proposed.

5.1 Procedures and Observation

The Installer will be responsible for means and methods to implement the work. The RPR will observe the compacted clay liner and clay cover construction activities and document relevant observations to support certification of the following requirements:

1. The RPR will confirm the uniformity of the bentonite-amended soil/clay borrow soils. Soil excavation, proportioning, mixing, and placement will be monitored for segregation and removal of unsuitable material and for changes in soil type, color, texture, and moisture content.
2. The construction contractor will segregate and/or remove unsuitable materials such as soils not meeting acceptance criteria (boulders, cobbles, and organic material).
3. The RPR will measure field densities and moisture contents, using methods described in Subsection 5.2 (Sampling Requirements and Acceptance Criteria), to document that the compacted liner is in substantial conformance with the placement specifications and that soil placement has been conducted in a manner to achieve a uniform, homogeneous clay mass.
4. Voids created by nuclear density gauge testing or retrieval of Shelby tube samples will be backfilled with sodium bentonite.
5. The bentonite-amended soil/clay shall be placed in loose lift thicknesses not exceeding 8 inches. Each loose lift shall be compacted with multiple passes using appropriate compaction equipment. If the soil is deposited in thickness exceeding 8 inches, dozers will be used to spread the soil to an 8-inch thickness prior to compaction. This will ensure adequate reduction of clod size and provide a thin layer to achieve required compaction throughout the lift.
6. Areas of unacceptable hydraulic conductivity, compaction density, or moisture content, as defined by Subsection 5.2 (Sampling Requirements and Acceptance Criteria), will be documented by the RPR. Corrective action will consist of moisture-conditioning of the soil or additional compactive effort as necessary. Methods for moisture-conditioning soils are described in Item 7 below. Following corrective actions, such areas will be retested.

7. If necessary, surfaces of liner to receive successive lifts of bentonite-amended soil/clay will be moisture-conditioned either by scarification and addition of water where desiccated, or by disking and air drying where saturated to promote effective bonding of lifts. Following scarification, water will be applied with a spray bar applicator or equivalent methods to achieve uniform distribution.

8. Bentonite-amended soil/clay compaction will be performed in a manner to achieve continuous and complete keying together of soil liner construction areas. Stepped joints will be utilized to connect lateral segments of the soil liner construction.

9. No frozen soils will be used for clay liner construction. Frozen soils in the compaction work area will be removed.

10. Stones that are larger than 0.5 inch in diameter shall be removed from the surface of the final lift of the clay liner to avoid potential for puncturing the geosynthetic clay liner. The method to detect and remove stones requires an initial overfill of compacted clay liner soils approximately 1 inch above designed liner grades. A grader will then blade the liner surface to obtain uniform liner grades and design elevations. Stones present will be exposed and loosened by the grading. The RPR shall inspect the liner during this process and document removal of stones by the Contractor. Voids made by removal of stones shall be filled with clay soil, and then the entire liner surface shall be rolled with a smooth drum compactor.

11. Preconstruction planning will be undertaken to sequence construction activities to minimize the length of time any completed clay liner surfaces are exposed prior to receiving protective cover. Protective cover will be provided by installation of the geosynthetic clay liner and the geomembrane.

12. Preconstruction planning will be undertaken to minimize the need for traffic over the completed bentonite-amended soil/clay surface. Heavy trucking of materials (ingress or egress) and cleated equipment will not be allowed directly on completed clay surfaces. If this is unavoidable, an evaluation will be made upon termination of the haul route to determine if the liner should be reconstructed or repaired in such areas. Flotation-type all-terrain vehicles will be used to assist in deployment of the geosynthetic clay liner to avoid disruption of the completed earth liner surface.

5.2 Sampling Requirements and Acceptance Criteria

Field and laboratory sampling frequencies are based on proportionate sampling of construction areas or volume of material placed as specified below. This section describes required analysis, methods, sample frequency, and acceptance limits. Table 5-1 summarizes the minimum quality assurance (QA) testing recommended in Subsection 5.3. The RPR will perform field tests and collect soil samples for laboratory analysis.

5.3 Field Testing and Sampling

The following field testing and sampling methods and frequencies will be used by the RPR during construction of the bentonite-amended soil/clay liner and final cover.

- One field density and as-placed moisture content test (ASTM D 3017 and ASTM D 2922 Method B) will be performed for each compacted lift on an approximate 100-foot grid pattern.
- Representative (grab) soil samples of the liner and cover soils will be collected from the initial clay borrow source or from the on-site amended source and submitted to the Soils Testing Laboratory for testing described in Subsection 5.3.4. Additional samples will be collected every 4,000 cubic yards for each major soil type utilized. A sample will also be collected when changes in the physical appearance or soil characteristics are observed.
- A minimum of one undisturbed Shelby tube sample will be obtained for each acre (43,560 ft^2) or less for every lift of bentonite-amended soil/clay placed. A minimum of one test per lift will be performed in each of the leachate sump areas. Samples will be submitted to the Soils Testing Laboratory for testing described in Subsection 5.3.3.
- At a minimum, at least one field density/moisture content test will be conducted per lift and at least one test per day of compacted bentonite-amended soil/clay construction. In confined areas where compaction equipment is hindered or hand compaction is necessary, a minimum of two field density/moisture content tests will be performed for each lift of soil liner placed.

A nuclear density-moisture gauge (NDG) may be used for field moisture and density determination. The calibration of NDGs used for documentation shall be initially checked and adjusted (if necessary) according to the manufacturer's guidelines. Initial calibration shall be made with a one of the alternate test methods identified in the construction specifications for field density and moisture content.

5.3.1 Field Testing Acceptance Criteria

Acceptance criteria for field density will require soil compaction to a minimum of 95 percent of the Standard Proctor (ASTM D 698) maximum dry density. Specific moisture content requirements will be identified in the construction specifications. The acceptable range will be based on Proctor moisture-density relationships and compaction versus permeability relationships.

5.3.2 Laboratory Testing

Routine laboratory testing of the compacted liner soils will be performed on samples from the clay borrow area or samples from the disking operation and on the in-place soils collected by the RPR. Samples for determining in-place properties will be collected by pushing Shelby tubes. Soil characteristics will be determined from representative samples and from Shelby tube samples.

5.3.3 Undisturbed Sample Analysis

The following analysis will be performed on *all* undisturbed samples obtained:

PARAMETER	TEST METHOD
Hydraulic Conductivity	ASTM D 5084 or SW 846-USEPA Method 9100
Moisture Content and Dry Density	ASTM D 2216
Atterberg Limits	ASTM D 4318
Grain-size Analysis (P200)	ASTM D 422 (1)

(1) Percentage of soil finer than the No. 200 sieve (*i.e.*, soil finer than 0.075 mm).

5.3.4 Representative Sample Analysis

The following laboratory analyses will be performed on *all* representative samples obtained, except where noted:

PARAMETER	TEST METHOD
Moisture-Density Relationship using Standard Proctor Compaction	ASTM D 698 (1, 2)
Atterberg Limits	ASTM D 4318
Grain-size Analysis (sieve and hydrometer)	ASTM D 422 (3)
Moisture Content	ASTM D 2216
Hydraulic Conductivity (4)	ASTM D 5084 or SW 846-USEPA Method 9100

(1) A five-point Proctor analysis is required for first and second sampling criteria.

(2) A one-point Proctor analysis may be utilized for representative samples collected for the third sampling criteria (apparent changes in soil quality) to verify applicability of previously analyzed moisture-density relationships. If the result does not verify applicability, a five-point analysis will be performed in accordance with the first sampling criteria.

(3) Distribution shall be reported through the 0.002-mm particle size.

(4) For every 8,000 cubic yards of soil extracted from the borrow source, perform one set of hydraulic conductivity tests. A set typically consists of four hydraulic conductivity tests run on a sample of soil remolded to four different moistures and dry densities.

5.3.5 Laboratory Testing Acceptance Criteria

1. A saturated hydraulic conductivity of 1×10^{-7} cm/s or less

5.3.6 Typical Index Properties Recommended for Achieving Hydraulic Conductivities of 1×10^{-7} cm/s or Less

1. A liquid limit of 30 percent or greater
2. A plasticity index of 15 percent or greater
3. A percentage of fines (*i.e.,* material finer than the No. 200 sieve or 0.075 mm) 60 percent or greater.
4. A percentage of clay (*i.e.,* material finer than 0.002 mm) 20 percent or greater.

5.4 Thickness Documentation

The top of clay liner grades will be surveyed at a minimum on the same 50-foot grid pattern, as other locations surveyed for subbase grades. Clay thickness at slope breaks will be surveyed. The clay liner thickness will be determined at surveyed locations and reported in table fashion. The minimum acceptable bentonite-amended soil/select clay liner thickness will be 2-foot vertical to the bottom or to the slope. The location and elevation of samples requiring surveying will be recorded.

Table 5-1
Summary of Quality Assurance Testing for the Select Clay/Bentonite-Amended Soil Liner

TEST	FREQUENCY	COMMENT
Atterberg Limits Test [ASTM D 4318]	One every 4,000 cubic yards and material changes	Source Material: Clay/ Bentonite-amended soil
Grain-size analyses (sieve and hydrometer) [ASTM D 422]	One every 4,000 cubic yards and material changes	Source Material: Clay/ Bentonite-amended soil
Moisture Content [ASTM D 2216]	One every 4,000 cubic yards and material changes	Source Material: Clay/ Bentonite-amended soil
Density/Moisture (Standard Proctor) [ASTM D 698]	One every 4,000 cubic yards and material changes	Source Material: Clay/ Bentonite-amended soil
Permability Testing (Falling Head) [ASTM D 5084 or SW846-USEPA Method 9100]	Four tests on one sample obtained every 8,000 cubic yards and material changes	Source Material: Clay/ Bentonite-amended soil (on remolded source material)
Proofroll	All surfaces prior to liner placement	Subgrades for liner construction
Density/Moisture Content [ASTM D 2922 and ASTM D 3017] or [ASTM D 1556] or [ASTM D 2937]	One per 10,000 square feet per lift (approximate 100-foot grid pattern)	Liner: Clay/Bentonite-amended soil
Permability Testing (Falling Head) [ASTM D 5084 or SW 846-USEPA Method 9110]	One per acre (43,560 square feet) per lift	Source Material: Clay/ Bentonite-amended soil (on tube samples obtained from the *in-situ* liner)
Atterberg Limits Test [ASTM D 4318]	One per acre (43,560 square feet) per lift	Source Material: Clay/ Bentonite-amended soil (on tube samples obtained from the *in-situ* liner)
Grain-size analyses (P200) [ASTM D 422]	One per acre (43,560 square feet) per lift	Source Material: Clay/ Bentonite-amended soil (on tube samples obtained from the *in-situ* liner)
Density/Moisture [ASTM D 2216]	One per acre (43,560 square feet) per lift	Source Material: Clay/ Bentonite-amended soil (on tube samples obtained from the *in-situ* liner and subgrade)

Section 6
Granular Materials

Granular materials include "granular fill," "aggregate fill," and other granular materials shown or specified for pipe bedding and backfill material. The aggregate fill drainage layer overlies the geomembrane liner between the leachate drainage blanket and the protection layer of select waste (ash). The granular fill covers the aggregate fill drainage layer and acts as a filtration layer. Granular materials refers to pipe-bedded material to be used for structural support of leachate collection pipes. Limestone and dolomite stone shall not be used in the leachate collection system unless no other suitable material is reasonably available. The aggregate fill should be rounded to subangular.

Refer to details on the drawings prepared as part of the Construction Plan Application for specific details regarding the leachate drainage blanket and leachate collection pipe trench.

6.1 Procedures and Observation

The RPR will observe granular material placement activities and document relevant observations to support certification of the following requirements:

1. The RPR shall periodically observe aggregate fill material used for pipe bedding material, and granular fill for general conformance to material specifications and may randomly sample loads. The RPR will perform routine conformance sampling as defined in Subsection 6.2.
2. No trucks or heavy equipment shall travel directly on the geomembrane. Only low-contact-pressure equipment may operate over the geomembrane when there is a minimum 12-inch-thick layer of granular fill in-place. Procedures for deployment of pipe, aggregate fill, and/or geotextiles overlying geomembranes will be planned at the Pre-Construction Meeting. Special requirements for geomembrane protection and equipment necessary to deploy materials must be approved by the CQA Officer.
3. Care shall be exercised during placement of pipe bedding material to prevent undue damage to pipes, geomembrane, and geotextiles. Stone shall not be dropped from a height greater than 3 feet above the bottom of the pipe trench.
4. A geotextile cushion (Geocushion) shall be placed between the geomembrane and the leachate collection/pipe bedding material.
5. A minimum of 3 inches of bedding material shall be placed under leachate collection pipes prior to pipe placement, and a minimum of 6 inches of bedding material shall be placed over the top of leachate collection pipes.

6. A minimum 18-inch-thick granular fill shall be placed between the top of the composite liner and the layer of select waste (ash).
7. If granular fill is stockpiled on site prior to use, measures should be taken to minimize contamination by fines such as wind-blown particles and surface soils during loading operations.

6.2 Sampling Requirements and Acceptance Criteria

Field sampling and laboratory testing frequencies are based on proportionate sampling of construction areas or volume of material placed as specified below. This section describes the required analysis, methods, sampling frequency, and acceptance limits. The RPR will collect granular material samples for laboratory analysis.

6.2.1 Field Testing

No field testing will be required for pipe bedding material or granular fill. However, as stated in Subsection 6.1 above, the RPR will perform visual inspection of these materials for conformance to material specifications and may randomly sample deliveries.

6.2.2 Laboratory Testing

Representative (grab) samples will be obtained from the proposed bedding material, and graded granular fill sources prior to delivery of the material. The source sampling frequency will be dependent on the apparent uniformity of the source and must be approved by the CQA Officer.

Grab samples of pipe bedding material, and graded fill soils placed will be collected and analyzed as follows:

SOIL TYPE	FREQUENCY	PARAMETER	TEST METHOD
Granular Fill	1/1,000 CY (1, 2)	Grain-size	ASTM D 422 (3)
Granular Fill	1/2,500 CY (2, 4)	Remolded hydraulic conductivity	ASTM D 2434
Pipe Bedding Material	1/1,000 L.F. of Trench (5)	Grain-size	ASTM D 422 (3)
Pipe Bedding Material	1/2,000 L.F. of Trench	Remolded hydraulic conductivity	ASTM D 2434

(1) For lesser volumes, a minimum of four samples shall be tested.
(2) This frequency may be reduced for uniform sources. Proposed reductions will be submitted for NC DENR approval prior to implementation.
(3) Testing shall be required only to the #200 sieve.
(4) For lesser volumes, a minimum of two samples shall be tested.
(5) For documentation areas with less than 3,000 feet of pipe trench, a minimum of three samples shall be tested.

Laboratory Testing Acceptance Criteria

Pipe bedding material shall have a uniformity coefficient less than 4, contain no more than 5 percent by weight passing the #4 sieve, have a maximum particle diameter of ¾ inch, have a remolded hydraulic conductivity of 1 cm/s or greater, and have a rounded to subangular particle shape. Granular fill materials shall meet the grain-size distribution criteria specified in the construction plans and specifications.

6.3 Thickness Documentation

Granular fill in the leachate collection layer, and placed along collection pipe alignments will be surveyed for elevation. Granular materials in the leachate drainage blanket will be surveyed on a 50-foot grid. Pipe bedding material will also be surveyed prior to pipe placement and following pipe backfilling at 50-foot intervals to document the thickness of aggregate fill placed below pipe inverts and above the top of pipe. The minimum acceptable stone thickness will be 3 inches below and 6 inches above the leachate collection piping.

Section 7
Geotextiles and Geocushion™

This section of the CQA Plan applies to non-woven geotextiles used for soil separation/ filtration in roadways and riprap channels, and for protection of the geomembrane. The geotextiles used in the geocomposites will meet the applicable requirements of this section. Geocomposites are discussed in Section 11. A Geocushion™ will be placed over the geomembrane. The Geocushion™ will meet the applicable requirements of this section.

This section is divided into three major subheadings, which cover the QA requirements for Pre-Installation (includes geotextile manufacturers), Installation, and Post-Installation (includes the final examination of the geotextiles prior to placing the appropriate material above the geotextile). The terms Pre-Installation, Installation, and Post-Installation are applicable only to the geotextile installation and do not apply to the overall construction of the landfill facility.

7.1 Pre-Installation

7.1.1 Manufacturing

Material Specifications

The geotextile or Geocushion™ will be supplied to the site in factory rolls.

Quality Control Requirements

Prior to the delivery of any geotextile or Geocushion™ rolls to the site, the geotextile or Geocushion™ manufacturer will provide to the CQA Officer the manufacturer's QC Plan used for production of the geotextile rolls.

Every roll of geotextile for delivery to the site must be manufactured and inspected by the geotextile or Geocushion™ manufacturer, according to the following requirements:

1. The geotextile or Geocushion™ must contain no needles used for punching.
2. The geotextile or Geocushion™ must be free of holes and any other sign of contamination by foreign matter.

Manufacturer's Certification

The geotextile manufacturer will provide certification, based on tests performed in accordance with the methods listed in Table 7-1, that the geotextile supplied under this plan will meet the material specifications listed in Table 7-3. The Geocushion™ manufacturer will provide certification based on tests performed in accordance with the methods and frequency listed in Table 7-2 that the Geocushion™ supplied under this plan will meet the material specifications listed in Table 7-4. These tests may be performed by the geotextile or Geocushion™ manufacturer's laboratory or a laboratory contracted by the manufacturer. Additionally, the manufacturer shall provide certification that the manufacturer's QC Plan was fully implemented for the geotextile or Geocushion™ materials supplied under this Plan. The manufacturer shall provide documentation to verify the results of the manufacturer's QC Plan implementation if required by the CQA Officer.

7.1.2 Delivery, Handling, and Storage of Geotextile and Geocushion™ Rolls

(Note: ASTM Standard D4873 titled *Standard Guide for Identification, Storage and Handling of geotextiles* was used in preparing these guidelines.)

Each geotextile or Geocushion™ roll, for use at the landfill facility, will be marked by the geotextile or Geocushion™ manufacturer with the following information and in the following manner:

1. When fabric is rolled on a core, identify each roll with a durable gummed label, or an equivalent, on the inside of the core and on the outside of the protective wrapping for the roll.
2. Each roll label will contain the following information at a minimum:
   - Name of manufacturer (or supplier)
   - Style and type number
   - Unit weight (ounces per square yard)
   - Roll length and width
   - Batch (or lot) number
   - Nominal product thickness
   - Date of manufacture
   - Direction for unrolling
   - Roll number

3. On the outside of the wrapping, all lettering should be a minimum ½ inch high, and on the inside of the core, the lettering should be at least ¼ inch high.

The geotextile or Geocushion™ manufacturer will use the following guidelines in packaging, wrapping, and preparing all geotextile rolls for shipment:

1. When cores are required, use those that have a crushing strength sufficient to avoid collapse or other damage while in use.
2. Cover each roll with a wrapping material that will protect the geotextile from damage due to shipment, water, sunlight, or contaminants.

The following practices should be used as a minimum in receiving and storing geotextile rolls in the designated storage area at the job site:

1. While unloading or transferring the geotextile rolls from one location to another, prevent damage to the wrapping or to the geotextile itself. If practicable, the Installer may use forklift trucks fitted with poles that can be inserted into the cores of rolls. Be sure that the poles are at least 2/3 the length of the rolls to avoid breaking the cores and possibly damaging the geotextile. Do not drag rolls.
2. Store the geotextile rolls to ensure that they are adequately protected from the following:
   - Precipitation
   - Ultraviolet radiation, including sunlight
   - Strong oxidizing chemicals, acids, or bases
   - Flames, including welding sparks
   - Temperatures in excess of 160°F
   - Soiling

The RPR will observe and document, throughout the pre-installation, installation, and post-installation periods, that the Installer provides adequate handling equipment used for moving geotextile or Geocushion™ rolls and the equipment and that the handling methods used do not pose unnecessary risk of damage. The Installer is responsible for means and methods to implement the work.

The Installer will be responsible for ensuring that all materials installed meet specifications (*i.e.*, the roll marking label information indicates required specifications and properly represents materials). The RPR will maintain a log of geotextile or Geocushion™ roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:

1. Date of shipment from geotextile or Geocushion™ manufacturer

2. Date of receipt of delivery at job site
3. For each geotextile roll, the following information will be noted:
   - Roll number
   - Batch (lot) number

7.2 Installation

This section describes the QA requirements applicable to the installation of geotextiles. This section describes installation, observation, and documentation of geotextiles or Geocushion™.

7.2.1 Placement

The Installer will install all geotextiles or Geocushion™ in such a manner to ensure that they are not damaged and in a manner that complies with the following:

1. On sideslopes, the geotextiles will be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile or Geocushion™ in tension.
2. In the presence of winds, all geotextiles or Geocushion™ will be secured by other suitable methods. The temporary weighted material will be left in place until replaced with cover material as shown on the design plans and specifications.
3. In-place geotextiles or Geocushion™ will be cut with special care to protect other materials from damage that could be caused by the cutting of the geotextiles.
4. The Installer will take necessary precautions to prevent damage to any underlying layers during placement of the geotextile or Geocushion™ .
5. During placement of geotextiles, care will be taken not to entrap in the geotextile or Geocushion™ any stones, excessive dust, or moisture that could damage the geotextile or Geocushion™, or generate clogging of drains or filters.
6. A visual examination of the geotextile or Geocushion™ will be carried out over the entire surface after installation by the Installer to ensure that no potentially harmful foreign objects, such as needles, are present.

7.2.2 Seams and Overlaps

The Geocushion™ manufacturer's requirements for seaming and overlapping of Geocushion™ rolls will be met. The following requirements will be met with regard to seaming and overlapping of geotextile rolls:

1. A minimum 12-inch fabric overlap will be required to form geotextile seams.
2. No horizontal seams will be allowed on slopes steeper than 10-horizontal to 1-vertical (*i.e.*, seams will be along, not across, the slope), except as part of a

geotextile repair. Horizontal repair seams on such slopes will be sewn or thermally bonded.

3. The Installer will pay particular attention to seams to ensure that no earthen materials could be inadvertently trapped beneath the geotextile.
4. Sewing (if required per item 2 above) will be performed with thread made from the same base material as the geotextile, or suitable equivalent.

The RPR will be responsible for observing and documenting that the above provisions are performed by the Installer in an acceptable manner.

7.3 Post-Installation

7.3.1 Final Examination

The RPR will perform a final geotextile or Geocushion™ examination after installation of each geotextile or Geocushion™ layer has been completed. The objectives of the final examination are as follows:

1. Examine for presence of holes, tears, or other deterioration.
2. Examine geotextile or Geocushion™ for excessive tension due to stretching of the fabric during installation.

If there will be an extended time delay between completion of the geotextile or Geocushion™ and the start of the installation of any overlying cover, then the Installer will make provisions, by temporarily covering or using other suitable methods, to protect the geotextile against exposure to sunlight and ultraviolet radiation.

7.3.2 Placement of Soil Materials

The construction contractor will place all soil materials located on top of a geotextile or Geocushion™ in such a manner as to minimize the following:

1. Damage of the geotextile or Geocushion™
2. Slippage of the geotextile or Geocushion™ on underlying layers
3. Excessive tensile stresses imposed on the geotextile or Geocushion™

Table 7-1
Geotextile Tests and Test Methods

PROPERTY	TEST METHODS	MINIMUM FREQUENCY OF TESTING
Apparent Opening Size	ASTM D 4751	1 per 100,000 square feet
Grab Tensile Properties Tensile Strength Break Elongation	ASTM D 4632	1 per 100,000 square feet
Mass Per Unit Area	ASTM D 3776	1 per 100,000 square feet
Permitivity	ASTM D 4491	1 per 100,000 square feet
Puncture Resistance	ASTM D 4833	1 per 100,000 square feet
Trapezoidal Tear	ASTM D 4533	1 per 100,000 square feet
Mullen Burst	ASTM D 2210	1 per 100,000 square feet

Table 7-2
Geocushion™ Tests And Test Methods

PROPERTY	TEST METHODS	MINIMUM FREQUENCY OF TESTING
Mass Per Unit Area	ASTM D 3776	1 per 100,000 square feet
Thickness	ASTM D 1777	1 per 100,000 square feet
Tapered Pin Puncture	FTM 101C-M2065	1 per 100,000 square feet
Truncated Cone Puncture	GRI-GM3 2 inch (50 mm) cone height	1 per 100,000 square feet

Table 7-3
Geotextile Acceptance Specifications

TEST	TYPE A FINAL COVER SYSTEM AND UNDER RIPRAP	TYPE B USED UNDER ROADWAYS	CRITERION
Apparent Opening Size (US Sieve Number)	70	70-100	Maximum
Grab Tensile Properties (1) Tensile Strength (lbs)	200	200	Minimum
Grab Tensile Properties (1) Break Elongation (%)	50	50	Minimum
Permitivity (1/sec)	1.2	1.2	Minimum
Puncture Resistance (lbs)	80	80	Minimum
Mullen Burst (psi)	400	360	Minimum
Trapezoidal Tear (lb)	65	65	Minimum

(1) These tests will be performed and results will be reported in both the machine and cross directions.

Table 7-4
Geocushion™ Acceptance Specifications

TEST	GEOCUSHION™ 32R	CRITERION
Mass/Area	32 oz/yd^2 (1,080 g/m^2)	Minimum
Thickness	0.3 in. (7.5 mm)	Minimum
Tapered Pin Puncture	400 lb. (1,780 N)	Minimum
Truncated Cone Puncture	32 psi (220 kPa)	Minimum

Section 8
Geomembranes

This section of the CQA Plan applies to the HDPE geomembrane used in the landfill base composite liner and the VFPE geomembrane used in the cap composite liner.

The geomembrane will be supplied to the site in factory rolls. ***No factory seams will be used to prepare larger panels of geomembrane for delivery to the site.*** This plan, therefore, does not contain any QA/QC requirements for factory seaming.

This section is divided into four major subheadings, which cover the QA requirements for the Pre-Installation (includes Resin Manufacturers and Geomembrane Manufacturers), Installation, Field Seaming, and Post-Installation (includes the final examination of the geomembranes prior to placing the appropriate material above the geomembrane). These terms Pre-Installation, Installation, Field Seaming, and Post-Installation are applicable only to the geomembrane installation and do not apply to the overall construction of the landfill facility.

8.1 Pre-Installation

This section describes the QC measures that are applicable to the polyethylene (PE) Resin Manufacturers, Geomembrane Manufacturers, and finished geomembrane roll delivery to the site prior to installation.

The geomembranes must be fabricated from polyethylene resin, and the fabricated HDPE geomembrane must be classified as Type III, Class C, Category 4 or 5 as defined by ASTM D 1248. The fabricated VFPE membrane must be classified as Type III, Class C, Category 3 or 4 per ASTM D 1248. (Note: the classifications are based on tests performed on the finished product, ***not*** the polyethylene resin used to fabricate the geomembrane.)

In the event that during the course of construction, geomembrane materials are obtained from a different manufacturer or are made from different resins, seam samples formed by joining the original and the proposed geomembrane shall be tested to confirm the construction compatibility of the two geomembrane materials. Prior to the use of the new geomembrane material, a minimum of two seamed samples (as described above) shall be submitted to the geosynthetics laboratory for nondestructive and destructive seam testing as described in Subsections 8.3.4 and 8.3.5. The CQA officer shall review the testing results prior to authorizing the use of the new geomembrane material.

8.1.1 Manufacturing

Material Specifications

The following list specifies the required membrane materials for liner construction:

LINER	MEMBRANE MATERIALS
Base liner	60-mil HDPE (textured on slide slopes)
Final cover side slopes and cap	40-mil VFPE-textured

Quality Control Requirements

Prior to the delivery of any geomembrane rolls to the site, the Geomembrane Manufacturer will provide the CQA Officer with the following information:

1. The resin supplier, location of supplier's production plant(s), and resin brand name and product number.
2. Any test results conducted by the Geomembrane Manufacturer and/or the Resin Manufacturer testing laboratories to document the quality of the resin used in fabricating the geomembrane.
3. The QC Plan that the Geomembrane Manufacturer will be using for the geomembrane being supplied.

Every roll of geomembrane for delivery to the site must be manufactured and inspected by the Geomembrane Manufacturer according to the following requirements:

1. First quality polyethylene resin must be used.
2. The geomembrane must contain no more than a maximum of 1 percent by weight of additives, fillers, or extenders, excluding carbon black.
3. The geomembrane must have no striations, roughness (except for where the textured geomembrane is specified), or bubbles on the surface.
4. The geomembrane must be free of holes, blisters, undispersed raw materials, or any other sign of contamination by foreign matter.

The Geomembrane Manufacturer will routinely perform the following test program on the raw resin and will report the results on a periodic basis to the CQA Officer:

1. Collect and test a minimum of one sample for the parameters in Item #2 below for every 50,000 pounds of resin received.

2. Perform carbon black content, carbon black dispersion, specific gravity, melt flow, and moisture content. Moisture content can be performed by any approved method. All other test methods are listed in Table 8-2.

Manufacturer's Certification

The Geomembrane Manufacturer will provide certification, based on tests performed by either the Geomembrane Manufacturer's laboratory or other outside laboratory contracted by the Geomembrane Manufacturer, that the geomembrane supplied under this plan will meet the specifications of the National Sanitation Foundation (NSF) Standard 54 titled *Flexible Membrane Liners*, Table 4 (revised 1993), except as noted in Subsection 8.2.1 under Procedures for Determining Geomembrane Roll Test Failures. Additionally, the manufacturer shall provide certification that the manufacturer's QC Plan was fully implemented for the geomembrane material supplied under this plan. The manufacturer shall provide documentation to verify results of the manufacturer's QC Plan implementation if requested by the CQA officer.

8.1.2 Delivery, Handling, and Storage of Geomembrane Rolls

The geomembrane will be protected during shipment from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The geomembrane rolls will be stored on site in a designated area and will be protected from long-term ultraviolet exposure prior to actual installation.

Each geomembrane roll will be marked by the Geomembrane Manufacturer with the following information (on a durable gummed label, or equivalent, on the inside of the core):

1. Name of manufacturer
2. Product type and identification number (if any)
3. Roll length and width
4. Batch (or lot) number
5. Nominal product thickness
6. Date of manufacture
7. Roll (or field panel) number

When cores are required for preparing geomembranes for shipment, the manufacturer shall use cores with sufficient crushing strength to avoid collapse or other damage while in use.

The following practices should be used as a minimum in receiving and storing geomembrane rolls in the designated storage area at the job site:

1. While unloading or transferring the geomembrane rolls from one location to another, prevent damage to the geomembrane itself. The preferred method involves use of a spreader-bar, straps, and a loader. Do not drag rolls.
2. Store the geomembrane rolls to ensure that they are adequately protected from the following:
    - Equipment damage
    - Strong oxidizing chemicals, acids, or bases
    - Flames including welding sparks
    - Temperatures in excess of 160°F
    - Soiling

The RPR will observe and document, throughout the pre-installation, installation, and post-installation periods that the Installer provides adequate handling equipment for moving geomembrane rolls and that the equipment and the handling methods used do not pose unnecessary risk of damage. The Installer is responsible for means and methods to implement the work.

The Installer will be responsible for ensuring that all materials installed meet specifications (*i.e.*, that the roll marking label information indicates required specifications and properly represents materials). The RPR will maintain a log of geomembrane roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:

1. Date of shipment from Geomembrane Manufacturer
2. Date of receipt of delivery at job site
3. For each geomembrane roll, the following information will be noted:
    - Roll number
    - Batch (lot) number

8.2 Installation

This section includes discussions of geomembrane roll testing requirements, earthwork required for geomembrane placement, placement of the geomembrane, defects and repairs of geomembranes, and requirements applicable to other materials in contact with the geomembranes. Subsection 8.3 describes the installation and testing requirements for geomembrane seams.

All parties involved in the installation of the geomembrane should be familiar with geomembranes and should emphasize protection of the geomembrane from damage during construction activities.

8.2.1 Testing Requirements

This subsection describes the test methods, including sampling procedures and frequencies, and the role of the Geosynthetic Testing Laboratory in testing the geomembrane roll samples. Subsection 8.1.1, under QC Requirements, describes the test methods that are performed on an infrequent basis to demonstrate the uniformity of resin used to fabricate geomembranes shipped to the job site. Seam testing is described in Subsections 8.3.4 and 8.3.5.

Test Methods

Geomembrane roll samples will be collected by the RPR. Sample frequency will be based on ASTM D 4354 Procedure A where the number of units per lot is defined as the number of rolls for a specified lot (using batch or lot numbers) delivered to the job site in one shipment or one test per 100,000 square yards of material delivered to the site, whichever is less. Required sampling frequencies are shown in Table 8-1.

Samples will be 3 feet long by the full width of the roll and will not include the first 3 feet of any roll. Since machine direction for geomembrane rolls is the direction that the material comes off the roll, machine direction for any sample will always be along the 3-foot-length dimension of the sample.

Table 8-2 and Table 8-3 list the tests and the test methods to be performed on the HDPE and VFPE geomembrane roll samples, respectively. The specifications and methods used in evaluating the results are discussed below under Procedures for Determining Geomembrane Roll Test Failures. Unless specified otherwise, preparation of sample specimens will be performed in accordance with the referenced test method. Results for tear resistance and each of the tensile property tests will be reported for both the machine and cross direction.

Role of Testing Laboratory

The Geosynthetic Testing Laboratory will be responsible for performing the tests on samples submitted to them as described above under Test Methods. Results of tests performed will be reported to the CQA Officer and the RPR.

Retesting of geomembrane rolls for QA purposes, because of failure to meet any or all of the acceptance specifications listed in Table 8-2 and Table 8-3, can only be authorized by the CQA Officer.

The Geomembrane Manufacturer and/or Installer may perform their own tests according to the methods and procedures defined in Table 8-2 and Table 8-3; however, the results will only be applicable to their own QC needs. These results will not be substituted for the QA testing described herein.

Procedures for Determining Geomembrane Roll Test Failures

Table 8-4 and Table 8-5 list the acceptance specifications for the HDPE and VFPE geomembranes, respectively. These tables apply to both textured and nontextured geomembranes. For those tests where results are reported for both machine and cross direction, each result will be compared to the listed specification to determine acceptance.

The HDPE membrane values listed in the acceptance specifications of Table 8-4 are from Table 4 of NSF 54, Flexible Membrane Liners (revised 1993), except for the property of melt flow index, which is based on current acceptable industry practice. Currently, no industry-accepted standard specifications exist for textured geomembranes. Therefore, textured HDPE geomembranes will be required to meet the same specifications listed for nontextured geomembranes in Table 8-4.

NSF is currently developing material property standards for VLDPE membranes; however, these standards are not final. Therefore, the acceptance values listed in Table 8-5 are based on current acceptable industry practice and manufacturer's minimum specifications for textured VLDPE geomembranes.

The following procedure will be used for interpreting results:

1. If the test values meet the stated specifications in Table 8-4 and Table 8-5, then the roll and the lot will be accepted for use at the job site. If the sample represents all rolls from an entire shipment, then the entire shipment will also be considered accepted.
2. If the results do not meet the specifications, then the roll, the lot, and the entire shipment, if applicable, will be considered unsuitable for use in the liners at the site. The Geomembrane Manufacturer can request, however, retesting of samples from either the original roll sample or another sample collected by the RPR and forwarded to the Geosynthetic Testing Laboratory. For retesting, *two* additional tests must be performed for the

failed test procedure. If both of the retests are acceptable, then the roll and lot will be considered acceptable; if either of the two additional tests fail, then the roll and lot are unsuitable without further recourse and will be immediately marked for removal from the site.

8.2.2 Earthwork

The Construction Contractor will be responsible for preparing the supporting soil according to the plans and specifications and Section 5 and Section 14 of this plan. For installation of any of the geomembranes, the Installer will certify in writing that the surface on which the geomembrane will be installed is acceptable. This certification of acceptance will be reported by the Installer prior to the start of geomembrane installation in the area under consideration. Unacceptable areas noted by the Installer will be immediately reported to the RPR.

The soil surface will also be examined by the RPR to evaluate any areas softened by precipitation or cracked due to desiccation. The daily observation will be documented in the daily report. Areas determined to be unacceptable will be reworked by the Construction Contractor until acceptable.

8.2.3 Placement

Location and Layout Drawing

A layout drawing for the geomembrane installation covered by this plan will be prepared by the Installer prior to installation and submitted to the CQA Officer, showing the location of geomembrane panels to be installed. Geomembrane panels will be identified by the RPR by the corresponding geomembrane roll number on the layout drawing as they are installed.

Installation Techniques

Geomembrane panels will be installed using one of the techniques described below. The Installer will determine the method that best suits the conditions at the time of installation considering factors such as schedule and weather conditions.

1. All geomembrane panels are placed prior to field seaming, in order to protect the underlying soil from rain, *etc.* Seams may be tack-welded or sand-bagged to prevent the geomembrane panels from shifting and to maintain proper overlap for eventual seaming.

2. Geomembrane rolls are placed one at a time, and each panel is seamed immediately after placement.
3. Any combination of the above two techniques.

If a decision is reached to place all panels prior to field seaming, care should be taken to facilitate drainage in the event of precipitation. Scheduling decisions must be made during placement in accordance with varying conditions. The RPR will evaluate changes in the schedule if proposed by the Installer and will advise the CQA Officer on the acceptability of the changes. The RPR will document that the condition of the supporting soil has not changed detrimentally during installation.

The RPR will record the roll number, location, and date of each geomembrane panel installed.

The Installer shall take the following precautions while installing the geomembrane:

1. Equipment used does not damage the geomembrane by handling, excessive heat, leakage of hydrocarbons, or by other means.
2. Personnel working on the geomembrane do not smoke, wear damaging clothing, or engage in other activities that could damage the geomembrane.
3. Method used to unroll the geomembrane does not cause scratches or crimps in the geomembrane and does not damage the supporting soil.
4. Method used to place the rolls minimizes wrinkles (especially differential wrinkles between adjacent panels).
5. Adequate temporary loading or anchoring (continuously placed, if necessary), which will not damage the geomembrane, will be placed to prevent uplift by the wind.
6. Direct contact with the geomembrane will be minimized. The geomembrane will be protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected.

Weather Conditions

Geomembrane placement will not be performed in an area of ponded water, during precipitation events, or in the presence of excessive winds. The RPR will document that this condition is fulfilled. The CQA Officer will cause to cease or postpone the geomembrane placement when conditions are unacceptable.

Damages

The RPR will examine each panel for damage after placement and determine which panels, or panel portions, should be rejected, repaired, or accepted. Damaged panels or panel portions that have been rejected will be marked, and their removal from the site will be recorded by the RPR. Panel repairs will be made according to the procedures described in Subsection 8.2.4.

8.2.4 Defects and Repairs

This section applies to all defects and repairs resulting from examinations, tests, or visual observations performed on the geomembrane material itself and on the seams used in joining rolls in the field.

Identification

All seam and non-seam areas of the geomembranes will be examined and documented by the RPR for identification of defects, holes, blisters, undispersed raw materials, and any signs of contamination by any foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane will be clean at the time of examination. The smooth nonconductive geomembrane surface will be swept with a broom and/or washed by the Installer if the amount of dust or mud inhibits examination. The textured conductive backed HDPE will be spark tested in accordance with technical specifications and manufacturer's recommended procedure. Spark testing will be performed in addition to destructive and nondestructive seam testing.

Evaluation

Each suspect area identified will be nondestructively tested using the vacuum box test method described in Subsection 8.3.4. Each location that fails the nondestructive tests will be marked by the RPR and repaired by the Installer.

Repair Procedures

Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test will be repaired. Several procedures exist for the repair of these areas. The procedures available include the following:

1. Patching—used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
2. Grinding and rewelding—used to repair small sections of extruded seams.

3. Spot welding or seaming—used to repair small tears, pinholes, or other minor, localized flaws.
4. Capping—used to repair large lengths of failed seams.
5. Topping—used to repair areas of inadequate seams that have an exposed edge.
6. Removing the bad seam and replacing with a strip of new material welded into place—used for repairing large lengths of fusion seams.
7. Others may be used at the recommendation of the Installer if agreed upon by the CQA Officer and the RPR.

The repair procedures, materials, and techniques will be approved in advance of the specific repair by the CQA Officer, RPR, and Installer. At a minimum, the following provisions will be satisfied:

1. Patches or caps will extend at least 6 inches beyond the edge of the defect, and all corners of patches will be rounded with a radius of at least 3 inches.
2. The geomembrane below large caps should be appropriately cut to avoid water or gas collection between the two sheets.

Examination of Repairs

Each repair will be numbered and logged by the RPR. Each repair will be nondestructively tested according to Subsection 8.3.4. Repairs that pass the above testing will be considered to be adequately repaired, except that large caps may be of sufficient extent to require destructive seam sampling and testing, at the discretion of the RPR, according to the provisions of Subsection 8.3.5.

Failed tests indicate that the repair was inadequate and will be redone and retested until a passing result is obtained. The RPR will document that all repairs have been subjected to nondestructive testing and will record the number of each repair, the date, and the test outcome.

Large Wrinkles

When seaming of the geomembrane is completed, the RPR will examine the geomembrane for wrinkles and determine which wrinkles should be cut and seamed by the Installer. The wrinkle repair will be done in accordance with the equipment and procedures described in Subsections 8.3.2 and 8.3.3 (General Seaming Procedures), respectively, and it will be nondestructively tested using the vacuum box test method described in Section 8.3.4.

8.3 Field Seaming

This section covers the QA procedures on seams used to join the rolls of geomembrane into a continuous layer. The installation of each of the geomembranes at the landfill facility will include 100 percent nondestructive testing of all field seams for joining adjacent rolls of geomembranes to determine openings or gaps between geomembrane sheets. In addition, destructive testing will be performed at a routine interval for determining the strength and mode of failure of field seams in both the shear and peel modes.

The allowable field seam methods, equipment, personnel qualifications, and destructive and nondestructive testing methods are described in this section.

8.3.1 Seam Layout

The Installer will provide the CQA Officer and the RPR with seam layout drawings for each of the geomembrane installations covered by this plan showing each expected seam. The CQA Officer will review the seam layout drawing and document that it is consistent with accepted practice and the design plans and specifications.

No horizontal seams will be allowed on slopes greater than 5- horizontal to 1- vertical. In corners and at other odd-shaped geometric intersections, the number of seams should be minimized. A seam numbering system comparable and compatible with the geomembrane roll numbering system will be agreed upon at the Preconstruction Meeting.

8.3.2 Seaming Equipment

The approved process for production field seaming (roll to roll) are the dual hot wedge (fusion-type) seam method and the extrusion fillet weld process. Specialty seams and repair seams (non-production) will be done by the extrusion fillet weld process. No other processes can be used without prior written authorization from the CQA Officer and the RPR. Only equipment that has been specifically approved by make and model will be used.

Dual Hot Wedge Process

The Installer will meet the following requirements regarding the use, availability, and cleaning of the equipment to be used at the job site:

1. An automated self-propelled type of apparatus will be used.
2. The welding apparatus will be equipped to continuously monitor applicable temperatures.

3. One spare operable seaming device will be maintained on site at all times.
4. Equipment used for seaming should not damage the geomembrane.
5. The geomembrane should be protected in areas of heavy traffic to prevent damage as discussed in Subsection 8.2.3.
6. For cross seams, the edge of the cross seams will be ground to a smooth incline (top and bottom) prior to welding.
7. For cross seams, the intersecting dual hot wedge seam must be patched using the extrusion fillet process described below.
8. The electric generator for the equipment will be placed on a smooth base in such a way that no damage occurs to the geomembrane. Similarly, a smooth insulating plate or fabric will be placed beneath the hot equipment after usage.

The Installer will keep records for each seamer performing dual hot wedge seaming, including welding machine I.D. number, ambient air temperature, geomembrane surface temperature, and machine operating pressures and temperatures. This data will be recorded at intervals as agreed to at the Preconstruction Meeting.

Extrusion Fillet Process

The Installer will meet the following requirements regarding the use, availability, and cleaning of extrusion welding equipment to be used at the job site:

1. The welding apparatus will be equipped to continuously monitor temperature at the nozzle.
2. One spare operable seaming device will be maintained on site at all times.
3. Equipment used for seaming should not damage the geomembrane.
4. The geomembrane should be protected in areas of heavy traffic to prevent damage.
5. The extruder will be cleaned and purged prior to beginning seaming, and at any time that seaming operations are stopped, until all heat-degraded extrudate has been removed from the barrel.
6. The electric generator for the equipment will be placed on a smooth base in such a way that no damage occurs to the geomembrane. Similarly, a smooth insulating plate or fabric will be placed beneath the hot equipment after usage.
7. Grinding geomembrane surfaces for welding preparation shall not be performed more than 1 hour prior to seaming.

The Installer and, if applicable, the Geomembrane Manufacturer will provide documentation to the CQA Officer regarding the quality of the extrudate used in the welding apparatus. At a minimum, the extrudate should be compatible with the base liner material and contain the same grade and quality of polyethylene resin as used in the base material.

The Installer will keep records for each seamer performing extrusion weld seaming, including welding machine I.D. number, extrudate, ambient air, and geomembrane surface temperatures. This data will be recorded at intervals as agreed to at the Preconstruction Meeting.

8.3.3 Initial Requirements

All personnel performing seaming operations will be qualified by experience or by successfully passing seaming tests for the type of seaming equipment to be used. At least one seamer will have experience seaming a minimum of 1,000,000 ft^2 of polyethylene geomembrane using the same type of seaming apparatus to be used at the landfill facility. The most experienced seamer, the "master seamer," will have direct supervisory responsibility at the job site over less experienced seamers.

The Installer will provide a list of proposed seaming personnel and their experience records to the CQA Officer and the RPR for their review and approval.

Weather Conditions

The range of weather conditions under which geomembrane seaming can be performed are as follows:

1. Unless otherwise authorized in writing by the CQA Officer, no seaming will be attempted or performed at an ambient temperature below 32°F (0°C) or above 104°F (40°C).
2. Between ambient temperatures of 32°F (0°C) and 50°F (10°C), seaming will be performed only if the geomembrane is preheated by either sun or a hot air device to a temperature provided by the manufacturer, provided there is no excessive ambient cooling resulting from high winds.
3. Above 50°F (10°C), no preheating of the geomembrane is required.
4. Geomembrane will be dry and protected from the wind.
5. Seaming will not be performed during any precipitation event unless the Installer erects satisfactory shelter to protect the geomembrane areas for seaming from water and/or moisture.

6. Seaming will not be performed in areas where ponded water has collected below the surface of the geomembrane.

If the Installer wishes to use methods that may allow seaming at ambient temperatures below 32°F or above 104°F, the Installer will demonstrate and certify that the methods and techniques used to perform the seaming produce seams that are entirely equivalent to seams produced at temperatures above 50°F and below 104°F, and that the overall quality of the geomembrane is not adversely affected.

The RPR will document the following items:

1. Ambient temperature at which seaming is performed.
2. Any precipitation events occurring at the site, including the time of such occurrences, the intensity, and the amount of the event.

The RPR will inform the CQA Officer if any of the weather conditions are not being fulfilled. The CQA Officer will cause to cease or postpone the geomembrane seaming when weather conditions are unacceptable.

Overlapping and Temporary Bond

The Installer will be responsible for the following:

1. Panels of geomembranes have a finished overlap of a minimum of 3 inches for extrusion welding and 4 inches for fusion welding; but, in any event, sufficient overlap will be provided to allow peel tests to be performed on the seam.
2. No solvents or adhesives will be used on the geomembranes unless the product has been approved in writing by the CQA Officer. Approval can only be obtained by submitting samples and data sheets to the CQA Officer for testing and evaluation.
3. Procedures used to temporarily bond adjacent geomembrane rolls must not damage the geomembrane; in particular, the temperature of the hot air at the nozzle of any spot welding apparatus must be controlled such that the geomembrane is protected at all times against potential damage.

Trial Seams

Trial seams will be made on fragment pieces of geomembrane to document that seaming conditions are adequate. Such trial seams will be made at the beginning of each seaming period, and at least once every 4 hours thereafter, for each seaming apparatus used that day. Also, each seamer will make at least

one trial seam each day. Trial seams will be made under the same conditions as actual seams.

The trial seams will be examined by the Installer for squeeze-out, foot pressure applied by seaming equipment, and general appearance. If the seam fails any of these examinations, it will be repeated until satisfactory seams are obtained.

The trial seam samples will be at least 3 feet long by 1 foot wide after seaming, with the seam centered lengthwise. Seam overlap will be as indicated above, under Overlapping and Temporary Bond.

Two specimens, each 1-inch wide, will be cut from opposite ends of the trial seam sample by the Installer. The specimens will be tested respectively in shear and peel using a field tensiometer provided by the Installer, and they should not fail in the seam. If a specimen fails, the entire test will be repeated using two additional specimens cut from the trial seam sample or a new trial seam sample shall be made (with or without adjustments in the seaming process) and specimens cut for testing. If the second set of specimens also fails, the seaming apparatus and seamer will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved.

The remainder of the trial seam sample will be identified and marked by the RPR as follows:

1. An assigned sample number, welding apparatus used, and seamer name
2. The date, time, applicable welding equipment operating temperatures, and ambient temperature at the time of seaming
3. Whether the sample passes or fails

The RPR may randomly select trial field samples for destructive testing by the Geosynthetic Testing Laboratory according to the test procedures described in Subsection 8.3.5 under Field Test Methods. The frequency for trial seam laboratory testing will be at the discretion of the RPR.

If a trial seam sample fails a destructive test performed by the Geosynthetic Testing Laboratory according to the acceptance criteria stated in Subsection 8.3.5, then a destructive test seam sample(s) will be taken from each of the seams completed by the seamer during the shift related to the failed trial seam test. These samples will be forwarded by the RPR to the Geosynthetic Testing Laboratory and, if any of them fails the tests, the procedures described

in Subsection 8.3.5 will apply. The conditions of this paragraph will be considered met if a destructive seam test sample, collected and tested according to the provisions under Location and Sampling Frequency and Sampling Procedure of Subsection 8.3.5, has already been taken and passed.

Seam Preparation

The Installer will meet the following conditions for each of the geomembrane installations covered by this plan:

1. Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material.
2. If seam overlap grinding is required, the grinding process will be completed according to the Geomembrane Manufacturer's instructions within 1 hour of the seaming operation, and in a way that will not damage the geomembrane or cause excessive striation of the geomembrane surface.
3. Seams will be aligned so as to minimize the number of wrinkles and "fishmouths."

General Seaming Procedures

Unless otherwise specified, the general seaming procedures to be used by the Installer for each of the geomembrane installations covered by this plan, and observed by the RPR, will be as follows:

1. A firm substrate will be provided to achieve proper support for seaming.
2. Fishmouths or wrinkles at the seam overlaps will be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles will be seamed, and any portion where the overlap is inadequate will then be patched with an oval or patch of the same geomembrane (including thickness) extending a minimum of 6 inches beyond the cut in all directions.
3. If seaming operations are to be conducted at night, adequate illumination will be provided.

8.3.4 Nondestructive Testing

Each field seam will be nondestructively tested over its full length using one of the methods described in this section. The purpose of nondestructive testing is to determine the continuity of the seams. Nondestructive testing, at this stage of development, does not provide any information on the strength of seams. Seam strengths will be determined by destructive testing methods that are described in Subsection 8.3.5.

Failure of any of the nondestructive or destructive tests will require the repair of the failed section according to the procedures contained in Subsection 8.3.5.

Nondestructive testing as described in this section will be performed on seams for every geomembrane installation covered by this plan. The recommended test methods for conducting the nondestructive seam testing are the air pressure test for dual hot wedge seams and the vacuum box test for extrusion fillet welds. These two nondestructive testing methods are described below.

The RPR will perform the following:

1. Observe all nondestructive seam testing, and examine all seams for squeeze-out, foot pressure, and general appearance. Failure of these criteria based on the RPR's judgement will be considered as failure of the seam, and repair or reconstruction will be required.
2. Document location, date, test unit number, name of tester, and outcome of all testing.
3. Inform the Installer and CQA Officer of any required repairs.
4. Document that appropriate repairs are made and that the repairs are retested nondestructively with passing results.

Air Pressure Testing

The following test procedures are applicable only to dual hot wedge seams. The equipment for performing the test should meet the following minimum requirements:

1. An air compressor or hand pump equipped with a pressure gauge and regulator capable of producing and sustaining a pressure between 25 to 30 psig and mounted on a cushion to protect the geomembrane surface.
2. Fittings, rubber hose, valves, *etc.*, to operate the equipment, and a sharp hollow needle or other approved pressure feed device.

Air pressure testing will be performed according to the following procedure:

1. Seal both ends of the seam to be tested.
2. Insert needle or other approved pressure feed device into the air space at one end of the dual hot wedge seam.
3. Energize the air compressor or hand pump to a pressure of 25 to 30 psig. Close the valve and observe the pressure response in the seam air space for approximately 7 minutes. The pressure should stabilize within the first 2 minutes and then remain essentially constant.

4. Record the pressure in the seam at the end of 2 minutes and again at the end of 7 minutes.
5. If the subsequent pressure loss exceeds 2 psig over the last 5-minute period or if the pressure does not stabilize, then the seam fails, and the defect must be located, repaired, and retested nondestructively.
6. If pressure loss does not exceed 2 psig over the last 5-minute period, then the seam is considered to have passed the nondestructive test provided the Installer has verified that the air channel tested was not obstructed by noting a release of air pressure at the end of the tested seam interval opposite the pressure gauge.

Vacuum Box Test

Vacuum box testing is to be used on those seams made by the extrusion fillet process, to locate precisely the defects identified from air pressure testing, or to evaluate suspect seam and non-seam areas as discussed in Subsection 8.2.4.

Vacuum box testing equipment must meet the following minimum standards:

1. A five-sided vacuum box with an open bottom, a clear viewing panel on top, and a pliable gasket attached to the bottom.
2. A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections capable of achieving a vacuum of 10 psig.
3. A vacuum gauge on the tank with an operating range of 0 to 10 psig, and a vacuum gauge on the vacuum box with an operating range from 0 to 10 psig.

The following procedures will be used in performing the vacuum box test:

1. Ensure seams to be tested are clean and relatively free from soil or foreign objects that might prohibit a good seal from being formed between the vacuum chamber and the geomembrane.
2. Energize the vacuum pump and create a vacuum in the tank of 5 to 10 psig.
3. Wet a strip of geomembrane approximately twice the size of the vacuum box with the soapy solution.
4. Place and center the vacuum box with the gasket in contact with the geomembrane surface over the wetted area of the seam.
5. Applying a normal force to the top of the vacuum box, close the bleed valve, and open the vacuum valve. Check to make certain that a tight seal is created between the geomembrane and the vacuum box. A minimum vacuum of 5 psig should be used for testing with the maximum allowable testing pressure never exceeding 10 psig of vacuum.

6. With the vacuum drawn, use the viewing panel to examine the geomembrane seam for bubbles resulting from the flow of air through the seam. Continue this examination for not less than 10 seconds.
7. Remove the vacuum box by first closing the vacuum valve and opening the bleed valve. Proceed to step 8 if bubbles appear in Step 6. If no bubbles appear in step 6, then proceed directly to Step 9.
8. If bubbles appear through the geomembrane, mark the defective area for repair according to the provisions of Subsection 8.2.4. All repairs must be tested with passing nondestructive results.
9. Move the vacuum box along the seam to be tested, overlapping the previously tested area by no less than 3 inches.

8.3.5 Destructive Seam Testing

Destructive seam testing will be performed on the geomembrane seams covered by this plan. Destructive seam testing is performed to determine the strength of the seam in both shear and peel failure modes. Destructive seam testing will be performed within 48 hours of sampling either in an on-site laboratory by personnel under the direction of the CQA Officer or at the Geosynthetic Testing Laboratory.

Location and Sampling Frequency

The RPR will select locations where seam samples will be cut out for the destructive testing. Test locations will be determined during seaming at the RPR's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential causes of an imperfect seam. The Installer will not be informed in advance of any location where seam samples will be taken.

The minimum frequency of sample collection will be one test location per every 500 linear feet of seam length. This minimum frequency is to be taken as an average for the entire installation area.

Sampling Procedure

Samples will be cut under the direction of the RPR as the seaming progresses. For each sample location, information will be documented as follows:

1. Assign a sample number and mark accordingly.
2. Record sample location on the layout drawing.

3. By sample number, record the reason for collecting the sample (*e.g.*, as part of statistical testing program, suspicious seam, *etc.*).
4. Note on the sample, for the peel test, which geomembrane is the top and which is the bottom with respect to seams performed using dual hot wedge (fusion) weld techniques.
5. Record pertinent information including date, time, seaming unit number, and name of seamer.

Specimens for qualitative field testing will be taken prior to removal of the laboratory sample. Samples for field tensiometer testing will be 1 inch wide by 16 inches long with the seam centered parallel to the width. The distance between the two samples should be 42 inches measured from inside edge to inside edge. If both samples pass the field tensiometer test described below under Field Test Methods, then the sample for laboratory testing will be taken according to the procedure described below.

The sample for laboratory testing will be located between the two samples used for field testing. Therefore, the laboratory sample will be 12 inches wide by 42 inches long with the seam centered lengthwise. The sample will be cut by the RPR into three parts and distributed as follows:

1. A 12-inch-by-16-inch sample will be given to the Installer for testing if so desired.
2. A 12-inch-by-16-inch sample will be given to the Owner for record storage.
3. An 8-inch-by-16-inch sample will be transmitted to the Geosynthetic Testing Laboratory or on-site testing laboratory by the RPR.

The RPR will make periodic reports to the Installer detailing the locations of samples taken that must be repaired.

All holes cut into the geomembrane resulting from destructive seam sampling will be immediately repaired by the Installer in accordance with the repair procedures described in Subsection 8.2.4. The repaired area will be nondestructively tested in accordance with the requirements of Subsection 8.3.4.

Field Test Methods

The two 1-inch-wide samples described above under Sampling Procedure will be field tested for both peel and shear. Testing will be performed using a field tensiometer or equivalent device to qualitatively determine the mode of failure. The seam will be considered as passing if the failure in both peel and shear does not occur with the seam. If the samples fail the field tensiometer test, then the repair procedures of Subsection 8.2.4 for the holes left by the cut-out samples, and seam reconstruction procedures for the repair of the defective seam, discussed later in this subsection, must be implemented.

Laboratory Test Methods

Laboratory testing of the destructive seam samples will be performed by the Geosynthetic Testing Laboratory or on-site testing laboratory under the direction of the CQA Officer. All destructive seam tests, whether performed on trial seam samples (as described above) or on samples cut out from production seams, will be performed in general accordance with the methodology of ASTM D 4437, which stipulates that at least five specimens should be tested in shear and five in peel. Samples will be cut in alternating order (*e.g.*, shear and peel, peel and shear) and should be tested in the order of cutting, to determine if any trend in seam quality along the length of the sample exists. All specimens will be cut as 1-inch-wide strips to ensure that the seam does not exceed the test gauge length of the specimen.

The following tests will be performed on each seam sample submitted for laboratory testing:

1. *Shear and peel maximum tension* is the maximum load per unit width of a 1-inch-wide specimen expressed in pounds per inch of width in both the shear and peel mode, according to ASTM D 4437 as modified by NSF Standard 54.
2. *Shear elongation at break* is the extension at break expressed as a percentage of the initial distance between the edge of the fused track and the nearer grip. This distance should be the same on both sides of the seam and is usually 1 inch. No referenced ASTM test exists for this procedure as defined. The value that failure occurred will be noted on the results.
3. *Peel seam separation* estimates the area of seam interface separation expressed as a percentage of the original area.

Also, for both the seam shear and peel tension tests, an indication will be given for each specimen tested that defines the locus of the failure. The loci will be defined by using Figure A-4 and Figure A-6 from Part 5, Annex A of NSF 54.

For the seam shear tests, specimens should be inserted in the test machine with minimum gauge lengths of ½ inch between each edge of the seam and the adjacent grip. The crosshead speed will be 2 inches per minute for HDPE and 20 inches per minute for VFPE. Parameters monitored during the test will be load and crosshead displacement.

For the peel tests, specimens will be inserted in the tensile machine so the grips are no closer than 1 inch to the edge of the seam. The grips may be closer than 1 inch only if there is insufficient material to allow insertion at this setting. Seam peel specimens will be tested at 2 inches per minute crosshead speed for HDPE and 20 inches per minute for VFPE.

For shear tests, the following values will be reported for each specimen tested:

1. Maximum tension in pounds per inch
2. Elongation at break indicating at what percentage the specimen failed
3. The locus of failure using the above designations

For peel tests, the following values will be reported for each specimen tested:

1. Maximum tension in pounds per inch
2. Seam separation expressed as percent of original seam area
3. Locus of failure

For each set of five specimens, the mean and standard deviation will be calculated and reported for shear maximum tension and peel maximum tension.

Role of Testing Laboratory

The Geosynthetic Testing Laboratory or on-site testing laboratory will be responsible for performing the tests on samples submitted to them as described above. Results of tests performed will be reported to the CQA Officer and the RPR. Retesting of seams, because of failure to meet any or all of the specifications listed below, can only be authorized by the CQA Officer.

The Geomembrane Manufacturer and/or Installer may perform their own QC testing in accordance with the methods and procedures defined above under Laboratory Test Methods; however, the results, if substantially different from those obtained by the Geosynthetic Testing Laboratory or on-site laboratory, may only be used to request a retesting by the Geosynthetic Testing Laboratory or on-site testing laboratory. All QA test results from the Geosynthetic Testing Laboratory or on-site laboratory govern, over any test results from the Geomembrane Manufacturer of Installer. Only the CQA Officer is authorized to approve a retesting request.

Procedures for Determining Destructive Seam Test Failures

The procedures described in this section apply to the destructive testing procedures defined above under Field Test Methods and Laboratory Test Methods. Specifications for destructive seam testing are shown in Table 8-7 and Table 8-8. Procedures for repairing failed seams are given in Subsection 8.2.4 of this plan.

Results from the shear and peel tests for the HDPE geomembrane will be evaluated by criteria, which are based on the values for material properties for yield stress (Note: yield stress of the base geomembrane is considered a more representative criterion than bonded seam strength) from Table 4 (HDPE Geomembranes) of NSF Standard 54 titled *Flexible Membrane Liners* (revised 1993).

Results from the shear and peel tests for the VLDPE will be evaluated by the following criteria:

1. Minimum acceptable individual specimen shear elongation values will be no less than 50 percent.
2. Maximum allowable individual specimen peel separation value will be 10 percent.
3. Failure type in peel must be film-tear bond (FTB) for 4 out of 5 test specimens.

The Installer has the following two options in determining the repair boundary whenever a seam has failed: either the field tensiometer testing or laboratory destructive testing:

1. The seam can be reconstructed between any two previously tested and passed destructive seam test locations.

2. The Installer can trace the welding path to an intermediate location (at a 10-foot minimum from the point of the failed test in each direction) and request that field tensiometer tests be performed at these intermediate locations. If the field tensiometer sample results are acceptable, then full laboratory samples are taken and tested. If the laboratory tests are acceptable, then the seam is reconstructed between these intermediate locations. If either sample fails, then the process is repeated until acceptable destructive seam tests have been performed in both directions away from the original failed sample location. All retesting of seams, according to this procedure, will use the sampling methodology described above under Sampling Procedure.

For all seams reconstructed due to a failing destructive seam sample, an additional sample taken from the reconstructed zone must pass destructive seam testing.

The RPR will be responsible for documenting all actions, including test results submitted by the Geosynthetic Testing Laboratory, taken in conjunction with seam testing. The RPR will also be responsible for keeping the CQA Officer informed on seam testing results and seaming progress.

8.4 Post-Construction

Each geomembrane covered by this plan will be examined by the RPR. Any defects, whether due to failed seams, pinholes, or other penetrations, will be repaired. In addition, a stress crack examination will be performed along the seams of all the geomembrane installations covered by the plan.

This examination, by experienced personnel, will utilize the procedures described in the USEPA Field Inspector's Manual titled *Stress Cracking of Flexible Membrane Liner Seams*. This document identifies three levels of stress crack development with Level #1 being those that can be observed only under a microscope, Level #2 being those that are barely visible to the eye, and Level #3 being those that are complete fractures.

The geomembranes covered by this plan will be examined for Level #2 and Level #3 stress cracks according to the procedure described in the Field Inspector's Manual under the heading "Field Inspection Recommendations." This examination will be performed by experienced personnel only. Any Level #2 or Level #3 stress cracks found will be immediately marked by the RPR and will be repaired according to the provisions of Subsection 8.2.4.

Placement of the Geocushion™ drainage layer material shall proceed as soon as practical following the RPR's testing and acceptance of completed geomembrane areas. The granular layer will provide ultraviolet protection, thermal insulation, and protection from physical damage.

Table 8-1
Number Of Units To Be Selected As Lot Sample—
Specification Conformance

NUMBER OF UNITS IN LOT	NUMBER OF UNITS SELECTED
1 to 2	1
3 to 8	2
9 to 27	3
28 to 64	4
65 to 125	5
126 to 216	6
217 to 343	7
344 to 512	8
513 to 729	9
730 to 1,000	10
1,001 or more	11

Table 8-2
HDPE Geomembrane Tests And Test Methods

PROPERTY	TEST METHOD
Carbon Black Content	ASTM D 1603
Carbon Black Dispersion	ASTM D 3015 (1)
Dimensional Stability (2)	ASTM D 1204, 1 Hour at 100°C
Melt Flow Index	ASTM D 1238 with load of 2.16 kg at 190°C
Density	ASTM D 792
Tear Resistance (2)	ASTM D 1004
Puncture Resistance	FTMS 101, Method 2065
Tensile Properties(2) Yield Stress Yield Elongation Break Stress Break Elongation	ASTM D 638 (1), Type IV specimen at 2 inches/minute
Thickness	ASTM D 751 (3,4) (nontextured) ASTM D 1593 (5) (textured
Coefficient of Friction	ASTM D 5321

(1) Test method as modified in Annex A of NSF Standard 54.
(2) These tests will be performed and results reported for both machine and cross direction.
(3) Use ASTM test method as modified by NSF Standard 54, Flexible Membrane Liners (revised November 1993).
(4) In the absence of a standard test method for the thickness of textured geomembranes, this test method will be used; however, it may not be applicable for some geomembranes, depending on the manufacturing process.
(5) ASTM D 751 shall be used for textured geomembranes manufactured during impingement or lamination texturing processes.

Table 8-3
VFPE Geomembrane Tests and Test Methods

PROPERTY	TEST METHOD
Carbon Black Content	ASTM D 1603
Carbon Black Dispersion	ASTM D 3015 (2)
Melt Flow Index	ASTM D 1238 with load of 2.16 kg at 190°C
Density	ASTM D 792, Method A; or ASTM D 1505
Tear Resistance (1)	ASTM D 1004
Puncture Resistance	FTMS 101, Method 2065
Tensile Properties (1) Yield Stress Yield Elongation Break Stress Break Elongation	ASTM D 638 (2), Type IV specimen at 2 inches/minute
Environmental Stress Crack Resistance (ESCR)	ASTM D 1693 (2)
Thickness	ASTM D 751 (2) (nontextured) ASTM D 1593 (4) (textured)
Coefficient of Friction	ASTM D 5321

(1) These tests will be performed and results reported for both machine and cross direction.
(2) Use ASTM test method as modified by NSF Standard 54, Flexible Membrane Liners (revised November 1993).
(3) In the absence of a standard test method for the thickness of textured geomembranes, this test method will be used; however, it may not be applicable for some geomembranes depending on the manufacturing process.
(4) ASTM D 751 shall be used for textured geomembranes manufactured using impingement or lamination texturing process.

Table 8-4
HDPE Geomembrane 60-Mil Acceptance Specifications

PROPERTY	UNITS	TYPE OF CRITERION	ACCEPTABLE VALUE (1, 2)
Carbon Black Content	% by weight	Range	2 - 3
Carbon Black Dispersion	N/A	Range	A1, A2, or B1
Dimensional Stability	% change	Range	± 2.0
Melt Flow Index	g/10 min	Maximum	0.3 (3)
Density	g/cc	Minimum	0.940
Tear Resistance (4)	lb	Minimum	39
Puncture Resistance	lb	Minimum	72
Tensile Properties			
Yield Stress (3, 4)	ppi	Minimum	126
Yield Elongation (3)	%	Minimum	12
Break Stress (3, 5, 6)	ppi	Minimum	228
Break Elongation (3, 6)	%	Minimum	560
ESCR	hours	Minimum	1,500
Thickness (lowest individual)	mils	Minimum	54
Thickness (minimum average)	mils	Average	60

(1) Values are from Table 4 of NSF Standard 54, Flexible Membrane Liners (revised May 1991), unless otherwise indicated.
(2) Values are based on current acceptable industry practice.
(3) Test is performed in both machine and cross direction.
(4) Values given correspond to a minimum yield stress of 2,100 psi for either machine or cross direction.
(5) Values given correspond to a minimum break stress of 3,800 psi for either machine or cross direction.
(6) Values given apply to nontextured geomembranes only. Refer to manufacturer's specifications for minimum acceptable values of textured geomembranes.

Table 8-5
VFPE Geomembrane 40-Mil Acceptance Specifications

PROPERTY	UNITS	TYPE OF CRITERION	ACCEPTABLE VALUE [1]
Carbon Black Content	% by weight	Range	2 - 3
Carbon Black Dispersion	N/A	Range	A1, A2, or B1
Dimensional Stability	% change	Range	± 3.0
Melt Flow Index	g/10 min	Maximum	0.10 [2]
Density	g/cc	Minimum	0.89 - 0.92
Tear Resistance [3]	lb	Minimum	16
Puncture Resistance	lb	Minimum	52
Tensile Properties [3] Break Stress [4, 5] Break Elongation [5]	 ppi %	 Minimum Minimum	 128 625
ESCR	hours	Minimum	1,500
Thickness (lowest individual)	mils	Minimum	36
Thickness (minimum average)	mils	Average	40

(1) Values are from Table 11 of NSF Standard 54, Flexible Membrane Liners (revised November 1993), unless otherwise noted.
(2) Values are based on current acceptable industry practice.
(3) Test is performed in both machine and cross direction.
(4) Values given correspond to a minimum break stress of 3,200 psi for either machine or cross section.
(5) Values given apply to nontextured geomembranes only. Refer to manufacturer's specifications for minimum acceptable values of textured membranes.

Table 8-6
60-Mil Smooth or Textured HDPE Geomembrane Seam Acceptable Specifications

PROPERTY	TEST METHOD	UNITS	TYPE OF CRITERION	MINIMUM AVERAGE VALUE (1)	
				NONTEXTURED	TEXTURED
Shear Strength (2)	ASTM D 4437 (NSF 54 modified)	ppi	Minimum	126	113
Shear Elongation	--	percent	Minimum	50	50
Peel Strength (2) Fusion	ASTM D 4437 (NSF 54 modified)	ppi	Minimum	90	82
Peel Strength (2) Extrusion	ASTM D 4437 (NSF 54 modified)	ppi	Minimum	78	63
Peel Separation (3)	--	percent	Maximum	10	10

(1) The average of all five specimen test results must meet these requirements. In addition, five out of the five test results must meet these requirements.
(2) Failure type in peel must be film-tear bond (FTB) for four out of five test specimens.
(3) Maximum acceptable value.

Table 8-7
40-Mil VFPE Smooth or Textured Geomembrane Seam Acceptable Specifications

PROPERTY	TEST METHOD	UNITS	MINIMUM AVERAGE VALUE (1)	
			NONTEXTURED	TEXTURED
Shear Strength (2)	ASTM D 4437 (NSF 54 modified)	ppi	44	40
Shear Elongation (2)	—	percent	50	50
Peel Strength (3, 4) Fusion	ASTM D 4437 (NSF 54 modified)	ppi	40	36
Peel Strength (3,4) Extrusion	ASTM D 4437 (NSF 54 modified)	ppi	36	36
Peel Separation (5)	—	percent	10	10

(1) If the lengthwise edges of the textured geomembrane panels are nontextured, then the nontextured specifications shall apply for the testing of seams made along these edges.
(2) Five out of the five test specimens must meet these requirements. In addition, failure type must be FTB for all five specimens.
(3) Four out of the five specimens must meet the three requirements. The fifth specimen shall achieve 90 percent of the listed peel strength.
(4) Failure type must be FTB for four out of five test specimens.
(5) Maximum Acceptance Value for four out of five test specimens. The fifth specimen shall have no more than 50 percent peel separation.

Section 9
Geonets

Geonets will be part of a geocomposite consisting of a non-woven geotextile heat bonded to the top of the geonet. The geonets used in the geocomposites will meet the applicable requirements of this section. Geocomposites are discussed in Section 11.

As geonets will not be used independently (*i.e.*, only used as a component of the geocomposite), portions of this section are not applicable. Section 9 (Geonets) is included to provide a reference source for geonet material specifications and testing requirements as called for in Section 11.

This section is divided into three major subheadings that cover the QA requirements for Pre-Installation (includes geonet manufacturers), Installation, and Post-Installation (includes the final examination of the geonets prior to placing the appropriate material above the geonet). The terms Pre-Installation, Installation, and Post-Installation are applicable only to the geonet installation and do not apply to the overall construction of the landfill facility.

9.1 Pre-Installation

9.1.1 Manufacturing

Material Specifications

The geonets used must be fabricated from polyethylene resin, and the fabricated geonet must be classified as Type III, Class C, Category 4 or 5 as defined by ASTM D 1248 (Note: this classification is based on tests performed on the finished product, ***not*** the polyethylene resin used to fabricate the geonet).

Quality Control Requirements

Prior to the delivery of any geonet rolls to the site, the Geonet Manufacturer will provide the CQA Officer with the following information:

1. The resin supplier, location of supplier's production plant(s), and resin brand name and product number.
2. Test results obtained by the Geonet Manufacturer and/or the Resin Manufacturer's testing laboratories to document the quality of the resin used in fabricating the geonet.

3. The QC Plan that the Geonet Manufacturer will be using for the geonet being supplied.

Every roll of geonet for delivery to the site must be manufactured and inspected by the Geonet Manufacturer, according to the following requirements:

1. First-quality polyethylene resin must be used.
2. The geonet must contain no more than a maximum of 1 percent by weight of additives, fillers, or extenders, excluding carbon black.
3. The geonet must have no striations, roughness, or cuts on the surface.
4. The geonet must be free of blisters, undispersed raw materials, or any other sign of contamination by foreign matter.

The Geonet Manufacturer will routinely perform the following tests on the raw resin, at the stated frequencies, and will report the results on a periodic basis to the CQA Officer:

1. Collect and test a minimum of one sample for the parameters in Item #2 below for every 50,000 pounds of resin received.
2. Perform carbon black content by ASTM D 1603, carbon black dispersion by ASTM D 2663 Method B, specific gravity by ASTM D 792 Method A, melt flow index by ASTM D 1238 with a load of 2.16 kg and at 190°C, and moisture content by any approved method.

Manufacturer's Certification

The Geonet Manufacturer will provide certification, based on tests performed in accordance with the methods listed in Table 9-1 that the geonet supplied under this plan will meet the material specifications listed in Table 9-1. These tests may be performed at a minimum frequency of 1 per 100,000 square yards of material delivered to the site by the Geonet Manufacturer's laboratory or by a laboratory contracted by the manufacturer. Additionally, the manufacturer shall provide certification that the manufacturer's QC Plan was fully implemented for the geonet materials supplied under this plan. The manufacturer shall provide documentation to verify the results of the manufacturer's CQA Plan implementation if requested by the CQA Officer.

9.1.2 Delivery, Handling, and Storage of Geonet Rolls

Each geonet roll for use at the landfill facility will be marked by the Geonet Manufacturer with the following information and in the following manner:

1. When the net is rolled on a core, identify each roll with a durable gummed label, or an equivalent, on the inside of the core and on the outside of the protective wrapping for the roll.
2. Each roll label will contain the following information at a minimum:
   - Name of manufacturer (or supplier)
   - Style and type number
   - Roll length and width
   - Batch (or lot) number
   - Nominal product thickness
   - Date of manufacture
   - Direction for unrolling
   - Roll number
3. On the outside of the roll, all lettering should be a minimum ½ inch high; and on the inside of the core, the lettering should be at least ¼ inch high.

The Geonet Manufacturer will use the following guidelines in packaging and preparing all geonet rolls for shipment:

1. When cores are required, use those that have a crushing strength sufficient to avoid collapse or other damage while in use.
2. Geonets must be rolled on the cores so that they will unroll in the machine direction. The machine direction is defined as the direction parallel with the longest diagonal in the diamond pattern of the geonet.

The following practices should be used as a minimum in receiving and storing geonet rolls in the designated storage area at the job site:

1. While unloading or transferring the geonet rolls from one location to another, prevent damage to the geonet. If practicable, the Installer may use forklift trucks fitted with poles that can be inserted into the cores of rolls. Be sure that the poles are at least $^{2}/_{3}$ the length of the rolls to avoid breaking the cores and possibly damaging the geonet. Do not drag the rolls.
2. Store the geonet rolls to ensure that they are adequately covered to protect the geonet from the following:
   - Precipitation
   - Ultraviolet radiation, including sunlight

- Strong oxidizing chemicals, acids or bases
- Flames, including welding sparks
- Temperatures in excess of 160°F
- Soiling

The RPR will observe and document throughout the pre-installation, installation, and post-installation periods that the Installer provides adequate handling equipment used for moving geonet rolls and that the equipment and handling methods used do not pose unnecessary risk of damage. The Installer is responsible for means and methods to implement the work.

The Installer will be responsible for ensuring that materials installed meet specifications (*i.e.*, the roll marking label information indicates required specifications and properly represents materials). The RPR will maintain a log of geonet roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:

1. Date of shipment from Geonet Manufacturer
2. Date of receipt of delivery at job site
3. For each geonet roll the following information will be noted:
    - Roll number
    - Batch (lot) number

9.2 Installation

This section describes the QA requirements applicable to the installation of geonets. This section includes installation, observations, and documentation of geonets.

9.2.1 Placement

The Installer will install all geonets in such a manner as to ensure that they are not damaged in any way and in a manner that complies with the following:

1. On sideslopes, the geonets will be securely anchored, then rolled down the slope in such a manner as to continually keep the geonet in tension. If necessary, the geonet will be positioned by hand after being unrolled to minimize wrinkles.
2. In the presence of winds, all geonets will be secured by suitable methods. The temporary weighted material will be left in place until replaced with cover material as shown on the design plans and specifications.
3. Cutting should be done according to manufacturer's recommendations.

4. The Installer will take necessary precautions to prevent damage to underlying layers during placement of the geonet.
5. During placement of geonets, care will be taken not to entrap in the geonet any stones, excessive dust, or moisture that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane. If dirt or excessive dust is entrapped in the geonet, the geonet will be cleaned prior to placement of the next material on top of the geonet.
6. Unless otherwise approved by the CQA Officer, geonets will not be welded or tack welded to the underlying geomembranes.

9.2.2 Stacking and Joining

When several layers of geonets are stacked, care should be taken to prevent strands from one layer from penetrating the channels of the adjacent layer, thereby significantly reducing the transmissivity. This cannot happen if stacked geonets are placed in the same direction. A stacked geonet should not be laid in a perpendicular direction to the underlying layer.

The following guidelines should be used in stacking and joining geonets:

1. Adjacent rolls will be overlapped by a minimum of four (4) inches.
2. These overlaps will be secured by spot-welding to each other or tying.
3. Tying can be achieved by strings, plastic fasteners, or polymer braid. Tying devices will be white or brightly colored for easy identification. Metallic devices will not be used in any circumstances.

9.2.3 Repairs

Any tears or other defects in the geonet will be repaired by placing a patch extending a minimum of 2 feet beyond the edges of the hole or tear. The patch will be secured to the original geonet by spot-welding or tying every 6 inches. If the tear or other defect width is more than 50 percent of the roll width, the damaged area will be cut out and replaced with new geonet. Tying devices as indicated in Subsection 9.2.2 will be used. The RPR will examine and document that the repair of any geonets is performed according to the above procedure.

9.3 Post-Installation

9.3.1 Final Examination

The RPR will perform a final geonet examination after installation of each geonet layer has been completed. The objectives of this step are as follows:

1. Examine for presence of tears or defects.
2. Examine overlaps and tying or spot-welding.

If any portion of the geonet requires repairs due to the above examination, they will be performed according to the procedures in Subsection 9.2.3. The RPR will document the result of the final examination, including any subsequent repairs.

Table 9-1
Geonet Properties

PROPERTY	UNITS	VALUE	TEST	CRITERION
Thickness	mils	225	ASTM D 1777	Minimum
Density	g/cu cm	0.93	ASTM D 1505	Minimum
Melt Flow Index	g/10 min	1.0	ASTM D 1238	Maximum
Carbon Black Content	Percent	2 - 3	ASTM D 1603	Range

Section 10
Geosynthetic Clay Liner

10.1 Introduction

This section of the CQA Plan applies to the geosynthetic clay liner used in the landfill base composite liner and in the composite final cover. This section is divided into three major subheadings, which cover the quality assurance requirements for pre-installation (includes the GCL manufacturer), installation, and post-installation (includes the final examination of GCL prior to the placement of the geomembrane). The terms pre-installation, installation, and post-installation are applicable only to the GCL installation and do not apply to the overall construction of the landfill facility.

10.2 Pre-installation

Pre-installation activities are designed to help ensure that a high-quality product is being manufactured and that it is properly delivered, handled, and stored to maintain its quality.

10.2.1 Manufacturer's Quality Control Plan

The manufacturer of each component of the GCL and the GCL itself will have a Manufacturer's Quality Control Plan (MQCP) to ensure that their product meets all of the stated minimum properties. These manufacturers include the Bentonite Supplier, the Geotextile Manufacturer, and the GCL Manufacturer.

Bentonite Supplier

The Bentonite Supplier will have a MQCP that will be adhered to in the manufacturing process. This plan will include the following information:

1. Documentation that the bentonite is sodium bentonite
2. Testing that demonstrates that the bentonite meets specified gradation requirements
3. Testing that demonstrates that the bentonite meets specified index test requirements
4. Testing that demonstrates that the bentonite has not been treated with synthetic chemicals or polymers

Geotextile Manufacturer

The Geotextile Manufacturer will have a MQCP that will be adhered to in their manufacturing process. This plan will include the following provisions:

1. Testing that demonstrates that the product is made of specified polymers
2. Testing that demonstrates that the product meets certain minimum average roll values for geotextiles

GCL Manufacturer

The GCL manufacturer will have a MQCP that describes the procedures for accomplishing quality in the final product. At a minimum, the tests shown in Table 10-1 shall be performed by the Manufacturer.

This MQCP will also dictate the following requirements:

- Overlap alignment lines are to be marked on the edges.
- Completed rolls are to be securely wrapped in plastic.
- Completed rolls are to be stored indoors, and provisions are to be in place to prevent rolls from being stacked too high, to ensure that they are kept dry, and to prevent damage during handling.
- QC certificates are to be provided.

10.2.2 Materials

The GCL will consist of a layer of pure sodium bentonite clay encapsulated between two geotextiles, and will comply with all of the manufacturing processes and physical/chemical criteria listed in this Section.

The bentonite clay utilized in the manufacture of the GCL, as well as any accessory bentonite clay (*i.e.*, Volclay® granular sodium bentonite or approved equivalent) provided for seaming and detail work, will meet the manufacturer's minimum requirements, as specified in the MQCP.

The geotextile components of the GCL, and the GCL itself, will meet the minimum requirements of the respective MQCPs.

10.2.3 GCL Delivery, Handling, and Storage

The GCL panels will be supplied to the site in factory-produced rolls, which are of standard factory roll dimensions.

Each roll of GCL supplied to the site will be labeled with the following information:

1. Name of manufacturer
2. Product type and identification number (if any)
3. Lot (Batch) number
4. Date of manufacture
5. Roll number and dimensions

The GCL Manufacturer will ensure that the crushing strength of all GCL roll cores will be sufficient to avoid collapse or other damage while in use.

The rolls of GCL will be carefully unloaded by the Contractor upon arrival at the site. At a minimum, the following practices will be followed in receiving and storing GCL rolls in the covered storage area at the job site:

1. While unloading or transferring the GCL rolls from one location to another, precautions will be taken to prevent damage to the GCL.
2. For standard rolls, a 3-inch Schedule 120 steel support pipe will be inserted through the cardboard roll core. The slings or lifting chains will be attached at one end to the support pipe and at the other end to the bucket of a front-end loader or lifting device. A spreader bar will be used to support and spread the slings. The bar and support pipe must be long enough to prevent damage to the edges of the GCL during hoisting.
3. Alternatively, forklift trucks can be modified to lift the rolls with a 3-inch Schedule 120 steel bar, securely attached to the forklift and inserted into the roll core. At no time will the rolls be lifted by sliding the forks under the roll.
4. The rolls of GCL will be stored in their original, unopened, wrapped cover in a clean, dry area. The material will be stored off the ground on pallets or by other suitable techniques that provide continuous support over the entire length of the roll. It will be covered with a heavy, protective tarpaulin or stored beneath a roof. Care will be used to protect the GCL from the following:

- Precipitation
- Ultraviolet radiation, including sunlight
- Strong oxidizing chemicals, acids or bases
- Flames, including welding sparks
- Temperatures in excess of 160°F

The RPR will be responsible throughout the pre-installation, installation, and post-installation periods, for observing and documenting that the Installer provides adequate handling equipment used for moving GCL rolls and that the equipment and handling methods used do not pose any risk of damage.

The RPR will be responsible for making certain that the name of the manufacturer, the type, and the thickness of each roll (as noted on the roll marking label described above) are correct. The RPR will also maintain a log of GCL roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:

1. Date of receipt of delivery at job site
2. For each GCL roll, the following information will be noted:

- Roll number
- Batch (lot) number

10.2.4 Submittals

Submittals will be made prior to installation of the GCL concerning the GCL manufacturer/production information and the GCL installer information.

The GCL Manufacturer/Production Information will include the following:

1. Corporate background and information.
2. MQCP for bentonite, geotextile, and GCL manufacturers.
3. Project reference list consisting of the principal details of at least 10 projects totaling at least 8 million square feet of GCL installation.
4. Results of tests conducted by the Bentonite Supplier and Geotextile Suppliers to document the quality of the materials used to manufacture the GCL rolls assigned to the project.
5. Copy of QC certificates, signed by a responsible entity of the Manufacturer. Each quality control certificate will include roll identification numbers, and the results of quality control tests (refer to Subsection 10.2.1 above for minimum testing requirements).
6. Manufacturer's written certification that the GCL meets the project specifications, that the GCL has been continuously inspected and found to be needle-free, that the bentonite will not shift during transportation or installation, and that the bentonite and geotextile materials meet the Manufacturer's specifications

GCL Installer information will include the following:

1. Corporate background information
2. Project reference list consisting of the principal details of at least five projects totaling at least 1 million square feet
3. List of personnel performing field operations, along with pertinent experience information, if required by the RPR or CQA Officer

The proposed panel layout diagram identifying placement of the GCL panels and seams, as well as any variances or additional details that deviate from the engineering drawings will also be submitted prior to installation. The layout will be drawn to scale, will include information such as dimensions and details, and will be adequate for use as a construction plan.

10.3 Installation

The following installation procedures are designed to ensure the effectiveness of the GCL in meeting its design requirements and to simplify the deployment procedures. These procedures are to be followed by the Installer, unless the Installer proposes alternative procedures in writing and the CQA Officer approves them in writing prior to installation.

10.3.1 Testing Requirements

This subsection describes the test methods, including sampling procedures and frequencies, and the role of the Geosynthetic Testing Laboratory in testing the GCL roll samples. Unless specified otherwise, all sampling procedures will be performed in accordance with the referenced test method defined in this section.

GCL roll samples will be collected by the Contractor at the discretion of, and under the direction of, the RPR, at a rate specified by the RPR.

Samples will be 3 feet long by the full width of the roll and will not include the first 3 feet of any roll.

Table 10-1 lists the tests and the test methods that may be performed on GCL roll samples. The specifications and methods used in evaluating the results are discussed later in this subsection.

Role of Testing Laboratory

The Geosynthetic Testing Laboratory will be responsible for performing the tests on samples submitted to them. The results of tests performed will be reported to the RPR and CQA Officer.

Retesting of GCL rolls for quality assurance purposes, because of failure to meet any or all of the acceptance specifications in this section, can only be authorized by the CQA Officer.

The GCL Manufacturer and/or Installer may perform their own tests according to the methods and procedures defined in Table 10-1; however, the results will only be applicable to their own quality control needs. These results will not be substituted for the quality assurance testing described herein.

Procedure for Determining GCL Roll Test Failures

Table 10-1 lists the specifications that are applicable to the GCL. For any referenced test method that requires the testing of multiple specimens, the criteria in Table 10-1 will be met based on the average results of the multiple specimen tests.

The following procedure will be used for interpreting the results relative to acceptance or rejection of rolls, lots, and shipments of GCL to the site:

1. If the test values meet the stated specifications, then the roll and batch will be accepted for use at the job site. If the sample represents all rolls from an entire shipment, then the entire shipment will also be considered accepted.
2. If the results do not meet the specification, then the roll and the batch will be retested at the Contractor's expense using specimens either from the original roll sample or from another sample collected by the RPR. For retesting, two additional tests will be performed for the failed test procedure. (Each additional test will consist of multiple specimen tests if multiple specimens are called for in the failed test procedure.) If both of the retests are acceptable, then the roll and batch will be considered as having passed this particular acceptance test; if either of the two additional tests fail, then the roll and batch will be considered as being unsuitable without further recourse. The RPR may obtain samples from other rolls in the batch. On the basis of testing these samples, the CQA Officer may choose to accept a portion of the batch while rejecting the remainder.

   If retesting does not result in passing test results as defined in the preceding paragraph, or if there is any other nonconformity with the material specifications, then the Contractor will withdraw the rolls from

use in the project at Contractor's sole risk, cost, and expense. Once withdrawn, the same rolls will not be resubmitted for use. Expenses for removing this GCL from the site and replacing it with acceptable GCL will be the sole risk and responsibility of the Contractor.

10.3.2 Required Equipment

The following installation equipment is required on site:

1. Front-end loader, crane, or other similar equipment. The selected piece of equipment will not cause damage to the subgrade, such as rutting. The Installer will verify in the presence of the RPR that the selected piece of equipment does not damage the subgrade
2. A spreader bar to prevent slings from damaging the ends of the rolls.
3. 3-inch–diameter Schedule 120 steel pipes to be inserted into the roll's core for lifting.
4. Wooden pallets for aboveground storage of the GCL rolls.
5. Heavy waterproof tarps for protecting all GCL rolls.
6. Sandbags for securing the GCL during installation and for securing the tarps.
7. Adhesive or tape for securing patches.
8. Granular bentonite for seams and patches, and for securing around penetrations and structures as shown on the drawings.

10.3.3 Surface/Subgrade Preparation

GCL liner installation will not begin until a proper subbase has been prepared to accept the bentonite liner. Base material will be fine-grained soil free from angular rocks, roots, grass, and vegetation. Foreign materials and protrusions will be removed; all cracks and voids will be filled; and the surface will be made smooth and uniformly sloping. Unless otherwise required by the contract specifications, the prepared surface will be free from excessive moisture, loose earth, rocks or clay clods larger than ½ inch in diameter, rubble, and other foreign matter. The subgrade will be uniformly compacted to ensure against localized settlement and rutting under wheel loads and will be smoothed with a smooth drum roller.

The surface on which the liner is to be placed will be maintained in a firm, clean, and smooth condition, free of standing water, during liner installation.

10.3.4 Deployment

As each roll is moved from the storage area, the labels will be removed by the Installer's Superintendent or RPR for storage in the project file.

The rolls of GCL will be brought to the area to be lined with a front-end loader, and support pipe will be set up such that the roll of liner is fully supported across its length. A spreader bar or similar device will be used to prevent the lifting chains or slings from damaging the edges. Dragging of the GCL liner will be minimized.

The Contractor will ensure, and the RPR will verify, that the following criteria are being met:

1. The equipment used does not damage the GCL by handling, excessive heat, leakage of hydrocarbons, or by other means.
2. The prepared surface underlying the GCL has not deteriorated since previous acceptance, and it is still acceptable at the time of GCL placement.
3. Personnel working on the GCL do not smoke, wear damaging clothing, or engage in other activities that could damage the GCL.
4. The method used to unroll the GCL does not cause damage to the GCL, and/or the subgrade.
5. The method used to place the rolls minimizes wrinkles (especially wrinkles between adjacent panels).

GCL must not be placed during precipitation events, in the presence of excessive moisture, in any area of ponded water, or during excessive winds. The GCL must be dry when installed and must be dry when covered with soil.

The proper side of the GCL, as per the manufacturer's recommendation, will face upward (unless otherwise dictated by project requirements). The liner will be placed over the prepared surface such that material handling will be minimized.

The GCL panels will be placed in a manner that ensures sufficient overlap as described in Subsection 10.3.5. Horizontal seams will not occur on slopes steeper than 7 horizontal: 1 vertical.

The cover material (*i.e.*, geocomposite and soil) will be placed over the bentonite liner during the same day as the placement of the GCL. Only those GCL rolls that can be covered that same day will be unpacked and placed in position.

When wind conditions could affect installation, the GCL liner installation will be started at the upwind side of the project and will proceed downwind. The leading edge of the liner will be secured at all times with sandbags or other means sufficient to hold it down during high winds.

The GCL will be installed in a relaxed condition and will be free of tension or stress upon completion of the installation. Stretching of the liner to fit will not be allowed. Deployed rolls (panels) will be straightened by the installation personnel to smooth out creases or irregularities.

The RPR will visually inspect the geotextile's quality, the bentonite uniformity, and the degree of hydration, if any, of the GCL. Any areas in need of repair will be marked.

10.3.5 Seaming

Once the first panel has been deployed, adjoining panels will be laid with a 6-inch minimum overlap on longitudinal seams, and 24 inches on the panel end seams. Six-inch and 12-inch overlap lines will be marked on the liner to assist in obtaining the proper overlap. All dirt, gravel, or other debris will be removed from the overlap area of the GCL.

Seam overlaps, whenever possible, will be placed such that the direction of flow is from the top panel to the underlying panel to form a shingle effect.

If the GCL requires a granular bentonite seam, then the overlapping panel edge will be pulled back and granular Volclay® (or approved equivalent) sodium bentonite will be poured continuously along all seams and lap areas from the panel edge to the 6-inch lapline, at a minimum application rate of ¼ pound per linear foot.

10.3.6 Patches/Repairs

Irregular shapes, cuts, or tears in the installed GCL will be covered with sufficient liner to provide a 12-inch overlap in all directions beyond the damaged area. A layer of granular bentonite will be placed in the overlap zone in accordance with the Manufacturer's recommendations. An epoxy-based adhesive, or other approved method, will be used to secure the patch during backfill operations. Alternatively, the patch can be placed underneath the defective liner.

Patch repairs should not be allowed on slopes greater than 7 horizontal: 1 vertical, unless a water-soluble adhesive, or other approved method, is used to secure the patch.

10.3.7 Penetration Seals

The GCL will be sealed around penetrations, pipes, and structures in accordance with the recommendations of the GCL Manufacturer.

Pipe penetrations will incorporate a collar of GCL wrapped around the pipe and securely fastened. A bentonite or mastic grout will be placed around the corners for additional protection.

Depending on the location of the pipe penetration, an additional GCL skirt placed over the bentonite grout may be required by the GCL Manufacturer to provide a third level of protection and to prevent the bentonite grout from being displaced.

If the seal requires granular bentonite, then a 1-inch to 2-inch cut will be excavated around the circumference of the pipe, into the subgrade at least 12 inches out from the pipe. Volclay® sodium bentonite (or approved equivalent) will then be packed around the pipe in the subgrade excavation and on adjacent areas so that the pipe is surrounded with granular bentonite.

The GCL panel will then be placed over the pipe by penetrating the GCL with slits in a "pie" configuration where the pipe is to protrude in a manner that will create a snug fit between the GCL and the pipe.

More sodium bentonite will then be spread around the cut edges of the GCL against the pipe and over adjacent areas.

To complete the pipe penetration seal, a collar of GCL will be cut in a manner similar to that made on the main panel and will be fit around the pipe, with additional Volclay® sodium bentonite being applied into any gaps that may remain.

10.3.8 Covering GCL

Only the amount of GCL that can be inspected, repaired, and covered in the same day will be installed. The GCL must be covered the same day on which it is installed.

Geosynthetics

When covering the GCL, precautions will be taken to prevent damage to the GCL by restricting heavy equipment traffic. The following requirements apply to material placement over the GCLs:

1. Equipment used for placing the material must not be driven directly on the GCL.

2. A minimum thickness of 1 foot of fill is specified between a light dozer (*i.e.*, maximum contact pressure of 5 lb/sq. inch) and the composite liner (consisting of a geomembrane overlying a GCL).
3. A minimum thickness of 3 feet of fill is specified between rubber-tired vehicles and the composite liner.

Any leading edge or panels of GCL left unprotected must be covered with a heavy, waterproofing tarp that is secured and protected with sandbags or other ballast.

10.3.9 Construction Quality Assurance

Installer

The Installer will maintain documentation in the daily installation records, and will provide such documentation to the RPR that the above conditions are fulfilled. The RPR will be informed if any of the above conditions are not met.

The GCL will be installed according to the manufacturer's guidelines, the CQA Plan, and the project specifications.

Resident Project Representative

The RPR will be responsible for the following quality assurance duties:

1. Observation of the installation of the GCL for compliance with the manufacturer's guidelines, the CQA Plan, and the project specifications.
2. Collection of the field acceptance samples to be tested as indicated in Table 10-2.
3. Visual inspection of the geotextile quality, bentonite uniformity, and degree of hydration, if any, on the GCL. Any areas in need of repair will be marked.
4. Recording each roll number and lot number as panels are deployed, along with a general description of the location of each panel.
5. Inspection of the overlaps.
6. Inspection of the anchoring and sealing around penetrations.

10.3.10 Submittals

The following will be submitted during installation:

1. Daily records/logs prepared by the Installer documenting work performed, personnel involved, general working conditions, and any problems encountered or expected on the project. These records will be submitted on a weekly basis.
2. Copy of subgrade acceptance forms by the Installer.
3. QC documentation.

10.4 Post-Installation

10.4.1 Final Examination

The RPR will perform a final GCL examination after portions of installation have been completed. The RPR will examine the GCL for the following:

1. Tears or defects
2. Proper overlaps
3. If any portion of the GCL requires repairs based on the above examination, it will be repaired in accordance with the procedures in Subsection 10.3.6.

10.4.2 Submittals

The following will be submitted after installation is completed:

1. Installation certification prepared by the Installer certifying that the GCL was installed in substantial accordance with the specifications and the CQA Plan.
2. An as-built panel layout diagram prepared by the Installer identifying the placement of panels and seams. The numbering sequence will be as agreed upon between the RPR and the Installer prior to commencing installation.
3. A copy of the Warranty obtained from the Manufacturer/Installer.

Table 10-1
Summary of Specifications and Quality Control Testing

	PROPERTY	TEST METHOD[5]	UNITS	VALUE	MIN. TESTING FREQUENCY	TESTED BY
Bentonite properties (bentonite removed from finished product)	Free swell Liquid limit Fluid loss Moisture content [1]	USP-NF-XVII ASTM D 4318 API 13 A ASTM D 4643	mL % mL %	30 (MARV) 500 (MARV) 15 (MAX.A.R.V.) 20 (TYP)	1/20,000 SF	Independent Laboratory
Adhesive	Adhesion	Visual	N/A	Continuous adhesion to backing materials	Periodic	Manufacturer
Physical GCL properties	Thickness	ASTM D 1777	inches	0.2 (TYP)	1/20,000 SF	Manufacturer
	Wide width tensile[2]	ASTM D 4595	ppi	100 (TYP)	Periodic	Independent Laboratory
	Grab tensile[3]	ASTM D 4632	lb	90 (MARV)	Per ASTM D 4354	Manufacturer
	Bentonite unit weight[1] @ 25% moisture	Direct measurement 12 inch x roll width	lb/sqf	0.95 (MARV)	1/20,000 SF	Manufacturer
	Shear resistance (hydrated) Shear resistance (dry)	ASTM D 35.01.81.07 (draft)	psf psf	500 (TYP)[4] 500 (TYP)[4]	Periodic	Independent Laboratory
Hydraulic Properties	Permeability GCL 5 psi effective stress Overlapped GCL 5 psi effective stress	ASTM 5084 ASTM 5084	cm/s cm/s	5×10^{-9} (MAX) 5×10^{-9} (MAX)	1/750,000 SF 1/750,000 SF	Manufacturer Manufacturer
	GCL 30 psi effective stress Damaged GCL 3 each, 1 inch holes (5 psi effective stress) After 3 wet-dry cycles (5 psi effective stress) After 5 freeze-thaw cycles (5 psi effective stress)	ASTM 5084 ASTM 5084 ASTM 5084 ASTM 5084	cm/s cm/s cm/s cm/s	$< 5 \times 10^{-10}$ (TYP) $< 5 \times 10^{-9}$ (TYP) $< 5 \times 10^{-9}$ (TYP) $< 5 \times 10^{-9}$ (TYP)	Periodic	Independent Laboratory

(1) D4643 modified to include wet weight as the denominator.
(2) Wide width tensile performed on finished 500SP.
(3) Machine (WARP) direction of primary backing.
(4) Shear resistance of 500SP is independent of normal stress.
(5) Standard test methods modified where appropriate to facilitate testing a GCL.

Table 10-2
Collection of Field Acceptance Samples

PROPERTY	METHOD	MINIMUM ACCEPTABLE VALUE
Fluid loss	API 13 A	15 mL[1]
Free swell	USP-NF-XVII	24 mL at 24 hours[2]
Liquid limit	ASTM D 4318	500%[2]

(1) Maximum Average Roll Value (Max.A.R.V.)
(2) Minimum Average Roll Value (M.A.R.V.)

Section 11
Geocomposites

A geocomposite will be installed over the barrier layer in the final cover and the barrier layer in the liner on the 3 (horizontal): 1 (vertical) sideslopes to provide drainage.

This section is divided into three major subheadings, which cover the QA requirements for Pre-Installation, Installation, and Post-Installation. The terms Pre-Installation, Installation, and Post-Installation are applicable only to the geocomposite installation and do not apply to the overall construction.

11.1 Pre-Installation

11.1.1 Manufacturing

Material Specifications

Geotextile and geonet suitable for producing the geocomposite to be used in the landfill final cover are based on the material specifications of the geotextile and geonet listed in Subsections 7.1.1 and 9.1.1, respectively.

Quality Control Requirements/Manufacturer's Certification

The Geocomposite Manufacturer (fabricator) will provide the CQA Officer with certification of geotextile and geonet materials used in the fabrication of the geocomposite rolls delivered to the job site. The Geocomposite Manufacturer will also provide the CQA Officer with representative samples of the geotextile used in the fabrication of the geocomposite rolls for conformance testing. Requirements for the manufacturer's certification for geonets are described in Subsection 9.1.1. Requirements for the manufacturer's certification of geotextiles are shown in Table 11-1.

11.1.2 Delivery, Handling, and Storage of Geocomposite Rolls

Each geocomposite roll, for use at the landfill facility, will be marked by the Geocomposite Manufacturer with the following information and in the following manner:

1. When fabric is rolled on a core, identify each roll with a durable gummed label, or an equivalent, on the inside of the core and on the outside of the protective wrapping for the roll.
2. Each roll label will contain the following information at a minimum:
   - Name of manufacturer (or fabricator)
   - Style and type number
   - Roll length and width
   - Batch (or lot) number, if applicable
   - Date of manufacture
   - Direction for unrolling
   - Roll number
3. On the outside of the roll, all lettering should be a minimum of ½ inch high, and on the inside of the core, the lettering should be at least ¼ inch high.

The Geocomposite Manufacturer will use the following guidelines in packaging, wrapping, and preparing all geocomposite rolls for shipment:

1. When cores are required, use those that have a crushing strength sufficient to avoid collapse or other damage while in use.
2. Cover each roll with a wrapping material that will protect the geotextile from damage due to shipment, water, sunlight, or contaminants.

The following practices should be used as a minimum in receiving and storing geocomposite rolls in the designated storage area at the job site:

1. While unloading or transferring the geocomposite rolls from one location to another, prevent damage to the geocomposite. If practicable, the Installer may use forklift trucks fitted with poles that can be inserted into the cores of rolls. Be sure that the poles are at least $^{2}/_{3}$ the length of the rolls to avoid breaking the cores and possibly damaging the geocomposite. Do not drag the rolls.
2. Store the geocomposite rolls to ensure that they are adequately covered to protect the geocomposite from the following:
   - Precipitation
   - Ultraviolet radiation, including sunlight

- Strong oxidizing chemicals, acids or bases
- Flames, including welding sparks
- Temperatures in excess of 160°F
- Soiling

The RPR will observe and document throughout the pre-installation, installation, and post-installation periods for observing and documenting that the Installer provides adequate handling equipment used for moving geocomposite rolls and that the equipment and handling methods used do not pose unnecessary risk of damage. The Installer is responsible for means and methods to implement the work.

The Installer will be responsible for ensuring that materials installed meet specifications (*i.e.*, the roll marking label information indicates required specifications and properly represents materials). The RPR will maintain a log of geocomposite roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:

1. Date of shipment from Geocomposite Manufacturer
2. Date of receipt of delivery at job site
3. For each geocomposite roll, the following information will be noted:
    - Roll number
    - Batch (lot) number, if applicable

11.2 Installation

This section describes the QA requirements applicable to the installation and testing of geocomposites. This section includes roll sample testing, installation, observations, and documentation of geocomposites.

11.2.1 Testing Requirements

This subsection describes the test method, including sampling procedures and frequencies, and the role of the Geosynthetic Testing Laboratory in testing the geocomposite roll samples.

Test Method

Unless specified otherwise, all sampling procedures will be performed in accordance with the referenced test method defined in this section.

Geocomposite roll samples will be collected by the RPR. Sample frequency will be based on ASTM D 4354, Procedure A, where the number of units per lot is defined as the number of rolls for a specified lot (using batch or lot numbers) delivered to the job site in one shipment. Required sampling frequencies are shown in Table 8-1.

Samples will be 3 feet long by the full width of the roll and will not include the first 3 feet of any roll. Since machine direction for the geocomposite rolls is the direction that the material comes off the roll, machine direction for any sample will always be along the 3-foot-length dimension of the sample.

Table 11-1 lists the test and the test method to be performed on geocomposite roll samples. The specifications and methods in evaluating the results are discussed below under Procedures for Determining Geocomposite Roll Test Failures.

Results for ply adhesion will be reported for both the machine and cross direction (machine direction will be taken as the direction the geonet is taken off of the rolls).

Role of Testing Laboratory

The Geosynthetic Testing Laboratory will be responsible for performing the test on samples submitted to them as described above. Results of tests performed will be reported to the CQA Officer and the RPR.

Retesting of geocomposite rolls for QA purposes, because of failure to meet any or all of the specifications listed below, can only be authorized by the CQA Officer.

The Geocomposite Manufacturer (fabricator) and/or Installer may perform their own tests according to the methods and procedures defined in Table 11-1; however, the results will only be applicable to their own QC needs. These results will not be substituted for the QA testing described herein.

Procedures for Determining Geocomposite Roll Test Failures

Table 11-1 lists the accepted values that are applicable to geotextile component the geocomposite. The values in Table 11-1 are based on minimum values.

The following procedure will be used for interpreting results relative to acceptance or rejection of rolls and shipments of geocomposites to the site:

1. Test results for the stated specifications in Table 11-1 will be evaluated in accordance with ASTM D 4759 for determining acceptance of roll shipments.
2. The RPR will coordinate and document the conformance testing and the determination of material acceptance or rejection.

11.2.2 Placement

The Installer will install all geocomposites in such a manner as to ensure that they are not damaged in any way and in a manner that complies with the following:

1. On sideslopes, the geocomposites will be securely anchored, then rolled down the slope in such a manner as to continually keep the geocomposite in tension. If necessary, the geocomposite will be positioned by hand after being unrolled to minimize wrinkles.
2. In the presence of winds, all geocomposites will be secured by suitable methods. The temporary weighted material will be left in place until replaced with cover material as shown on the design plans and specifications.
3. Cutting should be done according to manufacturer's recommendations.
4. The Installer will take necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
5. During placement of geocomposites, care will be taken not to entrap any stones, excessive dust, or moisture that could cause clogging of the drainage system.

11.2.3 Overlaps and Joining

The following requirements will be used with regard to overlapping and joining of geocomposite rolls:

1. Adjacent rolls will be overlapped by a minimum of 4 inches.
2. These overlaps may be secured by tying to each other.
3. Tying can be achieved by strings, plastic fasteners, or polymer braid. Tying devices will be black or brightly colored for easy identification. Metallic devices will not be used in any circumstances.

4. No horizontal joints or overlaps will be allowed on slopes greater than 5 horizontal to 1 vertical (*i.e.*, seams will be along, not across, the slope), except as part of a patch.

11.2.4 Repairs

Any tears or other defects in the geocomposite will be repaired by placing a patch extending a minimum of 2 feet beyond the edges of the hole or tear. The patch will be secured to the original geocomposite by tying every 6 inches. If the tear or other defect width is more than 50 percent of the roll width, the damaged area will be cut out and replaced with new geocomposite material. Tying devices will be as indicated in Subsection 11.2.3. The RPR will examine and document that the repair of any geonets is performed according to the above procedure.

11.3 Post-Installation

11.3.1 Final Examination

The RPR will perform a final geocomposite examination after installation of each geocomposite layer has been completed. The objectives of this step are as follows:

1. Examine for presence of tears or defects
2. Examine overlaps to make certain that they are in conformance with the requirements of Subsection 11.2.3.

If any portion of the geocomposite requires repairs due to the above examination, they will be performed according to the procedures in Subsection 11.2.4.

If there will be an extended time delay between completion of the geocomposite and the start of the installation of any overlying cover, the Installer will make provisions by using a temporary covering or other suitable methods, to protect the upper geotextile component against exposure to sunlight and ultraviolet radiation.

11.3.2 Placement of Soil Materials

The construction contractor will place all soil materials located on top of the geocomposite in such a manner as to minimize the following:

1. Damage of the geocomposite
2. Slippage of the geocomposite on underlying layers
3. Excessive tensile stresses imposed on the geocomposite

If portions of the geocomposite are exposed, the RPR will periodically place two (or more, at his discretion) marks on the geocomposite 10 feet apart along the slope and measure the elongation of the geocomposite during the placement of soil.

Table 11-1
Geotextile Component of Geocomposite Acceptance Specifications

PROPERTY	UNITS	ACCEPTABLE VALUE	TEST METHOD	TYPE OF CRITERION
Ply Adhesion - Machine Direction	ppi	1.0	ASTM F904	Minimum
Ply Adhesion - Cross Direction	ppi	1.0	ASTM F904	Minimum
Apparent Opening Size	NA	No. 70	ASTM D 4751	Minimum
Grab Strength	lb	50	ASTM D 4632	Minimum
Grab Strength Elongation	Percent	30	ASTM D 4632	Minimum
Trapezoidal Tear	lb	75	ASTM D 4533	Minimum
Puncture Strength	lb	95	ASTM D 4833	Minimum
Mullen Burst Strength	lb/sq in.	360	ASTM D 2210	Minimum
Permittivity	ga/min/ft^2	110	ASTM D 4491	Minimum

Section 12
Select Ash Fill

Select ash fill refers to select ash material that will be placed as a protective layer over the granular drainage material, and on the waste as it approaches final grade to provide a levelling course prior to placement of the final cover.

12.1 Procedures and Observations

The RPR will observe select ash fill placement activities and document relevant observations to support certification of the following requirements:

1. Select ash fill material shall be free of cinders and solid impurities capable of puncturing the GCL or the geomembrane.
2. Select ash fill shall be placed in 8-inch loose depth maximum lifts and compacted with a minimum of two passes of the compaction equipment.
3. The completed select ash fill layer shall have a uniform surface.

12.2 Field and Laboratory Testing

Field and laboratory testing of select ash fill material is not required; however, as discussed in Subsection 12.1 above, the RPR will observe and document the consistency of the fill material and placement procedures.

12.3 Thickness Documentation

The top and bottom of the select ash fill layer will be surveyed on a 50-foot grid pattern. The minimum acceptable compacted thickness will be 12 inches vertical in the liner and 12 inches vertical in the cap.

Section 13
Piping

This section of the CQA Plan applies to piping used in the leachate collection and removal system in the landfill liner and in the gas removal system. This section is divided into three major subheadings, which cover the QA requirements for the Pre-installation (which includes resin manufacturers, piping manufacturers, and fabricators), installation, and Post-installation (which includes the final observation and documentation of piping installations prior to installation of other materials over and around the pipe). These terms Pre-installation, Installation, and Post-installation are applicable only to the piping installation and do not apply to the overall construction.

Individual pipe sizes and SDRs to be used for each individual pipe installation are not detailed in this section; rather, the plans and specifications should be used for the determination of correct size and wall thickness.

13.1 Pre-Installation

This section describes the QA measures that are applicable to the polyethylene (PE) resin manufacturers, piping manufacturers, piping fabricator used to perforate the pipe, and finished piping delivery to the site, prior to installation.

13.1.1 Manufacturing

Material Specifications

Any pipe used must be made from extra high molecular weight (EHMW) PE resin, and the manufactured piping must be classified as Type III, Class C, Category 5, Grade P34 material according to ASTM D 1248 and also have a cell classification of 345434C as defined by ASTM D 3350. Pipe shall be free of paint or other surface treatments.

Quality Control Requirements

Prior to the delivery of any piping to the site, the piping manufacturer will provide the CQA Officer with the following information:

1. The resin supplier, location of suppliers production plant(s) and resin brand name and product number.

2. Any test results obtained by the piping manufacturer and/or the pipe manufacturer's testing laboratories to document the quality of the resin used in manufacturing the piping.
3. The QC Plan that the piping manufacturer will be using for the pipe being supplied.

Fabricator

The Piping Fabricator will be responsible for perforating the pipe, delivered by the Piping Manufacturer, according to the plans and specifications. The Piping Fabricator will be responsible for preparing and shipping the perforated pipe to the job site. Marking of the pipe must be performed in accordance with Subsection 13.1.2.

Manufacturer's Certification

The Piping Manufacturer will provide certification, based on tests performed by either the Piping Manufacturer's laboratory or other outside laboratory contracted by the Piping Manufacturer, that the pipe supplied under this plan will meet the following specifications:

1. The finished pipe is classified as Type III, Class C, Category 5, Grade P34 according to the provisions of ASTM D 1248.
2. The finished pipe meets the cell classification of 345434C according to the provisions of ASTM D 3350.
3. The finished pipe has the SDR value specified.

13.1.2 Delivery, Handling, and Storage of Piping

Each bundle of pipe prepared for shipment by the Piping Fabricator will be marked with the following information:

1. Nominal Size
2. Dimension Ratio
3. Pressure Rating
4. Type (Manufacturer)
5. Material Classification
6. Certification Bases
7. Blank Position for NSF/FM Use
8. Pipe Test Category

9. Plant
10. Extruder Number
11. Date
12. Operator Number
13. Shift Letter
14. Resin Supplier Code

Example: 10" IPS SDR 15.5 110 psi (Trade Name) PE 3408 ASTM F-714 NSF-pw C3 P5 06FEB89 55A P

The pipe will be protected, during shipment, from excessive heat or cold, puncture, or other damaging or deleterious conditions. The pipe will be stored on site in a manner suitable to protect it from long-term ultraviolet exposure, prior to actual installation.

The RPR will observe and document throughout the pre-construction, construction, and post-construction periods that the Installer provides adequate handling equipment for moving pipe and that the equipment and handling methods used do not pose unnecessary risk of damage. The Installer is responsible for means and methods to implement the work.

The Installer will be responsible for making certain that the manufacturer, type and size of each pipe is correct. The RPR will maintain a log of pipe deliveries throughout the installation. The following information at a minimum will be recorded on the log for each shipment received at the job site:

1. Date of shipment from piping manufacturer
2. Date of receipt of delivery at job site
3. For each pipe, the following information will be noted:
    - Pipe size and type
    - Batch (lot) number

13.2 Installation

This section describes the requirements applicable to pipe installation. This subsection includes installation, observations, and documentation of piping installations.

13.2.1 Pipe Seams

Unless approved otherwise by the CQA Officer, all pipe seams will be made by the butt fusion procedure as defined by Phillips Driscopipe, Inc. and Plexco Piping Company. Sections of polyethylene pipe should be joined into continuous lengths on the job site above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements of 400°F, alignment, and 75 psi interfacial fusion pressure. Butt fusion joining shall be 100 percent efficient offering a joint weld strength equal to or greater than the tensile strength of the pipe. Socket fusion shall not be used. Extrusion welding or hot gas welding of HDPE shall not be used for pressure pipe applications nor in fabrications where shear or structural strength is important. Flanges, unions, grooved-couplers, transition fittings, and some mechanical couplers may be used to mechanically connect HDPE pipe without butt fusion. Refer to the manufacturer's recommendations. The following procedures will be used regarding butt fusion seams:

1. Seams should be made at the pipe manufacturer's recommended heater plate temperature of approximately 400°F for fusing pipe and fittings.
2. For pipe diameter sizes 4 inches (nominal) and larger seams will be made using the hydraulic fusion machines. For pipe diameters of less than 4 inches, manual fusion equipment can be used.
3. Care will be taken to make certain that adequate pressures are used for fusing pipes and that sufficient cooling periods are allowed prior to testing, bending, or backfilling of pipe sections.

13.2.2 Placement Requirements

Pipe placement will be done in accordance with the following procedures and requirements:

1. Piping placement will not be performed in the presence of excessive moisture. The RPR will document that this condition is fulfilled. Additionally, the RPR will document that the supporting backfill has not been damaged by weather conditions. The RPR will inform the CQA Officer if any of the above conditions are not fulfilled for evaluation of the necessity of corrective action.

2. The prepared surface underlying the piping has not deteriorated since previous acceptance, and it is still acceptable immediately prior to piping placement.
3. Method used to place the piping does not cause damage to the piping and does not disturb the supporting backfill.
4. The RPR will observe and document all pipe installation. Deviations from the plans and specifications will be brought to the attention of the CQA Officer for evaluation of the necessity of corrective action.
5. The RPR will observe and document the placement of geotextile filter to line the trenches and placement of pipe bedding stone around collector pipes according to the plans and specifications and the procedures described in Subsection 7.2.1.
6. Observations and measurements should be made to ensure that the pipes are the specified size, manufactured of the specified material, and that pipe perforations are sized and spaced as specified.
7. All piping should be located as noted in the plans and specifications. Locations, grades, and size requirements are specified on the details of the plan set. Observations and surveying measurements should be made to ensure the pipes are placed at the specified locations and grades, and in the specified configuration. Observations should be made throughout the construction to ensure that backfilling is completed as specified in the plans and specifications and that, in the process, the pipe network is not damaged.

13.2.3 Pipe Boots

Pipe boots shall be installed as shown on approved shop drawings with a continuous extrusion weld joining the pipe to the geomembrane liner. The RPR shall observe all pipe boot installations.

13.2.4 Damages

The RPR will examine each pipe after placement for damage. Damaged pipes or portions of pipes that have been rejected will be marked and removed from the installation area and documented by the RPR.

13.3 Post-Installation

Pipe inverts (or top of pipe elevations) and coordinate locations shall be surveyed at 50-foot intervals and at all tee connection locations. Additional surveying requirements regarding granular soil backfill placement are discussed in Subsection 6.3.

Section 14
Compacted Prepared Subgrade Fill

Prepared subgrade fill refers to the 1-foot thick compacted subgrade soil beneath the composite liner with permeability of 4.2×10^{-4} cm/s or less. The existing on-site subgrade soils if appropriate and soil from the Owner's on-site borrow source are proposed for the prepared fill subgrade layer. Existing soil data, cross sections, and borrow investigation reports will be made available to the contractor.

14.1 Procedures and Observation

The installer will be responsible for means and methods to implement the work. The RPR will observe the compacted prepared subgrade construction activities and will document relevant observations to support certification of the following requirements:

1. The RPR will confirm the uniformity of the prepared subgrade fill. Soil excavation, proportioning, mixing, and placement will be monitored for segregation and removal of unsuitable material and for changes in soil type, color, texture, and moisture content.
2. The construction contractor will segregate and/or remove unsuitable materials such as soils not meeting acceptance criteria (boulders, cobbles, and organic material).
3. The RPR will measure field densities and moisture contents, using methods described in Subsection 14.2 (Sampling Requirements and Acceptance Criteria), to document that the compacted prepared subgrade is in substantial conformance with the placement specifications and that soil placement has been conducted in a manner to achieve a uniform, homogeneous mass meeting the permeability requirement.
4. Voids created by nuclear density gauge testing or retrieval of Shelby tube samples will be backfilled with sodium bentonite.
5. The prepared subgrade fill shall be placed in two loose lift thicknesses not exceeding 8 inches. Each loose lift shall be compacted with multiple passes using appropriate compaction equipment. If the soil is deposited in thickness exceeding 8 inches, dozers will be used to spread the soil to an 8-inch thickness prior to compaction. This will ensure adequate reduction of clod size and provide a thin layer to achieve required compaction throughout the lift.
6. Areas of unacceptable hydraulic conductivity, compaction density, or moisture content, as defined by Subsection 14.2 (Sampling Requirements and Acceptance Criteria), will be documented by the RPR. Corrective action will consist of moisture conditioning of the soil or additional compactive effort as necessary. Methods for moisture-conditioning soils are described in Item 7 below. Following corrective actions, such areas will be retested.

7. If necessary, surfaces of the prepared subgrade to receive successive lifts of prepared subgrade fill will be moisture-conditioned either by scarification and addition of water where desiccated, or by disking and air drying where saturated to promote effective bonding of lifts. Following scarification, water will be applied with a spray bar applicator or equivalent methods to achieve uniform distribution.
8. Soil compaction will be performed in a manner to achieve continuous and complete keying together of the prepared subgrade construction areas. Stepped joints will be utilized to connect lateral segments of the prepared subgrade construction.
9. No frozen soils will be used for prepared subgrade construction. Frozen soils in the compaction work area will be removed.
10. Stones that are larger than 0.5-inch in diameter shall be removed from the surface of the final lift of the prepared subgrade to avoid potential for puncturing the geosynthetic clay liner. The method to detect and remove stones requires an initial overfill of compacted prepared subgrade soils approximately 1 inch above design grades. A grader will then blade the prepared subgrade surface to obtain uniform subgrades and design elevations. Stones present will be exposed and loosened by the grading. The RPR shall inspect the prepared subgrade during this process and document removal of stones by the contractor. Voids made by removal of stones shall be filled with prepared subgrade soil, and then the entire prepared subgrade surface shall be rolled with a smooth drum compactor.
11. The prepared subgrade surface on which the composite liner will be placed shall be maintained in a firm, clean, and smooth condition, free of standing water, during liner installation.
12. Preconstruction planning will be undertaken to sequence construction activities to minimize the length of time any completed prepared subgrade surfaces are exposed prior to receiving protective cover. Protective cover will be provided by installation of the geosynthetic clay liner and the geomembrane.
13. Preconstruction planning will be undertaken to minimize the need for traffic over the completed prepared subgrade surface. Heavy trucking of materials (ingress or egress) and cleated equipment will not be allowed directly on completed prepared subgrade surfaces. If this is unavoidable, an evaluation will be made upon termination of the haul route to determine if the prepared subgrade should be reconstructed or repaired in such areas. Flotation-type all-terrain vehicles will be used to assist in deployment of the geosynthetic clay liner to avoid disruption of the completed prepared subgrade surface.

14.2 Sampling Requirements and Acceptance Criteria

Field and laboratory sampling frequencies are based on proportionate sampling of construction areas or volume of material placed as specified below. This section describes required analysis, methods, sample frequency, and acceptance limits. Table 14-1 summarizes the minimum QA testing recommended in Subsection 14.3. The RPR will perform field tests and collect soil samples for laboratory analysis.

14.3 Field Testing and Sampling

The following field testing and sampling methods and frequencies will be used by the RPR during construction of the prepared subgrade.

- One field density and as-placed moisture content test (ASTM D 3017 and ASTM D 2922 Method B) will be performed for each compacted lift on an approximate 100-foot grid pattern.
- Initially, a representative (grab) soil sample of the prepared subgrade soils will be collected from the borrow source and submitted to the Soils Testing Laboratory for testing described in Subsection 14.3.4. Additional samples will be collected every 4,000 cubic yards for each major soil type utilized. A sample will also be collected when changes in the physical appearance or soil characteristics are observed.
- A minimum of one undisturbed Shelby tube sample will be obtained for each acre or less for every lift of prepared subgrade placed. Samples will be submitted to the Soils Testing Laboratory for testing described in Subsection 14.3.3.
- At a minimum, at least one field density/moisture content test will be conducted per lift and at least one test per day of compacted prepared subgrade construction.

A NDG may be used for field moisture and density determination. The calibration of NDGs used for documentation shall be initially checked and adjusted (if necessary) according to the manufacturer's guidelines. Initial calibration of the NDG shall be made with one of the alternate test methods identified in Construction Specifications for determining field density and moisture content.

14.3.1 Field Testing Acceptance Criteria

Acceptance criteria for field density will require soil compaction to a minimum of 95 percent of the Standard Proctor (ASTM D 698) maximum dry density. Specific moisture content requirements will be identified in the construction specifications. The acceptable range will be based on Proctor moisture-density relationships and compaction versus permeability relationships.

14.3.2 Laboratory Testing

Routine laboratory testing of the compacted prepared subgrade soils will be performed on samples from the borrow area or samples from the disking operation and on the in-place soils collected by the RPR. Samples for determining in-place properties will be collected by pushing Shelby tubes. Soil characteristics will be determined from representative samples and from Shelby tube samples.

14.3.3 Undisturbed Sample Analysis

The following analysis will be performed on ***all*** undisturbed samples obtained:

PARAMETER	TEST METHOD
Hydraulic Conductivity	ASTM D 5084 or SW 846-USEPA Method 9100
Moisture Content and Dry Density	ASTM D 2216
Atterberg Limits	ASTM D 4318
Grain-size Analysis (P200)	ASTM D 422 (1)

(1) Percentage of soil finer than the No. 200 sieve (*i.e.*, soil finer than 0.075 mm).

14.3.4 Representative Sample Analysis

The following laboratory analyses will be performed on ***all*** representative samples obtained, except where noted:

PARAMETER	TEST METHOD
Moisture-Density Relationship using Standard Proctor Compaction	ASTM D 698 (1, 2)
Atterberg Limits	ASTM D 4318
Grain-size Analysis (sieve and hydrometer)	ASTM D 422 (3)
Moisture Content	ASTM D 2216
Hydraulic Conductivity (4)	ASTM D 5084 or SW 846-USEPA Method 9100

(1) A five-point Proctor analysis is required for first and second sampling criteria.
(2) A one-point Proctor analysis may be utilized for representative samples collected for the third sampling criteria (apparent changes in soil quality) to verify applicability of previously analyzed moisture-density relationships. If the result does not verify applicability, a five-point analysis will be performed in accordance with the first sampling criteria.
(3) Distribution shall be reported through the 0.002-mm particle size.
(4) For every 8,000 cubic yards of soil extracted from the borrow source, perform one hydraulic conductivity test. The hydraulic conductivity test will be run on a sample of soil remolded to 95 percent of its Standard Proctor (ASTM D 698) maximum dry density at 2 percent over its optimum moisture content.

14.3.5 Laboratory Testing Acceptance Criteria

- A saturated hydraulic conductivity of 4.2×10^{-4} cm/s or less

14.4 Thickness Documentation

The top of the prepared subgrade layer will be surveyed at a minimum on the same 50-foot grid pattern as other locations surveyed for bottom of the prepared subgrade layers. Prepared subgrade thicknesses at slope breaks will be surveyed. The prepared subgrade thickness will be determined at surveyed locations and reported in table fashion. The minimum acceptable prepared subgrade liner thickness will be 1-foot vertical to the bottom. The location and elevation of samples requiring surveying will be recorded.

Table 14-1
Summary of Quality Assurance Testing for the Prepared Subgrade Layer

TEST	FREQUENCY	COMMENT
Atterberg Limits Test [ASTM D 4318]	One every 4,000 cubic yards and material changes	Source Material: prepared subgrade
Grain-size analyses (sieve and hydrometer) [ASTM D 422]	One every 4,000 cubic yards and material changes	Source Material: prepared subgrade
Moisture Content [ASTM D 2216]	One every 4,000 cubic yards and material changes	Source Material: prepared subgrade
Density/Moisture (Standard Proctor) [ASTM D 698]	One every 4,000 cubic yards and material changes	Source Material: prepared subgrade
Permability Testing (Falling Head) [ASTM D 5084 or SW846-USEPA Method 9100]	One test on a sample obtained every 8,000 cubic yards and material changes	Remolded Source Material: prepared subgrade
Proofroll	All surfaces prior to prepared subgrade layer placement	Subgrades for prepared subgrade layer construction
Field Density and Moisture Content [ASTM D 2922 and ASTM D 3017] or [ASTM D 1556] or [ASTM D 2937]	One per 10,000 square feet per lift (approximate 200-foot grid pattern)	*In-situ* prepared subgrade
Permability Testing (Falling Head) [ASTM D 5084 or SW 846-USEPA Method 9110]	One per acre(43,560 square feet) per lift	Tube samples obtained from the *in-situ* prepared subgrade
Atterberg Limits Test [ASTM D 4318]	One per acre(43,560 square feet) per lift	Tube samples obtained from the *in-situ* prepared subgrade
Grain-size analyses (P200) [ASTM D 422]	One per acre(43,560 square feet) per lift	Tube samples obtained from the *in-situ* prepared subgrade
Density/Moisture [ASTM D 2216]	One per acre(43,560 square feet) per lift	Tube samples obtained from the *in-situ* prepared subgrade