INTERNATIONAL PAPER

Certified Mail

RIEGELWOOD MILL
JOHN L. RIEGEL ROAD
RIEGELWOOD NC 28456

Carmen Johnson
24-02 (2/2/12)

June 29, 2000

Mr. James C. Coffey
North Carolina Department of Environment and Natural Resources
Division of Waste Management
Solid Waste Section
P.O. Box 27687
Raleigh, North Carolina 27611-7687

Dear Mr. Coffey:

Reference: **Closure Plan**
International Paper – Riegelwood Mill Facility
Riegelwood, North Carolina

Please find enclosed two copies of the Closure Plan for a 50-acre industrial landfill owned and operated by International Paper at the Riegelwood, North Carolina, facility.

Please contact me at (910) 655-6229 if you have any questions or need additional information during your review.

Sincerely,
International Paper

Edward J. Kreul
Manager, Environment, Health and Safety

EJK:ylb
Enclosures (2)

cc: Christopher Stahl, S&ME, Inc.

Carmen Johnson
24-02 2/2/12(4)

CLOSURE PLAN
INTERNATIONAL PAPER
RIEGELWOOD MILL FACILITY
RIEGELWOOD, NORTH CAROLINA
S&ME PROJECT NO. 1356-99-573

Prepared for:

North Carolina Department of Environment and Natural Resources
Division of Waste Management
Solid Waste Section
Raleigh, North Carolina

Prepared by:

S&ME, Inc.

June, 2000

S&ME

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Appendix	
I	CALCULATIONS
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III	INTERIM CLOSURE PLAN
IV	EROSION & SEDIMENTATION CONTROL PLAN
V	CLOSURE INSPECTION CHECKLIST
VI	CLOSURE/POST-CLOSURE COST ESTIMATE

1.0 INTRODUCTION

The purpose of this Closure Plan is to outline construction activities necessary to close an existing 50-acre industrial landfill. Post-closure maintenance activities are also outlined for the landfill. The Closure Plan was designed to minimize the need for long term maintenance and to control post-closure release of contaminants.

International Paper operates a pulp and paper mill in Riegelwood, North Carolina. The mill has been managing its solid waste on site since it opened in 1951. The existing industrial landfill facility is nearing capacity and cannot reasonably be expanded.

International Paper intends to initiate closure activities coincident with opening the proposed industrial landfill or as directed by the North Carolina Department of Environment and Natural Resources (NCDENR), Division of Waste Management. The new industrial landfill is tentatively scheduled to be opened in the fall of the year 2003. The final closure of the existing landfill is tentatively scheduled for the summer of year 2004.

The Closure Plan is designed to accommodate the waste generation from the facility until closure in the year 2004. International Paper currently estimates the following volumes of sludge and mill waste to be disposed of in the existing industrial landfill.

Year	Volume (cubic yards)
2000	440,000
2001	620,000
2002	300,000
2003	690,000
2004	240,000
	2,290,000

The mill residuals include wood, yard waste, boiler ash, grits, dregs, general mill waste, and sawmill waste (ash and bark/wood). Sludge is generated from the wastewater clarification process originating from the primary clarifiers and aeration lagoons. The sludge is temporarily stored and thickened in Ponds A, B, and C prior to landfilling.

Complete closure of the landfill will encompass an additional gross waste volume (including operational cover soils and interim containment berms) of approximately 2,300,000 cubic yards. Final landfill operational grades are illustrated on the Closure Plan, Sheet 2 of 7.

The phasing of the landfill development is designed so that final cover can be established as soon as possible. Waste shall be placed in phases in conjunction with the construction of the interim containment berms. This phasing for intermediate grading is described in the Interim Closure Plan. The operational grades will have 3H:1V side slopes and 5 percent slope on top of the landfill. The maximum elevation of the facility will be 131 feet above mean sea level (MSL). The landfill cap will incorporate erosion control benches for stormwater management. The initial interim containment berms will become the base of the exterior 3H:1V side slopes. The top width of the containment berm will be utilized as the first erosion control bench of the capping system.

The Owner (operator) shall notify the Division that a notice of intent to close the Industrial Landfill has been placed in the operating records. Closure activities for the Industrial Landfill shall begin no later than 30 days after final receipt of waste unless otherwise approved by the Division.

The final cover system for the closed landfill will be certified by a professional engineer as being completed in accordance with the Closure Plan. International Paper shall record a notation on the deed to the landfill property stating that the property has been used as a landfill and its use is restricted under the Closure Plan approved by the Division of Waste Management. The Division will be notified by International Paper of the closure completion, certification, deed notation, and placement in the operating record.

If the landfill must be closed prior to reaching the final contours, the surface of the landfill will be sloped to a minimum grade of 5 percent and maximum grade of 3H:1V. A final cover will be established over the landfill unit being closed.

2.0 FINAL COVER SYSTEM

2.1 Final Cover Design

The primary purpose of a landfill cover system is to minimize infiltration of precipitation into the waste, thereby minimizing leachate generation. One of the primary goals of the landfill operator is to reduce the amount of leachate generation, thereby reducing risk to the environment.

The final cover system intends to meet the two feet of suitable compacted earth as outlined in Solid Waste Management Rule .0505(3)(c). The proposed final cover will consist of a 18-inch thick soil liner system and a 6-inch thick layer of material suitable to support vegetation. The soil liner would consist of on-site sludge material generated from the on-site paper mill wastewater clarification process, other on-site residuals with on-site or off-site soils, on-site soils with Bentonite, or off-site borrow soils meeting 1.0×10^{-5} cm/sec permeability or less.

The vegetative layer will be on-site soil potentially conditioned with sludge and lime for the purpose of maintaining a grass cover and controlling erosion. This layer will protect the soil liner from damage due to desiccation (drying), freeze-thaw, erosion, and vectors.

A grass cover is proposed to provide the required vegetative cover while reducing cap maintenance. The surface will be prepared by spreading the vegetative cover soil, lightly compacting the material, and then fertilizing and placing seed in accordance with the Drawings and the North Carolina Erosion and Sediment Control Standards and the North Carolina Sedimentation Pollution Control Act of 1973, as amended 1987. The performance objectives used in selecting the vegetative cover include:

- creating drought resistant vegetative cap
- providing a low maintenance cover

- cover selection to minimize volunteer woody vegetation
- minimizing erodability of erosion control
- tolerant of final 3H:1V side slopes.

Newly seeded areas will be mulched to protect the grass until growth has been established.

The selected vegetative cover and installation is presented on the Closure Details (Sheet 3 of 3) and the detail of the 18-inch soil liner and 6-inch vegetative layer is depicted on Sheet 4 of 7.

2.2 Compacted Embankments

Compacted embankment will be used in select areas to create perimeter interim containment berms for the industrial landfill. The purpose of the compacted embankments is to provide containment for the low-strength sludges removed after thickening in Ponds A, B, and C. These berms are also designed to form the perimeter foundation and first erosion control bench for the closure of the landfill. .

The compacted embankment will consist of waste materials from on-site and ash residuals. The specific sequence for constructing the compacted embankments is further described in Section 3.0 of this Closure Plan and in the Interim Closure Plan. The compacted embankment material will be placed, compacted and maintained as it is brought up to design grades.

2.3 Slope Stability

An important aspect of the final cover design is selecting the closure side slopes that are as steep as possible to maximize stormwater runoff while providing a stable landfill condition. Slope stability analyses were performed on the sludge landfill utilizing a two-

dimensional limiting equilibrium stability analysis of selected trial failure surfaces using the computer program PCSTABL6H (Purdue University) in conjunction with the graphical program STED6.5 (Annapolis Engineering Software).

Final closure conditions (i.e. slope and height) were analyzed to simulate the anticipated stresses on the slope faces. Three cross-sections were analyzed, with cross-section "B" yielding the most critical slope. The slopes were analyzed using circular arc trial potential failure surfaces using the Modified Bishop Method. The computer program used soil properties (from testing and literature) and geometry (from the cross-section) to search for potential failure surfaces with the lowest computed factors of safety (FOS). Seismic analyses were also performed using a North Carolina Standard Building Code acceleration coefficient of 0.075. For purposes of this evaluation, a target FOS of 1.5 was established for static conditions and 1.0 for earthquake loading.

The results of the analyses, as presented in Appendix I, indicate a low static FOS of 1.70 and 1.39 for earthquake loading. Based on soil parameters and design grades, factors of safety indicate that the final closure slopes will be stable as designed.

2.4 Waste Settlement

Data from the subsurface exploration was used in the calculations to determine anticipated settlement. Two settlement analyses were performed to determine subgrade settlement due to waste and cover system placement. The analysis-based conditions were encountered in soil test borings B-1 through B-9. An undisturbed sample was obtained from a soft zone and a consolidation test was performed on this sample to determine estimated long-term settlement within this layer.

The Federal Highway Administration and Dilatometer settlement analysis procedures were applied to each soil layer encountered in the soil test borings listed above. In

addition, the settlement from the consolidation test was estimated for comparison. The total settlement for each boring was calculated by comparing the two methods results and using the larger settlement result for each as presented in Appendix I. Settlement for the newly placed sludge was estimated at 30 percent consolidation of the fill height based on an article in the Tappi Journal entitled "Closure of a nine-acre industrial landfill using pulp and paper mill residuals" (February, 1999).

2.5 Cover Material

Cover material is to be obtained from wood waste generated from the facility as described in the Conceptual Landfill Design Plan dated November, 1997. An approved 120-day biweekly cover demonstration was performed during the months of July through November 1997 and the observations of the demonstration were submitted to the Solid Waste Section in November 1997.

Cover material will be continued biweekly as a permanent operational procedure to control odor vectors and litter as necessary for the remaining life of the facility. Cover material will be wood waste, soil, or other suitable material and compacted at least 6 inches thick to control odor, vectors, and litter. After final disposal operations of the landfill cease, a final cover system will be placed on the landfill as discussed in this Closure Plan.

2.6 Stormwater Management

Stormwater running off the landfill during and after a rainfall event will be collected and routed off the cover system by erosion control benches, berms, and channels located at intervals of approximately 30 to 40 vertical feet. Stormwater control structures are designed to accommodate a 25 year - 24 hour storm event. Drop inlet downchutes are located at low points along the control benches and berms to convey the run-off to the existing wastewater

channels or into the existing North and South Wastewater Lagoons. Benches and channels will be lined with a synthetic plastic material to prevent concentrated infiltration of stormwater.

2.7 Erosion Control

Erosion will be controlled by vegetation, erosion control benches, berms, channels, and downchutes. Vegetation will aid in reducing soil erosion. Benches, berms, channels, and downchutes control the development of erosion before it damages the final cover and divide the watershed into manageable areas. Benches and channels will be lined with a synthetic plastic material to prevent potential erosion.

2.8 Vector Control

Potential nuisances to the areas surrounding the landfill from the operations include odor, dust, fires, sedimentation, blowing litter and scavenging. Odors, fires, and blowing litter will be controlled with the soil cover and vegetative layer cover. In addition, equipment will be maintained on site to extinguish any fires that may develop.

Dust will be minimized by use of road surfaces with aggregate and regular spraying with water. Sedimentation will be controlled with appropriate erosion and sedimentation control devices. Potential vectors that include rodents, birds, and other scavengers will be controlled by covering the waste with the soil cover and vegetative layer. Periodic inspection for evidence of vectors will be performed and pest control will be implemented if necessary.

3.0 CONSTRUCTION

Construction at the landfill will include the placement of embankment fill, a stormwater management system, a cover system, and access roads.

3.1 Site Preparation

Site stripping will be required since a good portion of the site is overgrown with vegetation. Specifics as to site preparation and placement of structural fill and soil liner are covered in detail in the Technical Specifications in Appendix II.

3.2 Sequence of Construction

The final operational grades will be constructed by filling initial Phases I and II and sequential phasing as specified in the Interim Closure Plan. Sequential filling of the landfill phases is shown in Appendix III of the Closure Plan. Development of the landfill will proceed generally as shown, with filling from the constructed interim containment berms toward the center of the landfill in each phase.

Temporary access to the landfill will continue over the current access road that enters the landfill on the south side for Phases I an II. A permanent access road is proposed on the west side of the landfill for Phase III construction as shown on the Closure Plan, Sheet 2 of 7. The temporary road will be eliminated during future phasing.

3.3 Elements of Construction

A brief description of the items incorporated in the development of the landfill follows.

3.3.1 Embankments

Interim containment berms will allow for the establishment of stable closure grades, delineate the footprint of the landfill, and allow for stable cap construction. All fill placement for the berms will be placed and monitored for compliance according to the Technical Specifications and Drawings.

Some structural filling may be required prior to constructing the interim containment berms. Unsuitable soils encountered in these areas will be excavated and removed prior to placing compacted fill. Areas that are unsuitable soils were removed will be refilled with suitable structural fill material to reduce differential landfill settlement.

3.3.2 Cover System

The landfill cover will be prepared for placement of the soil liner layer by stabilizing soft or loose areas with compacted structural fill. The soil liner layer will be constructed as required by the Technical Specifications. The soil liner layer will be a minimum of 18 inches thick with a permeability not greater than 1.0×10^{-5} cm/sec. The installation and compaction of the soil liner system will require full time, on-site inspection and testing to verify conformance with the Drawings and Technical Specifications. Soil liner material will be obtained from on-site or off-site sources. Above the soil liner, a 6-inch vegetative layer will be placed that is suitable for establishing a grass cover. The vegetative layer will be constructed as required by the Technical Specifications.

3.3.3 Stormwater Management

Stormwater control structures are to be sized in accordance with the North Carolina Erosion and Sedimentation Control Act. Stormwater control structures are designed to accommodate a 25 year - 24 hour storm event. Channels and diversion benches will be

lined with a 20-mil synthetic liner to prevent erosion and stormwater infiltration during concentrated flow conditions. Berms will be lined with straw/net to prevent erosion until vegetation can be established along the berms.

3.3.4 Access Road

The access road is 25 feet wide and is constructed on the operational grade. The slopes of the access road vary from 2 to 10 percent. The cover system does not extend over the access road. An alternative cover system was designed for the access road for stability and long term maintenance. A geosynthetic clay liner (GCL) with a permeability not greater than 5×10^{-9} cm/sec is deployed on the operational grade and anchored in the road where slopes exceed 5 percent. Twelve inches of NCDOT aggregate base course (ABC) stone is placed on top of the GCL for post closure maintenance access.

4.0 POST-CLOSURE MAINTENANCE

Post-closure maintenance of the facility after closure will be conducted for 30 years and consist of the following elements:

- Operation, inspection and maintenance of the stormwater management system,
- Inspection and maintenance of final cover,
- Control of access with fences and/or signs, and
- Operation, inspection and maintenance of the gas venting system.

The post-closure care period may be decreased by the Division of Waste Management if the owner or operator demonstrates that the decreased period is sufficient to protect human health and the environment. However, the post-closure care period may also be increased by the Division if the Division determines that an increased period is required to protect human health and the environment.

Following completion of the post-closure care period of the MSWLF unit, the owner or operator shall notify the Division that certification, by a registered professional engineer, verifying that post-closure care has been completed in accordance with the post-closure plan, has been placed in the operating record.

The final cover system will be inspected quarterly for signs of settlement, erosion, vector damage, and dead vegetation or vegetative stress. Additional inspections will be performed after large storm events. Depressions in the cover that pond water or otherwise impair the function of the final cover will be filled and/or regraded. Areas subject to regrading will be revegetated. Erosion and vector damage will be repaired, and the source of the damage will be corrected, if possible. The grass will be mowed at least once annually and revegetated with grass seed if needed. Any deep-rooted or woody vegetation that may have established itself on the cover soil will be removed so that deep root growth will not compromise the integrity of the barrier layer of the final cover.

The geomembrane lining located in the channels and benches shall be inspected quarterly for any signs of damage. Any such lining that appears to be damaged shall be repaired and/or replaced as needed.

5.0 POST-CLOSURE MONITORING

Following closure of the landfill, a monitoring program will be implemented to monitor the quality of groundwater and surface water surrounding the landfill. The monitoring program will be in accordance with the State approved monitoring plan and will continue for a period of 30 years after final closure. The length of the post-closure care period may be decreased or increased by the Division if the reduced period is sufficient or the lengthened period is necessary to protect human health and the environment. Following completion of the post-closure period for the industrial landfill, the owner or operator shall notify the Division that a certification signed by a registered professional engineer, verifying that post-closure care has been completed in accordance with the post-closure plan, has been placed in the operating record. A post-closure inspection checklist is included in Appendix VI. During the post-closure period, the facility contact will be Mr. Ed Kreul, International Paper, Riegelwood Mill, 865 John C. Riegel Road, Riegelwood, NC 28546

5.1 Groundwater Monitoring

5.1.1 Monitoring Wells

The 50-acre landfill at the Riegelwood Mill is constructed on a peninsula within the mill's wastewater treatment bays. The landfill groundwater monitoring program will consist of semi-annual sample collection and analysis of groundwater collected from six wells (MW-1A, MW-1B, MW-4A, MW-5A, MW-7A, and MW-08A). MW-1A and MW-1B are located up gradient of the landfill and wastewater treatment bays and the other wells are located down gradient of the landfill and bays as shown on attached Figure 1 following Section 5.0. The groundwater flow direction in the vicinity of the landfill is toward the Cape Fear River and Livingston Creek.

5.1.2 Monitoring Parameters

Currently, landfill semi-annual monitoring parameters include:

BOD	Sulfate	Arsenic	Manganese
COD	Chloride	Barium	Mercury
TOX	Fluoride	Cadmium	Selenium
TOC	Nitrate	Chromium	Silver
TDS		Copper	Zinc
pH		Iron	
Conductivity		Lead	

All results are reported in parts per million (milligrams per liter), except the field parameters of conductivity and pH. The results of this analytical testing will be submitted to NCDENR Semi-annually.

5.2 Surface Water Monitoring

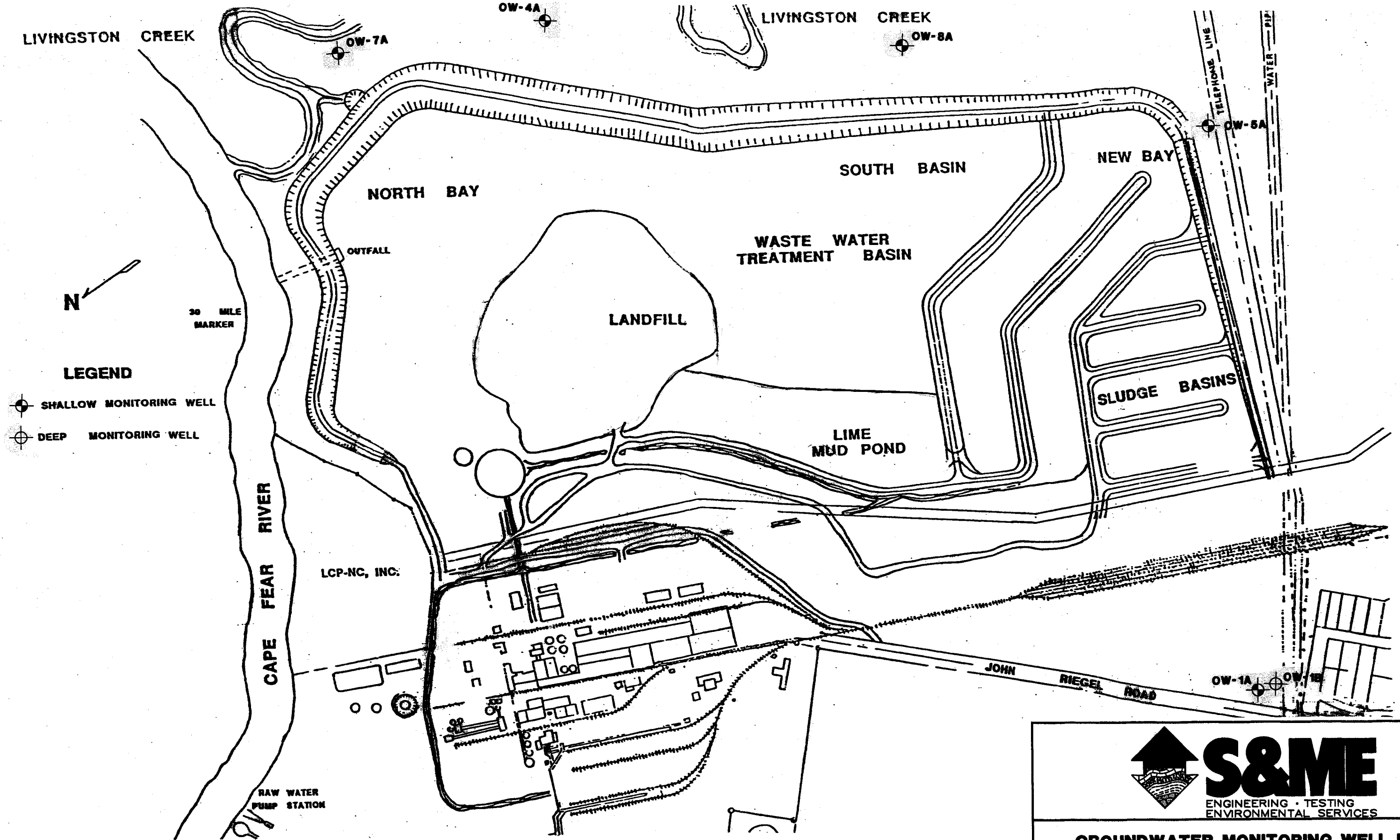
Surface water sampling of Cape Fear Watershed is currently being conducted at the following locations:

Location	Description
Livingston Creek	131 feet (40 m) up Livingston Creek from Cape Fear River
Acme	3.1 miles (5 km) downstream from International Paper

This surface water sampling will be continued after closure as required by the Division of Waste Management. Surface water discharge at the outfall for the wastewater treatment system will be sampled and analyzed as required by the existing facility NPDES stormwater permit number NCS000101 and wastewater permit number NC0003298.

6.0 FINANCIAL ASSURANCE

The owner (operator) must have a detailed written cost estimate, in current dollars, of the cost of hiring a third party to close the largest area of the landfill and conduct post-closure care of the landfill in compliance with the post-closure plan. Closure/post closure cost estimates for the landfill, as required for financial assurance, are included in Appendix VI. The costs are represented in 2000 dollars and are to be updated annually.



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GROUNDWATER MONITORING WELL PLAN

INTERNATIONAL PAPER
RIEGELWOOD, NORTH CAROLINA

SCALE:	DRAWN BY:	CHECKED BY:
NTS	DPM	
JOB NO.	DATE:	FIGURE NO.
1356-99-573	3-22-00	1

Figures

CLOSURE PLAN APPENDIX

APPENDIX I

CALCULATIONS

- Slope Stability / Factors of Safety
- Settlement Calculations
- Channel Design (Berms, Benches, Roadside Channels)
- Piping Design
- Drop Inlet Grate Sizing

Slope Stability / Factors of Safety

		JOB NO.	1356-99-573
		SHEET NO.	1 of 144
		DATE	3/29/00
JOB NAME	International Paper Sludge Landfill	COMPUTED BY	RK
SUBJECT	Slope Stability/ Factors of Safety	CHECKED BY	BJDC

OBJECTIVE

Perform stability analysis for critical cross-sections to determine the minimal factors of safety.

REFERENCE

1. PCSTABL6H software by Purdue University with graphics by STED6.5 (Annapolis Engineering Software) *(Page 3 of 144)*
2. S&ME Laboratory data, Table 1, "Summary of Laboratory Test Data" *(Page 104 of 144)*
3. Terzaghi, Karil and Ralph B. Peck. Soil Mechanics in Engineering Practice. 2nd Edititon, John Wiley & Sons, Inc., 1967 *(Page 105 of 144)*
4. S&ME Triaxial test data *(Page 106 of 144)*
5. North Carolina State Building Code, 1996 Edition, Vol. 1, Section 1607 *(Page 107 of 144)*
6. S&ME report, "Subsurface Exploration Existing Landfill International Paper Landfill", August 17, 1998 *(Page 109 of 144)*

GIVEN

Seismic: *(Ref. #5)*

Factor = 0.075

RESULTS

LABEL	SOIL TYPE NO.	TOTAL UNIT WT. (pcf)	SAT. UNIT WT. (pcf)	COHESION INTERCEPT (psf)	FRICTION ANGLE (deg)	REFERENCES
Berm	1	75	75	150	30	2,6
New Sludge	2	75	75	150	20	2,4,6
Pee Dee Form.	3	115	120	0	30	3,6
Old Sludge	4	75	75	150	20	2,4,6

CROSS-SECTION A: *(Pages 3 to 36)*

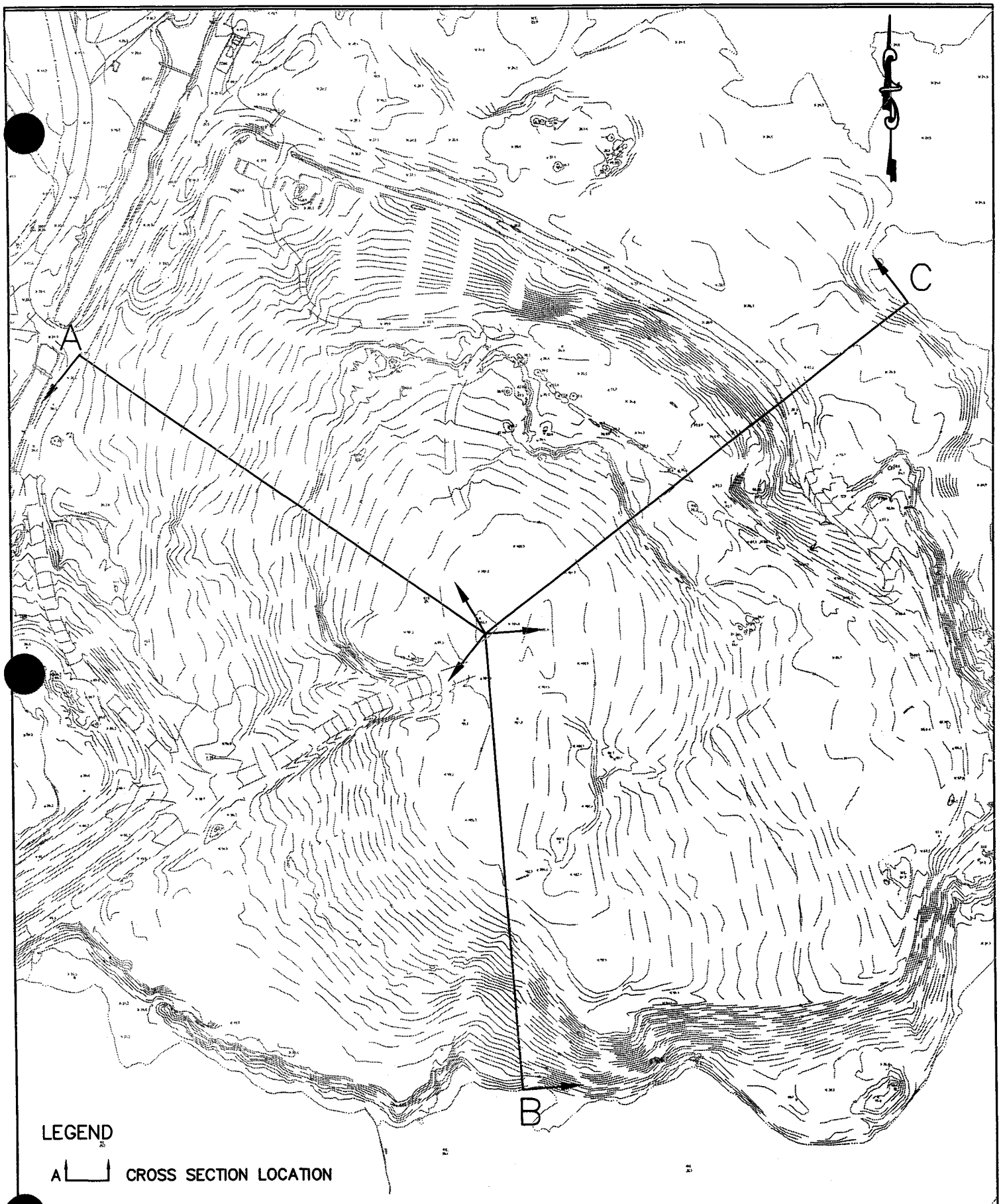
Total Stress Analysis	F.S. = 1.78
Seismic Analysis	F.S. = 1.38
Random w/ Seismic Analysis	F.S. = 1.36

CROSS-SECTION B: *(Pages 37 to 70)*

Total Stress Analysis	F.S. = 1.58
Seismic Analysis	F.S. = 1.21
Random w/ Seismic Analysis	F.S. = 1.20

CROSS-SECTION C: *(Pages 71 to 103)*

Total Stress Analysis	F.S. = 1.77
Seismic Analysis	F.S. = 1.39
Random w/ Seismic Analysis	F.S. = 1.36

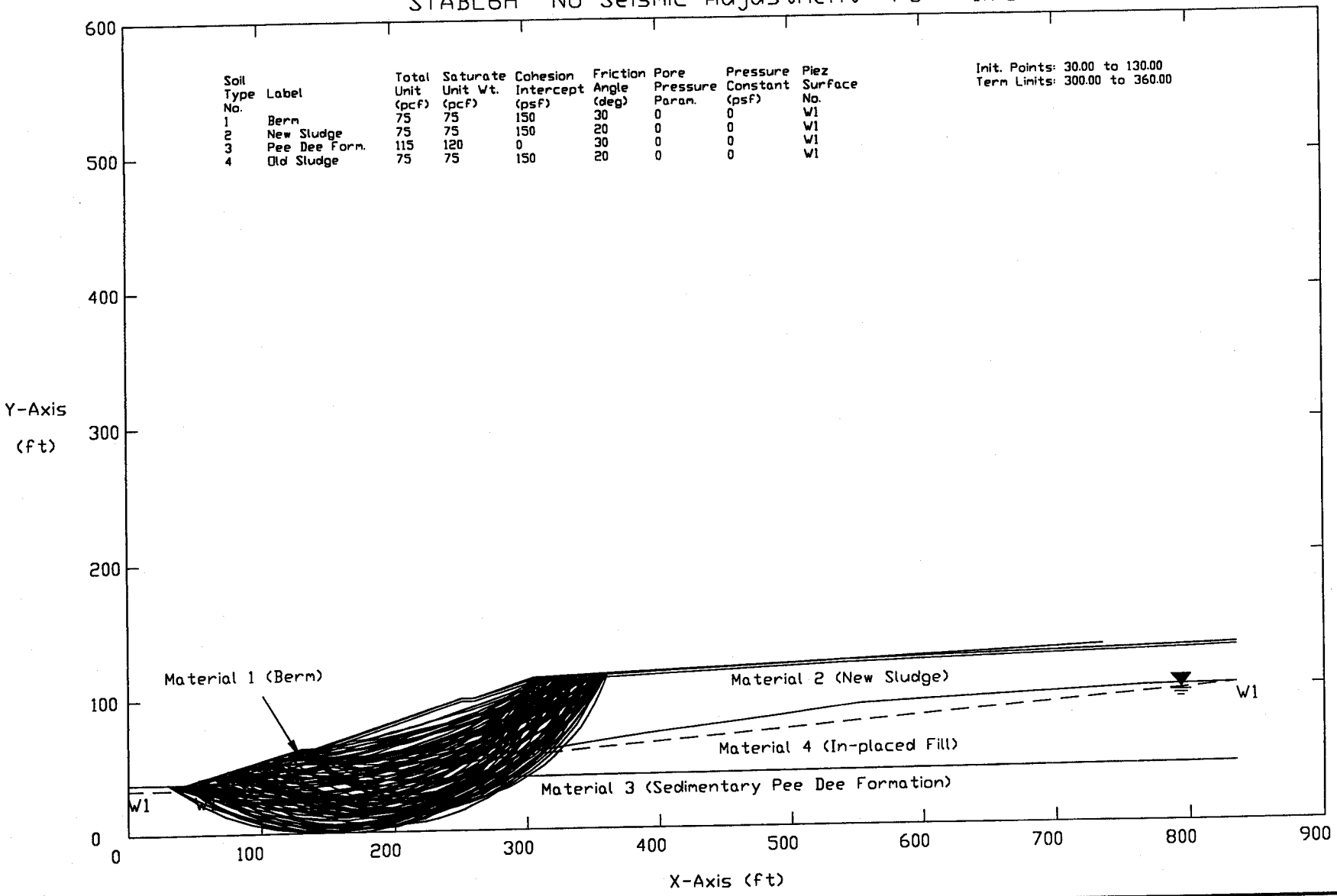


SCALE: 1"=200'	S&ME ENGINEERING · TESTING ENVIRONMENTAL SERVICES	SLOPE STABILITY CROSS SECTION LOCATIONS INTERNATIONAL PAPER RIEGELWOOD, NORTH CAROLINA	FIGURE NO. 1
CHECKED BY:			
DRAWN BY: RK			
DATE: March, 2000 3/23/00		JOB NO: 1356-99-573	

CROSS SECTION A
Stability Ananlysis of All Failure Surfaces
STABL6H No Seismic Adjustment FS = 1.78

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	Berm	75	75	150	30	0	0	W1
2	New Sludge	75	75	150	20	0	0	W1
3	Pee Dee Form.	115	120	0	30	0	0	W1
4	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 30.00 to 130.00
Term Limits: 300.00 to 360.00



SCALE:	AS SHOWN
CHECKED BY:	
DRAWN BY:	RK
DATE:	3-23-00

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SLOPE STABLILITY
CROSS SECTION A
International Paper
RIEGELWOOD, NORTH CAROLINA

JOB NO. 1356-99-573

FIGURE NO. 2

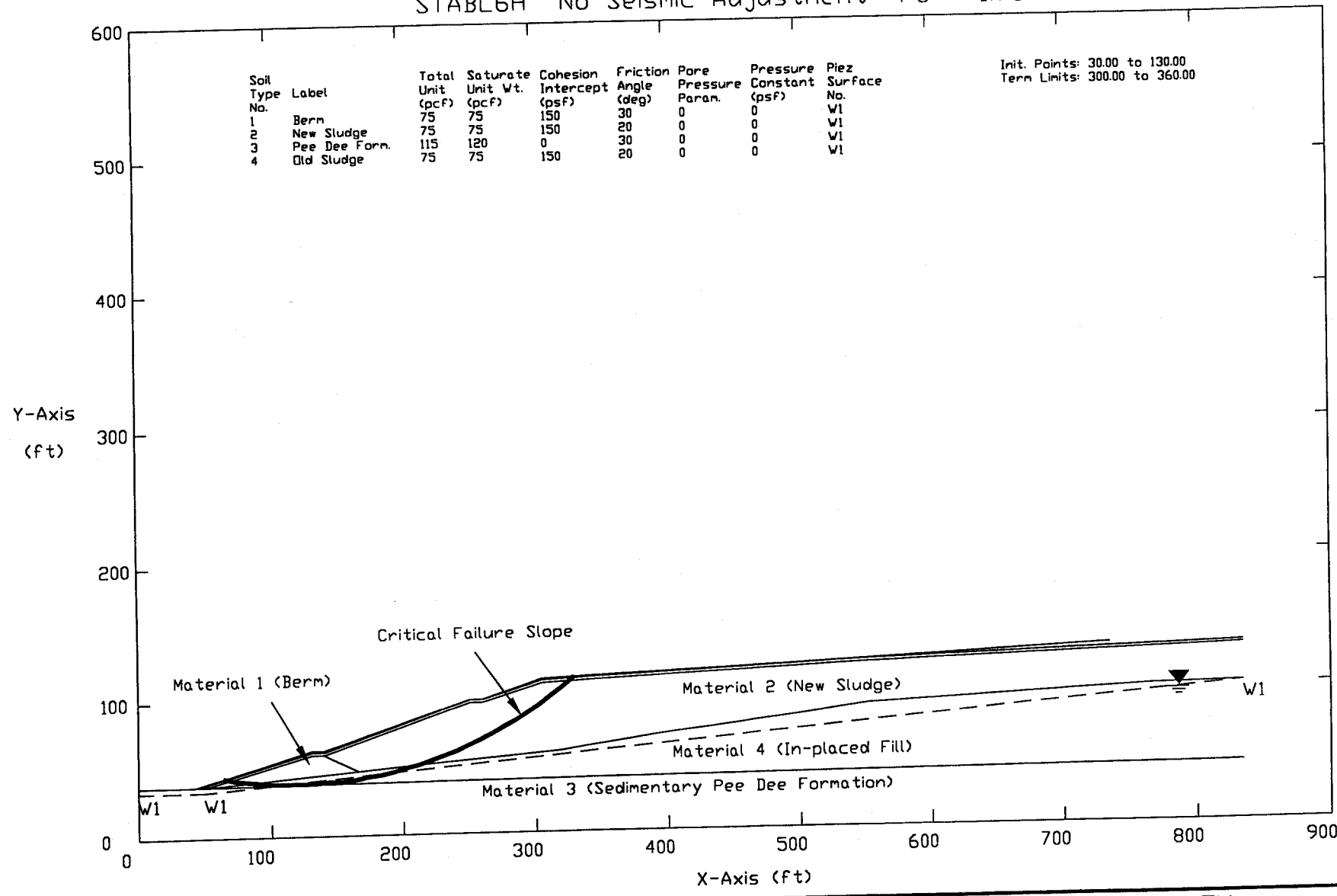
CROSS SECTION A

Factors of Safety Calculated by The Modified Bishop Method

STABL6H No Seismic Adjustment FS = 1.78

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	Berm	75	75	150	30	0	0	W1
2	New Sludge	75	75	150	20	0	0	W1
3	Pee Dee Form.	115	120	0	30	0	0	W1
4	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 30.00 to 130.00
Term Limits: 300.00 to 360.00



SCALE:	AS SHOWN
CHECKED BY:	
DRAWN BY:	RK
DATE:	2-23-00

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SLOPE STABILITY
CROSS SECTION A
International Paper
RIEGELWOOD, NORTH CAROLINA

JOB NO. 1356-99-573

FIGURE NO. 3

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	3/22/2000
Time of Run:	10:41am
Run By:	Rotthachack Kirivong
Input Data Filename:	G:99573CA3
Output Filename:	G:99573CA3.OUT
Plotted Output Filename:	G:99573CA3.PLT

PROBLEM DESCRIPTION International Paper
1356-99-573

BOUNDARY COORDINATES

8 Top Boundaries
34 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	38.00	42.50	38.00	3
2	42.50	38.00	130.00	62.50	2
3	130.00	62.50	140.00	62.50	2
4	140.00	62.50	250.00	98.50	2
5	250.00	98.50	260.00	98.50	2
6	260.00	98.50	305.00	112.50	2
7	305.00	112.50	535.00	122.50	2
8	535.00	122.50	735.00	132.00	2
9	42.50	38.00	44.00	38.00	3
10	44.00	38.00	130.00	62.00	2
11	130.00	62.00	140.00	62.00	2
12	140.00	62.00	250.00	98.00	2
13	250.00	98.00	260.00	98.00	2
14	260.00	98.00	305.00	112.00	2
15	305.00	112.00	535.00	122.00	2
16	535.00	122.00	835.00	131.50	2
17	44.00	38.00	50.00	38.00	3
18	50.00	38.00	130.00	60.00	1
19	130.00	60.00	140.00	60.00	1
20	140.00	60.00	250.00	96.00	2
21	250.00	96.00	260.00	96.00	2
22	260.00	96.00	305.00	110.00	2
23	305.00	110.00	535.00	120.00	2

24	535.00	120.00	835.00	129.50	2
25	140.00	60.00	166.00	47.00	1
26	50.00	38.00	166.00	47.00	4
27	166.00	47.00	200.00	50.00	4
28	200.00	50.00	318.00	60.00	4
29	318.00	60.00	390.00	70.00	4
30	390.00	70.00	480.00	80.00	4
31	480.00	80.00	552.00	90.00	4
32	552.00	90.00	767.00	100.00	4
33	767.00	100.00	835.00	101.00	4
34	50.00	38.00	835.00	43.00	3

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	75.0	75.0	150.0	30.0	.00	.0	1
2	75.0	75.0	150.0	20.0	.00	.0	1
3	115.0	120.0	.0	30.0	.00	.0	1
4	75.0	75.0	150.0	20.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 3 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	33.00
2	50.00	33.00
3	835.00	101.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced

Along The Ground Surface Between X = 30.00 ft.
and X = 130.00 ft.

Each Surface Terminates Between X = 300.00 ft.
and X = 360.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.33	43.83
2	73.20	42.18
3	83.11	40.84
4	93.05	39.80
5	103.02	39.07
6	113.02	38.64
7	123.02	38.53
8	133.01	38.72
9	143.00	39.23
10	152.97	40.04
11	162.91	41.15
12	172.80	42.58
13	182.65	44.31
14	192.44	46.34
15	202.17	48.67
16	211.82	51.30
17	221.38	54.23
18	230.84	57.45
19	240.21	60.96
20	249.46	64.76
21	258.59	68.85
22	267.58	73.21
23	276.44	77.85
24	285.16	82.76
25	293.71	87.93
26	302.10	93.37
27	310.32	99.06

28	318.37	105.01
29	326.22	111.20
30	329.01	113.54

Circle Center At X = 121.7 ; Y = 362.6 and Radius, 324.0

*** 1.777 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.33	43.83
2	73.24	42.45
3	83.18	41.39
4	93.15	40.65
5	103.15	40.23
6	113.14	40.13
7	123.14	40.35
8	133.13	40.90
9	143.09	41.77
10	153.02	42.95
11	162.90	44.46
12	172.74	46.28
13	182.51	48.42
14	192.20	50.88
15	201.81	53.64
16	211.33	56.71
17	220.74	60.09
18	230.04	63.77
19	239.22	67.74
20	248.26	72.01
21	257.16	76.57
22	265.91	81.41
23	274.50	86.53
24	282.92	91.92
25	291.16	97.59
26	299.22	103.51
27	307.08	109.69
28	310.71	112.75

Circle Center At X = 111.2 ; Y = 350.7 and Radius, 310.6

*** 1.820 ***

Failure Surface Specified By 33 Coordinate Points

Point	X-Surf	Y-Surf

No.	(ft)	(ft)
1	30.00	38.00
2	39.91	36.65
3	49.85	35.54
4	59.81	34.68
5	69.79	34.06
6	79.78	33.69
7	89.78	33.57
8	99.78	33.69
9	109.78	34.06
10	119.76	34.68
11	129.72	35.54
12	139.66	36.64
13	149.57	37.99
14	159.44	39.59
15	169.27	41.43
16	179.05	43.50
17	188.78	45.82
18	198.44	48.38
19	208.05	51.18
20	217.58	54.21
21	227.03	57.47
22	236.40	60.97
23	245.68	64.70
24	254.86	68.65
25	263.95	72.83
26	272.92	77.23
27	281.79	81.85
28	290.54	86.69
29	299.17	91.75
30	307.68	97.01
31	316.05	102.48
32	324.28	108.16
33	331.86	113.67

Circle Center At X = 89.8 ; Y = 439.4 and Radius, 405.8

*** 1.867 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	41.11	38.00
2	51.00	36.53
3	60.93	35.34
4	70.89	34.45
5	80.87	33.86
6	90.87	33.55
7	100.87	33.54
8	110.87	33.83
9	120.85	34.41

10	130.81	35.28
11	140.74	36.45
12	150.64	37.91
13	160.48	39.66
14	170.27	41.70
15	180.00	44.02
16	189.65	46.63
17	199.22	49.53
18	208.71	52.70
19	218.09	56.15
20	227.37	59.88
21	236.54	63.88
22	245.58	68.14
23	254.50	72.67
24	263.27	77.46
25	271.91	82.51
26	280.39	87.81
27	288.71	93.36
28	296.86	99.15
29	304.84	105.17
30	312.64	111.43
31	314.37	112.91

Circle Center At X = 96.1 ; Y = 373.2 and Radius, 339.7

*** 1.872 ***

Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.56	50.06
2	95.26	47.65
3	105.05	45.58
4	114.89	43.85
5	124.80	42.45
6	134.74	41.40
7	144.72	40.68
8	154.71	40.31
9	164.71	40.28
10	174.70	40.59
11	184.68	41.25
12	194.63	42.24
13	204.54	43.58
14	214.40	45.26
15	224.20	47.27
16	233.92	49.61
17	243.55	52.29
18	253.09	55.30
19	262.52	58.63
20	271.83	62.28
21	281.01	66.25

22	290.04	70.53
23	298.93	75.12
24	307.65	80.01
25	316.20	85.19
26	324.57	90.67
27	332.75	96.43
28	340.72	102.46
29	348.48	108.76
30	355.28	114.69

Circle Center At X = 160.6 ; Y = 332.2 and Radius, 291.9

*** 1.872 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	96.67	53.17
2	106.22	50.20
3	115.90	47.69
4	125.68	45.63
5	135.56	44.05
6	145.49	42.93
7	155.47	42.28
8	165.47	42.10
9	175.47	42.40
10	185.44	43.17
11	195.36	44.41
12	205.21	46.12
13	214.97	48.30
14	224.62	50.93
15	234.13	54.01
16	243.49	57.54
17	252.67	61.51
18	261.65	65.91
19	270.41	70.73
20	278.93	75.96
21	287.20	81.59
22	295.19	87.60
23	302.89	93.98
24	310.28	100.72
25	317.34	107.80
26	322.28	113.25

Circle Center At X = 164.2 ; Y = 253.5 and Radius, 211.4

*** 1.880 ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	30.00	38.00
2	39.86	36.31
3	49.76	34.89
4	59.69	33.75
5	69.65	32.90
6	79.64	32.32
7	89.63	32.03
8	99.63	32.02
9	109.63	32.30
10	119.61	32.85
11	129.58	33.69
12	139.52	34.81
13	149.42	36.20
14	159.28	37.88
15	169.08	39.83
16	178.83	42.06
17	188.51	44.57
18	198.12	47.34
19	207.65	50.39
20	217.08	53.70
21	226.42	57.28
22	235.65	61.12
23	244.77	65.22
24	253.77	69.58
25	262.65	74.19
26	271.39	79.04
27	279.99	84.14
28	288.44	89.48
29	296.74	95.06
30	304.88	100.87
31	312.85	106.91
32	320.65	113.17
33	320.66	113.18

Circle Center At X = 95.0 ; Y = 386.3 and Radius, 354.3

*** 1.883 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	74.44	46.94
2	84.33	45.42
3	94.25	44.17
4	104.20	43.18
5	114.17	42.45

6	124.16	42.00
7	134.16	41.81
8	144.16	41.89
9	154.16	42.25
10	164.14	42.86
11	174.10	43.75
12	184.03	44.90
13	193.93	46.32
14	203.79	48.01
15	213.59	49.96
16	223.35	52.17
17	233.04	54.64
18	242.66	57.37
19	252.20	60.36
20	261.66	63.60
21	271.03	67.10
22	280.30	70.85
23	289.47	74.84
24	298.52	79.08
25	307.46	83.56
26	316.28	88.28
27	324.97	93.23
28	333.52	98.42
29	341.93	103.83
30	350.19	109.47
31	357.55	114.78

Circle Center At X = 136.1 ; Y = 414.4 and Radius, 372.5

*** 1.890 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	118.89	59.39
2	128.74	57.65
3	138.65	56.37
4	148.62	55.54
5	158.61	55.18
6	168.61	55.27
7	178.60	55.83
8	188.55	56.85
9	198.44	58.33
10	208.25	60.26
11	217.96	62.64
12	227.55	65.46
13	237.00	68.73
14	246.30	72.43
15	255.41	76.55
16	264.32	81.09
17	273.01	86.03

18	281.46	91.37
19	289.66	97.09
20	297.59	103.19
21	305.23	109.65
22	308.47	112.65

Circle Center At X = 161.5 ; Y = 271.9 and Radius, 216.8

*** 1.898 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.33	43.83
2	73.07	41.54
3	82.87	39.58
4	92.74	37.96
5	102.66	36.67
6	112.61	35.73
7	122.59	35.12
8	132.59	34.86
9	142.59	34.94
10	152.58	35.36
11	162.55	36.12
12	172.49	37.22
13	182.39	38.66
14	192.23	40.43
15	202.00	42.55
16	211.70	44.99
17	221.31	47.77
18	230.81	50.87
19	240.21	54.29
20	249.48	58.03
21	258.62	62.09
22	267.62	66.46
23	276.46	71.13
24	285.14	76.10
25	293.64	81.37
26	301.96	86.92
27	310.08	92.75
28	318.00	98.86
29	325.70	105.24
30	333.18	111.87
31	335.23	113.81

Circle Center At X = 135.3 ; Y = 327.5 and Radius, 292.7

*** 1.906 ***

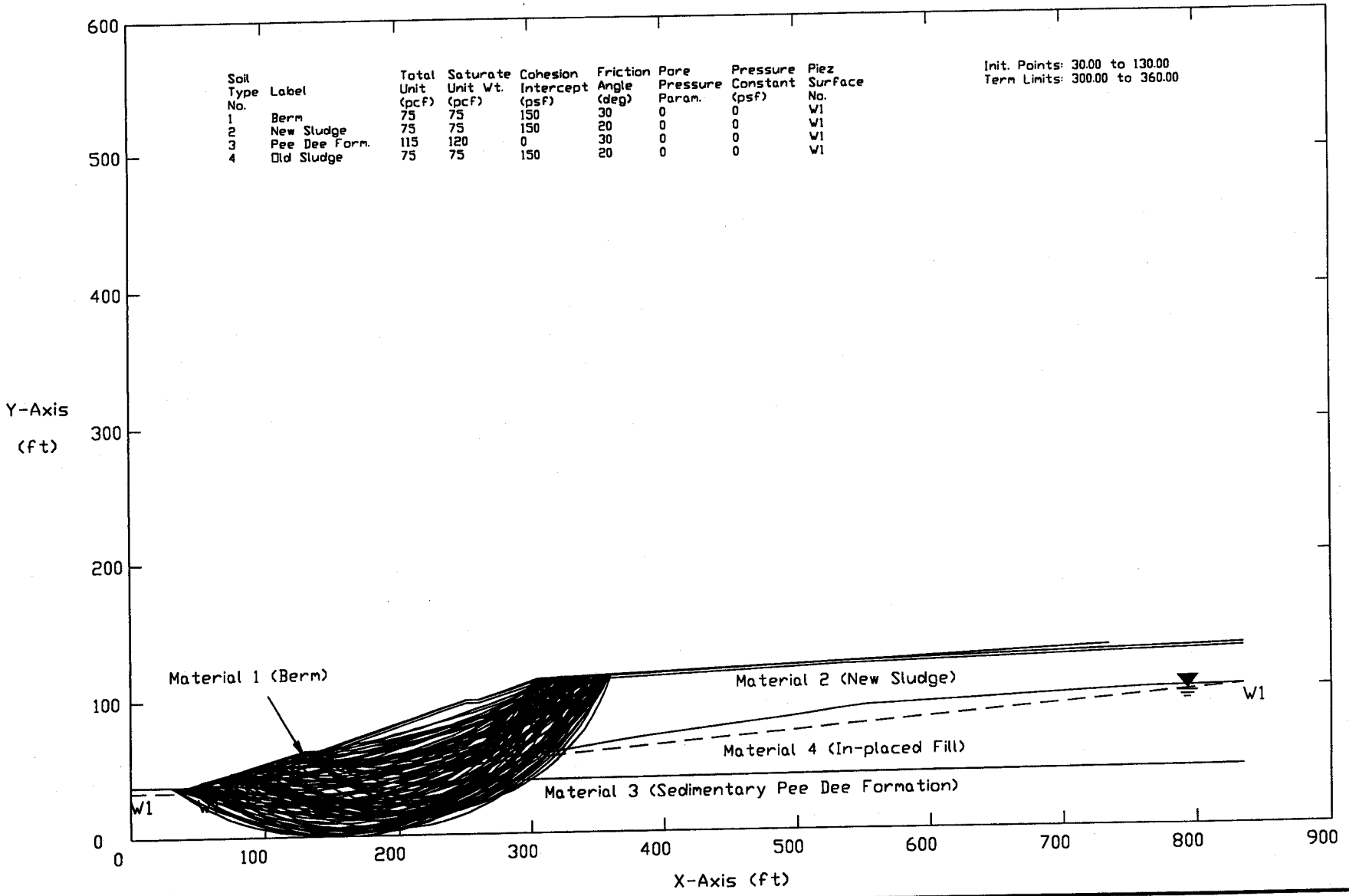
CROSS SECTION A

Stability Ananlysis of All Failure Surfaces

STABL6H Seismic Adjusted FS = 1.38

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	Berm	75	75	150	30	0	0	W1
2	New Sludge	75	75	150	20	0	0	W1
3	Pee Dee Form.	115	120	0	30	0	0	W1
4	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 30.00 to 130.00
Term Limits: 300.00 to 360.00



SCALE:	AS SHOWN
CHECKED BY:	
DRAWN BY:	RK
DATE:	2-23-00

S&ME
ENGINEERING · TESTING
ENVIRONMENTAL SERVICES

SLOPE STABILITY
CROSS SECTION A
International Paper
RIEGELWOOD, NORTH CAROLINA

JOB NO. 1356-99-573

FIGURE NO. 4

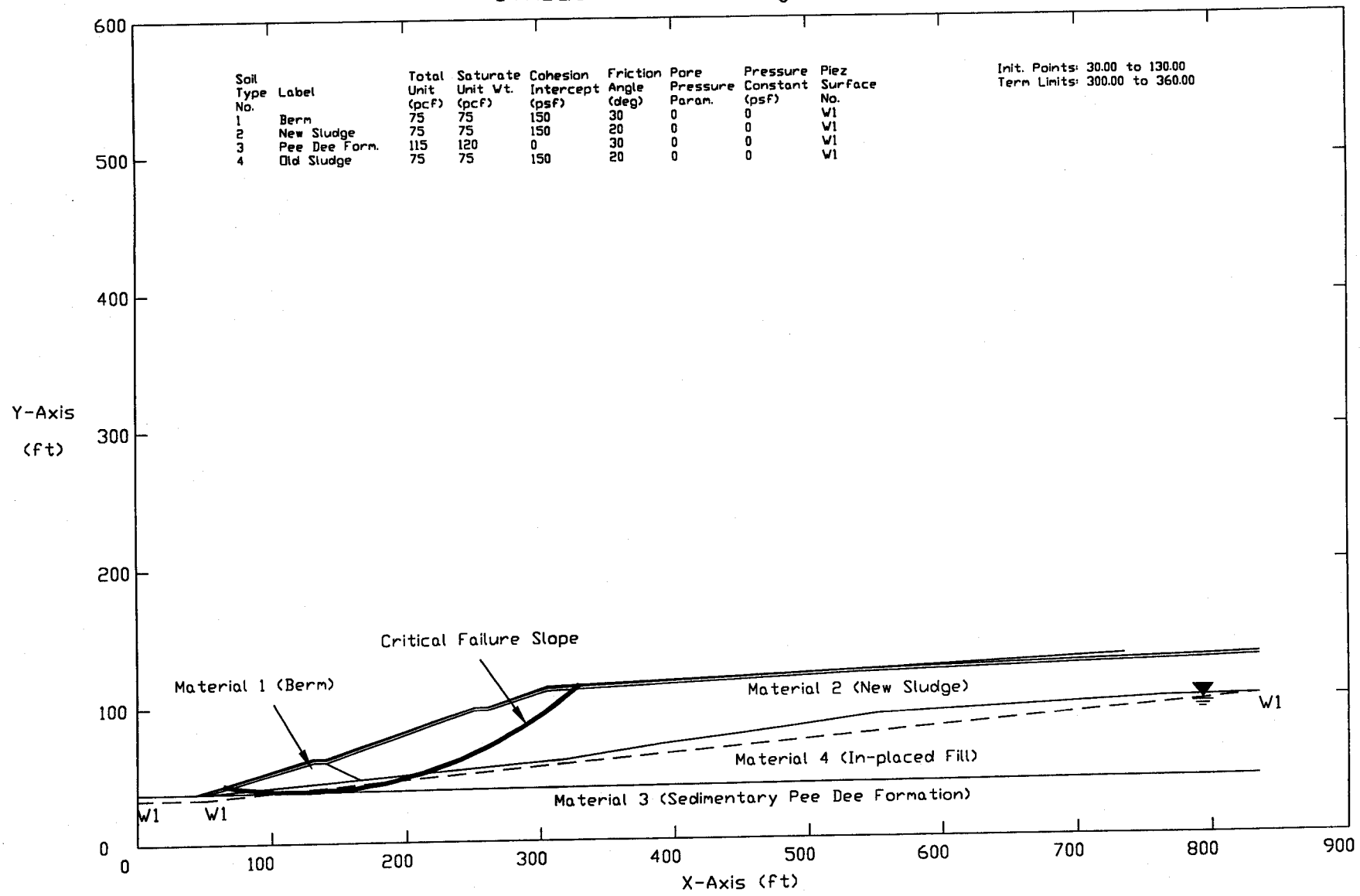
CROSS SECTION A

Factors of Safety Calculated by The Modified Bishop Method

STABL6H Seismic Adjusted FS = 1.38

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	Berm	75	75	150	30	0	0	W1
2	New Sludge	75	75	150	20	0	0	W1
3	Pee Dee Form.	115	120	0	30	0	0	W1
4	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 30.00 to 130.00
Term Limits: 300.00 to 360.00



SCALE:	AS SHOWN
CHECKED BY:	
DRAWN BY:	RK
DATE:	2-23-00

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SLOPE STABILITY
CROSS SECTION A
International Paper
RIEGELWOOD, NORTH CAROLINA

JOB NO. 1356-99-573

FIGURE NO. 5

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	3/22/2000
Time of Run:	10:42am
Run By:	Rotthachack Kirivong
Input Data Filename:	G:99573CA3
Output Filename:	G:99573CA3.OUT
Plotted Output Filename:	G:99573CA3.PLT

PROBLEM DESCRIPTION International Paper
1356-99-573

BOUNDARY COORDINATES

8 Top Boundaries
34 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	38.00	42.50	38.00	3
2	42.50	38.00	130.00	62.50	2
3	130.00	62.50	140.00	62.50	2
4	140.00	62.50	250.00	98.50	2
5	250.00	98.50	260.00	98.50	2
6	260.00	98.50	305.00	112.50	2
7	305.00	112.50	535.00	122.50	2
8	535.00	122.50	735.00	132.00	2
9	42.50	38.00	44.00	38.00	3
10	44.00	38.00	130.00	62.00	2
11	130.00	62.00	140.00	62.00	2
12	140.00	62.00	250.00	98.00	2
13	250.00	98.00	260.00	98.00	2
14	260.00	98.00	305.00	112.00	2
15	305.00	112.00	535.00	122.00	2
16	535.00	122.00	835.00	131.50	2
17	44.00	38.00	50.00	38.00	3
18	50.00	38.00	130.00	60.00	1
19	130.00	60.00	140.00	60.00	1
20	140.00	60.00	250.00	96.00	2
21	250.00	96.00	260.00	96.00	2
22	260.00	96.00	305.00	110.00	2
23	305.00	110.00	535.00	120.00	2

24	535.00	120.00	835.00	129.50	2
25	140.00	60.00	166.00	47.00	1
26	50.00	38.00	166.00	47.00	4
27	166.00	47.00	200.00	50.00	4
28	200.00	50.00	318.00	60.00	4
29	318.00	60.00	390.00	70.00	4
30	390.00	70.00	480.00	80.00	4
31	480.00	80.00	552.00	90.00	4
32	552.00	90.00	767.00	100.00	4
33	767.00	100.00	835.00	101.00	4
34	50.00	38.00	835.00	43.00	3

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	75.0	75.0	150.0	30.0	.00	.0	1
2	75.0	75.0	150.0	20.0	.00	.0	1
3	115.0	120.0	.0	30.0	.00	.0	1
4	75.0	75.0	150.0	20.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 3 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	33.00
2	50.00	33.00
3	835.00	101.00

A Horizontal Earthquake Loading Coefficient
Of .075 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .075 Has Been Assigned

Cavitation Pressure = .0 psf

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 30.00 ft.
and X = 130.00 ft.

Each Surface Terminates Between X = 300.00 ft.
and X = 360.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.33	43.83
2	73.20	42.18
3	83.11	40.84
4	93.05	39.80
5	103.02	39.07
6	113.02	38.64
7	123.02	38.53
8	133.01	38.72
9	143.00	39.23
10	152.97	40.04
11	162.91	41.15
12	172.80	42.58
13	182.65	44.31
14	192.44	46.34
15	202.17	48.67
16	211.82	51.30
17	221.38	54.23

18	230.84	57.45
19	240.21	60.96
20	249.46	64.76
21	258.59	68.85
22	267.58	73.21
23	276.44	77.85
24	285.16	82.76
25	293.71	87.93
26	302.10	93.37
27	310.32	99.06
28	318.37	105.01
29	326.22	111.20
30	329.01	113.54

Circle Center At X = 121.7 ; Y = 362.6 and Radius, 324.0

*** 1.379 ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	30.00	38.00
2	39.91	36.65
3	49.85	35.54
4	59.81	34.68
5	69.79	34.06
6	79.78	33.69
7	89.78	33.57
8	99.78	33.69
9	109.78	34.06
10	119.76	34.68
11	129.72	35.54
12	139.66	36.64
13	149.57	37.99
14	159.44	39.59
15	169.27	41.43
16	179.05	43.50
17	188.78	45.82
18	198.44	48.38
19	208.05	51.18
20	217.58	54.21
21	227.03	57.47
22	236.40	60.97
23	245.68	64.70
24	254.86	68.65
25	263.95	72.83
26	272.92	77.23
27	281.79	81.85
28	290.54	86.69
29	299.17	91.75
30	307.68	97.01
31	316.05	102.48

32	324.28	108.16
33	331.86	113.67

Circle Center At X = 89.8 ; Y = 439.4 and Radius, 405.8

*** 1.420 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.33	43.83
2	73.24	42.45
3	83.18	41.39
4	93.15	40.65
5	103.15	40.23
6	113.14	40.13
7	123.14	40.35
8	133.13	40.90
9	143.09	41.77
10	153.02	42.95
11	162.90	44.46
12	172.74	46.28
13	182.51	48.42
14	192.20	50.88
15	201.81	53.64
16	211.33	56.71
17	220.74	60.09
18	230.04	63.77
19	239.22	67.74
20	248.26	72.01
21	257.16	76.57
22	265.91	81.41
23	274.50	86.53
24	282.92	91.92
25	291.16	97.59
26	299.22	103.51
27	307.08	109.69
28	310.71	112.75

Circle Center At X = 111.2 ; Y = 350.7 and Radius, 310.6

*** 1.424 ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	30.00	38.00
2	39.86	36.31
3	49.76	34.89
4	59.69	33.75
5	69.65	32.90
6	79.64	32.32
7	89.63	32.03
8	99.63	32.02
9	109.63	32.30
10	119.61	32.85
11	129.58	33.69
12	139.52	34.81
13	149.42	36.20
14	159.28	37.88
15	169.08	39.83
16	178.83	42.06
17	188.51	44.57
18	198.12	47.34
19	207.65	50.39
20	217.08	53.70
21	226.42	57.28
22	235.65	61.12
23	244.77	65.22
24	253.77	69.58
25	262.65	74.19
26	271.39	79.04
27	279.99	84.14
28	288.44	89.48
29	296.74	95.06
30	304.88	100.87
31	312.85	106.91
32	320.65	113.17
33	320.66	113.18

Circle Center At X = 95.0 ; Y = 386.3 and Radius, 354.3

*** 1.427 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	41.11	38.00
2	51.00	36.53
3	60.93	35.34
4	70.89	34.45
5	80.87	33.86
6	90.87	33.55
7	100.87	33.54
8	110.87	33.83
9	120.85	34.41

10	130.81	35.28
11	140.74	36.45
12	150.64	37.91
13	160.48	39.66
14	170.27	41.70
15	180.00	44.02
16	189.65	46.63
17	199.22	49.53
18	208.71	52.70
19	218.09	56.15
20	227.37	59.88
21	236.54	63.88
22	245.58	68.14
23	254.50	72.67
24	263.27	77.46
25	271.91	82.51
26	280.39	87.81
27	288.71	93.36
28	296.86	99.15
29	304.84	105.17
30	312.64	111.43
31	314.37	112.91

Circle Center At X = 96.1 ; Y = 373.2 and Radius, 339.7

*** 1.430 ***

Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.56	50.06
2	95.26	47.65
3	105.05	45.58
4	114.89	43.85
5	124.80	42.45
6	134.74	41.40
7	144.72	40.68
8	154.71	40.31
9	164.71	40.28
10	174.70	40.59
11	184.68	41.25
12	194.63	42.24
13	204.54	43.58
14	214.40	45.26
15	224.20	47.27
16	233.92	49.61
17	243.55	52.29
18	253.09	55.30
19	262.52	58.63
20	271.83	62.28
21	281.01	66.25
22	290.04	70.53

23	298.93	75.12
24	307.65	80.01
25	316.20	85.19
26	324.57	90.67
27	332.75	96.43
28	340.72	102.46
29	348.48	108.76
30	355.28	114.69

Circle Center At X = 160.6 ; Y = 332.2 and Radius, 291.9

*** 1.430 ***

Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	30.00	38.00
2	39.78	35.91
3	49.61	34.09
4	59.49	32.55
5	69.41	31.27
6	79.36	30.27
7	89.33	29.54
8	99.32	29.08
9	109.32	28.89
10	119.32	28.99
11	129.31	29.35
12	139.29	29.99
13	149.25	30.90
14	159.18	32.09
15	169.08	33.54
16	178.93	35.27
17	188.72	37.27
18	198.46	39.53
19	208.14	42.06
20	217.74	44.86
21	227.26	47.91
22	236.70	51.23
23	246.03	54.81
24	255.27	58.64
25	264.40	62.72
26	273.42	67.05
27	282.31	71.62
28	291.07	76.44
29	299.70	81.49
30	308.19	86.78
31	316.52	92.30
32	324.71	98.05
33	332.73	104.02
34	340.58	110.21
35	345.45	114.26

Circle Center At X = 111.0 ; Y = 393.6 and Radius, 364.7

*** 1.431 ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	41.11	38.00
2	50.86	35.76
3	60.67	33.82
4	70.54	32.20
5	80.45	30.89
6	90.40	29.89
7	100.38	29.20
8	110.37	28.83
9	120.37	28.78
10	130.36	29.04
11	140.35	29.62
12	150.31	30.51
13	160.24	31.72
14	170.12	33.24
15	179.95	35.07
16	189.72	37.20
17	199.42	39.65
18	209.03	42.40
19	218.55	45.45
20	227.97	48.80
21	237.29	52.45
22	246.48	56.39
23	255.54	60.62
24	264.47	65.13
25	273.24	69.92
26	281.87	74.98
27	290.33	80.31
28	298.61	85.91
29	306.72	91.77
30	314.63	97.88
31	322.35	104.23
32	329.87	110.83
33	332.95	113.72

Circle Center At X = 117.1 ; Y = 345.7 and Radius, 316.9

*** 1.432 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	74.44	46.94
2	84.33	45.42
3	94.25	44.17
4	104.20	43.18
5	114.17	42.45
6	124.16	42.00
7	134.16	41.81
8	144.16	41.89
9	154.16	42.25
10	164.14	42.86
11	174.10	43.75
12	184.03	44.90
13	193.93	46.32
14	203.79	48.01
15	213.59	49.96
16	223.35	52.17
17	233.04	54.64
18	242.66	57.37
19	252.20	60.36
20	261.66	63.60
21	271.03	67.10
22	280.30	70.85
23	289.47	74.84
24	298.52	79.08
25	307.46	83.56
26	316.28	88.28
27	324.97	93.23
28	333.52	98.42
29	341.93	103.83
30	350.19	109.47
31	357.55	114.78

Circle Center At X = 136.1 ; Y = 414.4 and Radius, 372.5

*** 1.445 ***

Failure Surface Specified By 34 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	30.00	38.00
2	39.56	35.06
3	49.21	32.45
4	58.95	30.16
5	68.75	28.21
6	78.62	26.59
7	88.54	25.31
8	98.49	24.36
9	108.48	23.75

10	118.47	23.49
11	128.47	23.56
12	138.46	23.97
13	148.44	24.72
14	158.38	25.81
15	168.27	27.24
16	178.12	29.00
17	187.90	31.09
18	197.60	33.52
19	207.21	36.27
20	216.72	39.35
21	226.13	42.75
22	235.41	46.47
23	244.56	50.50
24	253.57	54.84
25	262.43	59.48
26	271.12	64.42
27	279.65	69.65
28	287.98	75.17
29	296.13	80.97
30	304.08	87.05
31	311.81	93.38
32	319.33	99.98
33	326.61	106.83
34	333.47	113.74

Circle Center At X = 121.3 ; Y = 317.9 and Radius, 294.4

*** 1.448 ***

CROSS SECTION A

Random Stability Anaylysis of All Failure Surfaces

STABL6H Seismic Adjusted FS = 1.36

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	Berm	75	75	150	30	0	0	W1
2	New Sludge	75	75	150	20	0	0	W1
3	Pee Dee Form.	115	120	0	30	0	0	W1
4	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 30.00 to 130.00
Term Limits: 300.00 to 360.00

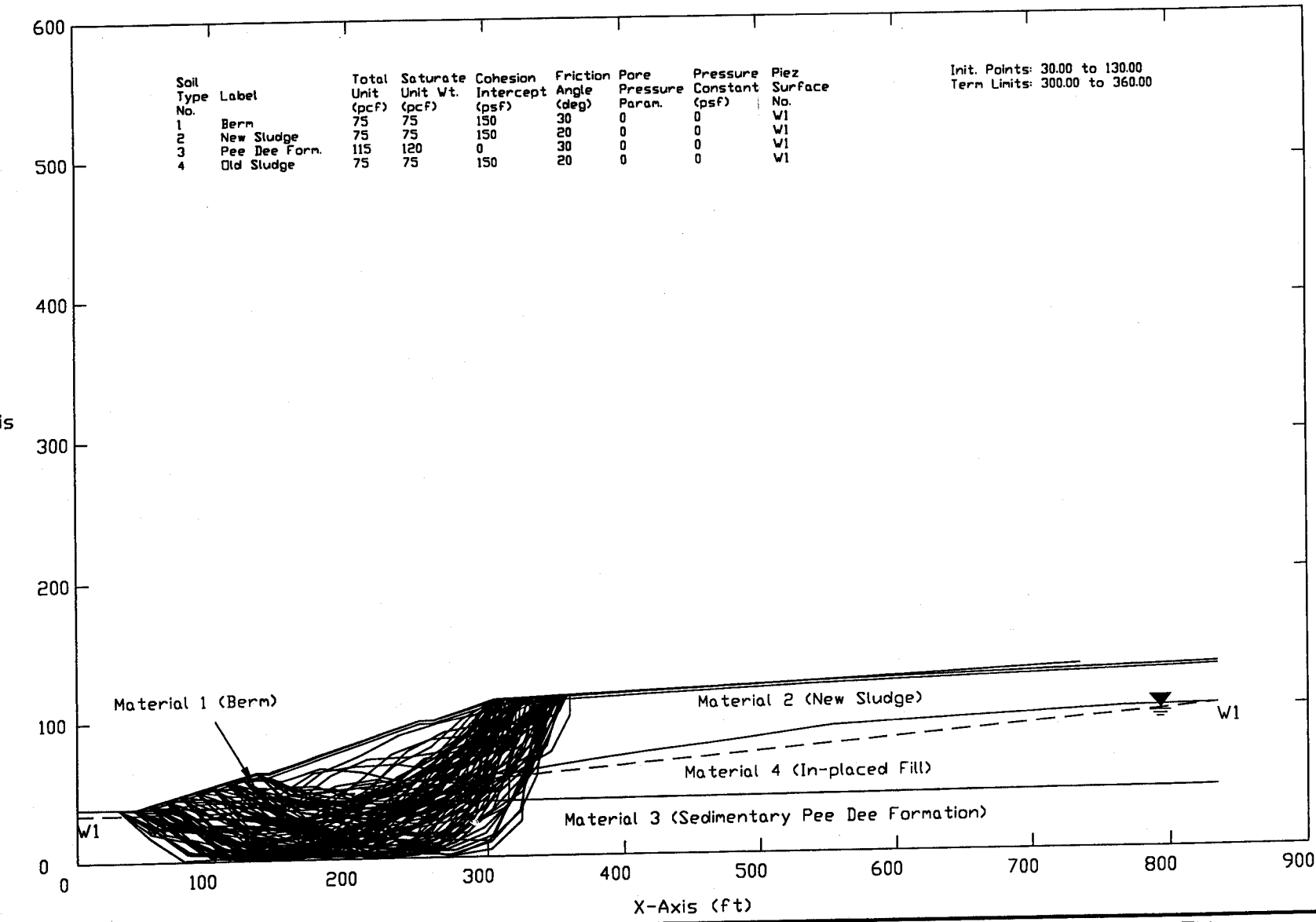

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FIGURE NO. 6

CROSS SECTION A

Factors of Safety Calculated by Random Method

STABL6H Seismic Adjusted FS = 1.36

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	Berm	75	75	150	30	0	0	W1
2	New Sludge	75	75	150	20	0	0	W1
3	Pee Dee Form.	115	120	0	30	0	0	W1
4	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 30.00 to 130.00
Term Limits: 300.00 to 360.00

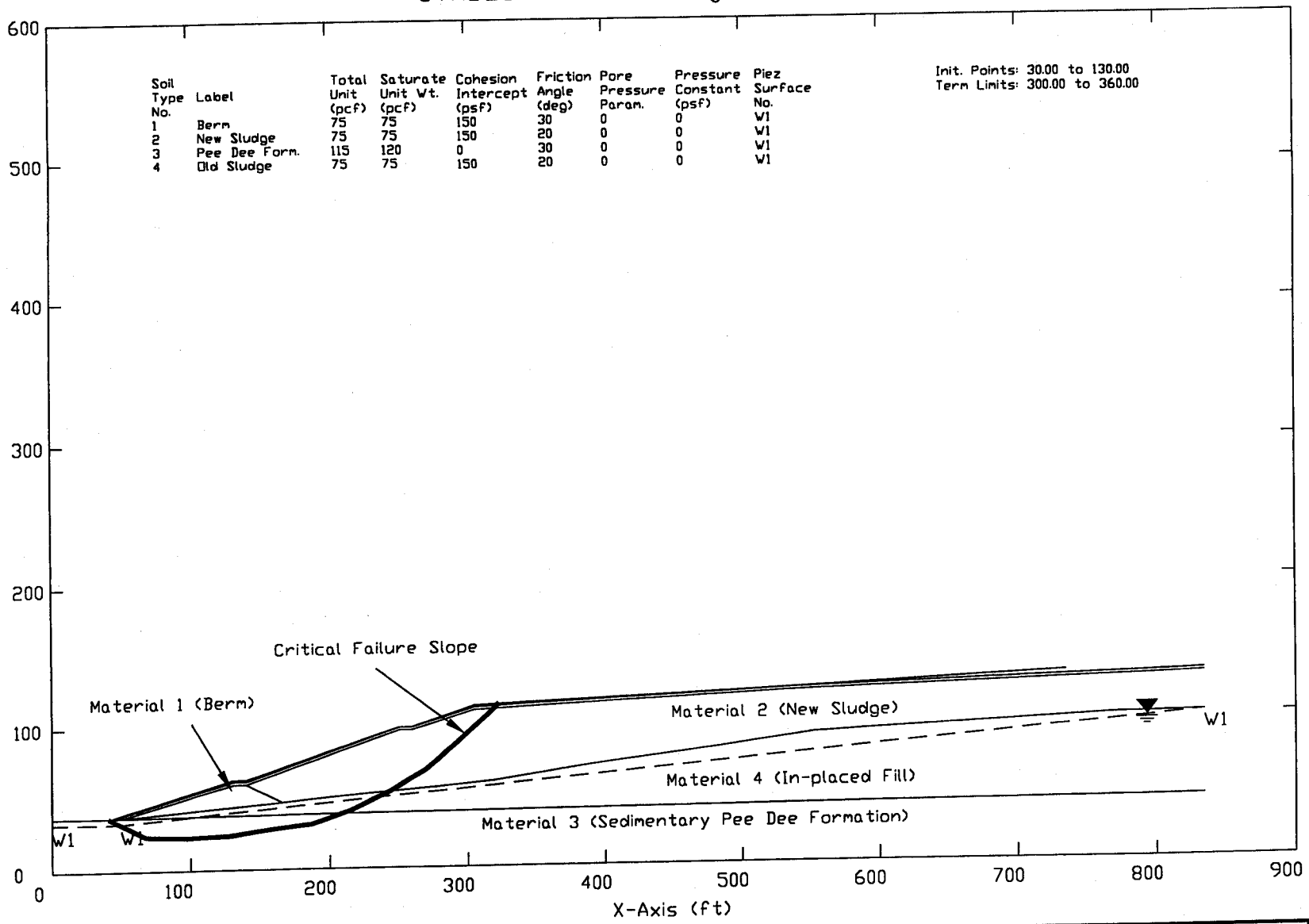

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FIGURE NO. 7

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 3/28/2000
Time of Run: 4:14pm
Run By: Rotthachack Kirivong
Input Data Filename: G:99573CA4
Output Filename: G:99573CA4.OUT
Plotted Output Filename: G:99573CA4.PLT

PROBLEM DESCRIPTION International Paper
1356-99-573

BOUNDARY COORDINATES

8 Top Boundaries
34 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	38.00	42.50	38.00	3
2	42.50	38.00	130.00	62.50	2
3	130.00	62.50	140.00	62.50	2
4	140.00	62.50	250.00	98.50	2
5	250.00	98.50	260.00	98.50	2
6	260.00	98.50	305.00	112.50	2
7	305.00	112.50	535.00	122.50	2
8	535.00	122.50	735.00	132.00	2
9	42.50	38.00	44.00	38.00	3
10	44.00	38.00	130.00	62.00	2
11	130.00	62.00	140.00	62.00	2
12	140.00	62.00	250.00	98.00	2
13	250.00	98.00	260.00	98.00	2
14	260.00	98.00	305.00	112.00	2
15	305.00	112.00	535.00	122.00	2
16	535.00	122.00	835.00	131.50	2
17	44.00	38.00	50.00	38.00	3
18	50.00	38.00	130.00	60.00	1
19	130.00	60.00	140.00	60.00	1
20	140.00	60.00	250.00	96.00	2
21	250.00	96.00	260.00	96.00	2
22	260.00	96.00	305.00	110.00	2
23	305.00	110.00	535.00	120.00	2

24	535.00	120.00	835.00	129.50	2
25	140.00	60.00	166.00	47.00	1
26	50.00	38.00	166.00	47.00	4
27	166.00	47.00	200.00	50.00	4
28	200.00	50.00	318.00	60.00	4
29	318.00	60.00	390.00	70.00	4
30	390.00	70.00	480.00	80.00	4
31	480.00	80.00	552.00	90.00	4
32	552.00	90.00	767.00	100.00	4
33	767.00	100.00	835.00	101.00	4
34	50.00	38.00	835.00	43.00	3

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	75.0	75.0	150.0	30.0	.00	.0	1
2	75.0	75.0	150.0	20.0	.00	.0	1
3	115.0	120.0	.0	30.0	.00	.0	1
4	75.0	75.0	150.0	20.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 3 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	33.00
2	50.00	33.00
3	835.00	101.00

A Horizontal Earthquake Loading Coefficient
Of .075 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .075 Has Been Assigned

Cavitation Pressure = .0 psf

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Irregular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 30.00 ft.
and X = 130.00 ft.

Each Surface Terminates Between X = 300.00 ft.
and X = 360.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

30.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	41.11	38.00
2	67.68	24.06
3	97.64	22.54
4	127.61	23.75
5	157.29	28.14
6	187.07	31.79
7	215.61	41.02
8	242.96	53.34
9	269.09	68.08
10	292.56	86.77
11	314.98	106.71
12	322.82	113.27

*** 1.360 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	107.78	56.28
2	136.82	48.77
3	165.87	41.27
4	195.87	41.17
5	225.87	41.18
6	254.82	49.05
7	278.13	67.93
8	301.63	86.58
9	322.63	108.00
10	325.82	113.41

*** 1.371 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.33	43.83
2	93.31	42.71
3	122.99	38.34
4	152.88	35.70
5	182.88	35.83
6	210.96	46.38
7	238.37	58.58
8	264.92	72.54
9	287.69	92.07
10	309.47	112.69

*** 1.420 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	107.78	56.28
2	135.84	45.67
3	163.95	35.19
4	193.63	39.58
5	223.14	44.95
6	252.75	49.82

7	280.15	62.04
8	306.49	76.39
9	329.62	95.50
10	351.77	114.53

*** 1.427 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	30.00	38.00
2	55.85	22.77
3	81.56	7.31
4	111.15	2.37
5	140.57	8.25
6	170.37	11.69
7	199.01	20.62
8	228.15	27.74
9	254.38	42.30
10	279.08	59.33
11	295.01	84.75
12	304.19	112.25

*** 1.445 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	52.22	40.72
2	78.18	25.68
3	105.96	14.35
4	135.83	11.57
5	165.80	10.28
6	195.70	12.75
7	221.49	28.07
8	247.17	43.59
9	271.49	61.15
10	295.74	78.80
11	307.52	106.39
12	308.08	112.63

*** 1.446 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	74.44	46.94
2	100.36	31.83
3	130.29	29.73
4	160.15	26.84
5	190.11	28.38
6	219.27	35.43
7	243.32	53.35
8	267.13	71.61
9	290.57	90.33
10	311.73	111.59
11	313.02	112.85

*** 1.453 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.56	50.06
2	113.54	39.24
3	141.88	29.41
4	171.88	29.75
5	201.02	36.88
6	228.61	48.65
7	254.79	63.30
8	278.61	81.55
9	299.05	103.50
10	302.19	111.63

*** 1.454 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	130.00	62.50
2	157.08	49.60
3	186.53	43.87
4	216.34	40.46

5	241.52	56.77
6	269.13	68.50
7	295.00	83.69
8	317.00	104.08
9	317.46	113.04

*** 1.455 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.56	50.06
2	108.23	30.42
3	138.00	26.68
4	167.93	28.72
5	196.93	36.38
6	225.86	44.35
7	252.52	58.11
8	278.83	72.51
9	301.14	92.57
10	323.32	112.78
11	323.64	113.31

*** 1.456 ***

CROSS SECTION B

Stability Analysis of All Failure Surfaces

STABL6H No Seismic Adjustment FS = 1.58

Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
Berm	75	75	150	30	0	0	W1
New Sludge	75	75	150	20	0	0	W1
Pee Dee Form.	115	120	0	30	0	0	W1
Old Sludge	75	75	150	20	0	0	W1

Init. Points: 50.00 to 90.00
Term Limits: 300.00 to 350.00

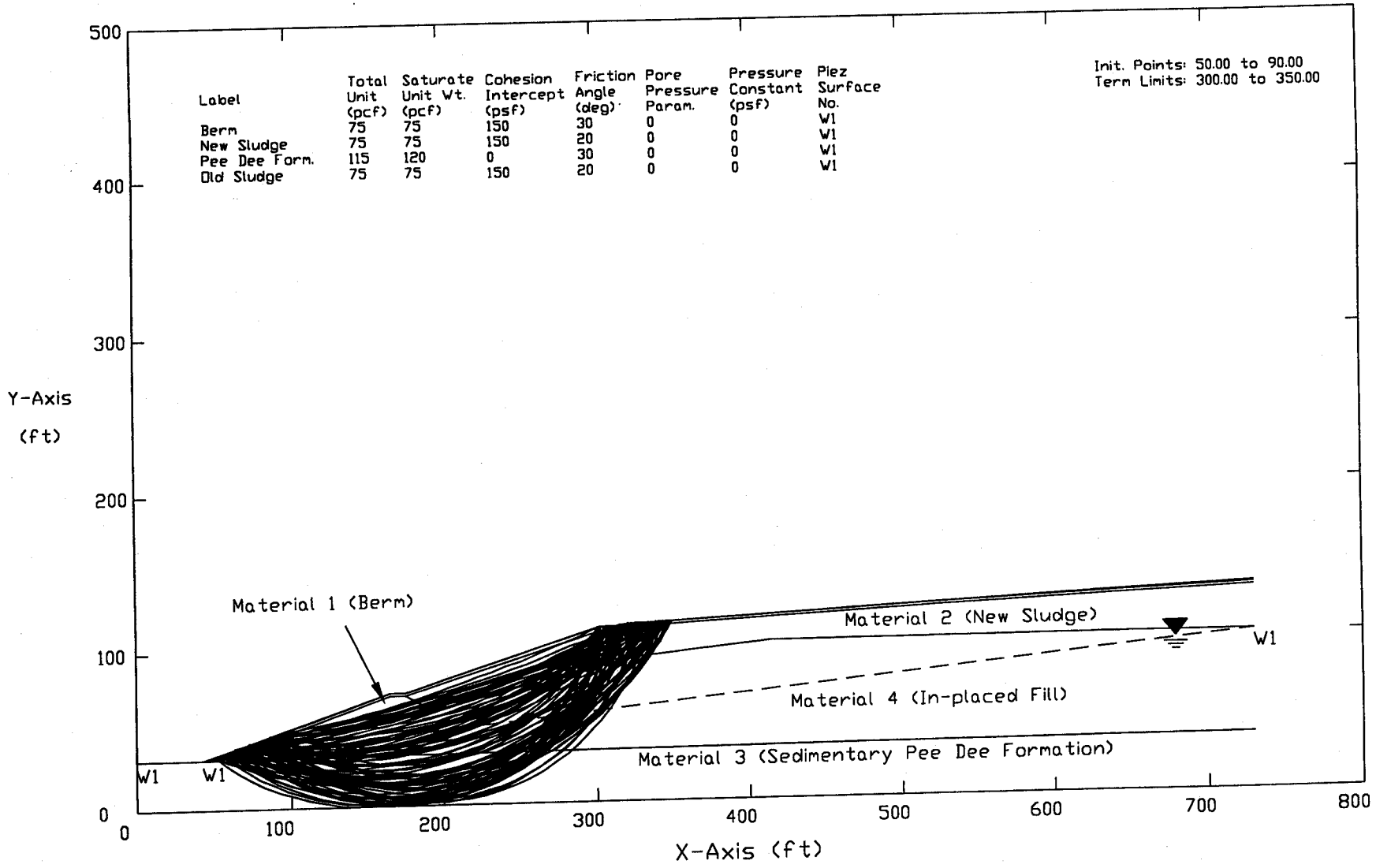

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FIGURE NO. 8

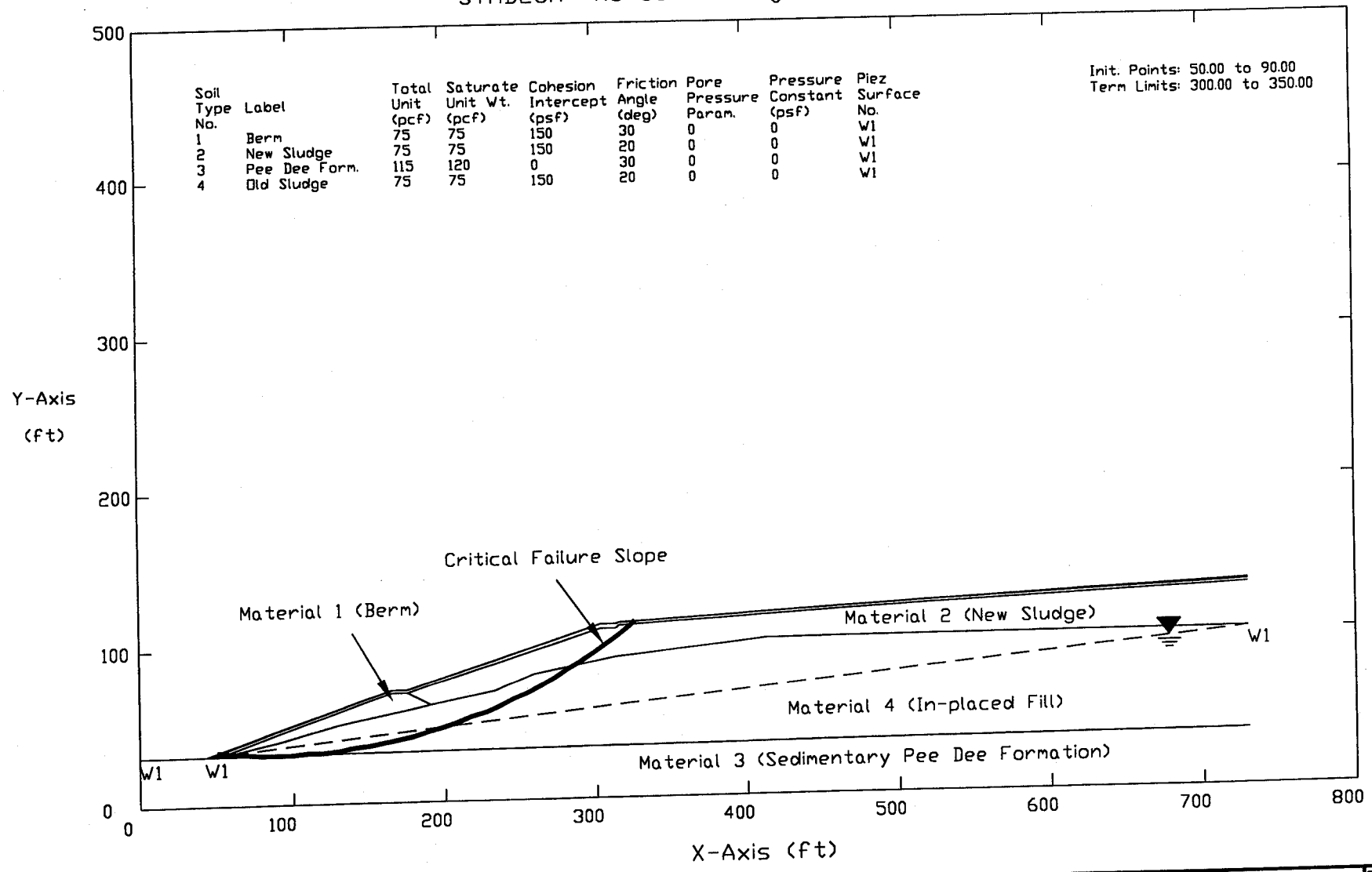
CROSS SECTION B

Factors of Safety Calculated by The Modified Bishop Method

STABL6H No Seismic Adjustment FS = 1.58

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	Berm	75	75	150	30	0	0	W1
2	New Sludge	75	75	150	20	0	0	W1
3	Pee Dee Form.	115	120	0	30	0	0	W1
4	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 50.00 to 90.00
Term Limits: 300.00 to 350.00



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JOB NO. 1356-99-573

FIGURE NO. 9

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	3/22/2000
Time of Run:	9:47am
Run By:	Rotthachack Kirivong
Input Data Filename:	G:99573CB3
Output Filename:	G:99573CB3.OUT
Plotted Output Filename:	G:99573CB3.PLT

PROBLEM DESCRIPTION International Paper
1356-99-573

BOUNDARY COORDINATES

8 Top Boundaries
34 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	32.00	42.50	32.00	3
2	42.50	32.00	165.00	72.50	2
3	165.00	72.50	175.00	72.50	2
4	175.00	72.50	303.00	111.50	2
5	303.00	111.50	313.00	111.50	2
6	313.00	111.50	316.00	112.50	2
7	316.00	112.50	516.00	122.50	2
8	516.00	122.50	730.00	132.00	2
9	42.50	32.00	44.00	32.00	3
10	44.00	32.00	165.00	72.00	2
11	165.00	72.00	175.00	72.00	2
12	175.00	72.00	303.00	111.00	2
13	303.00	111.00	313.00	111.00	2
14	313.00	111.00	316.00	112.00	2
15	316.00	112.00	516.00	122.00	2
16	516.00	122.00	730.00	131.50	2
17	44.00	32.00	50.00	32.00	3
18	50.00	32.00	165.00	70.00	1
19	165.00	70.00	175.00	70.00	1
20	175.00	70.00	303.00	109.00	2
21	303.00	109.00	313.00	109.00	2
22	313.00	109.00	316.00	110.00	2
23	316.00	110.00	516.00	120.00	2

24	516.00	120.00	730.00	129.50	2
25	175.00	70.00	191.00	62.00	1
26	50.00	32.00	90.00	40.00	4
27	90.00	40.00	130.00	50.00	4
28	130.00	50.00	191.00	62.00	4
29	191.00	62.00	233.00	70.00	4
30	233.00	70.00	258.00	80.00	4
31	258.00	80.00	313.00	90.00	4
32	313.00	90.00	413.00	100.00	4
33	413.00	100.00	730.00	101.00	4
34	50.00	32.00	730.00	36.00	3

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	75.0	75.0	150.0	30.0	.00	.0	1
2	75.0	75.0	150.0	20.0	.00	.0	1
3	115.0	120.0	.0	30.0	.00	.0	1
4	75.0	75.0	150.0	20.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 3 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	32.00
2	42.50	32.00
3	730.00	101.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced

Along The Ground Surface Between X = 50.00 ft.
and X = 90.00 ft.

Each Surface Terminates Between X = 300.00 ft.
and X = 350.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	34.48
2	59.95	33.50
3	69.93	32.79
4	79.92	32.33
5	89.91	32.14
6	99.91	32.22
7	109.91	32.56
8	119.89	33.16
9	129.85	34.03
10	139.79	35.15
11	149.69	36.54
12	159.56	38.19
13	169.37	40.10
14	179.13	42.27
15	188.83	44.70
16	198.47	47.38
17	208.03	50.31
18	217.51	53.50
19	226.90	56.93
20	236.20	60.61
21	245.40	64.53
22	254.49	68.70
23	263.47	73.10
24	272.33	77.74
25	281.06	82.61
26	289.66	87.71
27	298.13	93.03

28	306.45	98.58
29	314.62	104.34
30	322.64	110.32
31	326.04	113.00

Circle Center At X = 92.1 ; Y = 411.2 and Radius, 379.1

*** 1.576 ***

Failure Surface Specified By 32 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	54.44	35.95
2	64.37	34.73
3	74.32	33.77
4	84.30	33.07
5	94.29	32.63
6	104.29	32.45
7	114.29	32.52
8	124.28	32.86
9	134.27	33.45
10	144.23	34.30
11	154.17	35.40
12	164.07	36.77
13	173.94	38.39
14	183.76	40.26
15	193.54	42.39
16	203.25	44.77
17	212.90	47.40
18	222.47	50.28
19	231.97	53.41
20	241.39	56.78
21	250.71	60.39
22	259.94	64.25
23	269.06	68.34
24	278.08	72.66
25	286.98	77.22
26	295.76	82.00
27	304.41	87.02
28	312.94	92.25
29	321.32	97.70
30	329.56	103.37
31	337.65	109.25
32	343.69	113.88

Circle Center At X = 106.4 ; Y = 419.0 and Radius, 386.5

*** 1.579 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	72.22	41.83
2	81.91	39.36
3	91.70	37.31
4	101.57	35.68
5	111.49	34.46
6	121.46	33.66
7	131.45	33.28
8	141.45	33.32
9	151.44	33.79
10	161.40	34.67
11	171.32	35.98
12	181.17	37.70
13	190.94	39.83
14	200.61	42.38
15	210.16	45.33
16	219.59	48.68
17	228.86	52.42
18	237.96	56.56
19	246.89	61.07
20	255.61	65.95
21	264.13	71.20
22	272.41	76.81
23	280.45	82.75
24	288.23	89.03
25	295.74	95.64
26	302.96	102.55
27	309.89	109.76
28	311.42	111.50

Circle Center At X = 135.4 ; Y = 270.4 and Radius, 237.1

*** 1.594 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	34.48
2	59.86	32.80
3	69.76	31.43
4	79.71	30.37
5	89.68	29.61
6	99.67	29.17
7	109.67	29.03
8	119.67	29.20
9	129.66	29.68

10	139.62	30.47
11	149.56	31.57
12	159.46	32.97
13	169.32	34.68
14	179.11	36.70
15	188.84	39.01
16	198.49	41.62
17	208.06	44.54
18	217.53	47.74
19	226.90	51.24
20	236.16	55.03
21	245.29	59.10
22	254.30	63.45
23	263.16	68.07
24	271.88	72.97
25	280.44	78.14
26	288.84	83.56
27	297.07	89.25
28	305.11	95.19
29	312.97	101.37
30	320.64	107.79
31	326.51	113.03

Circle Center At X = 109.1 ; Y = 352.4 and Radius, 323.4

*** 1.595 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	76.67	43.30
2	86.28	40.55
3	96.01	38.22
4	105.82	36.32
5	115.71	34.84
6	125.66	33.79
7	135.64	33.17
8	145.64	32.99
9	155.64	33.24
10	165.61	33.92
11	175.55	35.03
12	185.43	36.58
13	195.23	38.55
14	204.94	40.94
15	214.54	43.75
16	224.01	46.97
17	233.33	50.60
18	242.48	54.63
19	251.45	59.05
20	260.22	63.86
21	268.77	69.04

22	277.09	74.59
23	285.16	80.49
24	292.97	86.74
25	300.50	93.32
26	307.74	100.22
27	314.67	107.42
28	319.30	112.67

Circle Center At X = 144.9 ; Y = 263.9 and Radius, 230.9

*** 1.597 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	34.48
2	59.97	33.72
3	69.96	33.21
4	79.96	32.95
5	89.96	32.93
6	99.95	33.15
7	109.94	33.63
8	119.92	34.34
9	129.87	35.31
10	139.80	36.51
11	149.69	37.97
12	159.55	39.66
13	169.36	41.60
14	179.12	43.78
15	188.82	46.19
16	198.46	48.85
17	208.03	51.74
18	217.53	54.87
19	226.95	58.22
20	236.28	61.81
21	245.53	65.63
22	254.67	69.68
23	263.72	73.95
24	272.65	78.44
25	281.47	83.14
26	290.18	88.07
27	298.76	93.20
28	307.21	98.55
29	315.53	104.10
30	323.70	109.86
31	328.08	113.10

Circle Center At X = 85.7 ; Y = 439.3 and Radius, 406.4

*** 1.602 ***

Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	54.44	35.95
2	64.28	34.13
3	74.17	32.64
4	84.10	31.49
5	94.07	30.67
6	104.06	30.20
7	114.05	30.07
8	124.05	30.27
9	134.04	30.82
10	144.00	31.70
11	153.92	32.92
12	163.80	34.48
13	173.62	36.38
14	183.37	38.60
15	193.04	41.16
16	202.61	44.05
17	212.08	47.25
18	221.44	50.78
19	230.67	54.62
20	239.77	58.78
21	248.72	63.24
22	257.51	68.01
23	266.13	73.07
24	274.58	78.42
25	282.84	84.05
26	290.91	89.96
27	298.77	96.14
28	306.42	102.59
29	313.84	109.29
30	317.22	112.56

Circle Center At X = 113.0 ; Y = 324.2 and Radius, 294.2

*** 1.602 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	67.78	40.36
2	77.59	38.44
3	87.47	36.89
4	97.40	35.72
5	107.37	34.92

6	117.36	34.50
7	127.36	34.46
8	137.36	34.80
9	147.33	35.52
10	157.27	36.61
11	167.16	38.08
12	176.99	39.93
13	186.74	42.14
14	196.40	44.72
15	205.96	47.67
16	215.40	50.98
17	224.70	54.64
18	233.86	58.65
19	242.87	63.00
20	251.70	67.69
21	260.34	72.71
22	268.80	78.06
23	277.04	83.72
24	285.06	89.69
25	292.85	95.96
26	300.40	102.53
27	307.69	109.37
28	309.80	111.50

Circle Center At X = 123.4 ; Y = 298.5 and Radius, 264.1

*** 1.616 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	76.67	43.30
2	86.35	40.81
3	96.12	38.67
4	105.96	36.88
5	115.86	35.46
6	125.80	34.39
7	135.78	33.68
8	145.77	33.33
9	155.77	33.35
10	165.76	33.72
11	175.74	34.46
12	185.68	35.55
13	195.57	37.01
14	205.40	38.82
15	215.17	40.98
16	224.84	43.50
17	234.43	46.36
18	243.90	49.57
19	253.25	53.12
20	262.46	57.00

21	271.53	61.22
22	280.44	65.76
23	289.18	70.61
24	297.74	75.79
25	306.11	81.26
26	314.27	87.04
27	322.22	93.11
28	329.94	99.46
29	337.43	106.08
30	344.68	112.97
31	345.67	113.98

Circle Center At X = 150.4 ; Y = 310.0 and Radius, 276.7

*** 1.617 ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	67.78	40.36
2	77.65	38.74
3	87.56	37.46
4	97.52	36.51
5	107.50	35.90
6	117.50	35.63
7	127.50	35.70
8	137.49	36.10
9	147.46	36.85
10	157.40	37.93
11	167.30	39.35
12	177.15	41.10
13	186.93	43.18
14	196.63	45.60
15	206.25	48.34
16	215.77	51.40
17	225.18	54.79
18	234.46	58.49
19	243.62	62.51
20	252.64	66.83
21	261.51	71.45
22	270.21	76.38
23	278.74	81.59
24	287.09	87.09
25	295.25	92.87
26	303.21	98.93
27	310.96	105.25
28	318.50	111.83
29	319.40	112.67

Circle Center At X = 120.5 ; Y = 330.9 and Radius, 295.3

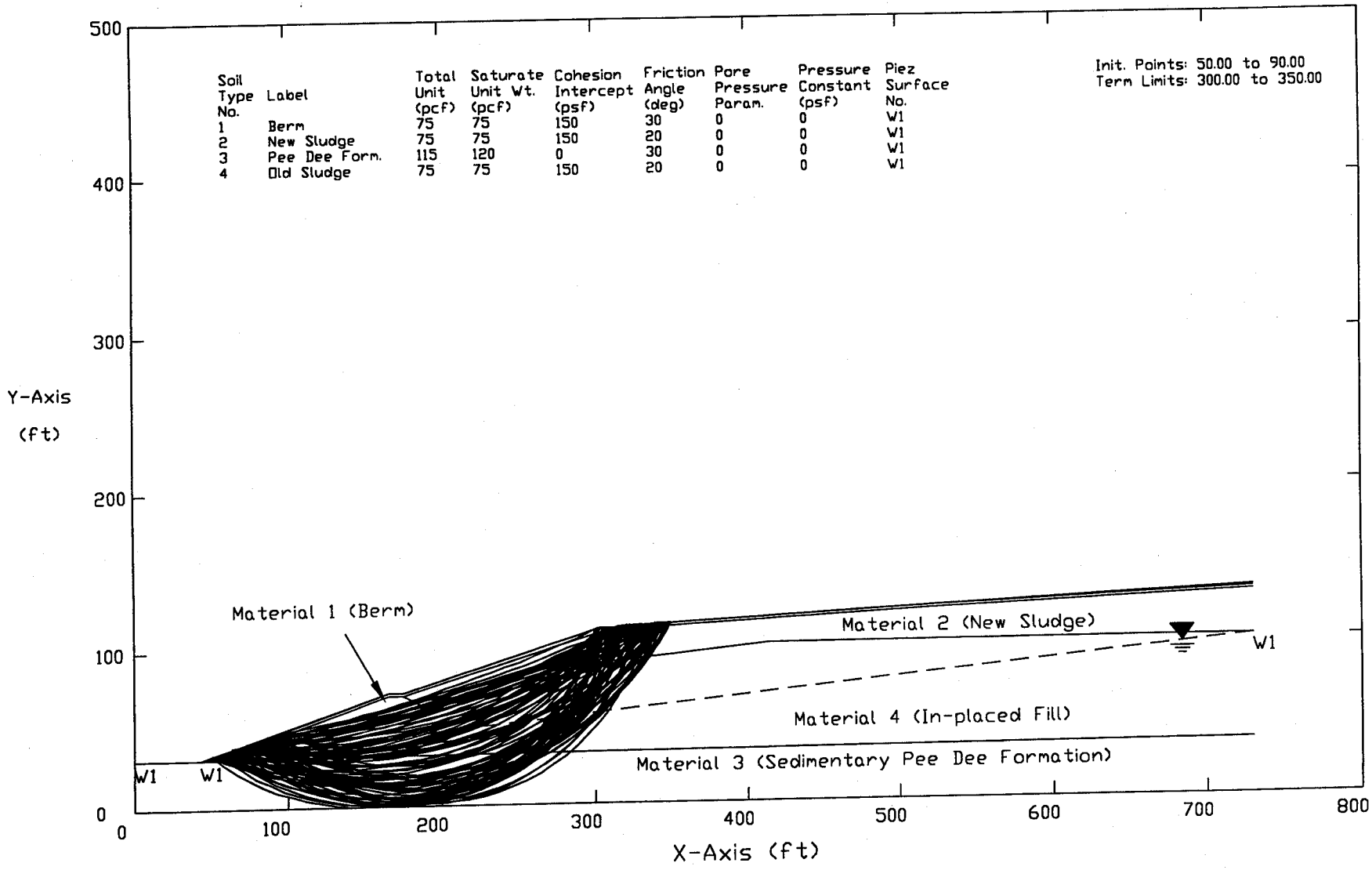
CROSS SECTION B

Stability Analysis of All Failure Surfaces

STABL6H Seismic Adjusted FS = 1.21

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	Berm	75	75	150	30	0	0	W1
2	New Sludge	75	75	150	20	0	0	W1
3	Pee Dee Form.	115	120	0	30	0	0	W1
4	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 50.00 to 90.00
Term Limits: 300.00 to 350.00



SCALE:	AS SHOWN
CHECKED BY:	
DRAWN BY:	RK
DATE:	3-23-00

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ENVIRONMENTAL SERVICES

SLOPE STABILITY
CROSS SECTION B
International Paper
REIGELWOOD, NORTH CAROLINA

JOB NO. 1356-99-573

FIGURE NO. 10

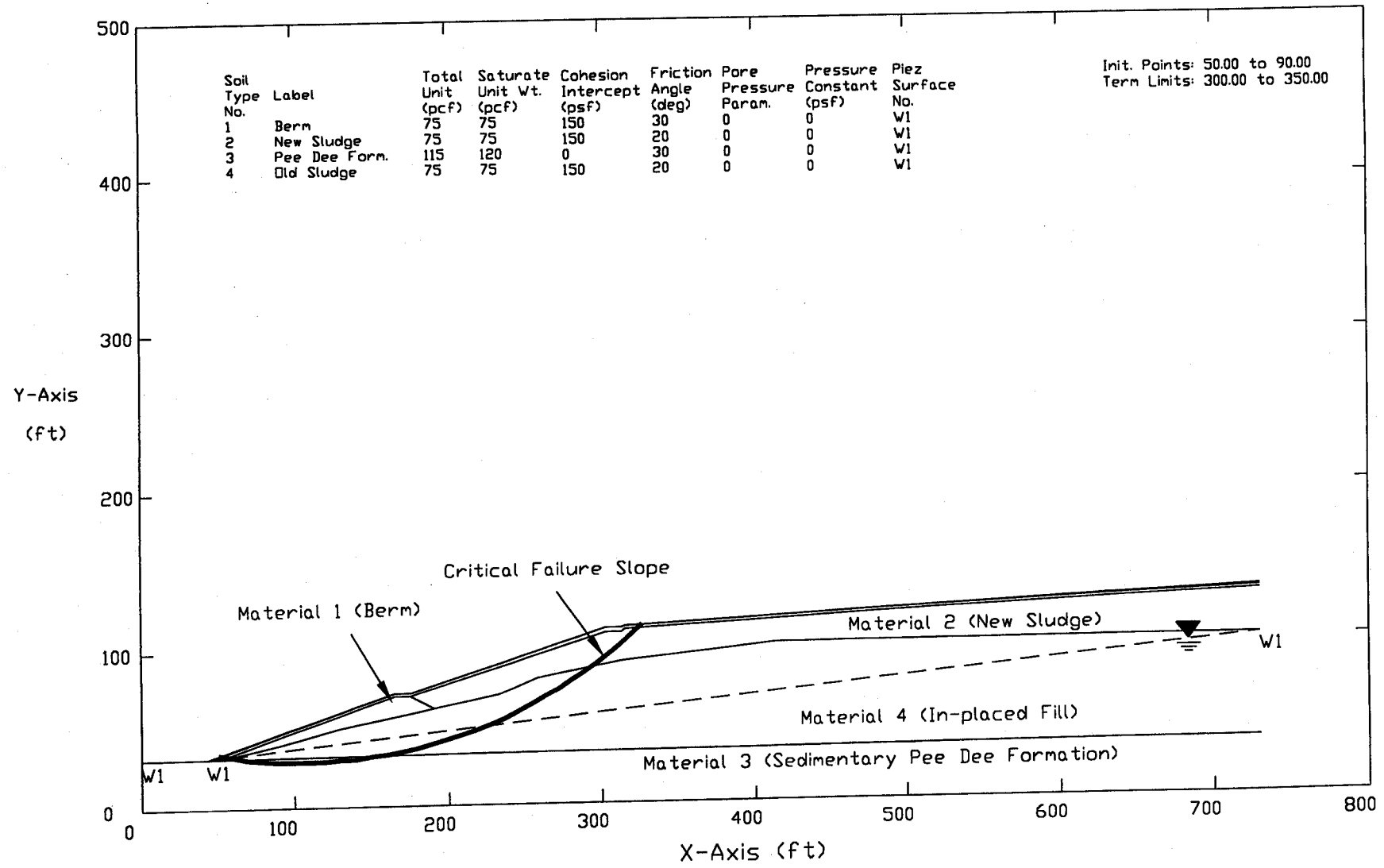
CROSS SECTION B

Factors of Safety Calculated by The Modified Bishop Method

STABL6H Seismic Adjusted FS = 1.21

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	Berm	75	75	150	30	0	0	W1
2	New Sludge	75	75	150	20	0	0	W1
3	Pee Dee Form.	115	120	0	30	0	0	W1
4	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 50.00 to 90.00
Term Limits: 300.00 to 350.00



SCALE:	AS SHOWN
CHECKED BY:	
DRAWN BY:	RK
DATE:	3-23-00

S&ME ENGINEERING · TESTING ENVIRONMENTAL SERVICES

SLOPE STABILITY
CROSS SECTION B
International Paper
REIGELWOOD, NORTH CAROLINA

JOB NO. 1356-99-573

FIGURE NO. 11

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	3/22/2000
Time of Run:	9:58am
Run By:	Rotthachack Kirivong
Input Data Filename:	G:99573CB3
Output Filename:	G:99573CB3.OUT
Plotted Output Filename:	G:99573CB3.PLT

PROBLEM DESCRIPTION International Paper
1356-99-573

BOUNDARY COORDINATES

8 Top Boundaries
34 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	32.00	42.50	32.00	3
2	42.50	32.00	165.00	72.50	2
3	165.00	72.50	175.00	72.50	2
4	175.00	72.50	303.00	111.50	2
5	303.00	111.50	313.00	111.50	2
6	313.00	111.50	316.00	112.50	2
7	316.00	112.50	516.00	122.50	2
8	516.00	122.50	730.00	132.00	2
9	42.50	32.00	44.00	32.00	3
10	44.00	32.00	165.00	72.00	2
11	165.00	72.00	175.00	72.00	2
12	175.00	72.00	303.00	111.00	2
13	303.00	111.00	313.00	111.00	2
14	313.00	111.00	316.00	112.00	2
15	316.00	112.00	516.00	122.00	2
16	516.00	122.00	730.00	131.50	2
17	44.00	32.00	50.00	32.00	3
18	50.00	32.00	165.00	70.00	1
19	165.00	70.00	175.00	70.00	1
20	175.00	70.00	303.00	109.00	2
21	303.00	109.00	313.00	109.00	2
22	313.00	109.00	316.00	110.00	2
23	316.00	110.00	516.00	120.00	2

24	516.00	120.00	730.00	129.50	2
25	175.00	70.00	191.00	62.00	1
26	50.00	32.00	90.00	40.00	4
27	90.00	40.00	130.00	50.00	4
28	130.00	50.00	191.00	62.00	4
29	191.00	62.00	233.00	70.00	4
30	233.00	70.00	258.00	80.00	4
31	258.00	80.00	313.00	90.00	4
32	313.00	90.00	413.00	100.00	4
33	413.00	100.00	730.00	101.00	4
34	50.00	32.00	730.00	36.00	3

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	75.0	75.0	150.0	30.0	.00	.0	1
2	75.0	75.0	150.0	20.0	.00	.0	1
3	115.0	120.0	.0	30.0	.00	.0	1
4	75.0	75.0	150.0	20.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 3 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	32.00
2	42.50	32.00
3	730.00	101.00

A Horizontal Earthquake Loading Coefficient
Of .075 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .075 Has Been Assigned

Cavitation Pressure = .0 psf

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 50.00 ft.
and X = 90.00 ft.

Each Surface Terminates Between X = 300.00 ft.
and X = 350.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	34.48
2	59.86	32.80
3	69.76	31.43
4	79.71	30.37
5	89.68	29.61
6	99.67	29.17
7	109.67	29.03
8	119.67	29.20
9	129.66	29.68
10	139.62	30.47
11	149.56	31.57
12	159.46	32.97
13	169.32	34.68
14	179.11	36.70
15	188.84	39.01
16	198.49	41.62
17	208.06	44.54

18	217.53	47.74
19	226.90	51.24
20	236.16	55.03
21	245.29	59.10
22	254.30	63.45
23	263.16	68.07
24	271.88	72.97
25	280.44	78.14
26	288.84	83.56
27	297.07	89.25
28	305.11	95.19
29	312.97	101.37
30	320.64	107.79
31	326.51	113.03

Circle Center At X = 109.1 ; Y = 352.4 and Radius, 323.4

*** 1.215 ***

Failure Surface Specified By 32 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	54.44	35.95
2	64.37	34.73
3	74.32	33.77
4	84.30	33.07
5	94.29	32.63
6	104.29	32.45
7	114.29	32.52
8	124.28	32.86
9	134.27	33.45
10	144.23	34.30
11	154.17	35.40
12	164.07	36.77
13	173.94	38.39
14	183.76	40.26
15	193.54	42.39
16	203.25	44.77
17	212.90	47.40
18	222.47	50.28
19	231.97	53.41
20	241.39	56.78
21	250.71	60.39
22	259.94	64.25
23	269.06	68.34
24	278.08	72.66
25	286.98	77.22
26	295.76	82.00
27	304.41	87.02
28	312.94	92.25
29	321.32	97.70
30	329.56	103.37

31	337.65	109.25
32	343.69	113.88

Circle Center At X = 106.4 ; Y = 419.0 and Radius, 386.5

*** 1.216 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	34.48
2	59.95	33.50
3	69.93	32.79
4	79.92	32.33
5	89.91	32.14
6	99.91	32.22
7	109.91	32.56
8	119.89	33.16
9	129.85	34.03
10	139.79	35.15
11	149.69	36.54
12	159.56	38.19
13	169.37	40.10
14	179.13	42.27
15	188.83	44.70
16	198.47	47.38
17	208.03	50.31
18	217.51	53.50
19	226.90	56.93
20	236.20	60.61
21	245.40	64.53
22	254.49	68.70
23	263.47	73.10
24	272.33	77.74
25	281.06	82.61
26	289.66	87.71
27	298.13	93.03
28	306.45	98.58
29	314.62	104.34
30	322.64	110.32
31	326.04	113.00

Circle Center At X = 92.1 ; Y = 411.2 and Radius, 379.1

*** 1.224 ***

Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	54.44	35.95
2	64.28	34.13
3	74.17	32.64
4	84.10	31.49
5	94.07	30.67
6	104.06	30.20
7	114.05	30.07
8	124.05	30.27
9	134.04	30.82
10	144.00	31.70
11	153.92	32.92
12	163.80	34.48
13	173.62	36.38
14	183.37	38.60
15	193.04	41.16
16	202.61	44.05
17	212.08	47.25
18	221.44	50.78
19	230.67	54.62
20	239.77	58.78
21	248.72	63.24
22	257.51	68.01
23	266.13	73.07
24	274.58	78.42
25	282.84	84.05
26	290.91	89.96
27	298.77	96.14
28	306.42	102.59
29	313.84	109.29
30	317.22	112.56

Circle Center At X = 113.0 ; Y = 324.2 and Radius, 294.2

*** 1.229 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	76.67	43.30
2	86.28	40.55
3	96.01	38.22
4	105.82	36.32
5	115.71	34.84
6	125.66	33.79
7	135.64	33.17
8	145.64	32.99
9	155.64	33.24

10	165.61	33.92
11	175.55	35.03
12	185.43	36.58
13	195.23	38.55
14	204.94	40.94
15	214.54	43.75
16	224.01	46.97
17	233.33	50.60
18	242.48	54.63
19	251.45	59.05
20	260.22	63.86
21	268.77	69.04
22	277.09	74.59
23	285.16	80.49
24	292.97	86.74
25	300.50	93.32
26	307.74	100.22
27	314.67	107.42
28	319.30	112.67

Circle Center At X = 144.9 ; Y = 263.9 and Radius, 230.9

*** 1.235 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	76.67	43.30
2	86.35	40.81
3	96.12	38.67
4	105.96	36.88
5	115.86	35.46
6	125.80	34.39
7	135.78	33.68
8	145.77	33.33
9	155.77	33.35
10	165.76	33.72
11	175.74	34.46
12	185.68	35.55
13	195.57	37.01
14	205.40	38.82
15	215.17	40.98
16	224.84	43.50
17	234.43	46.36
18	243.90	49.57
19	253.25	53.12
20	262.46	57.00
21	271.53	61.22
22	280.44	65.76
23	289.18	70.61
24	297.74	75.79
25	306.11	81.26

26	314.27	87.04
27	322.22	93.11
28	329.94	99.46
29	337.43	106.08
30	344.68	112.97
31	345.67	113.98

Circle Center At X = 150.4 ; Y = 310.0 and Radius, 276.7

*** 1.237 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	72.22	41.83
2	81.91	39.36
3	91.70	37.31
4	101.57	35.68
5	111.49	34.46
6	121.46	33.66
7	131.45	33.28
8	141.45	33.32
9	151.44	33.79
10	161.40	34.67
11	171.32	35.98
12	181.17	37.70
13	190.94	39.83
14	200.61	42.38
15	210.16	45.33
16	219.59	48.68
17	228.86	52.42
18	237.96	56.56
19	246.89	61.07
20	255.61	65.95
21	264.13	71.20
22	272.41	76.81
23	280.45	82.75
24	288.23	89.03
25	295.74	95.64
26	302.96	102.55
27	309.89	109.76
28	311.42	111.50

Circle Center At X = 135.4 ; Y = 270.4 and Radius, 237.1

*** 1.237 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	34.48
2	59.97	33.72
3	69.96	33.21
4	79.96	32.95
5	89.96	32.93
6	99.95	33.15
7	109.94	33.63
8	119.92	34.34
9	129.87	35.31
10	139.80	36.51
11	149.69	37.97
12	159.55	39.66
13	169.36	41.60
14	179.12	43.78
15	188.82	46.19
16	198.46	48.85
17	208.03	51.74
18	217.53	54.87
19	226.95	58.22
20	236.28	61.81
21	245.53	65.63
22	254.67	69.68
23	263.72	73.95
24	272.65	78.44
25	281.47	83.14
26	290.18	88.07
27	298.76	93.20
28	307.21	98.55
29	315.53	104.10
30	323.70	109.86
31	328.08	113.10

Circle Center At X = 85.7 ; Y = 439.3 and Radius, 406.4

*** 1.247 ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	58.89	37.42
2	68.69	35.41
3	78.54	33.70
4	88.44	32.29
5	98.38	31.19
6	108.35	30.38
7	118.33	29.89

8	128.33	29.69
9	138.33	29.81
10	148.32	30.23
11	158.30	30.95
12	168.24	31.98
13	178.15	33.30
14	188.02	34.94
15	197.83	36.87
16	207.58	39.10
17	217.25	41.63
18	226.85	44.45
19	236.35	47.56
20	245.76	50.96
21	255.05	54.65
22	264.23	58.61
23	273.28	62.86
24	282.20	67.38
25	290.98	72.17
26	299.61	77.23
27	308.08	82.55
28	316.38	88.12
29	324.51	93.94
30	332.46	100.01
31	340.22	106.32
32	347.78	112.86
33	349.19	114.16

Circle Center At X = 129.6 ; Y = 357.4 and Radius, 327.7

*** 1.251 ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	58.89	37.42
2	68.67	35.31
3	78.50	33.52
4	88.39	32.03
5	98.32	30.85
6	108.28	29.99
7	118.27	29.43
8	128.27	29.20
9	138.27	29.27
10	148.26	29.66
11	158.23	30.36
12	168.18	31.37
13	178.09	32.70
14	187.96	34.33
15	197.77	36.28
16	207.51	38.53
17	217.18	41.08
18	226.76	43.94

19	236.25	47.10
20	245.64	50.55
21	254.91	54.29
22	264.06	58.33
23	273.08	62.64
24	281.96	67.24
25	290.69	72.12
26	299.26	77.26
27	307.67	82.68
28	315.91	88.35
29	323.96	94.28
30	331.82	100.46
31	339.49	106.88
32	346.95	113.54
33	347.51	114.08

Circle Center At X = 130.9 ; Y = 348.1 and Radius, 318.9

*** 1.253 ***

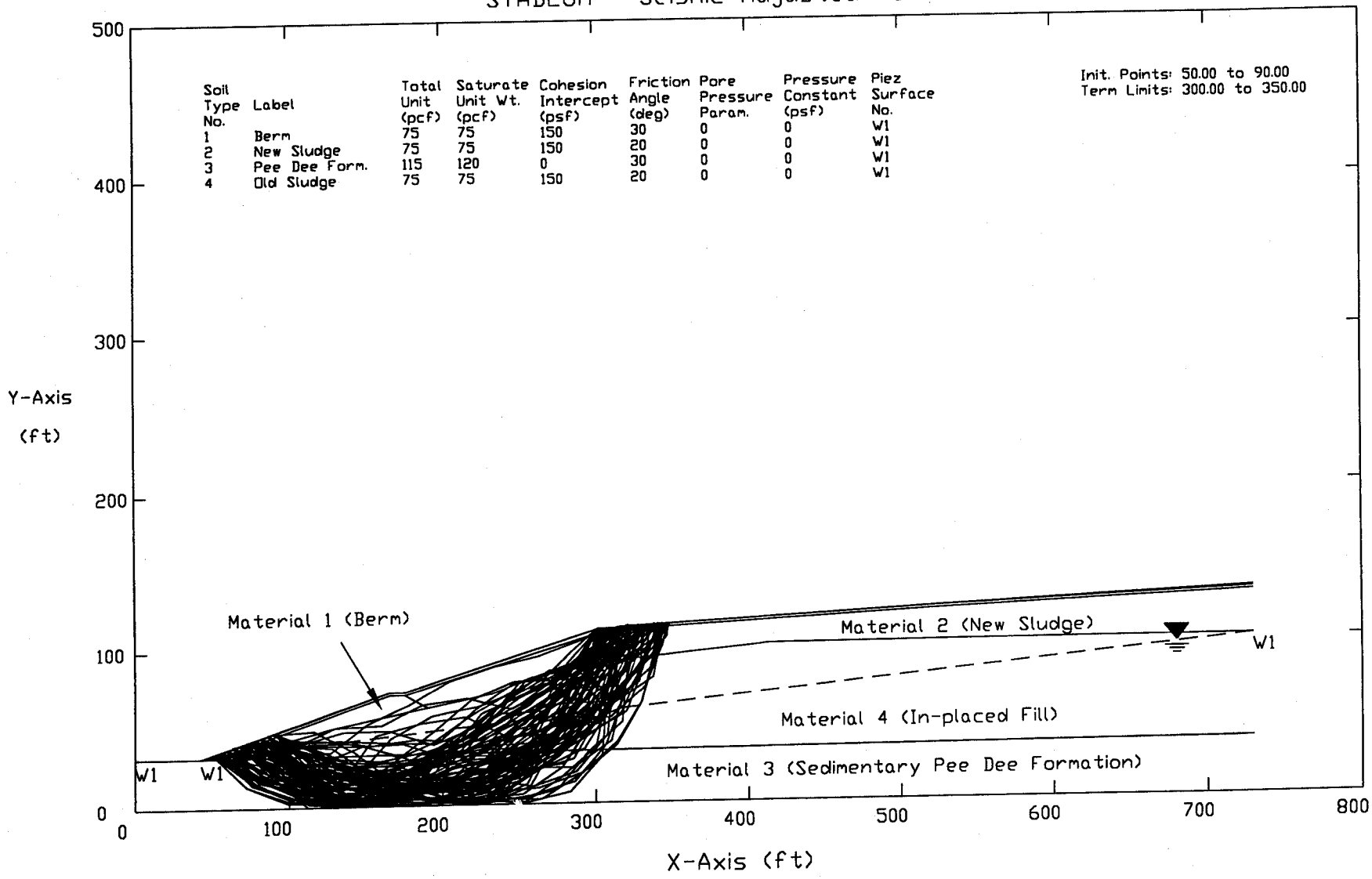
CROSS SECTION B

Random Stability Analysis of All Failure Surfaces

STABL6H Seismic Adjusted FS = 1.23

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	Berm	75	75	150	30	0	0	W1
2	New Sludge	75	75	150	20	0	0	W1
3	Pee Dee Form.	115	120	0	30	0	0	W1
4	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 50.00 to 90.00
Term Limits: 300.00 to 350.00



SCALE:	AS SHOWN
CHECKED BY:	
DRAWN BY:	RK
DATE:	3-23-00

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CROSS SECTION B
International Paper
REIGELWOOD, NORTH CAROLINA

JOB NO. 1356-99-573

FIGURE NO. 12

CROSS SECTION B

Factors of Safety Calculated by Random Method

STABL6H Seismic Adjusted FS = 1.23

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	Berm	75	75	150	30	0	0	W1
2	New Sludge	75	75	150	20	0	0	W1
3	Pee Dee Form.	115	120	0	30	0	0	W1
4	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 50.00 to 90.00
Term Limits: 300.00 to 350.00

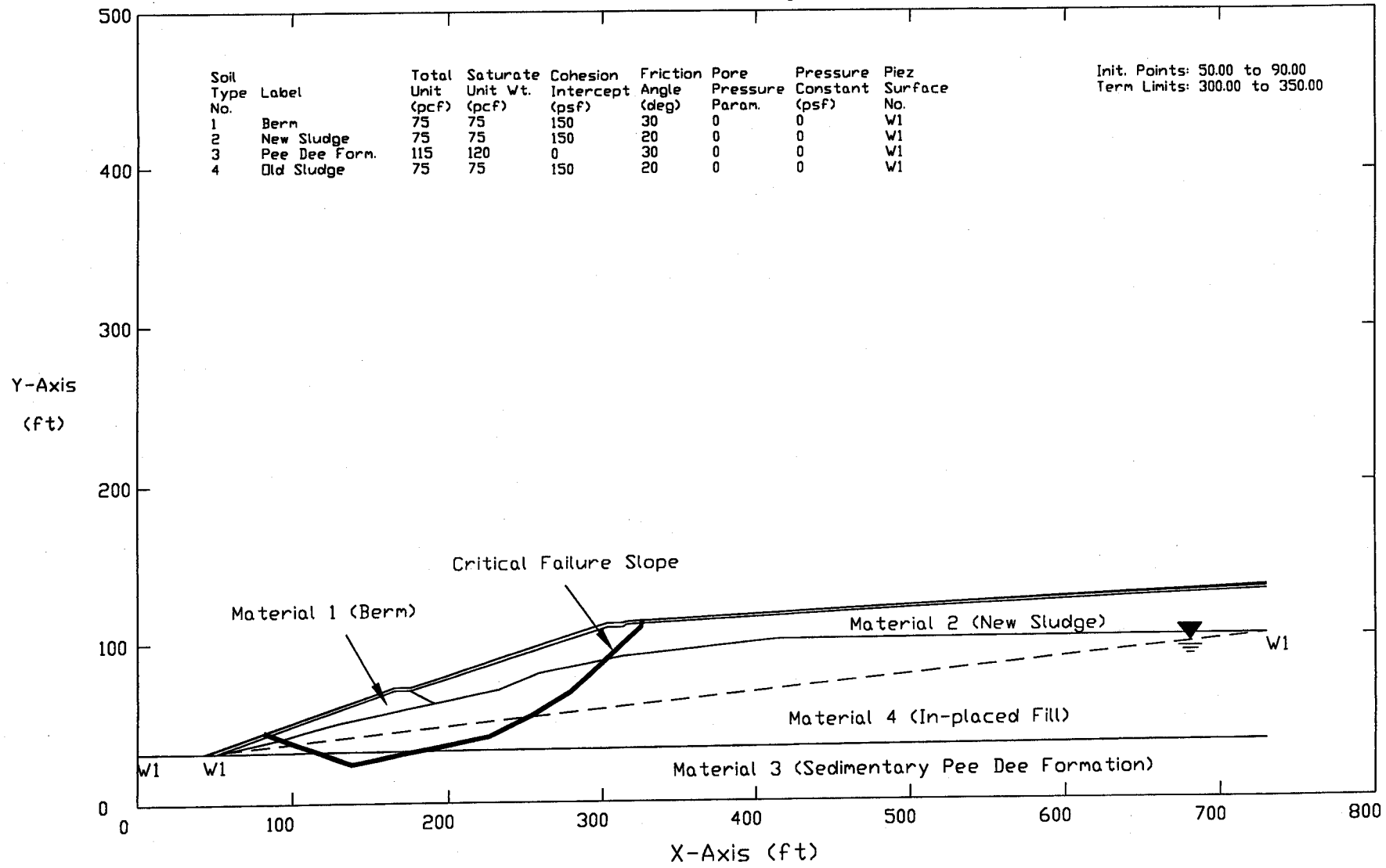

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FIGURE NO. 13

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	3/24/2000
Time of Run:	12:19pm
Run By:	Rotthachack Kirivong
Input Data Filename:	G:99573CB4
Output Filename:	G:99573CB4.OUT
Plotted Output Filename:	G:99573CB4.PLT

PROBLEM DESCRIPTION International Paper
1356-99-573

BOUNDARY COORDINATES

8 Top Boundaries
34 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	32.00	42.50	32.00	3
2	42.50	32.00	165.00	72.50	2
3	165.00	72.50	175.00	72.50	2
4	175.00	72.50	303.00	111.50	2
5	303.00	111.50	313.00	111.50	2
6	313.00	111.50	316.00	112.50	2
7	316.00	112.50	516.00	122.50	2
8	516.00	122.50	730.00	132.00	2
9	42.50	32.00	44.00	32.00	3
10	44.00	32.00	165.00	72.00	2
11	165.00	72.00	175.00	72.00	2
12	175.00	72.00	303.00	111.00	2
13	303.00	111.00	313.00	111.00	2
14	313.00	111.00	316.00	112.00	2
15	316.00	112.00	516.00	122.00	2
16	516.00	122.00	730.00	131.50	2
17	44.00	32.00	50.00	32.00	3
18	50.00	32.00	165.00	70.00	1
19	165.00	70.00	175.00	70.00	1
20	175.00	70.00	303.00	109.00	2
21	303.00	109.00	313.00	109.00	2
22	313.00	109.00	316.00	110.00	2
23	316.00	110.00	516.00	120.00	2

24	516.00	120.00	730.00	129.50	2
25	175.00	70.00	191.00	62.00	1
26	50.00	32.00	90.00	40.00	4
27	90.00	40.00	130.00	50.00	4
28	130.00	50.00	191.00	62.00	4
29	191.00	62.00	233.00	70.00	4
30	233.00	70.00	258.00	80.00	4
31	258.00	80.00	313.00	90.00	4
32	313.00	90.00	413.00	100.00	4
33	413.00	100.00	730.00	101.00	4
34	50.00	32.00	730.00	36.00	3

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	75.0	75.0	150.0	30.0	.00	.0	1
2	75.0	75.0	150.0	20.0	.00	.0	1
3	115.0	120.0	.0	30.0	.00	.0	1
4	75.0	75.0	150.0	20.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 3 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	32.00
2	42.50	32.00
3	730.00	101.00

A Horizontal Earthquake Loading Coefficient
Of .075 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .075 Has Been Assigned

Cavitation Pressure = .0 psf

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Irregular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 50.00 ft.
and X = 90.00 ft.

Each Surface Terminates Between X = 300.00 ft.
and X = 350.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

30.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	81.11	44.77
2	109.38	34.73
3	137.70	24.82
4	167.28	29.81
5	196.68	35.78
6	226.18	41.24
7	253.33	54.01
8	279.38	68.89
9	302.11	88.46
10	324.47	108.47
11	325.94	113.00

*** 1.226 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.33	38.89
2	86.08	19.33
3	115.86	15.69
4	145.78	17.83
5	174.76	25.59
6	203.65	33.67
7	230.27	47.51
8	256.53	62.01
9	278.78	82.14
10	300.88	102.42
11	306.29	111.50

*** 1.231 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	76.67	43.30
2	99.41	23.73
3	129.19	20.10
4	159.11	22.24
5	188.09	30.00
6	216.99	38.07
7	243.60	51.92
8	269.87	66.41
9	292.11	86.54
10	314.21	106.83
11	317.64	112.58

*** 1.251 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	58.89	37.42
2	80.81	16.93
3	109.83	9.33
4	139.42	4.43
5	167.19	15.79

6	195.01	27.01
7	220.98	42.04
8	246.02	58.55
9	271.24	74.80
10	295.54	92.40
11	307.48	111.50

*** 1.265 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	54.44	35.95
2	78.99	18.69
3	106.40	6.50
4	136.24	3.44
5	166.15	1.16
6	196.14	.30
7	223.05	13.57
8	247.63	30.76
9	271.78	48.56
10	295.49	66.94
11	319.73	84.62
12	340.94	105.84
13	347.55	114.08

*** 1.268 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.56	46.23
2	111.65	31.44
3	141.60	29.70
4	171.50	27.19
5	201.44	29.09
6	230.51	36.49
7	254.34	54.71
8	277.92	73.27
9	301.13	92.27
10	321.03	112.75

*** 1.273 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	90.00	47.70
2	112.75	28.14
3	142.52	24.51
4	172.45	26.65
5	201.43	34.41
6	230.32	42.48
7	256.93	56.33
8	283.20	70.82
9	305.44	90.95
10	327.54	111.24
11	328.68	113.13

*** 1.273 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	34.48
2	77.28	21.99
3	105.29	11.24
4	134.97	6.87
5	164.30	.59
6	192.76	10.07
7	221.23	19.52
8	249.58	29.34
9	278.14	38.51
10	304.73	52.42
11	321.69	77.17
12	337.74	102.51
13	338.69	113.63

*** 1.275 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	50.00	34.48
2	71.98	14.07
3	99.95	3.21
4	129.79	6.32
5	159.71	4.13
6	189.43	8.23
7	219.41	9.34
8	245.04	24.92
9	273.18	35.31
10	290.66	59.70
11	313.68	78.93
12	332.47	102.32
13	340.84	113.74

*** 1.278 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	34.48
2	71.98	14.07
3	99.95	3.21
4	129.79	6.32
5	159.71	4.13
6	189.43	8.23
7	219.41	9.34
8	245.04	24.92
9	273.18	35.31
10	290.66	59.70
11	313.68	78.93
12	332.47	102.32
13	340.84	113.74

*** 1.278 ***

CROSS SECTION C
Stability Ananlysis of All Failure Surfaces
STABL6H No Seismic Adjustment FS = 1.77

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	New Sludge	75	75	150	20	0	0	W1
2	Pee Dee Form.	115	120	0	30	0	0	W1
3	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 40.00 to 70.00
Term Limits: 280.00 to 320.00

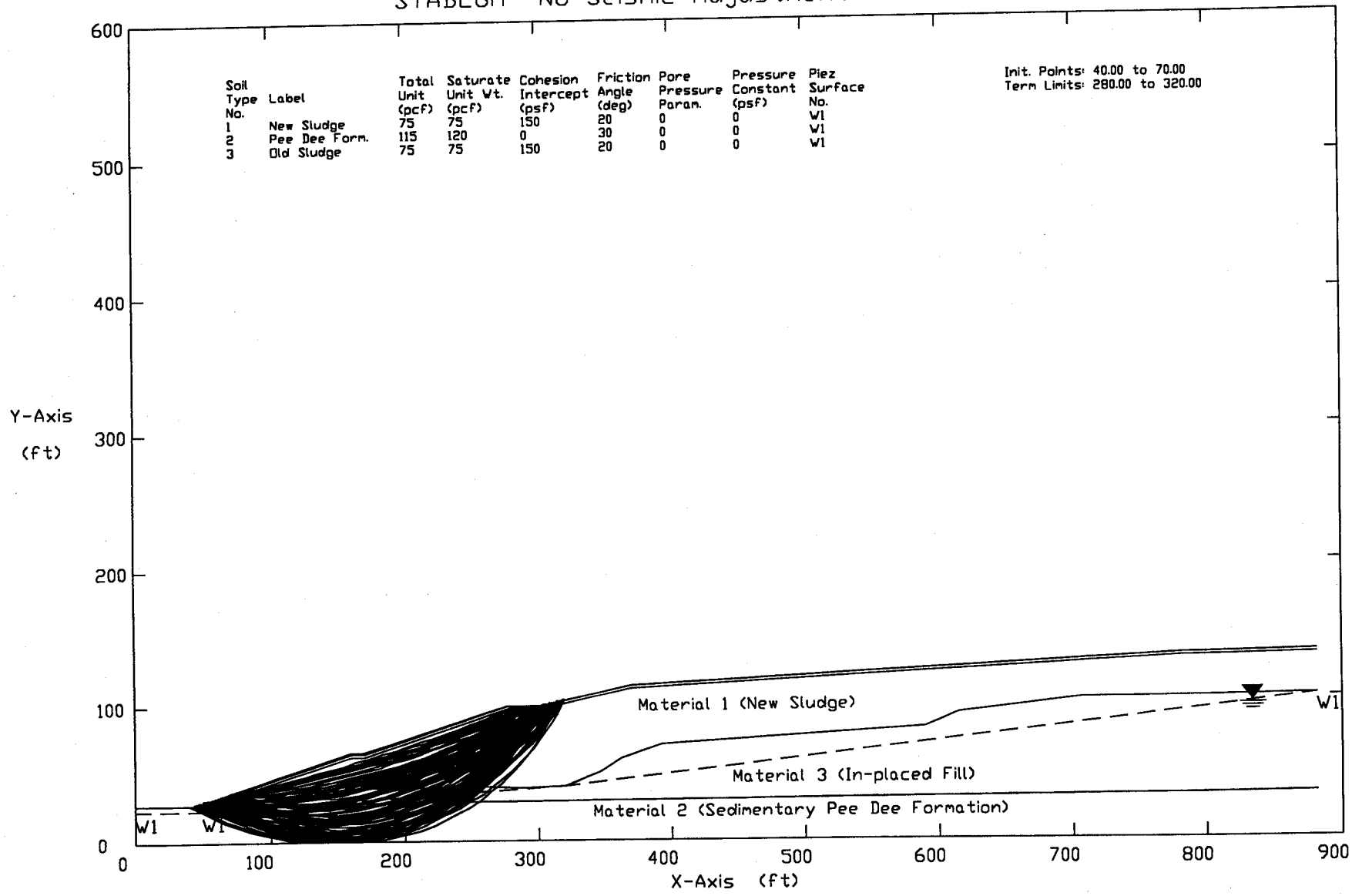

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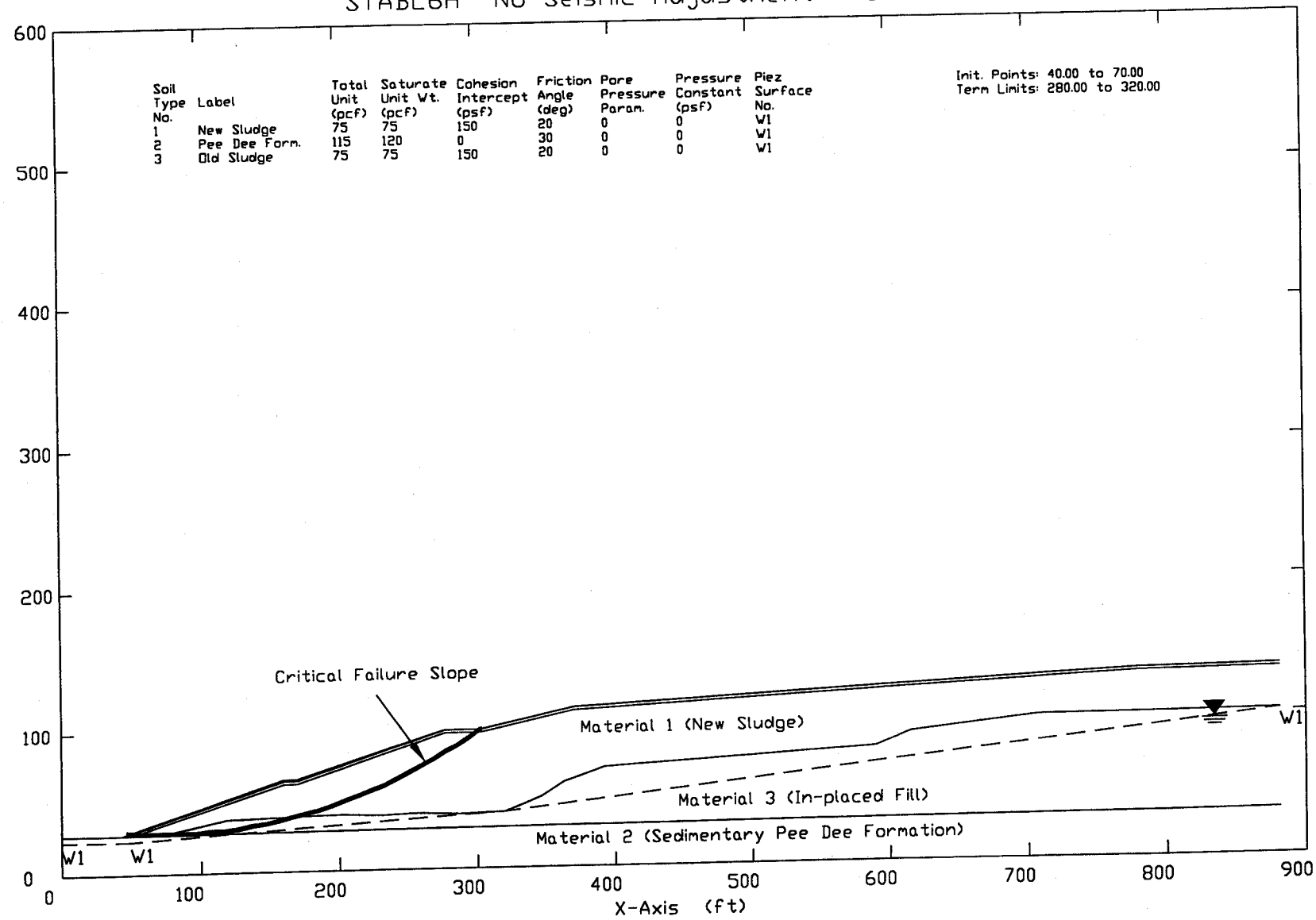
FIGURE NO. 14

CROSS SECTION C

Factors of Safety Calculated by the Modified Bishop Method

STABL6H No Seismic Adjustment FS = 1.77



SCALE:	AS SHOWN
CHECKED BY:	
DRAWN BY:	RK
DATE:	2-23-00

S&ME
ENGINEERING · TESTING
ENVIRONMENTAL SERVICES

SLOPE STABILITY
CROSS SECTION C
International Paper
REIGELWOOD, NORTH CAROLINA

JOB NO. 1356-99-573

FIGURE NO. 15

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	3/23/2000
Time of Run:	1:44pm
Run By:	Rotthachack Kirivong
Input Data Filename:	G:99573CC3
Output Filename:	G:99573CC3.OUT
Plotted Output Filename:	G:99573CC3.PLT

PROBLEM DESCRIPTION International Paper
1356-99-573

BOUNDARY COORDINATES

8 Top Boundaries
39 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	28.00	42.50	28.00	2
2	42.50	28.00	160.00	64.50	1
3	160.00	64.50	170.00	64.50	1
4	170.00	64.50	277.00	98.50	1
5	277.00	98.50	302.00	98.50	1
6	302.00	98.50	370.00	112.50	1
7	370.00	112.50	782.00	132.50	1
8	782.00	132.50	882.00	133.50	1
9	42.50	28.00	44.00	28.00	2
10	44.00	28.00	160.00	64.00	1
11	160.00	64.00	170.00	64.00	1
12	170.00	64.00	277.00	98.00	1
13	277.00	98.00	302.00	98.00	1
14	302.00	98.00	370.00	112.00	1
15	370.00	112.00	782.00	132.00	1
16	782.00	132.00	882.00	133.00	1
17	44.00	28.00	50.00	28.00	2
18	50.00	28.00	160.00	62.00	1
19	160.00	62.00	170.00	62.00	1
20	170.00	62.00	277.00	96.00	1
21	277.00	96.00	302.00	96.00	1
22	302.00	96.00	370.00	110.00	1
23	370.00	110.00	782.00	130.00	1

24	782.00	130.00	882.00	131.00	1
25	50.00	28.00	80.00	30.00	3
26	80.00	30.00	119.00	38.00	3
27	119.00	38.00	202.00	40.00	3
28	202.00	40.00	232.00	39.00	3
29	232.00	39.00	257.00	40.00	3
30	257.00	40.00	287.00	39.00	3
31	287.00	39.00	320.00	40.00	3
32	320.00	40.00	346.00	50.00	3
33	346.00	50.00	363.00	60.00	3
34	363.00	60.00	393.00	70.00	3
35	393.00	70.00	590.00	80.00	3
36	590.00	80.00	615.00	90.00	3
37	615.00	90.00	707.00	100.00	3
38	707.00	100.00	882.00	101.00	3
39	50.00	28.00	882.00	32.00	2

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	75.0	75.0	150.0	20.0	.00	.0	1
2	115.0	120.0	.0	30.0	.00	.0	1
3	75.0	75.0	150.0	20.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	23.00
2	50.00	23.00
3	320.00	40.00
4	882.00	101.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 40.00 ft.
and X = 70.00 ft.

Each Surface Terminates Between X = 280.00 ft.
and X = 320.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	29.29
2	56.65	28.69
3	66.64	28.33
4	76.64	28.22
5	86.64	28.36
6	96.63	28.75
7	106.61	29.39
8	116.57	30.28
9	126.51	31.42
10	136.41	32.80
11	146.28	34.44
12	156.10	36.32
13	165.87	38.44
14	175.59	40.81
15	185.24	43.41
16	194.83	46.26
17	204.34	49.35
18	213.77	52.67
19	223.11	56.23
20	232.37	60.02
21	241.52	64.05
22	250.58	68.29

23	259.52	72.77
24	268.35	77.46
25	277.06	82.38
26	285.64	87.51
27	294.10	92.85
28	302.41	98.40
29	302.78	98.66

Circle Center At X = 76.0 ; Y = 428.5 and Radius, 400.3

*** 1.774 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	29.29
2	56.65	28.74
3	66.65	28.44
4	76.65	28.39
5	86.65	28.58
6	96.64	29.02
7	106.61	29.71
8	116.57	30.64
9	126.50	31.82
10	136.40	33.25
11	146.26	34.92
12	156.07	36.83
13	165.84	38.99
14	175.54	41.38
15	185.19	44.02
16	194.77	46.90
17	204.27	50.01
18	213.70	53.35
19	223.03	56.93
20	232.28	60.74
21	241.43	64.77
22	250.48	69.03
23	259.42	73.52
24	268.24	78.22
25	276.95	83.14
26	285.53	88.27
27	293.98	93.62
28	301.29	98.50

Circle Center At X = 73.9 ; Y = 432.3 and Radius, 403.9

*** 1.776 ***

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.33	34.47
2	73.21	32.91
3	83.14	31.72
4	93.11	30.92
5	103.10	30.50
6	113.10	30.46
7	123.09	30.80
8	133.07	31.53
9	143.00	32.64
10	152.89	34.13
11	162.72	35.99
12	172.46	38.23
13	182.12	40.85
14	191.66	43.83
15	201.09	47.17
16	210.38	50.87
17	219.52	54.93
18	228.49	59.33
19	237.30	64.07
20	245.91	69.15
21	254.33	74.56
22	262.53	80.28
23	270.50	86.31
24	278.24	92.64
25	284.87	98.50

Circle Center At X = 109.1 ; Y = 291.4 and Radius, 261.0

*** 1.785 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	43.33	28.26
2	53.33	27.91
3	63.33	27.77
4	73.33	27.85
5	83.32	28.13
6	93.31	28.63
7	103.29	29.34
8	113.24	30.26
9	123.18	31.39
10	133.09	32.73
11	142.97	34.27
12	152.81	36.03
13	162.62	37.99

14	172.38	40.17
15	182.09	42.54
16	191.75	45.12
17	201.36	47.91
18	210.90	50.90
19	220.38	54.09
20	229.79	57.48
21	239.12	61.06
22	248.38	64.85
23	257.55	68.82
24	266.64	73.00
25	275.64	77.36
26	284.54	81.91
27	293.35	86.65
28	302.05	91.57
29	310.65	96.68
30	319.14	101.97
31	319.27	102.06

Circle Center At X = 64.8 ; Y = 500.8 and Radius, 473.0

*** 1.792 ***

Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	43.33	28.26
2	53.32	27.75
3	63.32	27.46
4	73.32	27.40
5	83.32	27.56
6	93.31	27.95
7	103.29	28.57
8	113.25	29.41
9	123.20	30.47
10	133.11	31.76
11	143.00	33.27
12	152.85	35.00
13	162.65	36.96
14	172.41	39.13
15	182.12	41.53
16	191.78	44.14
17	201.37	46.97
18	210.89	50.02
19	220.35	53.28
20	229.72	56.75
21	239.02	60.43
22	248.23	64.32
23	257.35	68.42
24	266.38	72.72
25	275.31	77.23

26	284.13	81.93
27	292.85	86.83
28	301.45	91.93
29	309.94	97.22
30	316.42	101.47

Circle Center At X = 71.0 ; Y = 470.9 and Radius, 443.5

*** 1.795 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.33	34.47
2	73.16	32.62
3	83.05	31.11
4	92.98	29.94
5	102.94	29.11
6	112.93	28.63
7	122.93	28.49
8	132.93	28.69
9	142.91	29.24
10	152.87	30.13
11	162.80	31.37
12	172.67	32.94
13	182.49	34.86
14	192.23	37.11
15	201.89	39.70
16	211.45	42.61
17	220.91	45.86
18	230.26	49.43
19	239.47	53.31
20	248.54	57.52
21	257.47	62.03
22	266.23	66.85
23	274.82	71.96
24	283.23	77.37
25	291.45	83.07
26	299.47	89.04
27	307.28	95.29
28	313.86	100.94

Circle Center At X = 122.0 ; Y = 318.8 and Radius, 290.4

*** 1.796 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	56.67	32.40
2	66.63	31.53
3	76.61	30.98
4	86.61	30.75
5	96.61	30.83
6	106.60	31.23
7	116.58	31.95
8	126.52	32.98
9	136.43	34.32
10	146.29	35.98
11	156.10	37.95
12	165.84	40.23
13	175.49	42.82
14	185.07	45.71
15	194.54	48.91
16	203.91	52.40
17	213.17	56.19
18	222.30	60.27
19	231.30	64.63
20	240.15	69.28
21	248.85	74.21
22	257.39	79.41
23	265.77	84.88
24	273.96	90.61
25	281.97	96.60
26	284.36	98.50

Circle Center At X = 89.0 ; Y = 346.4 and Radius, 315.6

*** 1.797 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	60.00	33.44
2	69.83	31.61
3	79.73	30.17
4	89.67	29.11
5	99.65	28.44
6	109.65	28.16
7	119.64	28.26
8	129.63	28.75
9	139.59	29.63
10	149.51	30.90
11	159.38	32.55
12	169.17	34.58
13	178.87	36.99
14	188.48	39.77

15	197.97	42.92
16	207.33	46.44
17	216.55	50.32
18	225.60	54.56
19	234.49	59.14
20	243.20	64.06
21	251.70	69.32
22	260.00	74.90
23	268.07	80.81
24	275.91	87.02
25	283.50	93.53
26	288.87	98.50

Circle Center At X = 112.0 ; Y = 285.9 and Radius, 257.8

*** 1.802 ***

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	53.33	31.37
2	63.33	31.00
3	73.33	30.88
4	83.33	31.02
5	93.32	31.41
6	103.30	32.05
7	113.26	32.95
8	123.19	34.10
9	133.09	35.50
10	142.96	37.15
11	152.77	39.04
12	162.54	41.19
13	172.25	43.59
14	181.89	46.23
15	191.47	49.11
16	200.97	52.23
17	210.39	55.60
18	219.71	59.20
19	228.95	63.04
20	238.08	67.11
21	247.11	71.41
22	256.03	75.94
23	264.83	80.69
24	273.50	85.66
25	282.05	90.85
26	290.46	96.26
27	293.76	98.50

Circle Center At X = 72.9 ; Y = 425.5 and Radius, 394.6

*** 1.806 ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.33	34.47
2	73.28	33.40
3	83.24	32.61
4	93.23	32.10
5	103.23	31.87
6	113.23	31.92
7	123.22	32.25
8	133.20	32.86
9	143.16	33.76
10	153.10	34.93
11	162.99	36.38
12	172.84	38.11
13	182.63	40.12
14	192.37	42.40
15	202.04	44.96
16	211.63	47.78
17	221.14	50.88
18	230.56	54.24
19	239.88	57.86
20	249.09	61.75
21	258.20	65.89
22	267.18	70.29
23	276.03	74.94
24	284.75	79.83
25	293.33	84.97
26	301.76	90.35
27	310.04	95.96
28	318.15	101.81
29	318.19	101.83

Circle Center At X = 106.4 ; Y = 387.3 and Radius, 355.4

*** 1.812 ***

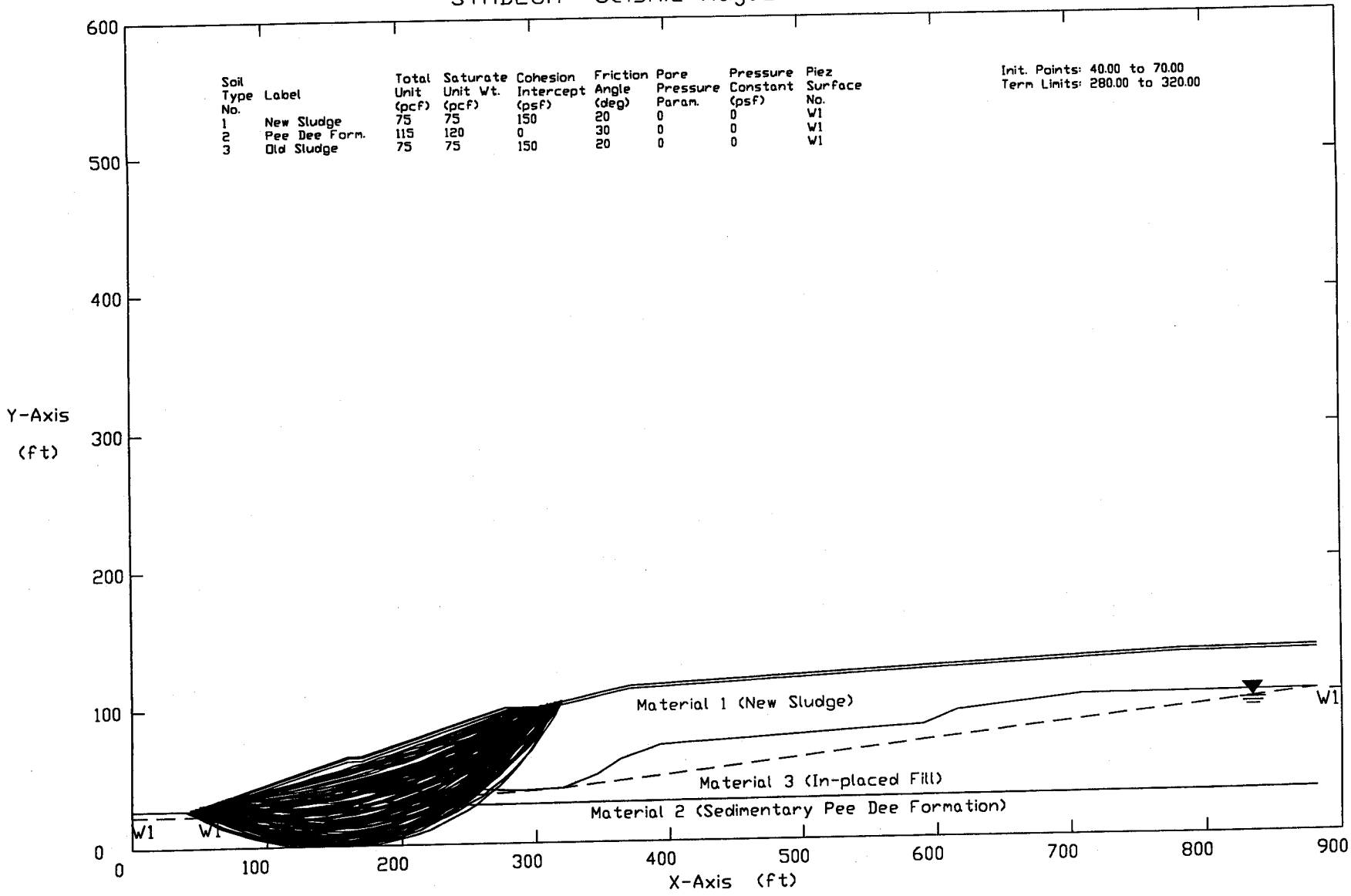
CROSS SECTION C

Stability Ananlysis of All Failure Surfaces

STABL6H Seismic Adjusted FS = 1.39

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	New Sludge	75	75	150	20	0	0	W1
2	Pee Dee Form.	115	120	0	30	0	0	W1
3	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 40.00 to 70.00
Term Limits: 280.00 to 320.00



SCALE:	AS SHOWN
CHECKED BY:	
DRAWN BY:	RK
DATE:	2-23-00

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SLOPE STABILITY
CROSS SECTION C
International Paper
REIGELWOOD, NORTH CAROLINA

JOB NO. 1356-99-573

FIGURE NO. 16

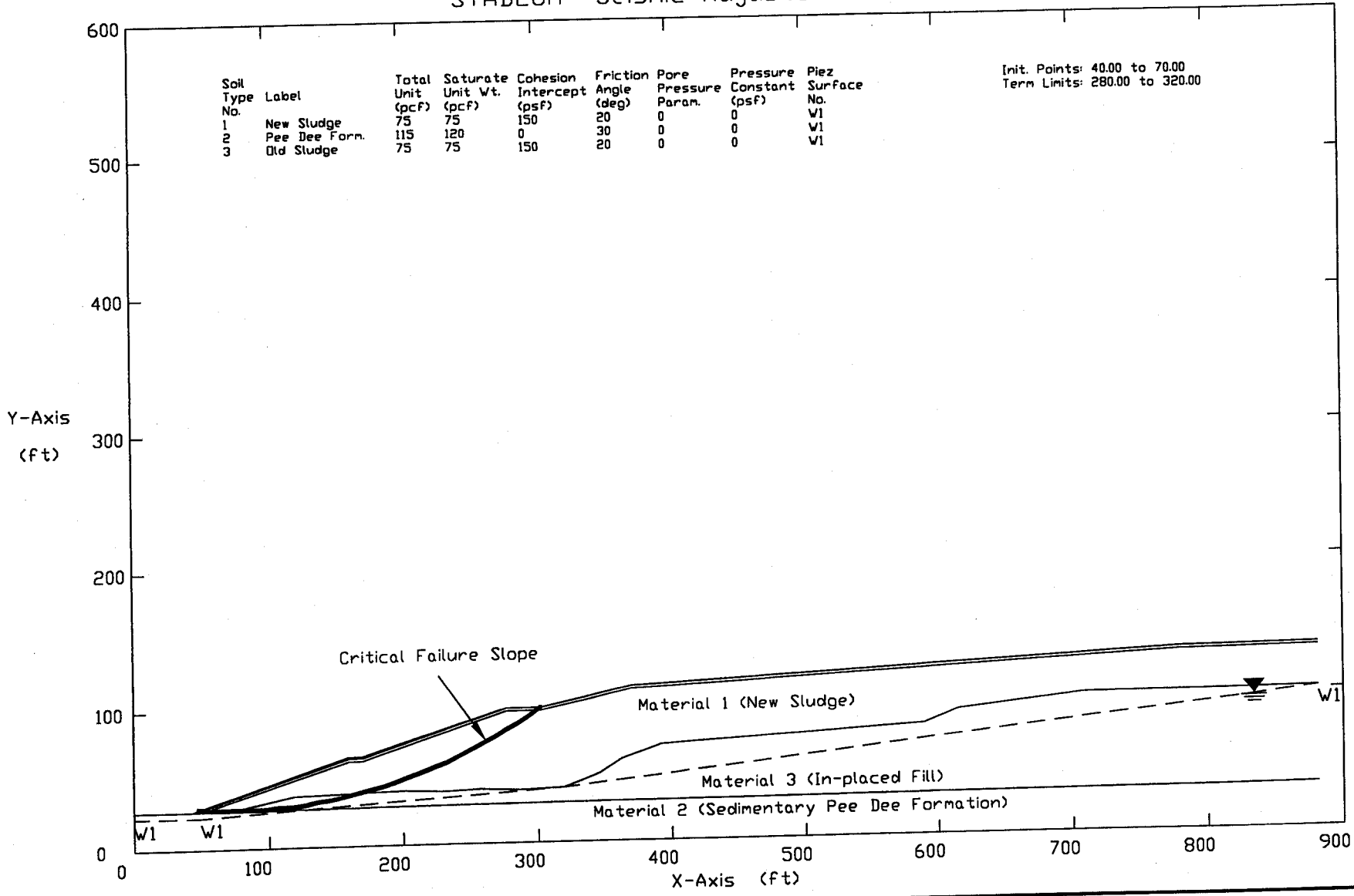
CROSS SECTION C

Factors of Safety Calculated by the Modified Bishop Method

STABL6H Seismic Adjusted FS = 1.39

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	New Sludge	75	75	150	20	0	0	W1
2	Pee Dee Form.	115	120	0	30	0	0	W1
3	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 40.00 to 70.00
Term Limits: 280.00 to 320.00



SCALE:	AS SHOWN
CHECKED BY:	
DRAWN BY:	RK
DATE:	3-23-00

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SLOPE STABILITY
CROSS SECTION C
Interanational Paper
REIGELWOOD, NORTH CAROLINA

JOB NO. 1356-99-573

FIGURE NO. 17

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 3/23/2000
Time of Run: 1:45pm
Run By: Rotthachack Kirivong
Input Data Filename: G:99573CC3
Output Filename: G:99573CC3.OUT
Plotted Output Filename: G:99573CC3.PLT

PROBLEM DESCRIPTION International Paper
1356-99-573

BOUNDARY COORDINATES

8 Top Boundaries
39 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	28.00	42.50	28.00	2
2	42.50	28.00	160.00	64.50	1
3	160.00	64.50	170.00	64.50	1
4	170.00	64.50	277.00	98.50	1
5	277.00	98.50	302.00	98.50	1
6	302.00	98.50	370.00	112.50	1
7	370.00	112.50	782.00	132.50	1
8	782.00	132.50	882.00	133.50	1
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16	782.00	132.00	882.00	133.00	1
17	44.00	28.00	50.00	28.00	2
18	50.00	28.00	160.00	62.00	1
19	160.00	62.00	170.00	62.00	1
20	170.00	62.00	277.00	96.00	1
21	277.00	96.00	302.00	96.00	1
22	302.00	96.00	370.00	110.00	1
23	370.00	110.00	782.00	130.00	1

24	782.00	130.00	882.00	131.00	1
25	50.00	28.00	80.00	30.00	3
26	80.00	30.00	119.00	38.00	3
27	119.00	38.00	202.00	40.00	3
28	202.00	40.00	232.00	39.00	3
29	232.00	39.00	257.00	40.00	3
30	257.00	40.00	287.00	39.00	3
31	287.00	39.00	320.00	40.00	3
32	320.00	40.00	346.00	50.00	3
33	346.00	50.00	363.00	60.00	3
34	363.00	60.00	393.00	70.00	3
35	393.00	70.00	590.00	80.00	3
36	590.00	80.00	615.00	90.00	3
37	615.00	90.00	707.00	100.00	3
38	707.00	100.00	882.00	101.00	3
39	50.00	28.00	882.00	32.00	2

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	75.0	75.0	150.0	20.0	.00	.0	1
2	115.0	120.0	.0	30.0	.00	.0	1
3	75.0	75.0	150.0	20.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	23.00
2	50.00	23.00
3	320.00	40.00
4	882.00	101.00

A Horizontal Earthquake Loading Coefficient
Of .075 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .075 Has Been Assigned

Cavitation Pressure = .0 psf

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 40.00 ft.
and X = 70.00 ft.

Each Surface Terminates Between X = 280.00 ft.
and X = 320.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	29.29
2	56.65	28.69
3	66.64	28.33
4	76.64	28.22
5	86.64	28.36
6	96.63	28.75
7	106.61	29.39
8	116.57	30.28
9	126.51	31.42
10	136.41	32.80
11	146.28	34.44
12	156.10	36.32

13	165.87	38.44
14	175.59	40.81
15	185.24	43.41
16	194.83	46.26
17	204.34	49.35
18	213.77	52.67
19	223.11	56.23
20	232.37	60.02
21	241.52	64.05
22	250.58	68.29
23	259.52	72.77
24	268.35	77.46
25	277.06	82.38
26	285.64	87.51
27	294.10	92.85
28	302.41	98.40
29	302.78	98.66

Circle Center At X = 76.0 ; Y = 428.5 and Radius, 400.3

*** 1.385 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	29.29
2	56.65	28.74
3	66.65	28.44
4	76.65	28.39
5	86.65	28.58
6	96.64	29.02
7	106.61	29.71
8	116.57	30.64
9	126.50	31.82
10	136.40	33.25
11	146.26	34.92
12	156.07	36.83
13	165.84	38.99
14	175.54	41.38
15	185.19	44.02
16	194.77	46.90
17	204.27	50.01
18	213.70	53.35
19	223.03	56.93
20	232.28	60.74
21	241.43	64.77
22	250.48	69.03
23	259.42	73.52
24	268.24	78.22
25	276.95	83.14
26	285.53	88.27
27	293.98	93.62

28 301.29 98.50

Circle Center At X = 73.9 ; Y = 432.3 and Radius, 403.9

*** 1.388 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	43.33	28.26
2	53.33	27.91
3	63.33	27.77
4	73.33	27.85
5	83.32	28.13
6	93.31	28.63
7	103.29	29.34
8	113.24	30.26
9	123.18	31.39
10	133.09	32.73
11	142.97	34.27
12	152.81	36.03
13	162.62	37.99
14	172.38	40.17
15	182.09	42.54
16	191.75	45.12
17	201.36	47.91
18	210.90	50.90
19	220.38	54.09
20	229.79	57.48
21	239.12	61.06
22	248.38	64.85
23	257.55	68.82
24	266.64	73.00
25	275.64	77.36
26	284.54	81.91
27	293.35	86.65
28	302.05	91.57
29	310.65	96.68
30	319.14	101.97
31	319.27	102.06

Circle Center At X = 64.8 ; Y = 500.8 and Radius, 473.0

*** 1.389 ***

Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	43.33	28.26
2	53.32	27.75
3	63.32	27.46
4	73.32	27.40
5	83.32	27.56
6	93.31	27.95
7	103.29	28.57
8	113.25	29.41
9	123.20	30.47
10	133.11	31.76
11	143.00	33.27
12	152.85	35.00
13	162.65	36.96
14	172.41	39.13
15	182.12	41.53
16	191.78	44.14
17	201.37	46.97
18	210.89	50.02
19	220.35	53.28
20	229.72	56.75
21	239.02	60.43
22	248.23	64.32
23	257.35	68.42
24	266.38	72.72
25	275.31	77.23
26	284.13	81.93
27	292.85	86.83
28	301.45	91.93
29	309.94	97.22
30	316.42	101.47

Circle Center At X = 71.0 ; Y = 470.9 and Radius, 443.5

*** 1.389 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.33	34.47
2	73.16	32.62
3	83.05	31.11
4	92.98	29.94
5	102.94	29.11
6	112.93	28.63
7	122.93	28.49
8	132.93	28.69
9	142.91	29.24
10	152.87	30.13

11	162.80	31.37
12	172.67	32.94
13	182.49	34.86
14	192.23	37.11
15	201.89	39.70
16	211.45	42.61
17	220.91	45.86
18	230.26	49.43
19	239.47	53.31
20	248.54	57.52
21	257.47	62.03
22	266.23	66.85
23	274.82	71.96
24	283.23	77.37
25	291.45	83.07
26	299.47	89.04
27	307.28	95.29
28	313.86	100.94

Circle Center At X = 122.0 ; Y = 318.8 and Radius, 290.4

*** 1.391 ***

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.33	34.47
2	73.21	32.91
3	83.14	31.72
4	93.11	30.92
5	103.10	30.50
6	113.10	30.46
7	123.09	30.80
8	133.07	31.53
9	143.00	32.64
10	152.89	34.13
11	162.72	35.99
12	172.46	38.23
13	182.12	40.85
14	191.66	43.83
15	201.09	47.17
16	210.38	50.87
17	219.52	54.93
18	228.49	59.33
19	237.30	64.07
20	245.91	69.15
21	254.33	74.56
22	262.53	80.28
23	270.50	86.31
24	278.24	92.64
25	284.87	98.50

Circle Center At X = 109.1 ; Y = 291.4 and Radius, 261.0

*** 1.401 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.67	35.51
2	76.55	34.00
3	86.48	32.80
4	96.44	31.92
5	106.43	31.35
6	116.42	31.10
7	126.42	31.16
8	136.42	31.53
9	146.39	32.22
10	156.34	33.22
11	166.25	34.53
12	176.12	36.16
13	185.93	38.09
14	195.68	40.33
15	205.35	42.88
16	214.93	45.73
17	224.43	48.88
18	233.81	52.32
19	243.09	56.06
20	252.24	60.09
21	261.26	64.41
22	270.14	69.00
23	278.87	73.88
24	287.45	79.02
25	295.86	84.43
26	304.09	90.11
27	312.14	96.04
28	319.98	102.20

Circle Center At X = 119.5 ; Y = 349.1 and Radius, 318.0

*** 1.402 ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.33	34.47
2	73.28	33.40

3	83.24	32.61
4	93.23	32.10
5	103.23	31.87
6	113.23	31.92
7	123.22	32.25
8	133.20	32.86
9	143.16	33.76
10	153.10	34.93
11	162.99	36.38
12	172.84	38.11
13	182.63	40.12
14	192.37	42.40
15	202.04	44.96
16	211.63	47.78
17	221.14	50.88
18	230.56	54.24
19	239.88	57.86
20	249.09	61.75
21	258.20	65.89
22	267.18	70.29
23	276.03	74.94
24	284.75	79.83
25	293.33	84.97
26	301.76	90.35
27	310.04	95.96
28	318.15	101.81
29	318.19	101.83

Circle Center At X = 106.4 ; Y = 387.3 and Radius, 355.4

*** 1.404 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	60.00	33.44
2	69.83	31.61
3	79.73	30.17
4	89.67	29.11
5	99.65	28.44
6	109.65	28.16
7	119.64	28.26
8	129.63	28.75
9	139.59	29.63
10	149.51	30.90
11	159.38	32.55
12	169.17	34.58
13	178.87	36.99
14	188.48	39.77
15	197.97	42.92
16	207.33	46.44

17	216.55	50.32
18	225.60	54.56
19	234.49	59.14
20	243.20	64.06
21	251.70	69.32
22	260.00	74.90
23	268.07	80.81
24	275.91	87.02
25	283.50	93.53
26	288.87	98.50

Circle Center At X = 112.0 ; Y = 285.9 and Radius, 257.8

*** 1.410 ***

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	70.00	36.54
2	79.93	35.37
3	89.89	34.50
4	99.88	33.93
5	109.87	33.67
6	119.87	33.70
7	129.87	34.04
8	139.85	34.68
9	149.80	35.63
10	159.73	36.87
11	169.61	38.41
12	179.43	40.26
13	189.20	42.40
14	198.90	44.83
15	208.52	47.56
16	218.06	50.57
17	227.50	53.88
18	236.83	57.46
19	246.05	61.33
20	255.15	65.48
21	264.12	69.90
22	272.96	74.58
23	281.64	79.54
24	290.17	84.75
25	298.55	90.22
26	306.75	95.95
27	313.32	100.83

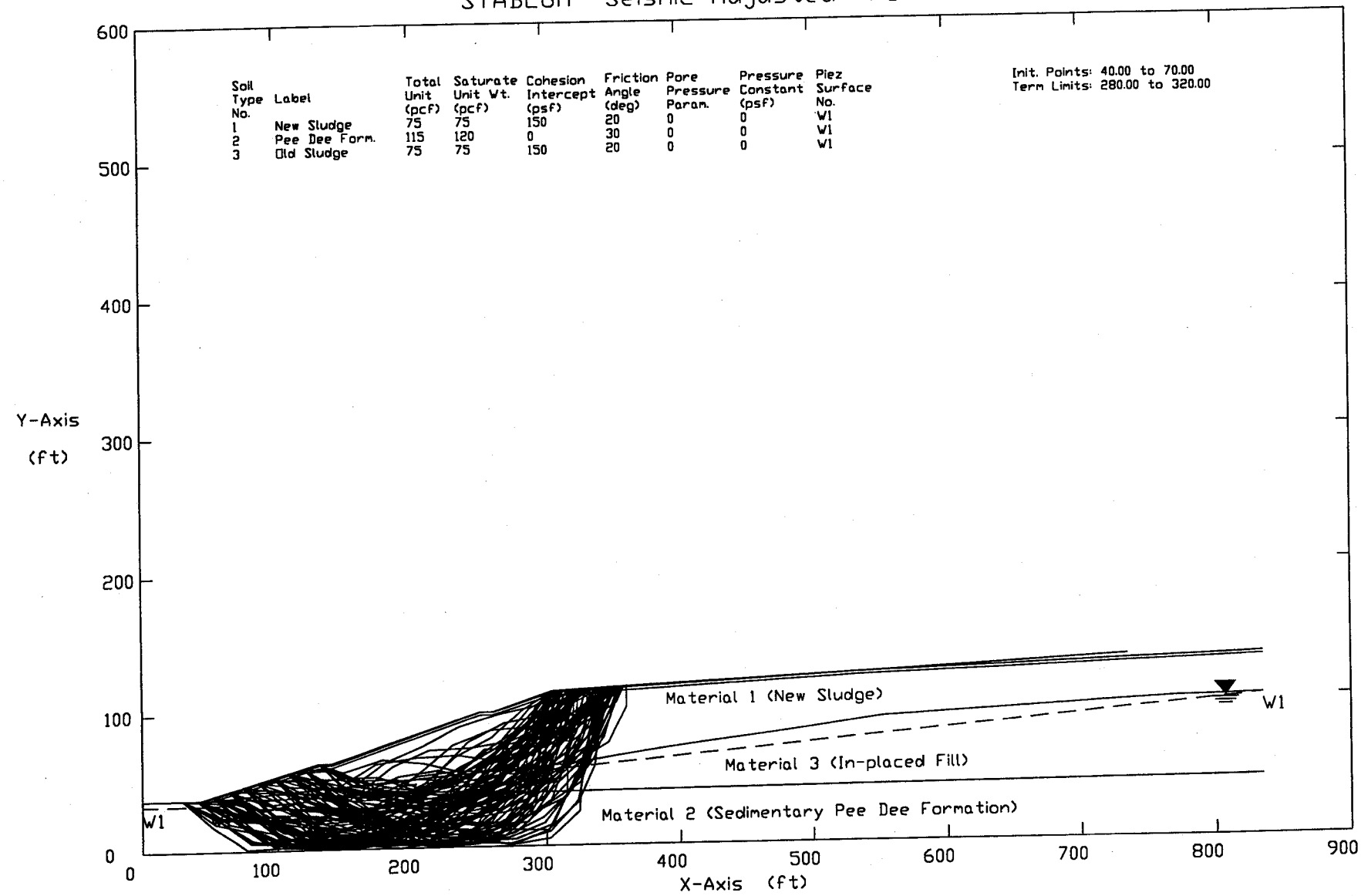
Circle Center At X = 113.7 ; Y = 364.0 and Radius, 330.3

*** 1.412 ***

CROSS SECTION C

Random Stability Ananlysis of All Failure Surfaces

STABL6H Seismic Adjusted FS = 1.36



SCALE:	AS SHOWN
CHECKED BY:	
DRAWN BY:	RK
DATE:	2-23-00

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SLOPE STABILITY
CROSS SECTION C
International Paper
REIGELWOOD, NORTH CAROLINA

JOB NO. 1356-99-573

FIGURE NO. 18

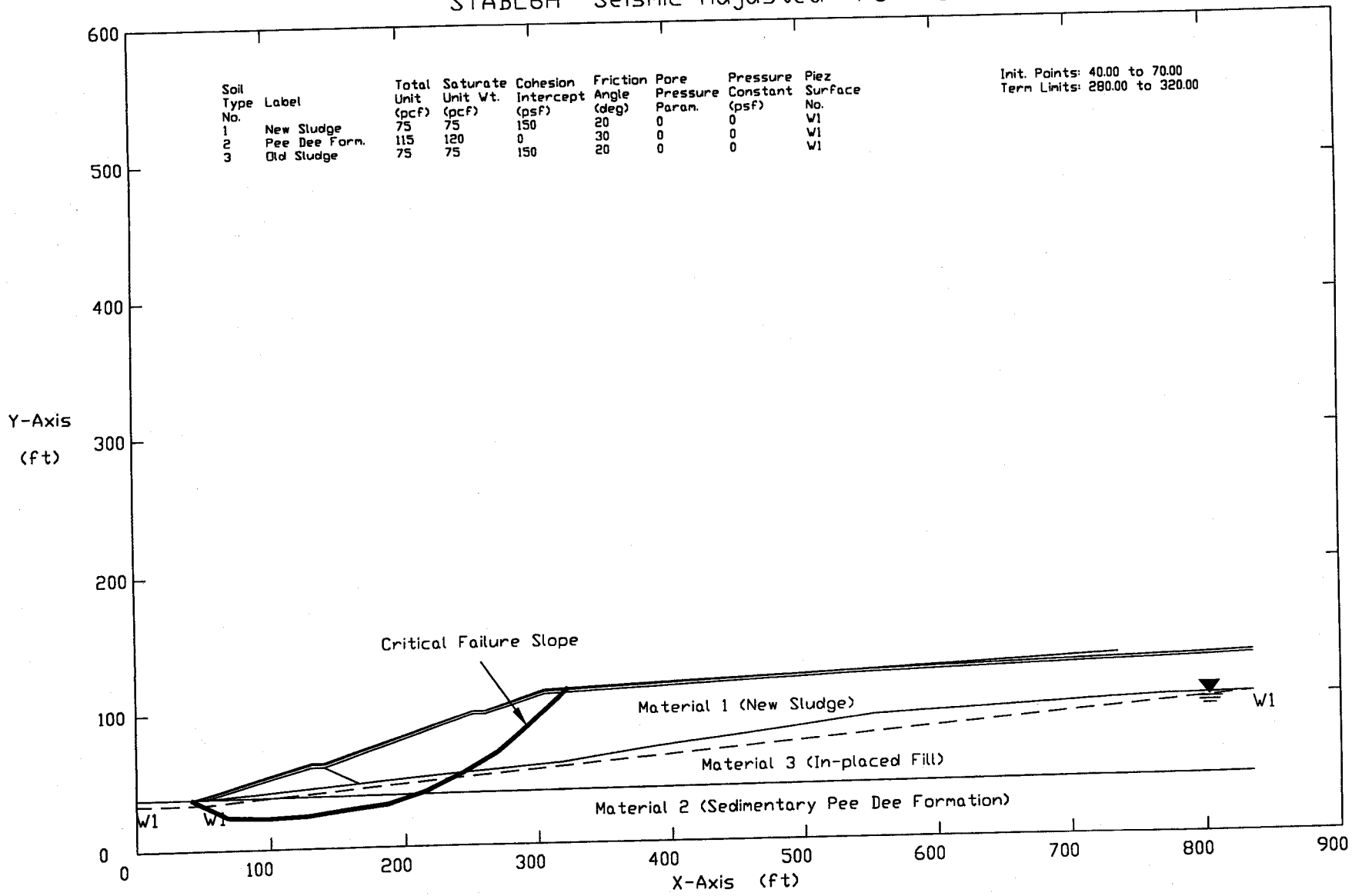
CROSS SECTION C

Factors of Safety Calculated by Random Method

STABL6H Seismic Adjusted FS = 1.36

Soil Type No.	Label	Total Unit (pcf)	Saturate Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surface No.
1	New Sludge	75	75	150	20	0	0	W1
2	Pee Dee Form.	115	120	0	30	0	0	W1
3	Old Sludge	75	75	150	20	0	0	W1

Init. Points: 40.00 to 70.00
Term Limits: 280.00 to 320.00



SCALE:	AS SHOWN
CHECKED BY:	
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DATE:	2-23-00

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JOB NO. 1356-99-573

FIGURE NO. 19

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	3/28/2000
Time of Run:	4:13pm
Run By:	Rotthachack Kirivong
Input Data Filename:	G:99573CC4
Output Filename:	G:99573CC4.OUT
Plotted Output Filename:	G:99573CC4.PLT

PROBLEM DESCRIPTION International Paper
1356-99-573

BOUNDARY COORDINATES

8 Top Boundaries
39 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	28.00	42.50	28.00	2
2	42.50	28.00	160.00	64.50	1
3	160.00	64.50	170.00	64.50	1
4	170.00	64.50	277.00	98.50	1
5	277.00	98.50	302.00	98.50	1
6	302.00	98.50	370.00	112.50	1
7	370.00	112.50	782.00	132.50	1
8	782.00	132.50	882.00	133.50	1
9	42.50	28.00	44.00	28.00	2
10	44.00	28.00	160.00	64.00	1
11	160.00	64.00	170.00	64.00	1
12	170.00	64.00	277.00	98.00	1
13	277.00	98.00	302.00	98.00	1
14	302.00	98.00	370.00	112.00	1
15	370.00	112.00	782.00	132.00	1
16	782.00	132.00	882.00	133.00	1
17	44.00	28.00	50.00	28.00	2
18	50.00	28.00	160.00	62.00	1
19	160.00	62.00	170.00	62.00	1
20	170.00	62.00	277.00	96.00	1
21	277.00	96.00	302.00	96.00	1
22	302.00	96.00	370.00	110.00	1
23	370.00	110.00	782.00	130.00	1

24	782.00	130.00	882.00	131.00	1
25	50.00	28.00	80.00	30.00	3
26	80.00	30.00	119.00	38.00	3
27	119.00	38.00	202.00	40.00	3
28	202.00	40.00	232.00	39.00	3
29	232.00	39.00	257.00	40.00	3
30	257.00	40.00	287.00	39.00	3
31	287.00	39.00	320.00	40.00	3
32	320.00	40.00	346.00	50.00	3
33	346.00	50.00	363.00	60.00	3
34	363.00	60.00	393.00	70.00	3
35	393.00	70.00	590.00	80.00	3
36	590.00	80.00	615.00	90.00	3
37	615.00	90.00	707.00	100.00	3
38	707.00	100.00	882.00	101.00	3
39	50.00	28.00	882.00	32.00	2

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	75.0	75.0	150.0	20.0	.00	.0	1
2	115.0	120.0	.0	30.0	.00	.0	1
3	75.0	75.0	150.0	20.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	23.00
2	50.00	23.00
3	320.00	40.00
4	882.00	101.00

A Horizontal Earthquake Loading Coefficient
Of .075 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .075 Has Been Assigned

Cavitation Pressure = .0 psf

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Irregular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 40.00 ft.
and X = 70.00 ft.

Each Surface Terminates Between X = 280.00 ft.
and X = 320.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

25.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	30.33
2	74.99	31.11
3	99.94	29.55
4	124.84	31.76
5	149.83	32.59
6	174.67	35.41
7	198.31	43.54
8	219.66	56.56
9	241.98	67.82
10	262.13	82.61
11	280.36	98.50

*** 1.364 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	43.33	28.26
2	68.09	31.74
3	93.05	33.09
4	118.02	34.42
5	143.02	34.57
6	167.87	37.28
7	192.76	39.60
8	216.06	48.67
9	238.40	59.90
10	262.15	67.70
11	286.19	74.55
12	305.52	90.40
13	316.88	101.56

*** 1.415 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	40.00	28.00
2	62.14	16.38
3	87.11	15.11
4	112.09	16.12
5	136.82	19.79
6	161.63	22.82
7	185.42	30.51
8	208.21	40.78
9	229.99	53.07
10	249.54	68.64
11	268.22	85.25
12	284.03	98.50

*** 1.427 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	30.33
2	70.34	15.80
3	94.77	10.50
4	119.21	15.77
5	141.14	27.77
6	165.47	33.52
7	187.92	44.52
8	211.96	51.40
9	236.83	53.88
10	256.95	68.72
11	279.22	80.08
12	294.11	98.50

*** 1.459 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	53.33	31.37
2	73.68	16.83
3	98.11	11.53
4	122.55	16.81
5	144.48	28.81
6	168.81	34.56
7	191.25	45.56
8	215.29	52.44
9	240.17	54.91
10	260.29	69.75
11	282.55	81.12
12	296.61	98.50

*** 1.467 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	56.67	32.40
2	77.01	17.87
3	101.44	12.57
4	125.88	17.84
5	147.81	29.84
6	172.14	35.59

7	194.59	46.59
8	218.62	53.47
9	243.50	55.95
10	263.62	70.79
11	285.89	82.15
12	299.10	98.50

*** 1.477 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	60.00	33.44
2	80.34	18.90
3	104.77	13.61
4	129.21	18.88
5	151.14	30.88
6	175.47	36.63
7	197.92	47.63
8	221.96	54.51
9	246.83	56.99
10	266.95	71.82
11	289.22	83.19
12	301.60	98.50

*** 1.487 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	43.33	28.26
2	66.12	17.98
3	88.83	7.51
4	113.52	3.62
5	138.42	1.35
6	162.50	8.05
7	187.06	12.75
8	210.31	21.93
9	234.09	29.65
10	254.98	43.38
11	274.46	59.05
12	286.13	81.16
13	291.24	98.50

*** 1.492 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	30.33
2	70.41	15.89
3	93.22	5.66
4	118.08	3.03
5	142.89	.00
6	165.84	9.94
7	187.00	23.24
8	207.83	37.07
9	228.32	51.39
10	249.22	65.12
11	267.74	81.90
12	282.46	98.50

*** 1.514 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	29.29
2	64.40	11.68
3	88.27	4.22
4	112.36	10.89
5	136.81	16.10
6	159.91	25.66
7	183.12	34.96
8	205.86	45.34
9	230.06	51.62
10	255.05	52.41
11	274.32	68.33
12	290.58	87.32
13	291.68	98.50

*** 1.516 ***

TABLE 1
SUMMARY OF LABORATORY TEST DATA

Boring No.	Sample Type*	Organic Content %	USCS Classification	Natural Moisture Content (%)	% Finer No. 200	Atterberg Limits		Proctor Data		In Situ Conditions				Hydraulic Conductivity k (cm/sec)
						LL	PI	Max. Dry Density (pcf)	Opt. Moisture Content (%)	Specific Gravity	% M.C. From Optimum	Unit Weight (pcf)	Moisture Content (%)	
LM-1	Bulk	3.4		71.5	96.0			70.1	40.2	2.67				
AS-1	Bulk	27.67		95.1	46.4			69.5	34.3	2.37				
BS-1	Bulk	40.82		229.3	32.9			39.4	80.4	2.16				
CS-1	Bulk	26.82		186.5	82.3			44.8	44.4	2.17				
TP-1	Bulk	27.88		213.8	73.0			39.6	73.1	2.17				
BA-1	Bulk	26.54		136	62.3			39.7	69.7	2.26				

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Note: Graphic Presentations of Results of Proctor, Grain Size, and other tests follow this summary.

*LM = Lime Mud
AS=A Sludge Pond
BS=B Sludge Pond
CS=C Sludge Pond
TP = Temporary Sludge Pond
BA = Ash

* Standard Proctor (ASTM D 698A)
** Modified Proctor (ASTM D 1557A)

Job Name: International Paper - Riegelwood
Location: Riegelwood, North Carolina
Job Number: 1356-99-573 Page 1 of 1

The unit weight of dry soil ($S_r = 0\%$) is

$$\gamma_d = (1 - n)\gamma_s \tag{6.5}$$

and of saturated soil ($S_r = 100\%$) is

$$\gamma = (1 - n)\gamma_s + n\gamma_w = \gamma_s - n(\gamma_s - \gamma_w) \tag{6.6}$$

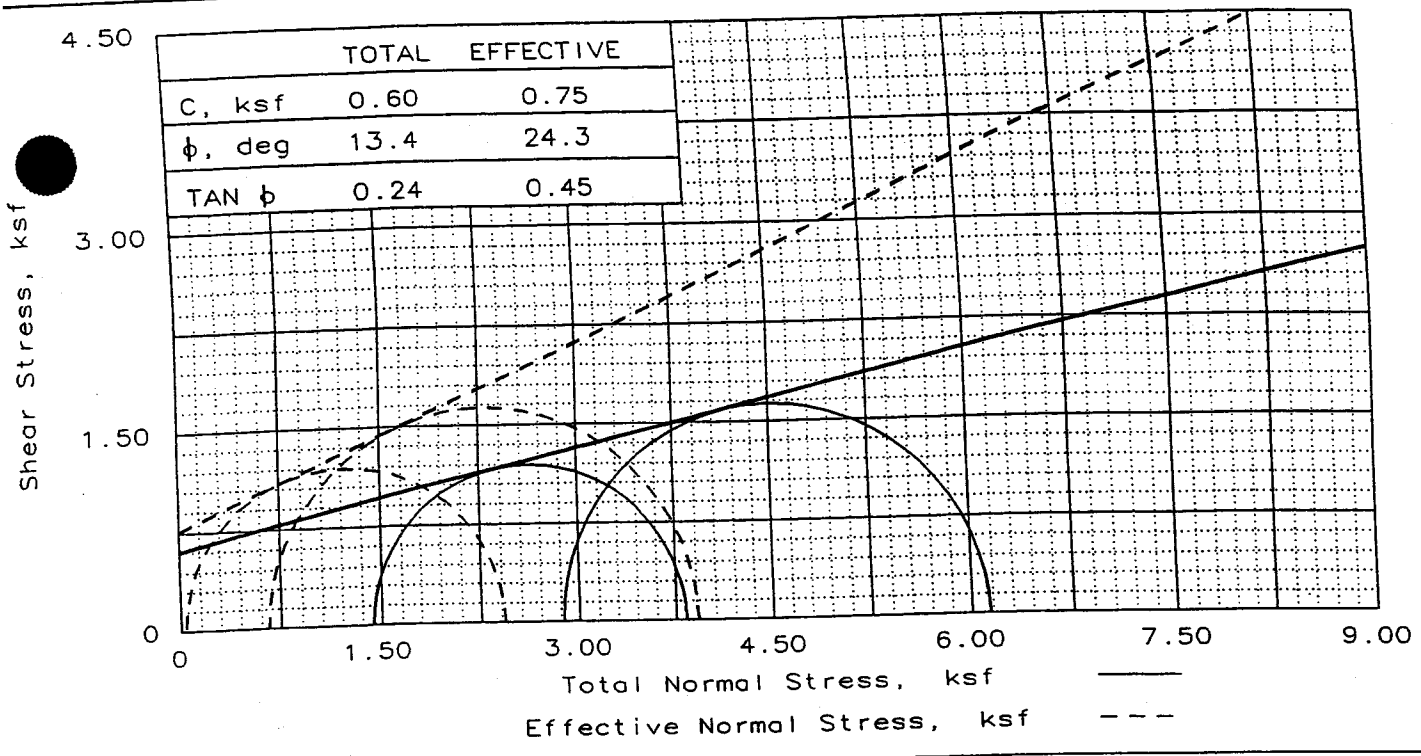
The unit weight of the principal solid constituents of soils is given in Table 6.2. For sand grains the average unit weight is usually about 2.65 gm/cm³. For clay particles the unit weight varies from 2.5 to 2.9 with a statistical average of approximately 2.7.

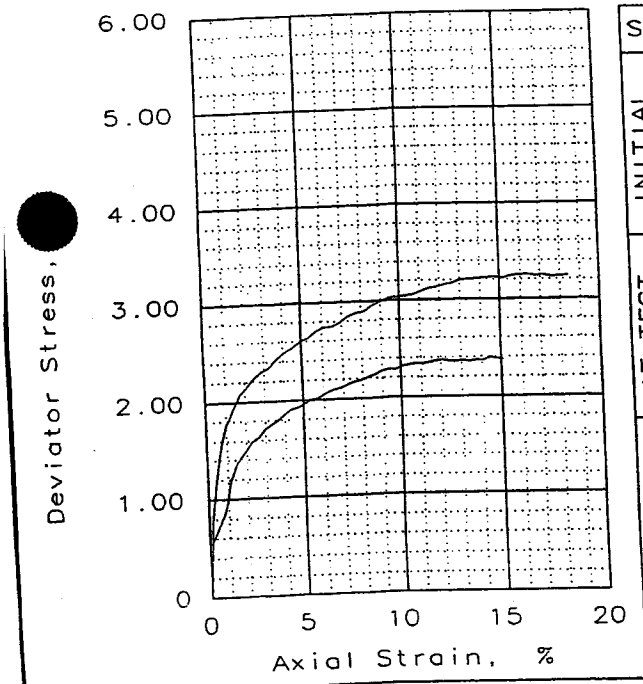
Given in Table 6.3 are the porosity and the saturated unit weight of typical soils. For sandy soils the weight of dry soil has also been included. The weights have been computed on the assumption that

Table 6.3
Porosity, Void Ratio, and Unit Weight of Typical Soils in Natural State

Description	Porosity, n (%)	Void ratio, e	Water content, w (%)	Unit weight grams/cm³ γ_d	grams/cm³ γ	lb/ft³ γ_d	lb/ft³ γ
1. Uniform sand, loose	46	0.85	32	1.43	1.89	90	118
2. Uniform sand, dense	34	0.51	19	1.75	2.09	109	130
3. Mixed-grained sand, loose	40	0.67	25	1.59	1.99	99	124
4. Mixed-grained sand, dense	30	0.43	16	1.86	2.16	116	135
5. Glacial till, very mixed-grained	20	0.25	9	2.12	2.32	132	145
6. Soft glacial clay	55	1.2	45	–	1.77	–	110
7. Stiff glacial clay	37	0.6	22	–	2.07	–	129
8. Soft slightly organic clay	66	1.9	70	–	1.58	–	98
9. Soft very organic clay	75	3.0	110	–	1.43	–	89
10. Soft bentonite	84	5.2	194	–	1.27	–	80

w = water content when saturated, in per cent of dry weight.
γ_d = unit weight in dry state.
γ = unit weight in saturated state.





SAMPLE NO.		1	2
INITIAL	WATER CONTENT, %	97.2	86.7
	DRY DENSITY, pcf	42.7	42.8
	SATURATION, %	89.7	80.1
	VOID RATIO	2.872	2.867
	DIAMETER, in	2.85	2.86
	HEIGHT, in	6.06	5.13
AT TEST	WATER CONTENT, %	95.4	79.9
	DRY DENSITY, pcf	46.9	53.1
	SATURATION, %	100.0	100.0
	VOID RATIO	2.529	2.118
	DIAMETER, in	2.75	2.63
	HEIGHT, in	5.96	4.89
Strain rate, %/min			
BACK PRESSURE, ksf		11.07	11.30
CELL PRESSURE, ksf		12.51	14.18
FAILURE STRESS, ksf		2.39	3.26
PORE PRESSURE, ksf		12.47	13.52
ULTIMATE STRESS, ksf		2.39	3.24
PORE PRESSURE, ksf		12.47	13.55
$\bar{\sigma}_1$ FAILURE, ksf		2.43	3.92
$\bar{\sigma}_3$ FAILURE, ksf		0.04	0.66

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE: Undisturbed
DESCRIPTION: Black Dark Gray
Silt w/ organics
LL= PL= PI=
SPECIFIC GRAVITY= 2.65
REMARKS:

CLIENT: International Paper

PROJECT: Rieglewood

SAMPLE LOCATION: Sludge Landfill

PROJ. NO.: 56-99-573 DATE: 9-1-99

TRIAXIAL SHEAR TEST REPORT

S&ME

FIG. NO. 1

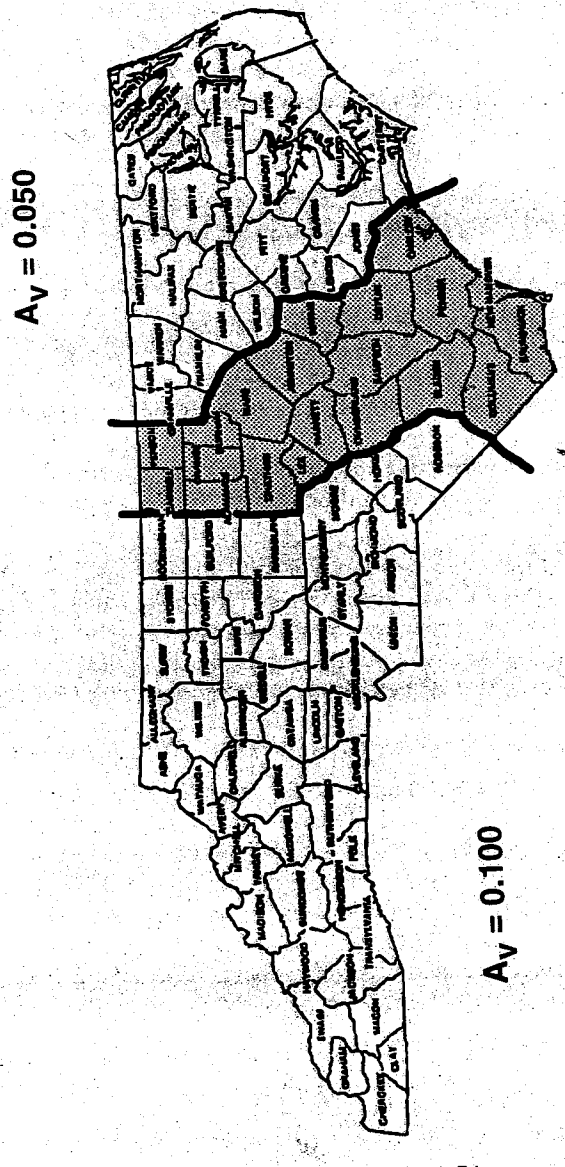


FIGURE 1607.1.5A
Map of Effective Peak Velocity-Related Acceleration Coefficient, A_v

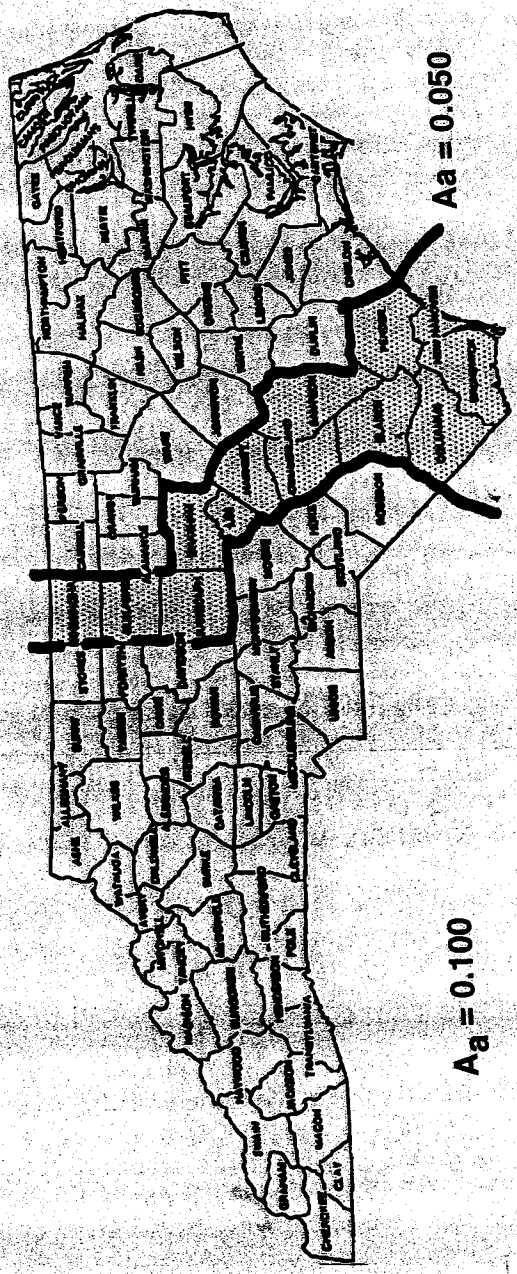


FIGURE 1607.1.5B
Map of Peak Acceleration Coefficient, A_a

Subsurface Exploration
Existing Landfill
International Paper Landfill
Riegelwood, North Carolina
Job No. 1061-98-682

S&ME *Celebrating 25 Years of Excellence*

August 17, 1998

International Paper
John L. Riegel Road
Riegelwood, North Carolina 28546

Attention: Mr. Edward J. Kreul, P.E.

Reference: Subsurface Exploration
Existing Landfill
International Paper Landfill
Riegelwood, North Carolina
Job No. 1061-98-682

Dear Mr. Kreul:

As requested, S&ME, Inc. has advanced soil test borings at the existing landfill at International Paper's plant in Riegelwood, North Carolina. The purpose of this subsurface exploration was to determine the nature of the in-place waste materials and the depth to the underlying natural soils. This letter describes the results of our field drilling work and the subsequent laboratory testing of selected samples.

Field Testing Work

During the period from May 12 through June 2, 1998, five test borings (Borings B-1 through B-5) were drilled at the approximate locations shown in Figure 1. These borings were drilled to depths ranging from 45 to 75 feet below the existing ground surface. Soil samples were obtained by the ASTM D-1586 standard penetration test method to determine the consistency of the in-place soils. An attempt was made to conduct vane shear testing at Boring B-3; however, the consistency of the in-place materials was too stiff (shear strength exceeding 500 pounds per square foot) to rotate the vane shear. In lieu of vane shear testing, three undisturbed samples of the in-place materials were obtained in general accordance with the procedures presented in ASTM D-1587 for subsequent laboratory shear strength testing.

The subsurface conditions encountered on the east side of the landfill (Borings B-1 and B-2) generally consisted of waste materials (wood, sludge, dregs, or fly ash) that extended to a depth of approximately 58 feet below the existing ground surface at Boring B-1 and to a depth of about 72 feet at Boring B-2. At both boring locations, these waste materials were underlain by medium dense or dense sands which extended to the completed boring depth of 65 feet and 75 feet at Borings B-1 and B-2, respectively.

On the south side of the landfill (Borings B-3 and B-4), the upper 7 to 9 feet of the in-place materials generally consisted of sand, grits, and construction debris. This surficial layer of granular material and construction debris was typically underlain by intermittent layers of dregs, sludge, wood fragments, and fly ash. These waste materials extended to a depth of approximately 53 feet at Boring B-3 and 57 feet at Boring B-4. At Boring B-3, medium dense clayey sands were noted from a depth of approximately 53 feet to the completed boring depth of 55 feet. At Boring B-4, medium dense to very dense clean sands were sampled from a depth of about 57 to 72 feet where medium dense clayey sand [the Pee Dee Formation] was encountered. These clayey sands extended to the completed boring depth of 75 feet.

On the west side of the landfill (Boring B-5), sludge with some wood and dregs was encountered from the original ground surface (a couple of feet of fill had been placed over the sludge for access purposes) and extended to a depth of approximately 37 feet. Loose clayey sands were noted from a depth of about 37 to 42 feet, and these clayey sands were underlain by the clayey sands of the Pee Dee Formation which extended to the completed boring depth of 45 feet.

A generalized subsurface profile, which has been prepared from the subsurface data to graphically illustrate the subsurface conditions encountered at the test borings, is attached to this report as Figure 2. Variations from the generalized subsurface profiles described above and a more detailed description of the subsurface conditions are presented in the Test Boring Records attached as Appendix A.

Laboratory Test Results

Upon completion of the field drilling work, our personnel conducted laboratory testing of selected samples obtained at Borings B-3, B-4 and B-5. Specifically, laboratory testing was performed to determine moisture contents, organic contents, gradation characteristics, and shear strength parameters.

The results of the moisture content determinations (Table 1) show that the in-place waste materials typically exhibit moisture contents ranging from about 40 to 125 percent at Boring B-3, from approximately 60 to 155 percent at Boring B-4, and from about 135 to 200 percent at Boring B-5. The in-place clean sands and clayey sands encountered at Borings B-4 and B-5 had moisture contents in the 15 to 32 percent range.

Five samples of the recovered waste materials were tested for organic content. The results of this testing (Table 2) show organic contents ranging from approximately 11 to 64 percent.

Two additional samples were subjected to gradation testing, primarily to determine the percentage of material finer than a No. 200 sieve. The gradation test results (Table 3) indicate that the percentage of material finer than a No. 200 sieve was approximately 41 percent and 22 percent for the samples obtained at Borings B-3 and B-4, respectively. Although the sample tested from Boring B-4 had the smaller percentage of material passing a No. 200 sieve, this sample had a higher percentage of wood fragments and a correspondingly higher moisture content.

The undisturbed soil sample obtained at Boring B-4 from a depth of 25 to 27 feet and the undisturbed soil sample obtained at Boring B-5 from a depth of 26 to 28 feet were subjected to triaxial shear strength testing with pore pressure measurements. The undisturbed material obtained at Boring B-5 from a depth of 5 to 7 feet could not be tested due to insufficient recovery of the in-place material.

The results of the shear strength testing show that the sample obtained at Boring B-4 had an effective angle of internal friction of 31.5 degrees and an effective cohesion of 160 pounds per square foot (psf). The test sample obtained at Boring B-5 had similar effective strength values: an effective angle of internal friction of 29.5 degrees and an effective cohesion of 330 psf. These strength values are comparable to those obtained when testing a loose to medium dense silty sand, although the test sample from Boring B-5 was more compressible with strain in the 8 to 9 percent range at failure.

For comparison purposes, the findings presented in a paper in the ASCE September 1996 Journal of Geotechnical Engineering entitled, "Geotechnical Properties of Paper Mill Sludges For Use In Landfill Covers," and authored by Horace K. Moo-Young and Thomas F. Zimmie were reviewed. As reported in this paper, five triaxial shear strength tests were conducted using paper mill sludge from four different facilities. A summary of some of the test results presented in this paper is presented on the next page:

Soil Parameter	Typical Range in Values
Moisture Content	150 to 270 percent
Organic Content	35 to 56 percent
Wet Unit Weight	70 to 80 pounds per cubic foot (pcf)
Effective Angle of Internal Friction	25 to 40 degrees
Effective Cohesion	60 to 190 psf

The low moisture content (about 25 percent) and the high wet unit weight (122 pcf) of the test sample obtained at Boring B-4 suggest that this test material contained a high percentage of grits and/or sand. However, the high moisture content (about 145 percent) and the low wet unit weight (about 72 pcf) of the sample obtained at Boring B-5 suggest that this test sample contained a significant amount of organics and is more representative of paper mill sludge. The effective cohesion value of 330 psf for the Boring B-5 test sample was somewhat higher than the maximum value of 190 psf presented in Moo-Young and Zimmie's paper, but the effective angle of internal friction value of 29.5 degrees is within the reported range of 25 to 40 degrees.

The results of the triaxial shear strength testing conducted by S&ME, Inc. are presented in Appendix B.

Closing Remarks

The results of the field and laboratory testing conducted for this subsurface exploration suggest that the in-place materials on the south side of the existing landfill (Borings B-3 and B-4) are more suitable for supporting a new sludge disposal containment embankment that the in-place sludge materials encountered on the northwest side of the existing landfill (Boring B-5). It is our opinion, though, that containment embankments can be constructed over the in-place soft sludge materials if the embankment is designed properly for soft ground construction techniques (such as the use of geotextiles and/or geogrids and incremental loading of the soft compressible materials).

TABLE 1

Percent Moisture
International Paper Landfill
Riegelwood, North Carolina
Job No. 1061-98-682

Boring	Depth (Feet)	Percent Moisture*
B-3	8.5-10	123.8
B-3	13.5-15	35.4
B-3	18.5-20	102.0
B-3	23.5-25	79.5
B-3	28.5-30	46.4
B-3	33.5-35	54.9
B-3	38.5-40	66.8
B-3	43.5-45	42.1
B-3	48.5-50	45.4
B-4	8.5-10	109.3
B-4	13.5-15	61.6
B-4	18.5-20	95.4
B-4	23.5-25	68.6
B-4	28.5-30	135.0
B-4	33.5-35	125.7
B-4	38.5-40	17.2
B-4	43.5-45	91.4
B-4	48.5-50	153.1
B-4	53.5-54.5	66.7
B-4	58.5-60	16.5
B-4	63.5-65	14.7
B-4	68.5-70	17.4
B-5	3.5-5	194.6
B-5	8.5-10	157.9
B-5	13.5-15	136.8
B-5	18.5-20	546.8
B-5	23.5-25	201.3
B-5	28.5-30	142.9
B-5	33.5-35	26.7
B-5	38.5-40	16.3
B-5	43.5-45	31.6

*Percent moisture = weight of water ÷ dry weight of material.

TABLE 2

Organic Content
International Paper Landfill
Riegelwood, North Carolina
Job No. 1061-98-682

Boring	Depth (Feet)	Percent Organics
B-3	13.5-15	11.2
B-4	33.5-35	25.2
B-4	48.5-50	42.2
B-5	8.5-10	50.7
B-5	18.5-20	63.6

TABLE 3

Gradation Test Results
International Paper Landfill
Riegelwood, North Carolina
Job No. 1061-98-682

Boring Number:	B-3	B-4
Depth (Feet):	38.5-40	28.5-30
Sieve Number	Percent Passing, By Weight	
4	96.6	89.3
10	93.3	76.6
20	83.4	64.8
40	73.1	52.3
60	63.0	40.8
200	41.4	22.3

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES
(Shown in Graphic Log)

Asphalt/Concrete

Topsoil

Gravel

Sand

Silt

Clay

Organic

Sandy

Silty

Clayey

Silty Sand

Clayey Sand

Sandy Silt

Clayey Silt

Sandy Clay

Silty Clay

Partially Weathered Rock

Cored Rock

WATER LEVELS
(Shown in Well Diagram Area)

- = Water Level At Termination Of Boring
- = Water Level Taken After 24 Hours
- = Loss Of Drilling Water
- = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES
(Shown in Samples Column)

- Shelby Tube
- Split Spoon
- Rock Core
- No Recovery

TERMS

Standard Penetration Resistance (SPR) – The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586

REC – Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD – Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks exluded) Divided by the Total Length of the Core Run Times 100%.

OVM – Organic Vapor Meter.

ELEVATION – Refers to Ground Surface at Location of Well

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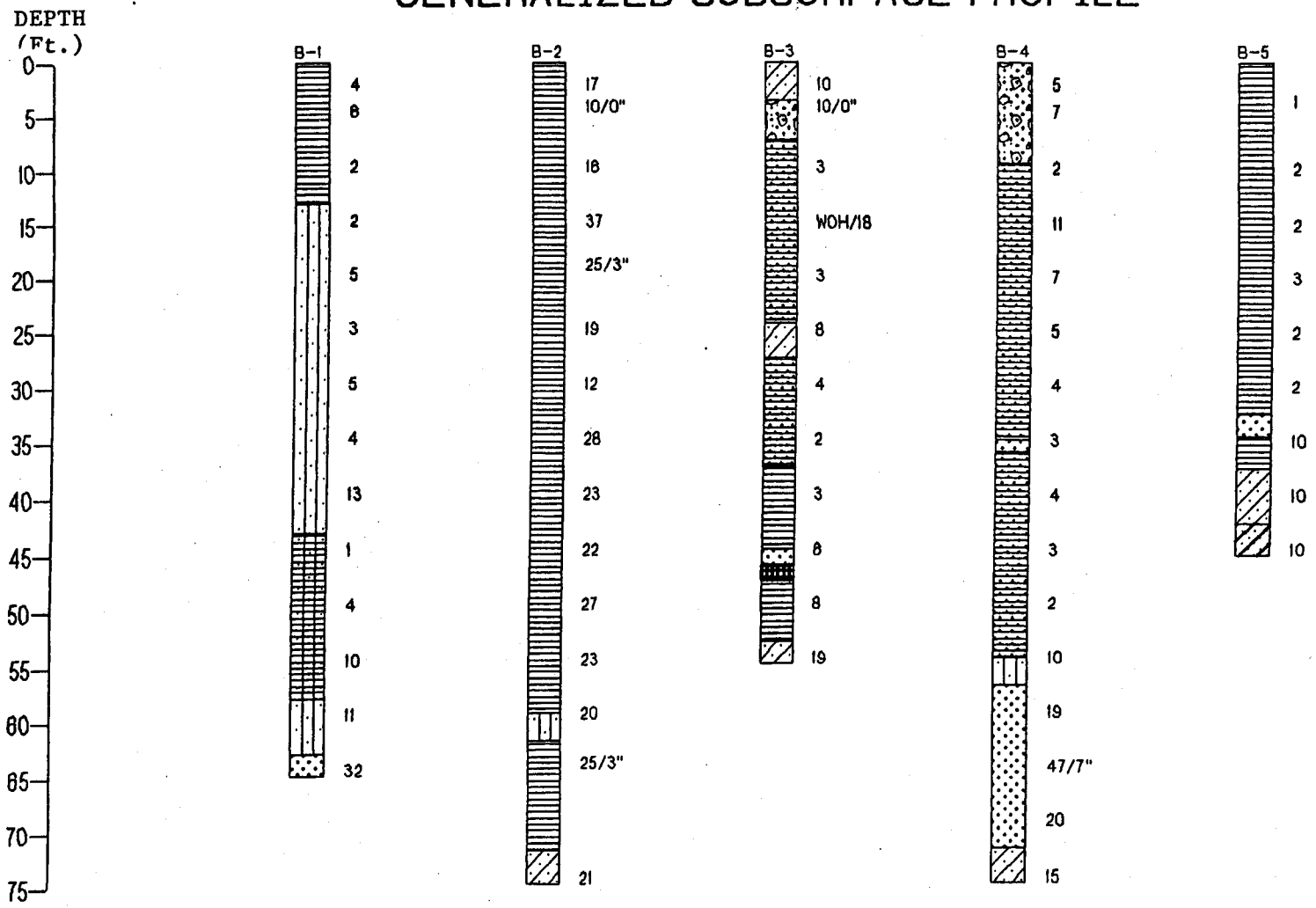
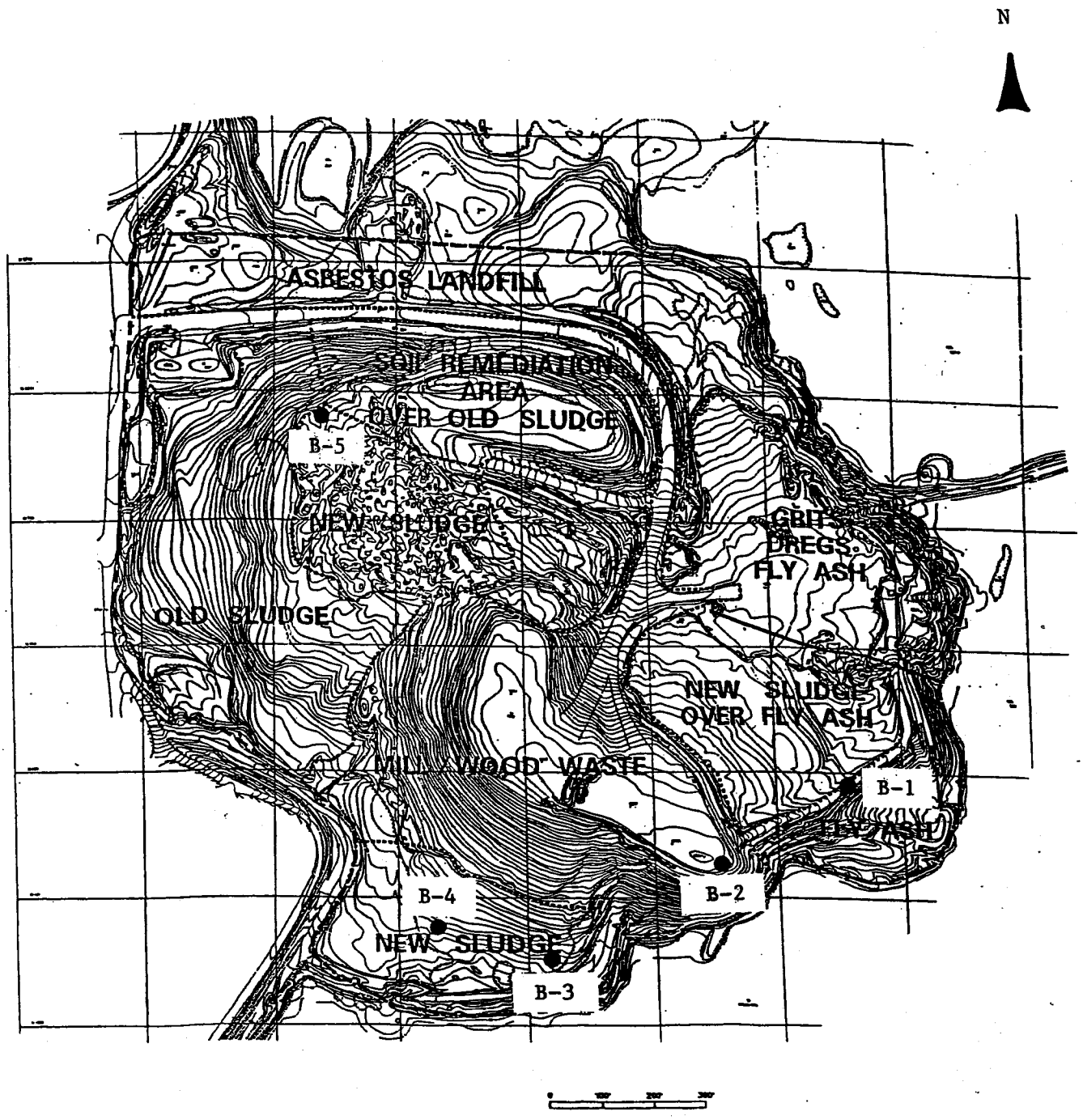
GENERALIZED SUBSURFACE PROFILE



NOTE: See Legend and attached Test Boring Records for soil descriptions. The subsurface conditions may vary intermediate of the soil test boring locations.

PROJECT		SCALE: Not to Scale
EXISTING LANDFILL INTERNATIONAL PAPER RIEGELWOOD, NORTH CAROLINA	S&ME	JOB NO: 1061-98-682
		FIG NO: 2



Note: Site plan drawing provided to S&ME by International Paper personnel.

LEGEND

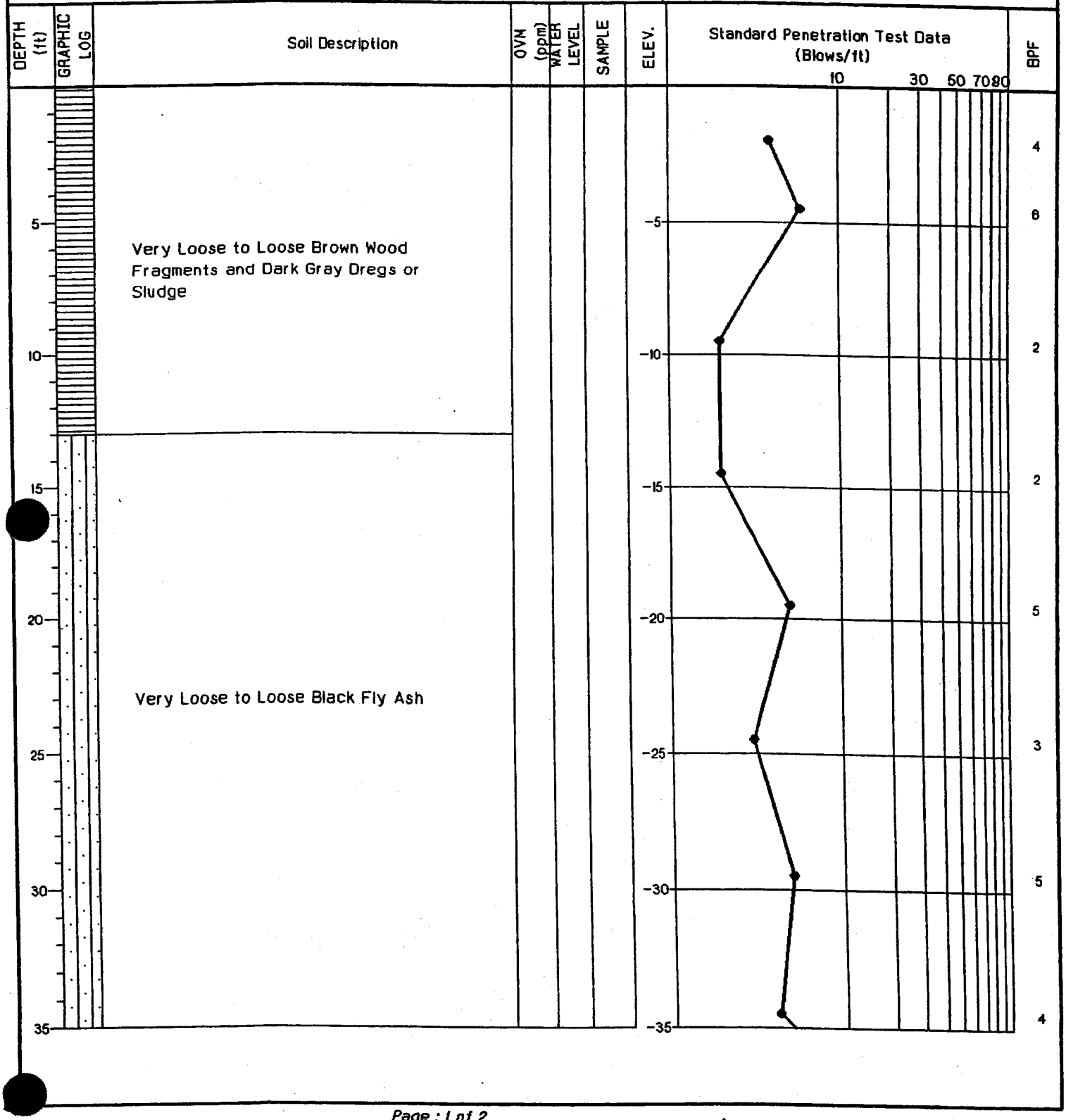
● B-1 Approximate boring location

PROJECT X[illegible]NG LANDFILL N[illegible]NATIONAL PAPER IEGELWOOD, NC	S&ME	SCALE: Not to Scale JOB NO: 1061-98-682 FIG. NO: 1

APPENDIX A
TEST BORING RECORDS

PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-1

PROJECT NO.: 1061-98-682	ELEVATION: 0	NOTES:
LOGGED BY: PB	BORING DEPTH: 65 FEET	
E DRILLED: 5-12-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	



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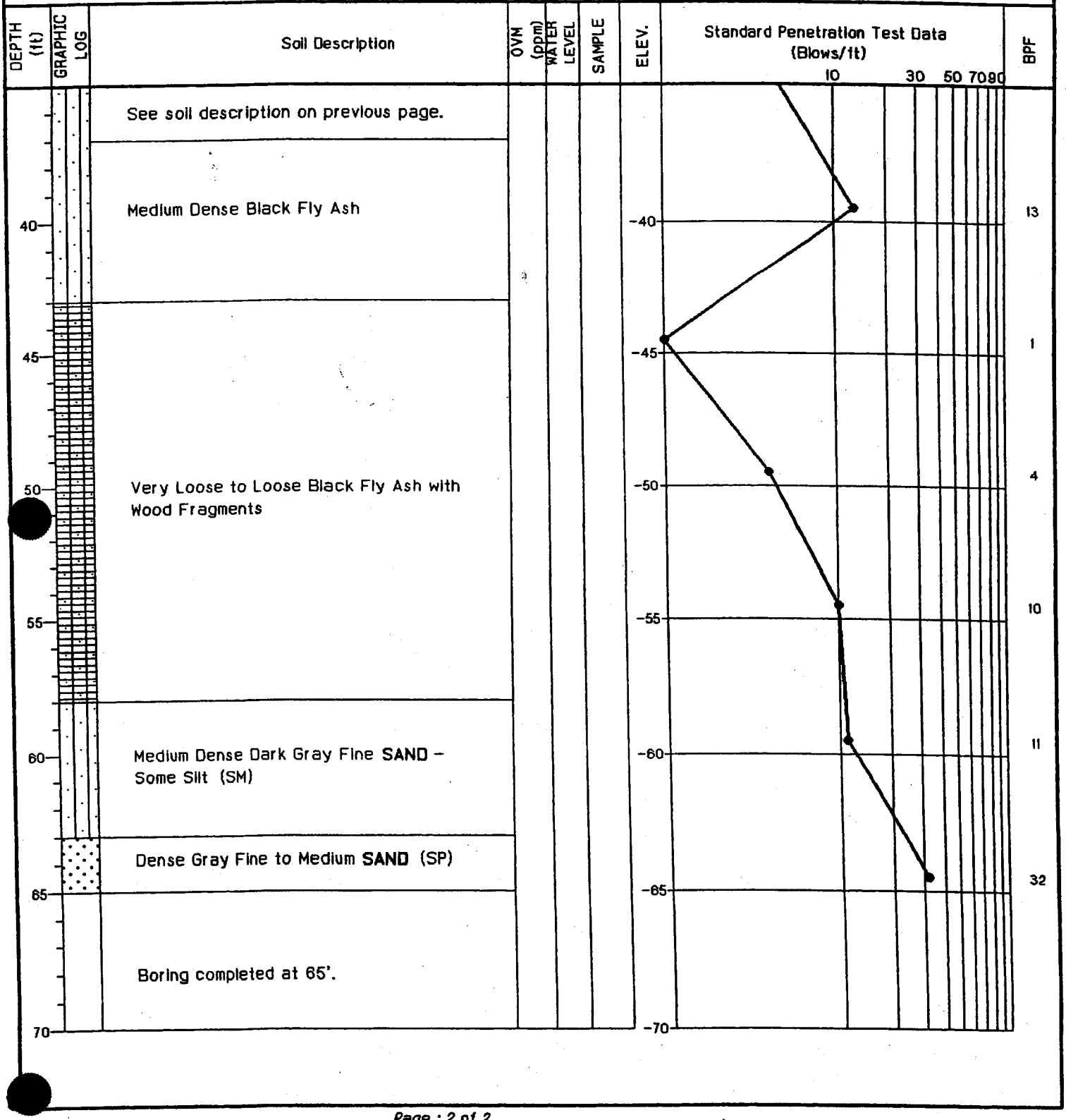
PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD B-1
PROJECT NO.: 1061-98-682	ELEVATION: 0	NOTES:
LOGGED BY: PB	BORING DEPTH: 65 FEET	
DATE DRILLED: 5-12-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	



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PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-2

PROJECT NO.: 1061-98-682	ELEVATION: 0	NOTES: Boring completed at a depth of 75'.
[redacted]ED BY: PB	BORING DEPTH: 75 FEET	
DATE DRILLED: 5-13-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
5		Brown Wood Fragments (a concrete obstruction was encountered at the original boring location and at 3 offset locations at a depth of 4', and a timber obstruction was encountered at a depth of 18.5')				-5		17
10						-10		10/0"
						-15		16
20						-20		37
						-25		25/3"
30						-30		19
35						-35		12
								28

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PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-2

PROJECT NO.: 1061-98-682	ELEVATION: 0	NOTES: Boring completed at a depth of 75'.
LOGGED BY: PB	BORING DEPTH: 75 FEET	
DATE DRILLED: 5-13-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
40		See soil description on previous page.				-40		23
45		Brown Wood Fragments, Cloth, and Paper				-45		22
50						-50		27
55		Brown Wood Fragments				-55		23
60		Medium Dense Black Fly Ash				-60		20
65		Wood Fragments (wood obstruction at a depth of 63.5') and Black Dregs or Sludge				-65		25/3"
70						-70		

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PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-2
PROJECT NO. :	1061-98-882	ELEVATION:	0
LOGGED BY:	PB	BORING DEPTH:	75 FEET
DRILLED:	5-13-98	WATER LEVEL:	
DRILLING METHOD:	WASH BORING	DRILL RIG:	CME45

NOTES:
Boring completed at a depth of 75'.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
75		See soil description on previous page.				-75		
		Medium Dense Gray Fine SAND - Some Clay (SC)						21
80						-80		
85						-85		
90						-90		
95						-95		
100						-100		
105						-105		

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PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-3

PROJECT NO.: 1061-98-682	ELEVATION: 0	NOTES:
LOGGED BY: PB	BORING DEPTH: 55 FEET	
DATE DRILLED: 5-13 & 5-14-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/1t)	BPF
0		Loose Orange and Dark Gray Fine **SAND** – Some Clay and Construction Debris (SC)				0	10	10
5		Concrete and Timber Obstructions with Brown Fine Sand				-5	10/0"	10/0"
10		Soft to Very Soft Dark Gray Dregs or Sludge – Some Fine Sand (Grits?)				-10		3
15						-15		WOH/18
20						-20		3
25		Loose Tan Fine **SAND** – Some Clay and Brick Fragments (SC)				-25		8
30		Soft to Very Soft Dark Gray Sludge or Dregs, Fine Gravel, and Fine Sand (Grits?)				-30		4
35						-35		2

PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-3

PROJECT NO. : 1061-98-682	ELEVATION: 0	NOTES:
LOGGED BY: PB	BORING DEPTH: 55 FEET	
DRILLED: 5-13 & 5-14-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
		See soil description on previous page.						
40		Soft to Very Soft Dark Gray Sludge or Dregs				-40		3
45		Loose Tan and Dark Gray Fine **SAND** (SP)				-45		6
		Concrete Obstruction						
50		Firm Brown Wood Fragments and Black and Dark Gray Sludge or Dregs				-50		8
55		Medium Dense Gray Fine **SAND** – Some Clay (SC)				-55		19
		Boring completed at 55'.						
60						-60		
65						-65		
70						-70		

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PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-4
PROJECT NO.:	1081-98-682	ELEVATION:	0
LOGGED BY:	PB	BORING DEPTH:	75 FEET
DATE DRILLED:	5-14-98	WATER LEVEL:	
DRILLING METHOD:	WASH BORING	DRILL RIG:	CME45

NOTES:
A Shelby tube sample was obtained from a depth of 25' to 27'.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 80	BPF
5		Dark Gray Fine Sand (Grits?), Brown Fine Sand, and Concrete and Wood Obstructions				-5		5 7
10						-10		2
15						-15		11
20		Very Soft to Firm Dark Gray Grits, Dregs or Sludge, and Wood Fragments				-20		7
25						-25		5
30						-30		4
35						-35		3

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PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-4
PROJECT NO.:	1061-98-682	ELEVATION:	0
LOGGED BY:	PB	BORING DEPTH:	75 FEET
DATE DRILLED:	5-14-98	WATER LEVEL:	
DRILLING METHOD:	WASH BORING	DRILL RIG:	CME45

NOTES:
A Shelby tube sample was obtained from a depth of 25' to 27'.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
		See soil description on previous page.						
40		Very Loose Gray Fine to Medium SAND (SP)				-40		4
45		Soft to Very Soft Dark Gray Dregs or Sludge with Wood Fragments – Some Grits				-45		3
50						-50		2
55		Medium Dense Black Fly Ash				-55		10
60		Medium Dense Tan Fine SAND (SP)				-60		19
65		Very Dense to Medium Dense Gray Fine to Medium SAND (SP)				-65		47/7"
70						-70		20

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PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-4

PROJECT NO.: 1061-98-682	ELEVATION: 0	NOTES: A Shelby tube sample was obtained from a depth of 25' to 27'.
LOGGED BY: PB	BORING DEPTH: 75 FEET	
DATE DRILLED: 5-14-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
75		See soil description on previous page.				-75		
		Medium Dense Dark Gray Clayey Fine SAND (SC) [Pee Dee Formation]						15
		Boring completed at 75'.						
80						-80		
85						-85		
90						-90		
95						-95		
100						-100		
105						-105		

S&ME
Environmental Services
Engineering * Testing

PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD B-5
PROJECT NO.: 1081-98-682	ELEVATION: 0	NOTES: Undisturbed Shelby tube samples were obtained from a depth of 5 to 7' at an offset location, and from 26 to 28' at Boring B-5. Borehole grouted.
LOGGED BY: PB	BORING DEPTH: 45 FEET	
DATE DRILLED: 6-2-98	WATER LEVEL: 15'	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
5						-5		1
10		Very Soft to Soft Gray and Dark Gray Sludge – Some Wood				-10		2
15						-15		2
20						-20		3
25		Very Soft Gray and Dark Gray Sludge – Some Dregs and Wood				-25		2
30						-30		2
35		Medium Dense Gray Fine to Medium **SAND** (SP)				-35		10

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Environmental Services
Engineering * Testing

PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-5

PROJECT NO.: 1081-98-682	ELEVATION: 0	NOTES: Undisturbed Shelby tube samples were obtained from a depth of 5 to 7' at an offset location, and from 26 to 28' at Boring B-5. Borehole grouted.
LOGGED BY: PB	BORING DEPTH: 45 FEET	
DATE DRILLED: 6-2-98	WATER LEVEL: 15'	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
		Soft Dark Gray Dregs - Some Wood						
40		Loose Brown Fine to Medium SAND - Some Clay (SC)				-40		10
		Loose Dark Gray Clayey Fine SAND (SC) [Pee Dee Formation]				-45		10
45		Boring completed at 45'.						
50						-50		
55						-55		
60						-60		
65						-65		
70						-70		

S&ME Environmental Services Engineering * Testing

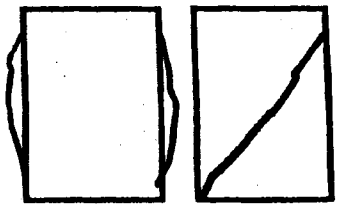
APPENDIX B
TRIAXIAL TEST RESULTS

S&ME

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
SHEAR STAGE

OB NUMBER:	1061-98-682
OB NAME:	INTERNATIONAL PAPER - RI EGELWOOD, NC.
ORING NO:	B-4
AMPLE NO:	1
AMPLE DEPTH:	25 - 27 FT.
AMPLE TYPE:	UD
AMPLE DESCRIPTION:	Black & Dark Gray Silty SAND with Organics

NTIAL CONDITIONONS	1	2
Sample Height (in)	5.78	5.80
Sample Diameter (in)	2.84	2.84
Specific Gravity	2.65	2.56
Water Content (%)	24.4	26.5
Wet Density PCF	122.5	122.4
Dry Density PCF	98.4	96.80
Void Ratio	0.681	0.709
Degree of Saturation	94.8	99.1
SHEARING STAGE		
Initial Cell Pressure PSI	79.0	94.0
Initial Pore Pressure PSI	69.0	74
Initial Effective Pressure PSI	10	20
Strain Rate in/min	0.0035	0.0035
SELECTED FAILURE CONDITIONS		
Strain (%)	2.73	3.32
Deviator Stress PSI	14.71	25.38
Shear Stress PSI	7.35	12.70
A Value	0.37	0.441
Stress Ratio	4.268	3.885
AT MAXIMUM DEVIATOR STRESS		
Strain (%)	2.73	5.59
Deviator Stress PSI	14.71	28.56
Shear Stress PSI	7.35	14.28
A Value	0.374	0.389
Stress Ratio	4.268	4.209
FINAL CONDITIONS		
Water Content (%)	23.9	21.6
Wet Density PCF	125.8	122.8
Dry Density PCF	98.3	96.8
Degree of Saturation	100.0	96.9



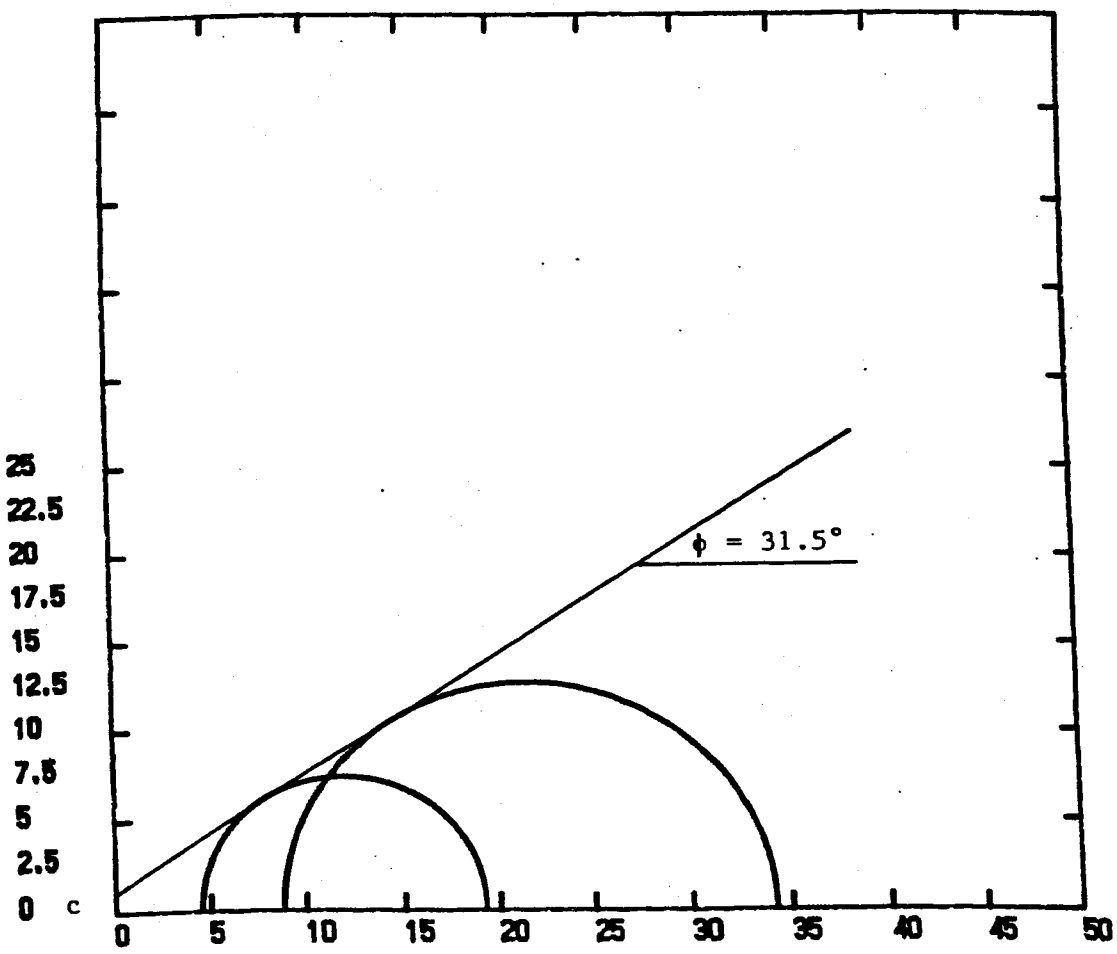
FAILURE MODE

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

SHEAR STAGE

C = 1.1 PSI = 160 PSF

PHI = 31.5 Degrees



Sample type UD
Sample Description Black & Dark Grey Silty SAND w/Organics
Boring No : B-4 Sample No: 1 Depth : 25-27 FT.

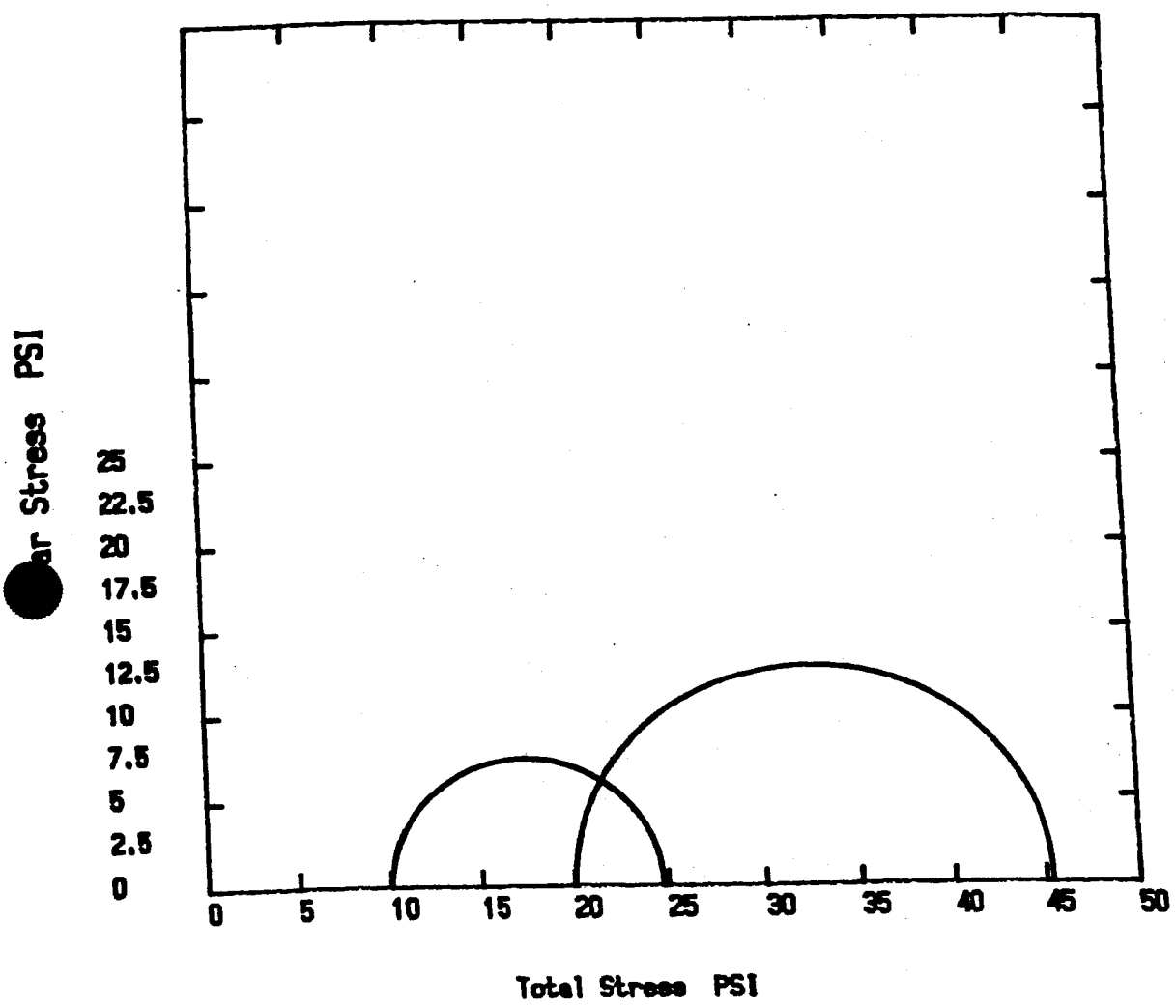
S&ME, INC	Job Name: INTERNATIONAL PAPER-RIEGELWOOD, NC.	Job No : 06198682 RALEIGH
Operator: MLK March, 2000	Checked: Ref. 6	Approved:
Date:	Date:	Date:

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

SHEAR STAGE

C = PSI

PHI = Degrees

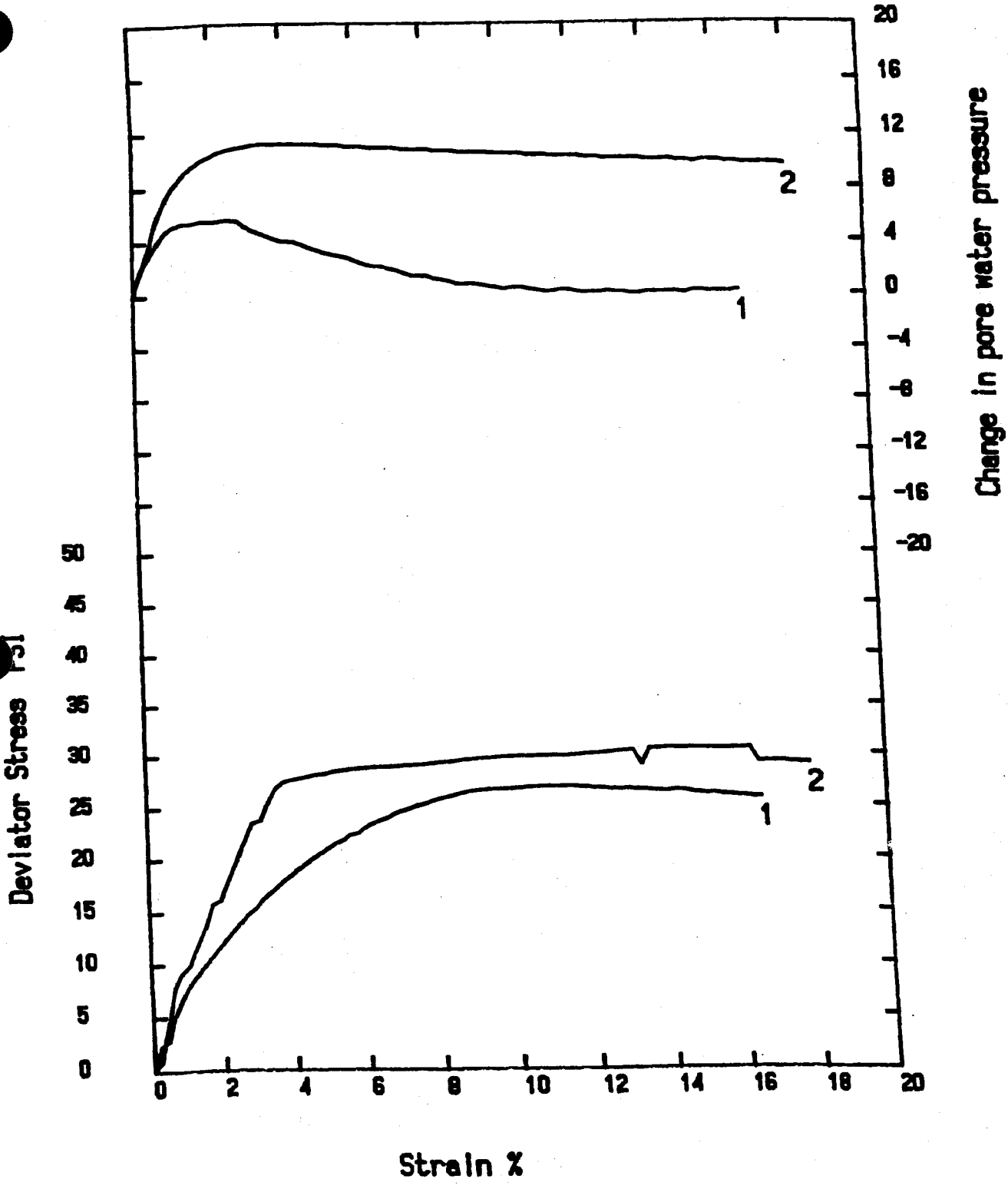


Sample type UD
Sample Description Black & Dark Grey Silty SAND w/Organics
oring No : B-4 Sample No: 1 Depth : 25-27 FT.

S&ME, INC	Job Name: INTERNATIONAL PAPER-RIEGELWOOD, NC.	Job No : 06199682 RALEIGH
Operator: MLK *March, 2000*	Checked: *Ref. 6*	Approved:
Date:	Date:	Date:

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

SHEAR STAGE



Sample type UD
Sample Description Black & Dark Gray Silty SAND w/Organics
Boring No : B-4 Sample No: 1 Depth : 25-27 FT.

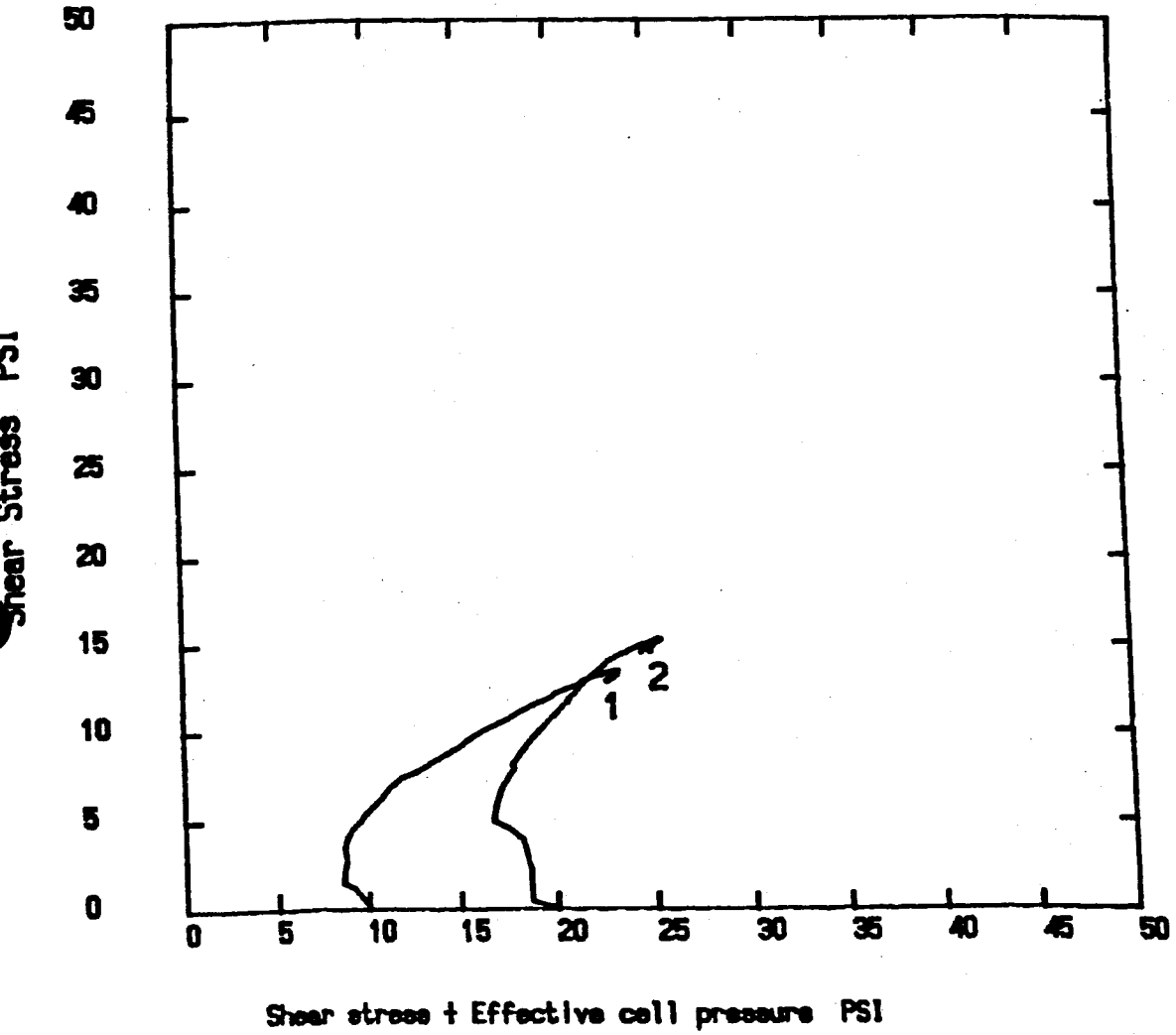
S&ME, INC	Job Name: INTERNATIONAL PAPER-RIEGELWOOD, NC.	Job No : 06198682 RALEIGH
Operator: MLK	Checked:	Approved:
Date:	Date:	Date:

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

SHEAR STAGE

C = PSI

PHI = Degrees



Sample type UD
Sample Description Black & Dark Grey Silty SAND w/Organics
Boring No : B-4 Sample No: 1 Depth : 25-27 FT.

S&ME, INC | Job Name: INTERNATIONAL PAPER-RIEGELWOOD, NC. | Job No : 06198682 RALEIGH

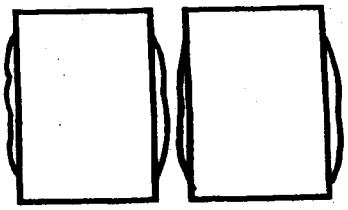
Operator: MLK	Checked:	Approved:
Date:	Date:	Date:

S&ME

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
SHEAR STAGE

B NUMBER:	1061-98-682
B NAME:	INTERNATIONAL PAPER - RI EGELWOOD, NC.
)RING NO:	B-5
MPLE NO:	1
MPLE DEPTH:	26 - 28 FT.
MPLE TYPE:	UD
MPLE DESCRIPTION:	Black Silty SAND Mixed with Woodchips

	1	2
TIAL CONDITIONONS		
Sample Height (in)	6.00	5.85
Sample Diameter (in)	2.86	2.86
Specific Gravity	2.56	2.56
Water Content (%)	138.9	154.4
Wet Density PCF	73.6	70.7
Dry Density PCF	30.8	27.80
Void Ratio	4.180	4.750
Degree of Saturation	85.0	83.2
HEARING STAGE		
Initial Cell Pressure PSI	80.3	93.5
Initial Pore Pressure PSI	70.3	73.5
Initial Effective Pressure PSI	10	20
Strain Rate in/min	0.0035	0.0035
TED FAILURE CONDITIONS		
Strain (%)	8.15	8.74
Deviator Stress PSI	14.27	23.78
Shear Stress PSI	7.13	11.89
A Value	0.49	0.534
Stress Ratio	5.754	4.257
AT MAXIMUM DEVIATOR STRESS		
Strain (%)	9.82	11.75
Deviator Stress PSI	14.94	24.18
Shear Stress PSI	7.47	12.09
A Value	0.47	0.53
Stress Ratio	5.979	4.358
FINAL CONDITIONS		
Water Content (%)	142.0	158.9
Wet Density PCF	73.6	68.2
Dry Density PCF	30.5	26.4
Degree of Saturation	84.9	79.8



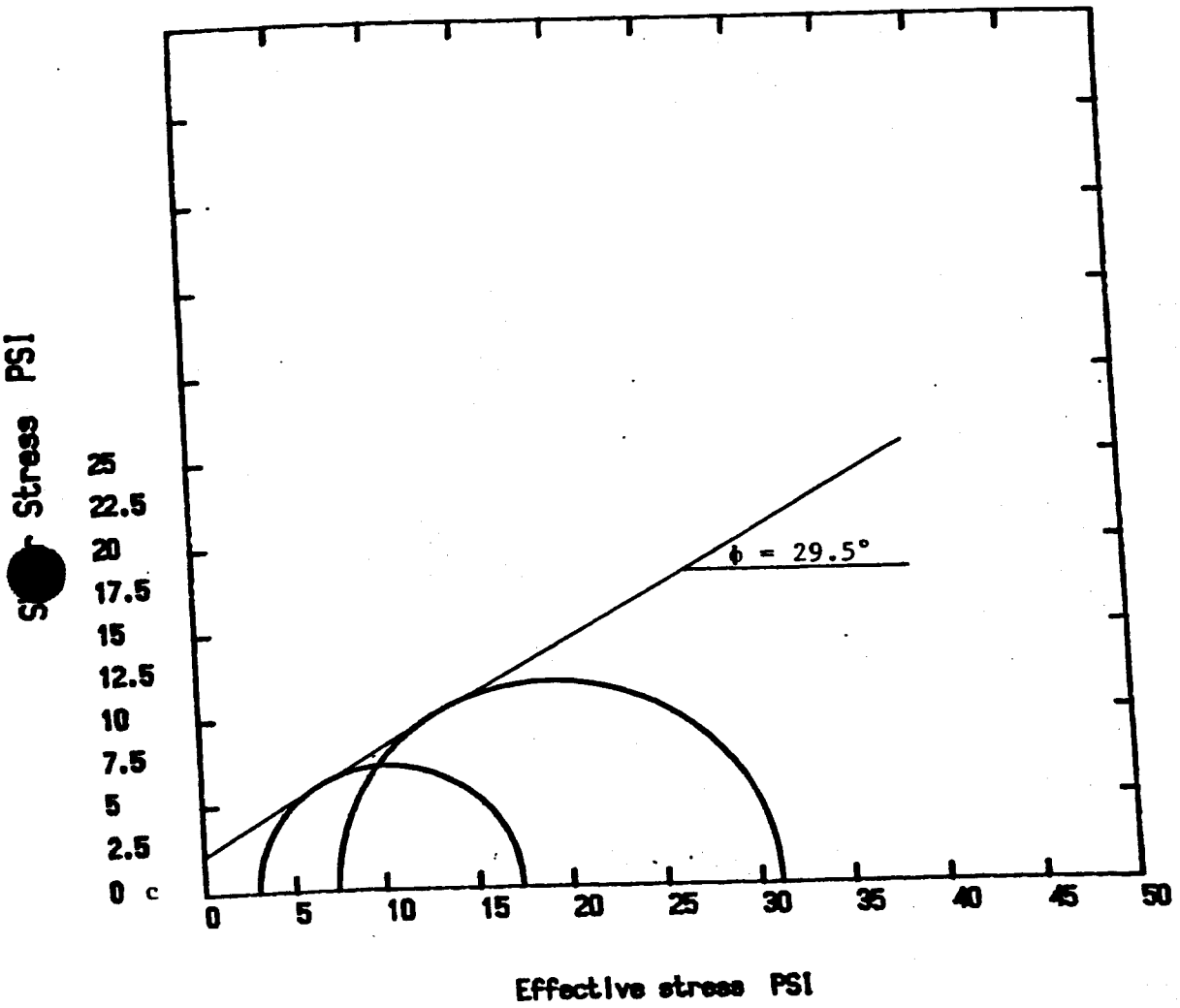
FAILURE MODE

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

SHEAR STAGE

C = 2.3 PSI = 330 PSF

PHI = 29.5 Degrees



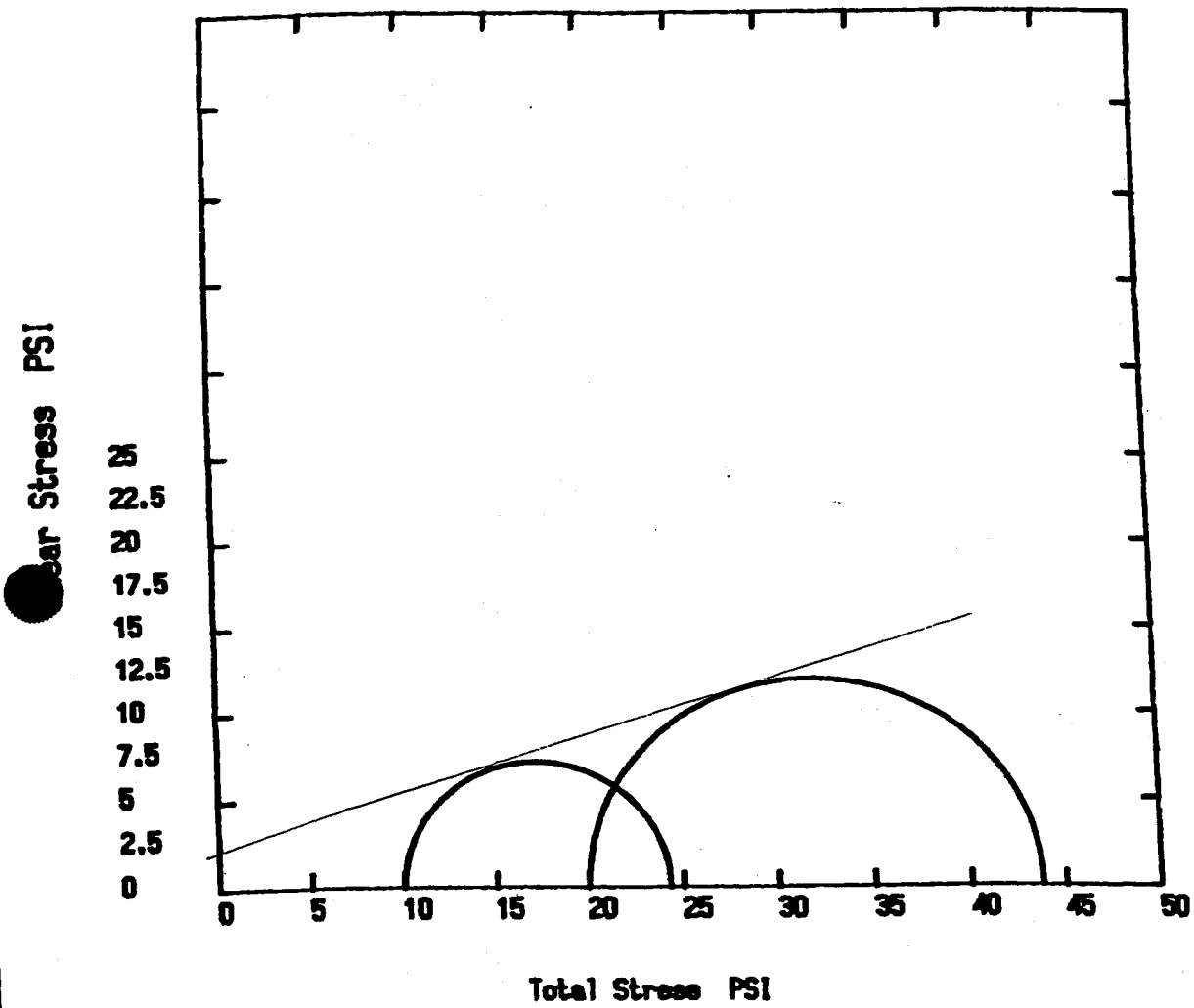
Sample type UD Sample Description Black Silty SAND Mixed with Woodchips Boring No : B-5	Sample No: 1	Depth : 26-28 FT	
S&ME, INC	Job Name: INTERNATIONAL PAPER-RIEGELWOOD, NC.		Job No : 06198682 RALEIGH
Operator: MLK Date: March, 2000	Checked: Date:	Approved: Date:	

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

SHEAR STAGE

C = PSI

PHI = Degrees



Sample type UD
Sample Description Black Silty SAND Mixed with Woodchips
Boring No : B-5 Sample No: 1 Depth : 26-28 FT

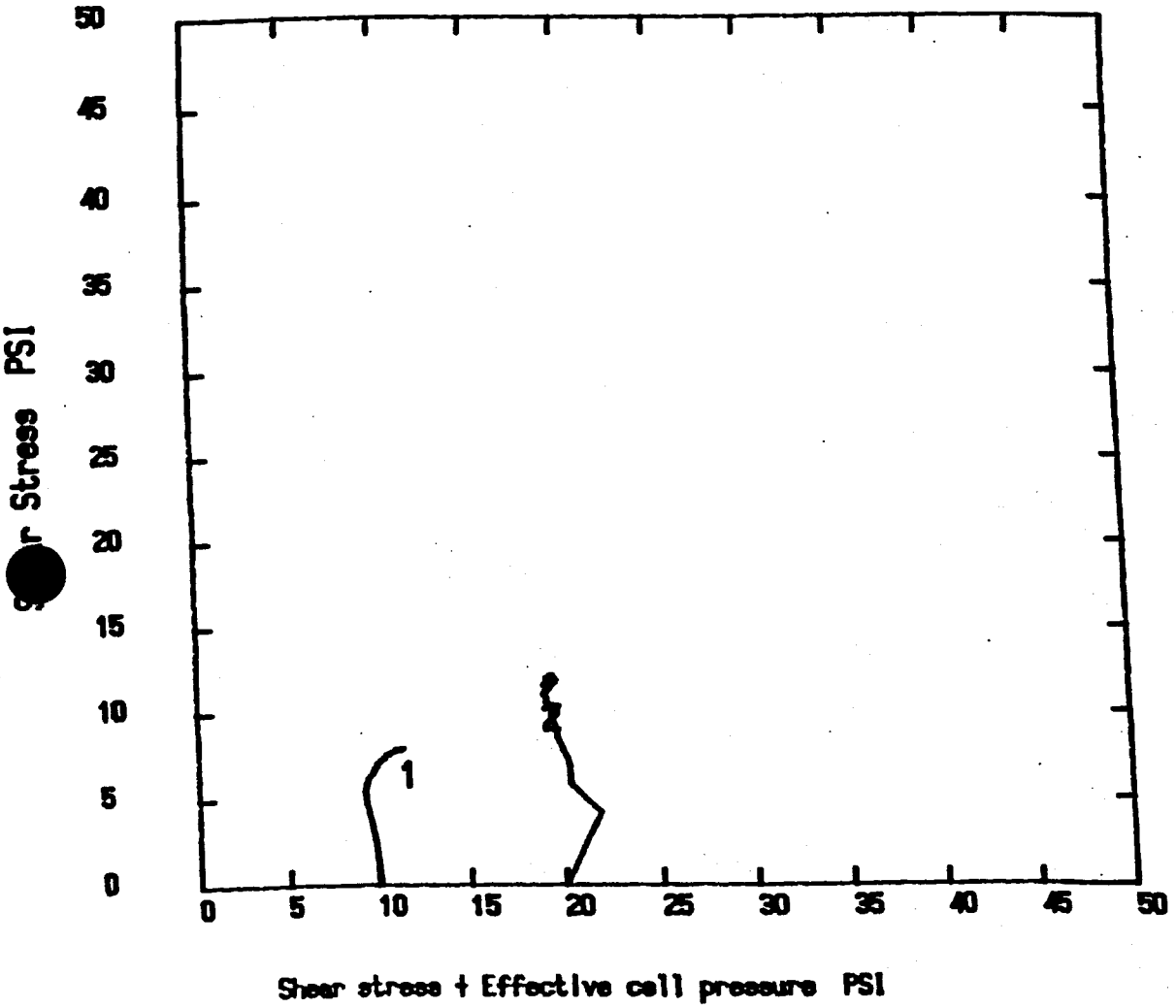
S&ME, INC	Job Name: INTERNATIONAL PAPER-RIEGELWOOD, NC.	Job No : 06198682 RALEIGH
Operator: MLK	Checked:	Approved:
Date:	Date:	Date:

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

SHEAR STAGE

C = PSI

PHI = Degrees



Sample type UD
Sample Description Black Silty SAND Mixed with Woodchips
Boring No : B-5 Sample No: 1 Depth : 26-28 FT

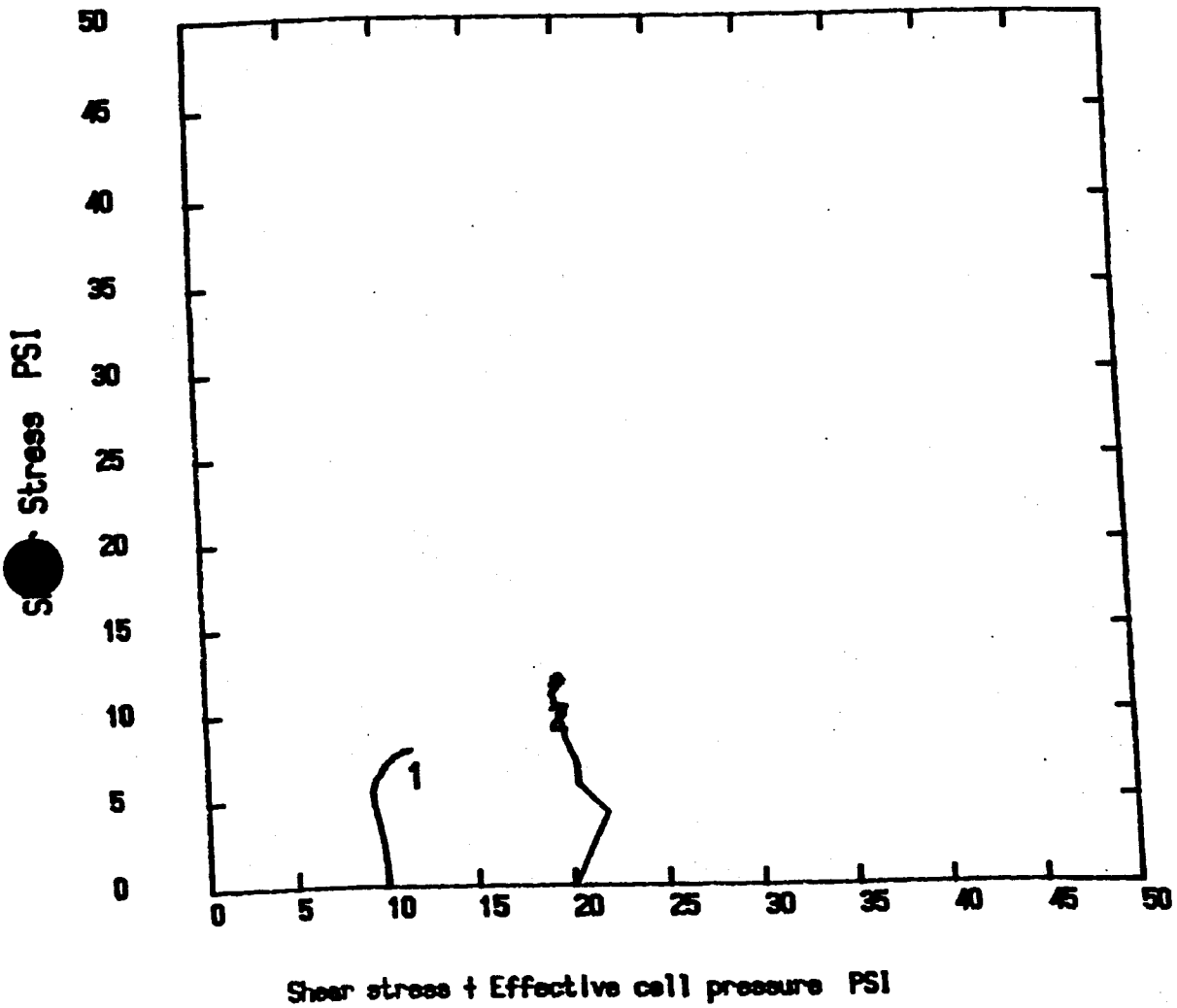
S&ME, INC	Job Name: INTERNATIONAL PAPER-RIEGELWOOD, NC.	Job No : 06198682 RALEIGH
Operator: MLK	Checked:	Approved:
Date:	Date:	Date:

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

SHEAR STAGE

C = PSI

PHI = Degree



Sample type UD
Sample Description Black Silty SAND Mixed with Woodchips
Boring No : B-5 Sample No: 1 Depth : 26-28 FT

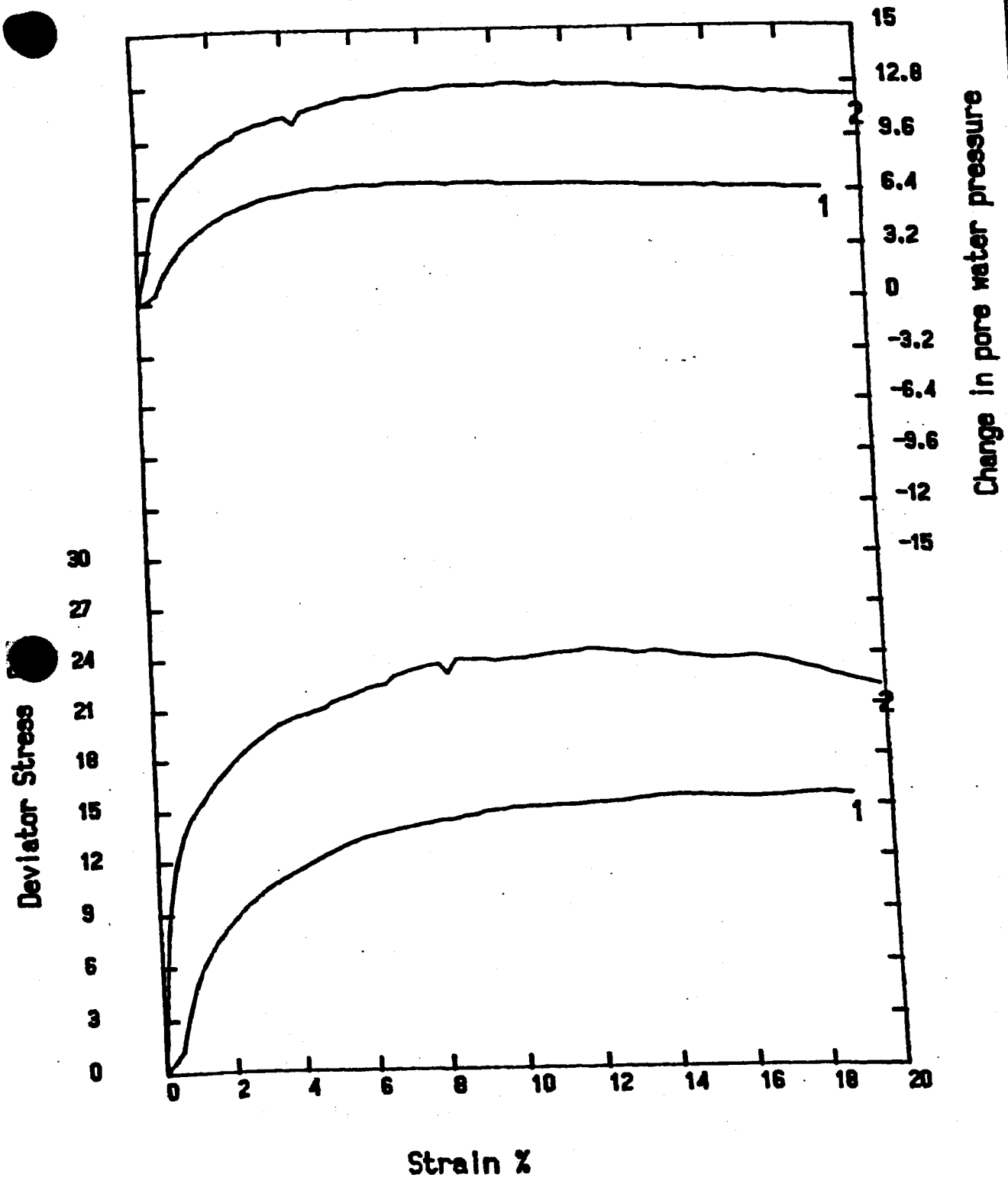
S&ME, INC | Job Name: INTERNATIONAL PAPER-RIEGELWOOD, NC. | Job No : 06198682 RALEIGH

Operator: MLK | Checked: | Approved:

Date: | Date: | Date:

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

SHEAR STAGE



Sample type UD Sample Description Black Silty SAND Mixed with Woodchips Boring No : B-5 Sample No: 1 Depth : 26-28 FT		
S&ME, INC	Job Name: INTERNATIONAL PAPER-RIEGELWOOD, NC.	Job No : 06198682 RALEIGH
Operator: MLK March, 2000 Date:	Checked: Date:	Approved: Date:

Settlement Calculations

S&ME

JOB NO. 1356-99-573
SHEET NO. 1 of 61
DATE 11/9/99
COMPUTED BY MDP
CHECKED BY RK

JOB NAME International Paper Sludge Landfill
SUBJECT Settlement Calculations

OBJECTIVE:

Determine the total amount of settlement for the Sludge Landfill to verify that a Minimum 5% slope will be sufficient to maintain positive drainage on top of the landfill.

REFERENCE:

1. S&ME laboratory testing, Table 1 "Summary of Laboratory Test Data"
2. Navfac Manual 7.1, Table 1 "Typical Properties of Compacted Soils", page 39
3. Waste Management Plan, by McKim & Creed, August 1995
4. Tappi Journal, "Closure of a nine-acre industrial landfill using pulp and paper mill residuals", Michael J. Malmstead, David F. Bonistall, and C. Van Maltby
5. S&ME Dilatometer testing data
6. S&ME boring logs

CALCULATION:

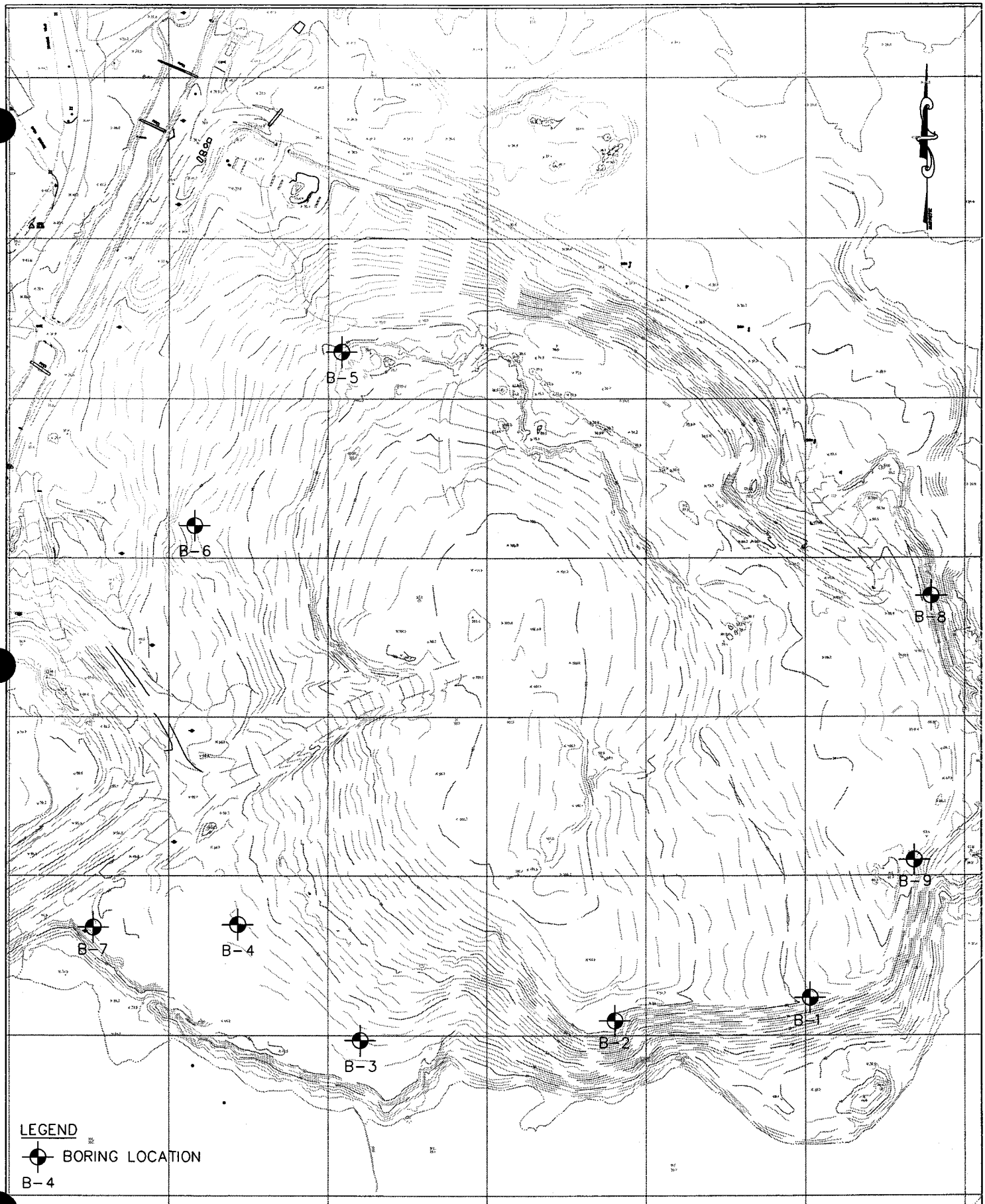
Boring	Settlement* (ft)	Height of added sludge (ft)	Consolidation of added Sludge (ft)**	Total Settlement (ft)
B-1	0.04	2.5	0.75	0.79
B-2	0.00	2.5	0.75	0.75
B-3	0.36	14.5	4.35	4.71
B-4	0.81	39.5	11.85	12.66
B-5	0.55	27.5	8.25	8.80
B-6	0.79	33.5	10.05	10.84
B-7	0.07	2.5	0.75	0.82
B-8	0.38	8.5	2.55	2.93
B-9	0.35	8.5	2.55	2.90

*Settlement based on FHWA method and Dilatometer data

**Assumed 30% consolidation (Ref. 4)

CONCLUSION:

Due to the 30% consolidation of newly placed sludge in areas with more fill will result in higher settlements. These areas receiving the greatest amount of fill will be the perimeter of the landfill that transitions from 3H:1V to 5% slope. Therefore, the differential settlement should promote drainage off of the landfill.



SCALE:	1"=200'
CHECKED BY:	
DRAWN BY:	RK
DATE:	3/22/00

S&ME
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ENVIRONMENTAL SERVICES

BORING LOCATIONS

INTERNATIONAL PAPER
RIEGELWOOD, NORTH CAROLINA

JOB NO: 1356-99-573

FIGURE NO.
1

S&ME, Inc.
Settlement Calculations

Job Name: INTERNATIONAL PAPER SLUDGE LANDFILL
Computed by: MIKE PLUMMER
Job #: 1356-99-573

Reference: FHWA Settlement Analysis Handbook, S&ME, Inc.

Calculation:

$$\text{Delta H} = Hi*(1/C')*LOG[(P_0 + \text{Delta P})/P_0]$$

Legend:

N = Blow count from boring log for each layer
Z= avg depth of center of layer
Hi = thickness of soil layer
Unit weight = satuarated unit weight of soil layer
N'/N = Blow Count correction factor (Figure 1)
N' = Corrected Blow Count
C' = Bearing Capacity Index (Figure 2)
P_0 = overburden stress at midpoint of the layer
Delta P = additional overburden at center of the layer due to waste or soil fill
Delta H = calculated settlement for each soil layer

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-1

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer	0	100
final cover lay	2.5	110
cut	2	100

delta P =	0.075 ksf

deltaH = Hi*(1/C')*LOG[(Po+delta P)/ Po]

Avg. N	Layer #	Hi (ft)	Z (ft)	Dens (kcf)	Layer Wt. Above (ksf)	N'/N	N'	C'	Po (ksf)	deltaP (ksf)	Po+deltaP (ksf)	deltaH (ft)
4	1	11	5.50	0.100		1.90	7.6	37	0.55	0.075	0.63	0.017
5	2	45	33.50	0.070	1.10	0.86	4.3	28	2.68	0.075	2.75	0.019
11	3	5	58.50	0.115	4.25	0.71	7.81	37	4.54	0.075	4.61	0.001
32	4	2	62.00	0.110	4.83	0.69	22.1	62	4.87	0.075	4.95	0.000

TOTAL SETTLEMENT = 0.04 FT
OR
0.44 IN

No groundwater indicated.
Indicates Settlement used based on Dilatometer data for this layer

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-2

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer		100
final cover lay	2.5	110
cut	28	100

delta P = -2.525 ksf

deltaH = Hi*(1/C')*LOG[(Po+delta P)/ Po]

Avg. N	Layer #	Hi (ft)	Z (ft)	Dens (kcf)	Layer Wt. Above (ksf)	N'/N	N'	C'	Po (ksf)	deltaP (ksf)	Po+deltaP (ksf)	deltaH (ft)
CUT	1	28.0	14.00	0.100								0.000
20.5	1	14.0	7.00	0.100		1.65	33.83	74	0.70	-2.525	-1.83	0.000
24	2	17.5	22.75	0.100	1.40	0.89	21.36	61	2.28	-2.525	-0.25	0.000
20	3	2.5	32.75	0.070	3.15	0.81	16.20	44	3.24	-2.525	0.71	0.000
25	4	10.0	39.00	0.100	3.33	0.76	19.00	57	3.83	-2.525	1.30	0.000
21	5	3.0	45.50	0.115	4.33	0.71	14.91	50	4.50	-2.525	1.97	0.000

TOTAL SETTLEMENT = 0.00 FT
OR
0.00 IN

No groundwater indicated.
' indicates Settlement used based on Dilatometer data for this layer

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-3

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer	12	100
final cover lay	2.5	110
cut	0	100

delta P =	1.475 ksf

deltaH = Hi*(1/C')*LOG[(Po+delta P)/ Po]

Avg. N	Layer #	Hi (ft)	Z (ft)	Dens (kcf)	Layer Wt. Above (ksf)	N'/N	N'	C'	Po (ksf)	deltaP (ksf)	Po+deltaP (ksf)	deltaH (ft)
10	1	3.50	1.75	0.100		3	30.00	76	0.18	1.475	1.65	0.045
100	2	3.50	5.25	0.125	0.35	1.85	185.0	255	0.57	1.475	2.04	0.008
2	3*	17.00	15.50	0.100	0.79	0.98	1.96	31	1.64	1.475	3.11	0.153
8	4*	3.00	25.50	0.115	2.49	0.85	6.80	37	2.57	1.475	4.04	0.016
3	5*	10.00	32.00	0.100	2.65	0.84	2.52	32	2.83	1.475	4.31	0.057
3	6	7.50	40.75	0.100	3.02	0.82	2.46	31	3.16	1.475	4.64	0.040
6	7	1.50	45.25	0.110	3.30	0.8	4.80	34	3.34	1.475	4.81	0.007
100	8	1.50	46.75	0.125	3.37	0.8	80.00	300	3.42	1.475	4.90	0.001
8	9	5.50	50.25	0.100	3.47	0.78	6.24	36	3.57	1.475	5.05	0.023
19	10	2.00	54.00	0.115	3.68	0.76	14.44	49	3.73	1.475	5.20	0.006

TOTAL SETTLEMENT = 0.36 FT
OR
4.26 IN

No groundwater indicated.
* Indicates Settlement used based on Dilatometer data for this layer

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-4

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer	37	100
final cover lay	2.5	110
cut	0	100

delta P =	3.975 ksf

deltaH = Hi*(1/C')*LOG[(Po+delta P)/ Po]

Avg. N	Layer #	Hi (ft)	Z (ft)	Dens (kcf)	Layer Wt. Above (ksf)	N'/N	N'	C'	Po (ksf)	deltaP (ksf)	Po+deltaP (ksf)	deltaH (ft)
6	1	9.0	4.50	0.120		1.9	11.40	44	0.54	3.975	4.52	0.189
5	2*	29.0	23.50	0.100	1.08	0.88	4.40	34	2.53	3.975	6.51	0.350
4	3	3.0	39.50	0.110	3.98	0.74	2.96	32	4.05	3.975	8.03	0.028
2	4	13.5	47.75	0.100	4.12	0.71	1.42	30	4.38	3.975	8.35	0.126
10	5	2.5	55.75	0.070	4.63	0.69	6.90	32	4.64	3.975	8.61	0.021
19	6	5.0	59.50	0.115	4.65	0.68	12.92	46	4.78	3.975	8.76	0.029
20	7	10.0	67.00	0.120	4.91	0.68	13.60	47	5.20	3.975	9.18	0.052
15	8	3.0	73.50	0.115	5.49	0.65	9.75	41	5.57	3.975	9.54	0.017

TOTAL SETTLEMENT = 0.81 FT
OR
9.74 IN

No groundwater indicated.
* Indicates Settlement used based on Dilatometer data for this layer

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-5

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer	25	100
final cover lay	2.5	110
cut	0	100

delta P =	2.775 ksf

deltaH = Hi*(1/C')*LOG[(Po+delta P)/ Po]

Avg. N	Layer #	Hi (ft)	Z (ft)	Dens (kcf)	Layer Wt. Above (ksf)	N'/N	N'	C'	Po (ksf)	deltaP (ksf)	Po+deltaP (ksf)	deltaH (ft)
2	1	32	16.0	0.100		0.98	1.96	30	1.60	2.775	4.38	0.466
6	2	2	33.0	0.115	3.20	0.80	4.80	34	3.32	2.775	6.09	0.016
10	3	3	35.5	0.100	3.43	0.78	7.80	39	3.58	2.775	6.36	0.019
10	4	5	39.5	0.115	3.73	0.74	7.40	35	4.02	2.775	6.79	0.033
10	5	3	43.5	0.110	4.31	0.71	7.10	37	4.47	2.775	7.25	0.017

TOTAL SETTLEMENT = 0.55 FT
OR
6.60 IN

No groundwater indicated.
Indicates Settlement used based on Dilatometer data for this layer

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-6

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer	31	100
final cover lay	2.5	110
cut	0	100

delta P = 3.375 ksf

deltaH = Hi*(1/C')*LOG[(Po+delta P)/ Po]

Avg. N	Layer #	Hi (ft)	Z (ft)	Dens (kcf)	Layer Wt. Above (ksf)	N'/N	N'	C'	Po (ksf)	deltaP (ksf)	Po+deltaP (ksf)	deltaH (ft)
10	1*	13.5	6.75	0.100		1.7	17.00	53	0.68	3.375	4.05	0.198
3	2*	14.5	20.75	0.100	1.35	0.92	2.76	32	2.08	3.375	5.45	0.190
7	3*	15.9	35.95	0.070	2.58	0.87	6.09	31	2.64	3.375	6.02	0.183
10	4	0.6	44.20	0.100	2.70	0.86	8.60	40	2.71	3.375	6.09	0.005
17.5	5	19.0	54.00	0.100	2.73	0.82	14.35	49	3.08	3.375	6.46	0.125
10	6	4.5	65.75	0.100	3.44	0.78	7.80	38	3.52	3.375	6.90	0.035
11	7	7.0	71.50	0.120	3.61	0.76	8.36	39	3.81	3.375	7.19	0.049

TOTAL SETTLEMENT = 0.79 FT
OR
9.42 IN

Groundwater at 24.5 feet.
* Indicates Settlement used based on Dilatometer data for this layer

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-7

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer	0	100
final cover lay	2.5	110
cut	0	100

delta P =	0.275 ksf

deltaH = Hi*(1/C')*LOG[(Po+delta P)/ Po]

Avg. N	Layer #	Hi (ft)	Z (ft)	Dens (kcf)	Layer Wt. Above (ksf)	N'/N	N'	C'	Po (ksf)	deltaP (ksf)	Po+deltaP (ksf)	deltaH (ft)
13	1	3.0	1.50	0.120		3.10	40.30	96	0.18	0.275	0.46	0.013
15	2	1.0	3.50	0.100	0.36	2.2	33.00	81	0.41	0.275	0.69	0.003
18	3	4.0	6.00	0.120	0.46	1.65	29.70	76	0.70	0.275	0.98	0.008
12	4	4.0	10.00	0.100	0.94	1.20	14.40	46	1.14	0.275	1.42	0.008
8	5	16.0	20.00	0.120	1.28	0.96	7.68	38	1.74	0.275	2.01	0.027
2	6	1.5	28.75	0.100	2.20	0.92	1.84	30	2.23	0.275	2.50	0.003
10	7	10.0	34.50	0.125	2.35	0.86	8.60	40	2.66	0.275	2.94	0.011
69	8	0.5	39.75	0.125	3.60	0.77	53.13	125	3.61	0.275	3.89	0.000

TOTAL SETTLEMENT = 0.07 FT
OR
0.86 IN

Groundwater at 11 feet.
* Indicates Settlement used based on Dilatometer data for this layer

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-8

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer	6	100
final cover lay	2.5	110
cut	0	100

delta P =	0.875 ksf

deltaH = Hi*(1/C')*LOG[(Po+delta P)/ Po]

Avg. N	Layer #	Hi (ft)	Z (ft)	Dens (kcf)	Layer Wt. Above (ksf)	N'/N	N'	C'	Po (ksf)	deltaP (ksf)	Po+deltaP (ksf)	deltaH (ft)
5	1	3.0	1.50	0.070		3.3	16.5	44	0.11	0.875	0.98	0.066
5	**2*	15.5	10.75	0.070	0.21	1.56	7.80	34	0.75	0.875	1.63	0.153
2	3*	3.5	20.25	0.070	1.30	1.02	2.04	25	1.42	0.875	2.29	0.029
4	4	6.0	25.00	0.070	1.54	0.98	3.92	29	1.75	0.875	2.63	0.036
5	5*	12.0	28.00	0.070	1.96	0.88	4.40	29	2.38	0.875	3.26	0.056
14	6*	14.5	47.25	0.100	2.80	0.82	11.48	51	3.07	0.875	3.95	0.031
9	7	2.5	55.75	0.110	3.47	0.78	7.02	38	3.53	0.875	4.40	0.006
45	8	3.0	58.50	0.120	3.59	0.76	34.20	85	3.68	0.875	4.55	0.003

TOTAL SETTLEMENT = 0.38 FT
OR
4.58 IN

Groundwater at 42 feet.
* Indicates Settlement used based on Dilatometer data for this layer

** Consolidation test data was compared with the other settlement methods and was less for this layer

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-9

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer	6	100
final cover lay	2.5	110
cut	0	100

delta P =	0.875 ksf

deltaH = Hi*(1/C')*LOG[(Po+delta P)/ Po]

Avg. N	Layer #	Hi (ft)	Z (ft)	Dens (kcf)	Layer Wt. Above (ksf)	N'/N	N'	C'	Po (ksf)	deltaP (ksf)	Po+deltaP (ksf)	deltaH (ft)
6	1	18.0	9.00	0.070		1.7	10.20	37	0.63	0.875	1.51	0.184
8	2	4.0	20.00	0.100	0.82	1.4	11.20	39	0.90	0.875	1.77	0.030
13	3	6.0	25.00	0.100	0.97	1.25	16.25	52	1.09	0.875	1.96	0.030
6	4	5.0	30.50	0.100	1.20	1.12	6.72	37	1.29	0.875	2.17	0.030
6	5	1.5	33.75	0.100	1.39	1.05	6.30	37	1.42	0.875	2.29	0.008
7	6	9.5	39.25	0.100	1.44	0.98	6.86	38	1.62	0.875	2.50	0.047
9	7	4.0	46.00	0.100	1.80	0.95	8.55	40	1.88	0.875	2.75	0.017
29	8	2.0	49.00	0.120	1.95	0.94	27.26	75	2.01	0.875	2.88	0.004

TOTAL SETTLEMENT = 0.35 FT
OR
4.20 IN

Groundwater at 11 feet.
* Indicates Settlement used based on Dilatometer data for this layer

S&ME, Inc.
Dilatometer Settlement Calculations

Job Name: INTERNATIONAL SLUDGE LANDFILL
Computed by: MIKE PLUMMER
Job #: 1356-99-573

Reference: FHWA Settlement Analysis Handbook, S&ME, Inc.

Calculations:

Delta H = (Delta P x Hi)/(0.8 x M)

Legend:

Hi = thickness of soil layer
M = Constrained Modulus (ksf)
Delta P = additional overburden at center of the layer due to waste or soil fill
Delta H = calculated settlement for each soil layer

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-1

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer	0	100
final cover layer	2.5	110
cut	2	100

Delta P = 0.075 Ksf

Delta H = (Delta P*Hi)/(0.8*M)

Layer #	Hi (ft)	M (Ksf)	deltaP (ksf)	deltaH (ft)
1	11	76.20	0.075	0.014
2	45	426.21	0.075	0.010
3	5	N/A	0.075	0.000
4	2	N/A	0.075	0.000

TOTAL SETTLEMENT = 0.02 FT
OR
0.28 IN

No groundwater indicated.

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-3

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer	12	100
final cover layer	2.5	110
cut	0	100

delta P = 1.475 ksf

Delta H = (Delta P*Hi)/(0.8*M)

Layer #	Hi (ft)	M (Ksf)	deltaP (ksf)	deltaH (ft)
1	3.5	N/A	1.475	0.000
2	3.5	N/A	1.475	0.000
3	17.0	143.97	1.475	0.218
4	3.0	256.83	1.475	0.022
5	10.0	206.65	1.475	0.089
6	7.5	455.25	1.475	0.030
7	1.5	N/A	1.475	0.000
8	1.5	N/A	1.475	0.000
9	5.5	N/A	1.475	0.000
10	2.0	N/A	1.475	0.000

TOTAL SETTLEMENT = 0.36 FT
OR
4.31 IN

No groundwater indicated.

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-4

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer	37	100
final cover layer	2.5	110
cut	0	100

delta P = 3.975 ksf

Delta H = (Delta P*Hi)/(0.8*M)

Layer #	Hi (ft)	M (ksf)	deltaP (ksf)	deltaH (ft)
1	9.0	N/A	3.975	0.000
2	29.0	127.68	3.975	1.129
3	3.0	N/A	3.975	0.000
4	13.5	N/A	3.975	0.000
5	2.5	N/A	3.975	0.000
6	5.0	N/A	3.975	0.000
7	10.0	N/A	3.975	0.000
8	3.0	N/A	3.975	0.000

TOTAL SETTLEMENT = 1.13 FT
OR
13.54 IN

No groundwater indicated.

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-6

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer	31	100
final cover layer	2.5	110
cut	0	100

delta P = 3.375 ksf

Delta H = (Delta P*Hi)/(0.8*M)

Layer #	Hi (ft)	M (ksf)	deltaP (ksf)	deltaH (ft)
1	13.5	235.77	3.375	0.242
2	14.5	130.54	3.375	0.469
3	15.9	130.80	3.375	0.513
4	0.6	N/A	3.375	0.000
5	19.0	N/A	3.375	0.000
6	4.5	N/A	3.375	0.000
7	7.0	N/A	3.375	0.000

TOTAL SETTLEMENT = 1.22 FT
OR
14.68 IN

Groundwater at 24.5 feet.

Dilatometer Settlement Calculations

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-8

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer	6	100
final cover layer	2.5	110
cut	0	100

delta P = 0.875 ksf

Delta H = (Delta P*Hi)/(0.8*M)

Layer #	Hi (ft)	M (ksf)	deltaP (ksf)	deltaH (ft)
1	3.0	297.90	0.875	0.011
2	15.5	33.44	0.875	0.507
3	3.5	26.83	0.875	0.143
4	6.0	259.40	0.875	0.025
5	12.0	96.55	0.875	0.136
6	14.5	226.04	0.875	0.070
7	2.5	N/A	0.875	0.000
8	3.0	N/A	0.875	0.000

TOTAL SETTLEMENT = 0.89 FT
OR
10.71 IN

No groundwater indicated.

Dilatometer Settlement Calculations

Job Name: INTERNATIONAL PAPER - RIEGELWOOD
Computed by: MIKE PLUMMER
Job #: 1356-99-573
Boring #: B-9

LAYER	THICKNESS (FT)	SPECIFIC WT (PCF)
sludge layer	6	100
final cover layer	2.5	110
cut	0	100

delta P = 0.875 ksf

Delta H = (Delta P*Hi)/(0.8*M)

Layer #	Hi (ft)	M (ksf)	deltaP (ksf)	deltaH (ft)
1	18.0	529.49	0.875	0.037
2	4.0	911.43	0.875	0.005
3	6.0	611.90	0.875	0.011
4	5.0	N/A	0.875	0.000
5	1.5	N/A	0.875	0.000
6	9.5	N/A	0.875	0.000
7	4.0	N/A	0.875	0.000
8	2.0	N/A	0.875	0.000

TOTAL SETTLEMENT = 0.05 FT
OR
0.63 IN

No groundwater indicated.

S&ME

JOB NO. 1356-99-573
SHEET NO. 20f 61
DATE 11/3/99

JOB NAME INTERNATIONAL PAPER - RIEGELWOOD
COMPUTED BY MDP
SUBJECT SETTLEMENT ANALYSIS
CHECKED BY DPM

OBJECTIVE: EVALUATE SUBGRADE SETTLEMENT DUE TO WASTE PLACEMENT USING LABORATORY CONSOLIDATION RESULTS

PARAMETERS: ATTACHED CONSOLIDATION TEST PLOT (STRAIN VS PRESSURE)
CAP γ = 110 pcf
FLY ASH γ = 70 pcf } REF S&ME LABORATORY TESTING
SLUDGE γ = 100 pcf }
SAMPLE TAKEN FROM BORING B-8 from 20'-22' DEEP

SOLUTION:

$P_o = (22')(0.070\ kcf) = 1.54\ ksf$

$P_f = P_o + \Delta P_{WASTE}$ ← (WEIGHT DUE TO 6' of ADDED SLUDGE AND 2.5' CAP)

$= 1.54\ ksf + [(6' \times 0.1\ kcf) + (2.5' \times 0.11\ kcf)]$

$= 2.42\ ksf$

FROM ATTACHED PLOT

ε_o @ P_o = 9.2 %

ε_f @ P_f = 11.7 %

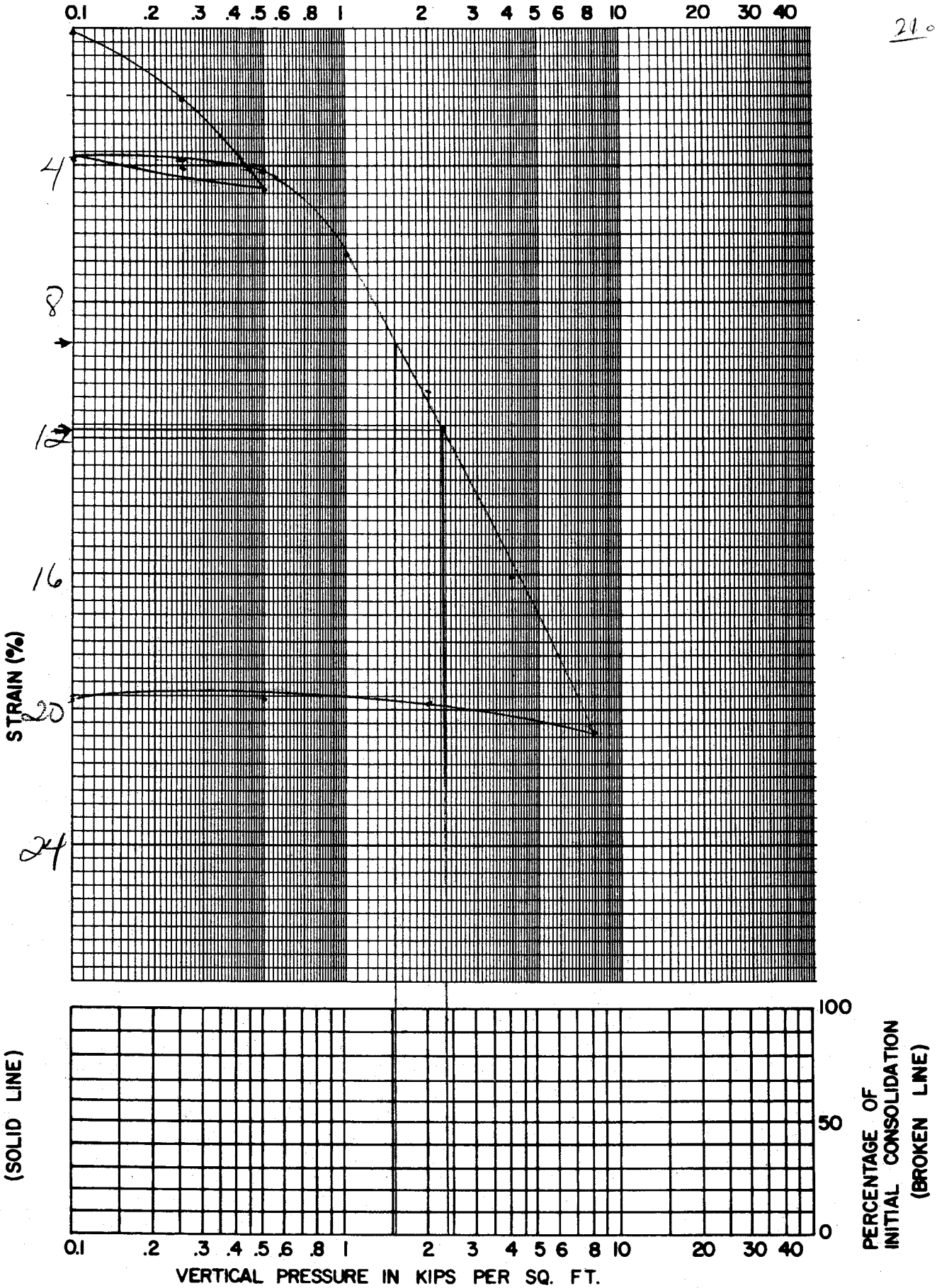
$\Delta\varepsilon = (0.117 - 0.092) = 0.025$

$\Delta H = \Delta\varepsilon H$ $\quad H = 3.5$ ft (REF BORING LOG B-8)

$= (0.025)(3.5\ ft)$

$= 0.0875$ ft OR 1.05 IN

THE SHARPE CO. 065549



COMPRESSION INDEX _____
UNIT WEIGHT 42.3
WATER CONTENT 76.6 %
SATURATION 73.0
INITIAL VOID RATIO 2.468

WE-11

CONSOLIDATION TEST

BORING NO. UD-1 SAMPLE NO. _____
ELEV. OR DEPTH 20-22' JOB NO. 1356-99-573
International Paper - Ruglewood

Westinghouse Environmental and Geotechnical Services, Inc.

REFERENCES

TABLE 1
SUMMARY OF LABORATORY TEST DATA

Boring No.	Sample Type*	Organic Content %	USCS Classification	Natural Moisture Content (%)	% Finer No. 200	Atterberg Limits		Proctor Data		In Situ Conditions				Hydraulic Conductivity k (cm/sec)
						LL	PI	Max. Dry Density (pcf)	Opt. Moisture Content (%)	Specific Gravity	% M.C. From Optimum	Unit Weight (pcf)	Moisture Content (%)	
LM-1	Bulk	3.4		71.5	96.0			70.1	40.2	2.67				
AS-1	Bulk	27.67		95.1	46.4			69.5	34.3	2.37				
BS-1	Bulk	40.82		229.3	32.9			39.4	80.4	2.16				
CS-1	Bulk	26.82		186.5	82.3			44.8	44.4	2.17				
TP-1	Bulk	27.88		213.8	73.0			39.6	73.1	2.17				
BA-1	Bulk	26.54		136	62.3			39.7	69.7	2.26				

K:\Shared...\99573\Sumlab.xls

Note: Graphic Presentations of Results of Proctor, Grain Size, and other tests follow this summary.

*LM = Lime Mud
AS=A Sludge Pond
BS=B Sludge Pond
CS=C Sludge Pond
TP = Temporary Sludge Pond
BA = Berm Ash

* Standard Proctor (ASTM D 698A)
** Modified Proctor (ASTM D 1557A)

Job Name: International Paper - Riegelwood
Location: Riegelwood, North Carolina
Job Number: 1356-99-573 Page 1 of 1

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TABLE 1
Typical Properties of Compacted Soils

Group Symbol	Soil Type	Range of Maximum Dry Unit Weight, pcf	Range of Optimum Moisture, Percent	Typical Value of Compression (Percent of Original Height)		Typical Strength Characteristics				Typical Coefficient of Permeability ft./min.	Range of CBR Values	Range of Subgrade Modulus k lbs/cu in.
				At 1.4 tsf (20 psi)	At 3.6 tsf (50 psi)	Cohesion (as compacted) psf	Cohesion (saturated) psf	ϕ (Effective Stress Envelope Degrees)	Tan ϕ			
GW	Well graded clean gravels, gravel-sand mixtures.	125 - 135	11 - 8	0.3	0.6	0	0	>38	>0.79	5×10^{-2}	40 - 80	300 - 500
GP	Poorly graded clean gravels, gravel-sand mix	115 - 125	14 - 11	0.4	0.9	0	0	>37	>0.74	10^{-1}	30 - 60	250 - 400
GM	Silty gravels, poorly graded gravel-sand-silt.	120 - 135	12 - 8	0.5	1.1	.....	.....	>34	>0.67	$>10^{-6}$	20 - 60	100 - 400
GC	Clayey gravels, poorly graded gravel-sand-clay.	115 - 130	14 - 9	0.7	1.6	.....	.....	>31	>0.60	$>10^{-7}$	20 - 40	100 - 300
SW	Well graded clean sands, gravelly sands.	110 - 130	16 - 9	0.6	1.2	0	0	38	0.79	$>10^{-3}$	20 - 40	200 - 300
SP	Poorly graded clean sands, sand-gravel mix.	100 - 120	21 - 12	0.8	1.4	0	0	37	0.74	$>10^{-3}$	10 - 40	200 - 300
SM	Silty sands, poorly graded sand-silt mix.	110 - 125	16 - 11	0.8	1.6	1050	420	34	0.67	$5 \times >10^{-5}$	10 - 40	100 - 300
SM-SC	Sand-silt clay mix with slightly plastic fines.	110 - 130	15 - 11	0.8	1.4	1050	300	33	0.66	$2 \times >10^{-6}$	5 - 30	100 - 300
SC	Clayey sands, poorly graded sand-clay-mix.	105 - 125	19 - 11	1.1	2.2	1550	230	31	0.60	$5 \times >10^{-7}$	5 - 20	100 - 300
ML	Inorganic silts and clayey silts.	95 - 120	24 - 12	0.9	1.7	1400	190	32	0.62	$>10^{-5}$	15 or less	100 - 200
ML-CL	Mixture of inorganic silt and clay.	100 - 120	22 - 12	1.0	2.2	1350	460	32	0.62	$5 \times >10^{-7}$	.....	
CL	Inorganic clays of low to medium plasticity.	95 - 120	24 - 12	1.3	2.5	1800	270	28	0.54	$>10^{-7}$	15 or less	50 - 200
OL	Organic silts and silt-clays, low plasticity.	80 - 100	33 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	50 - 100
MH	Inorganic clayey silts, elastic silts.	70 - 95	40 - 24	2.0	3.8	1500	420	25	0.47	$5 \times >10^{-7}$	10 or less	50 - 100
CH	Inorganic clays of high plasticity	75 - 105	36 - 19	2.6	3.9	2150	230	19	0.35	$>10^{-7}$	15 or less	50 - 150
OH	Organic clays and silty clays	65 - 100	45 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	25 - 100

Notes:

1. All properties are for condition of "Standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
2. Typical stength characteristics are for effective strength envelopes and are obtained from USBR data.
3. Compression values are for vertical loading with complete lateral confinement.
4. (>) indicates that typical property is greater than the value shown.
   (..) indicates insufficient data available for an estimate.

REF. 2 (4)
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Table 1
Estimated Current Waste Quantities
(Until January 1, 1996)

Waste	Estimated Quantity (tons/week)	Weight Contribution (%)	Density (lbs./ft^3)	Estimated Volume (yd^3/week)	Volume Contribution (%)
Wood Yard	507	35.5	26.3	1,428	47.5
Bottom Ash	211	14.8	55.2	283	9.4
Grits	28	2	63.6	33	1.1
Dregs	207	14.5	76.3	201	6.7
General Mill [a]	99	6.9	11.2	653	21.7
Sawmill Waste:	133	9.3		154	5.1
Trash	25	1.8	55	33	1.1
Ash	63	4.4	63.5	73	2.4
Bark/Wood	45	3	68.8	48	1.6
Sludge	242	17	70	256	8.5
TOTALS	1,427	100	N/A	3,008	100

Additional waste estimated from May 1995 through December 1997:

Construction and demolition debris	30,000 cubic yards[b]
ACM	10,000 cubic yards[b]

Notes: [a] For a breakdown of General Mill Wastes, see Table 4 of the June 28, 1995 memo to Rhonda Hall in Appendix A.

[b] These values are conservative and are total estimated quantities from now until December, 1997. Construction and demolition debris containing asbestos containing materials are landfilled in a designated area of the landfill.

REF. "CLOSURE OF A NINE-ACRE INDUSTRIAL LANDFILL USING PULP AND PAPER MILL RESIDUALS", MICHAEL J. MALMSTEAD, DAVID F. BONISTALL, AND C. VAN MALTBY

REF 4

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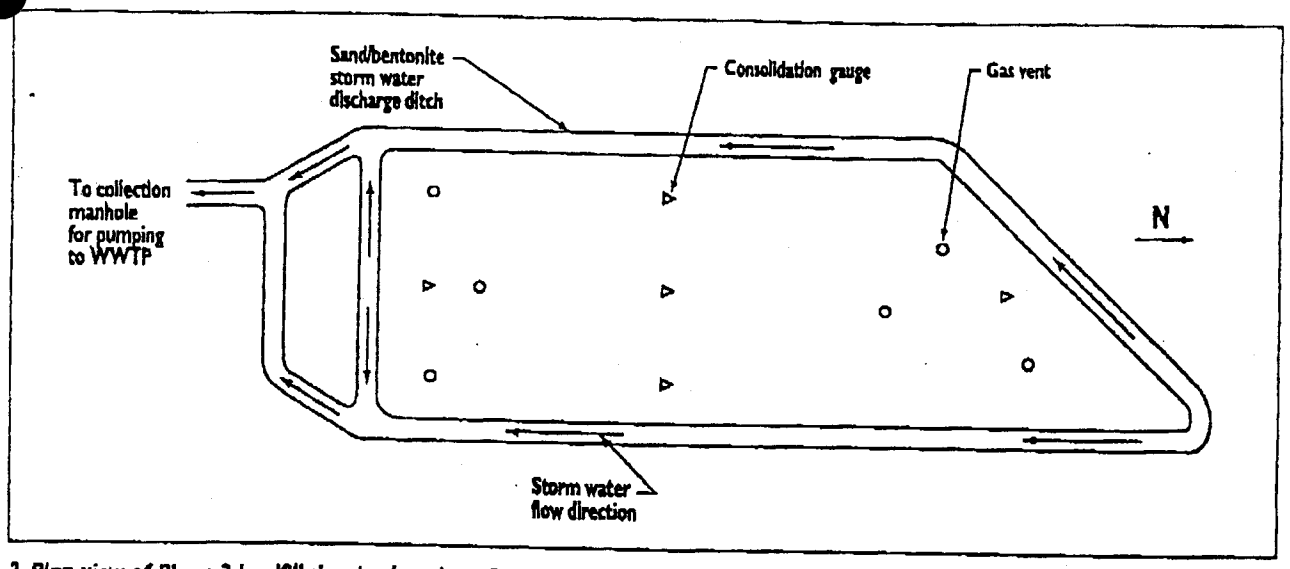

2. Plan view of Phase 2 landfill showing location of gas vents, consolidation gauges, and storm-water drainage

placement of the residuals were found to be fairly simple using the existing landfill equipment, and there were no limiting construction issues.

To evaluate the in-place hydraulic conductivity of the completed test pad, an undisturbed Shelby tube sample of the residuals layer was collected and submitted to a contract laboratory for hydraulic-conductivity analysis (ASTM D-5084). Results of the test indicated an in-place hydraulic-conductivity value of less than 1.0×10^{-7} cm/s.

PROJECT DEVELOPMENT AND DESIGN

Results of the feasibility evaluation indicated that the mill's residuals would be a viable construction material for the hydraulic-barrier layer in the mill's Phase 2 landfill cover system. To get MDEQ's approval of this concept—and their ultimate approval of a residuals cover project for the Phase 2 cell—extensive amounts of information were shared with MDEQ personnel. This information included research work completed by NCASI and others; details associated with completed full-scale projects; and data characterizing the properties of the mill's residuals. In addition to written correspondence, several meetings and many telephone conversations were held to discuss the information. Throughout these discussions, the mill's goal was to demonstrate that—in accordance with the state's rules—a hydraulic barrier constructed of residuals could provide protection equivalent to that of a conventional clay cover system.

After receiving conceptual agreement from MDEQ, detailed closure plans were prepared. The final Phase 2 landfill cover system design is depicted in Figs. 1 and 2. The cross-section of the cover system in Fig. 1 shows several general components, including:

- A 12-in. gas-venting layer consisting of specified sand
- A 32-in. hydraulic-barrier layer consisting of WWTP residuals
- A two-tiered 18-in. vegetative rooting zone consisting of a lower layer of sand and an upper layer of topsoil
- A drainage ditch consisting of a compacted sand–bentonite mixture.

Research by NCASI and others has shown that paper mill residuals can consolidate by as much as 35% in response to overburden stress (*4, 7, 8*). Consequently, the initial thickness of this layer was designed to allow for postclosure consolidation. A 30% consolidation was factored into the design of the barrier layer to allow for a long-term thickness of at least two feet.

The design objectives for the closure project were specifically chosen to minimize any risk of adverse impacts as a consequence of using WWTP residuals as the barrier layer material. To address concerns about the potential infiltration of water through the residuals barrier layer and into the groundwater, the outer edges of the barrier layer did not extend beyond the landfill's solid-waste boundary. With this design, any water that does infiltrate the residuals layer will be contained within the landfill's leachate collection system. In addition, to address concerns associated with the potential for impacted storm-water runoff, a sand–bentonite storm-water control channel (material specified to have hydraulic conductivities less than 1.0×10^{-7} cm/s) was designed to surround

DILATOMETER RESULTS

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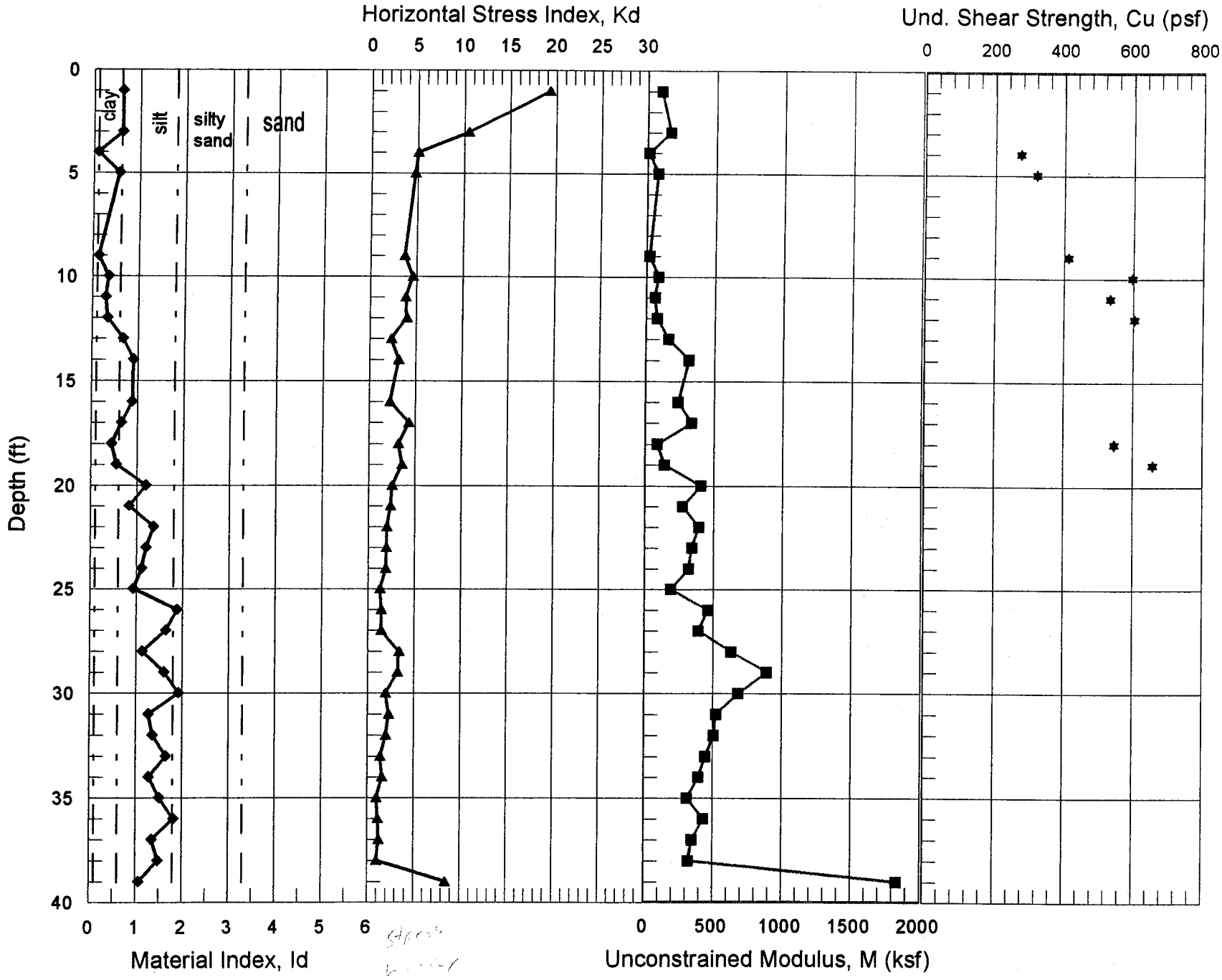

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D-B-1

JOB NAME International Paper
JOB NUMBER 1356-99-573
DATE 7/15/99
WATER DEPTH (FT) 12

Depth, z (ft)	Elev., v (ft)	Thrust (pounds)	Id	Kd	M (ksf)	Cu (psf)	Ed (ksf)	GAMMA (pcf)	Ovo' (psf)	Ko	OCR	PHI (deg)	Uo (ksf)	CLASSIFICATION
1	not known	not measured	0.61	19.3	101.0	Id>0.6	41.1	99.8	99.8	2.72	34.35	Id<1.8	1.67	CLAYEY SILT
3	not known	not measured	0.62	10.5	169.1	Id>0.6	67.7	99.8	299.5	1.90	13.28	Id<1.8	4.28	CLAYEY SILT
4	not known	not measured	0.10	5.0	12.3	273.37	6.8	93.6	393.1	1.16	4.20	Id<1.8	1.88	CLAY
5	not known	not measured	0.55	4.7	77.9	319.42	44.9	99.8	493.0	1.12	3.85	Id<1.8	1.57	SILTY CLAY
9	not known	not measured	0.13	3.7	21.4	412.88	14.5	93.6	867.4	0.93	2.62	Id<1.8	2.82	CLAY
10	not known	not measured	0.34	4.6	89.1	597.29	52.5	99.8	967.2	1.09	3.63	Id<1.8	4.38	SILTY CLAY
11	not known	not measured	0.29	3.9	62.6	534.15	41.1	99.8	1067.0	0.96	2.79	Id<1.8	4.38	CLAY
12	not known	not measured	0.33	4.0	81.5	603.78	52.5	99.8	1166.9	0.98	2.91	Id<1.8	4.18	CLAY
13	not known	not measured	0.66	2.3	165.9	Id>0.6	63.9	99.8	1204.3	0.62	1.25	Id<1.8	2.92	CLAYEY SILT
14	not known	not measured	0.90	3.1	313.7	Id>0.6	121.0	106.1	1248.0	0.81	1.99	Id<1.8	5.22	SILT
16	not known	not measured	0.88	2.2	237.0	Id>0.6	90.5	99.8	1322.9	0.61	1.20	Id<1.8	3.76	SILT
17	not known	not measured	0.65	4.3	338.1	Id>0.6	132.4	106.1	1366.6	1.04	3.30	Id<1.8	6.06	CLAYEY SILT
18	not known	not measured	0.44	3.2	89.4	547.76	67.7	99.8	1404.0	0.82	2.04	Id<1.8	4.49	SILTY CLAY
19	not known	not measured	0.55	3.6	141.8	657.68	98.1	106.1	1447.7	0.90	2.47	Id<1.8	5.12	SILTY CLAY
20	not known	not measured	1.18	2.5	409.0	Id>0.6	155.2	106.1	1491.4	0.68	1.45	Id<1.8	5.43	SILT
21	not known	not measured	0.83	2.4	275.8	Id>0.6	105.7	106.1	1535.0	0.65	1.33	Id<1.8	4.91	SILT
22	not known	not measured	1.35	2.0	395.1	Id>0.6	147.6	106.1	1578.7	Id>1.2	Id>1.2	Id<1.8	5.43	SANDY SILT
23	not known	not measured	1.19	1.9	342.6	Id>0.6	128.6	106.1	1622.4	0.52	0.93	Id<1.8	3.86	SILT
24	not known	not measured	1.10	1.9	321.2	Id>0.6	121.0	106.1	1666.1	0.52	0.92	Id<1.8	5.01	SILT
25	not known	not measured	0.93	1.3	190.7	Id>0.6	71.5	99.8	1703.5	0.34	0.51	Id<1.8	3.34	SILT
26	not known	not measured	1.88	1.5	462.8	Id>0.6	166.6	112.3	1753.4	Id>1.2	Id>1.2	30.3	5.64	SILTY SAND
27	not known	not measured	1.64	1.4	395.7	Id>0.6	143.8	99.8	1790.9	Id>1.2	Id>1.2	Id<1.8	5.22	SANDY SILT
28	not known	not measured	1.13	3.4	631.9	Id>0.6	242.7	112.3	1840.8	0.86	2.25	Id<1.8	8.87	SILT
29	not known	not measured	1.60	3.2	892.5	Id>0.6	337.8	112.3	1890.7	Id>1.2	Id>1.2	Id<1.8	11.07	SANDY SILT
30	not known	not measured	1.92	1.9	686.1	Id>0.6	250.3	112.3	1940.6	Id>1.2	Id>1.2	32.0	6.79	SILTY SAND
31	not known	not measured	1.26	2.3	523.0	Id>0.6	197.0	106.1	1984.3	Id>1.2	Id>1.2	Id<1.8	6.89	SANDY SILT
32	not known	not measured	1.36	2.0	507.2	Id>0.6	189.4	106.1	2028.0	Id>1.2	Id>1.2	Id<1.8	7.10	SANDY SILT
33	not known	not measured	1.64	1.4	448.6	Id>0.6	162.8	106.1	2071.7	Id>1.2	Id>1.2	Id<1.8	5.53	SANDY SILT
34	not known	not measured	1.28	1.6	397.5	Id>0.6	147.6	106.1	2115.4	Id>1.2	Id>1.2	Id<1.8	4.80	SANDY SILT
35	not known	not measured	1.50	1.0	314.5	Id>0.6	113.4	99.8	2152.8	Id>1.2	Id>1.2	Id<1.8	4.80	SANDY SILT
36	not known	not measured	1.81	1.1	435.4	Id>0.6	155.2	106.1	2196.5	Id>1.2	Id>1.2	28.7	6.58	SILTY SAND
37	not known	not measured	1.34	1.2	350.8	Id>0.6	128.6	99.8	2233.9	Id>1.2	Id>1.2	Id<1.8	5.85	SANDY SILT
38	not known	not measured	1.47	1.0	324.5	Id>0.6	117.2	99.8	2271.4	Id>1.2	Id>1.2	Id<1.8	5.22	SANDY SILT
39	not known	not measured	1.07	8.4	1835.3	Id>0.6	729.6	121.7	2330.6	1.65	9.44	Id<1.8	25.26	SILT

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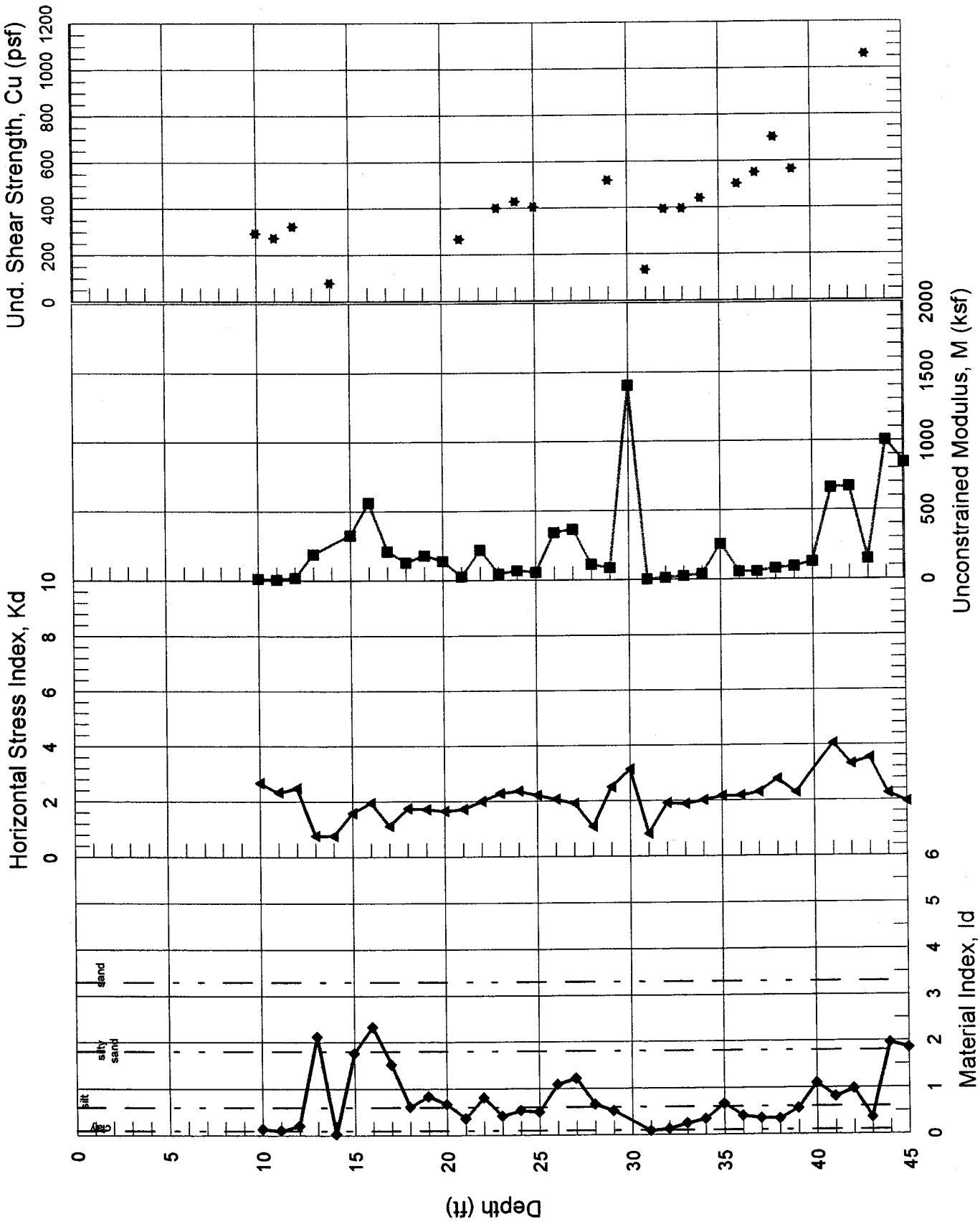
DMT Sounding D-B-3



D-B-3

JOB NAME	International Paper
JOB NUMBER	1356-99-573
DATE	7/14/99
WATER DEPTH (FT)	12

Depth, z (ft)	Elev., v (ft)	Thrust (pounds)	Id	Kd	M (ksf)	Cu (psf)	Ed (ksf)	GAMMA (pcf)	Ovo' (psf)	Ko	OCR	PHI (deg)	Uo (ksf)	CLASSIFICATION
10	not known	not measured	0.14	2.7	13.9	293.98	12.2	93.6	936.0	0.71	1.56	Id<1.8	3.13	CLAY
11	not known	not measured	0.10	2.3	8.4	272.84	8.4	93.6	1029.6	0.63	1.26	Id<1.8	3.24	CLAY
12	not known	not measured	0.20	2.5	21.2	324.23	19.8	93.6	1123.2	0.67	1.40	Id<1.8	3.65	CLAY
13	not known	not measured	2.11	0.8	190.4	Id>0.6	65.4	106.1	1166.9	Id>1.2	Id>1.2	26.3	3.65	SILTY SAND
14	not known	not measured	0.02	0.8	0.6	79.50	0.8	93.6	1198.1	0.13	0.22	Id<1.8	1.88	CLAY
15	not known	not measured	1.76	1.6	326.5	Id>0.6	118.7	99.8	1235.5	Id>1.2	Id>1.2	Id<1.8	3.03	SANDY SILT
16	not known	not measured	2.33	1.9	563.4	Id>0.6	202.4	112.3	1285.4	Id>1.2	Id>1.2	32.0	6.99	SILTY SAND
17	not known	not measured	1.51	1.1	212.5	Id>0.6	76.8	99.8	1322.9	Id>1.2	Id>1.2	Id<1.8	3.13	SANDY SILT
18	not known	not measured	0.61	1.7	130.9	Id>0.6	50.2	99.8	1360.3	0.47	0.81	Id<1.8	3.55	CLAYEY SILT
19	not known	not measured	0.83	1.7	182.4	Id>0.6	69.2	99.8	1397.8	0.46	0.78	Id<1.8	4.80	SILT
20	not known	not measured	0.66	1.6	141.4	Id>0.6	54.0	99.8	1435.2	0.44	0.73	Id<1.8	4.07	CLAYEY SILT
21	not known	not measured	0.36	1.7	26.5	267.82	31.2	99.8	1472.6	0.47	0.79	Id<1.8	3.76	SILTY CLAY
22	not known	not measured	0.81	2.0	221.2	Id>0.6	84.4	99.8	1510.1	0.54	1.00	Id<1.8	4.28	SILT
23	not known	not measured	0.41	2.3	49.4	400.86	50.2	99.8	1547.5	0.62	1.23	Id<1.8	4.70	SILTY CLAY
24	not known	not measured	0.53	2.4	70.8	430.48	69.2	99.8	1585.0	0.64	1.30	Id<1.8	5.22	SILTY CLAY
25	not known	not measured	0.49	2.2	58.9	405.82	61.6	99.8	1622.4	0.60	1.17	Id<1.8	5.12	SILTY CLAY
26	not known	not measured	1.09	2.1	344.3	Id>0.6	130.1	106.1	1666.1	0.56	1.05	Id<1.8	4.70	SILT
27	not known	not measured	1.22	1.9	367.3	Id>0.6	137.7	106.1	1709.8	Id>1.2	Id>1.2	Id<1.8	5.74	SANDY SILT
28	not known	not measured	0.66	1.1	112.6	Id>0.6	42.6	99.8	1747.2	0.25	0.38	Id<1.8	3.86	CLAYEY SILT
29	not known	not measured	0.52	2.5	86.9	519.58	80.6	106.1	1790.9	0.67	1.41	Id<1.8	5.32	SILTY CLAY
30	not known	not measured	2.58	3.1	1409.2	Id>0.6	518.1	118.6	1847.0	Id>1.2	Id>1.2	34.7	16.70	SILTY SAND
31	not known	not measured	0.09	0.8	3.9	134.00	4.6	93.6	1878.2	0.15	0.25	Id<1.8	2.40	CLAY
32	not known	not measured	0.13	1.9	13.6	395.68	16.0	93.6	1909.4	0.52	0.93	Id<1.8	4.59	CLAY
33	not known	not measured	0.25	1.9	26.5	396.65	31.2	99.8	1946.9	0.51	0.91	Id<1.8	4.49	CLAY
34	not known	not measured	0.33	2.0	39.8	440.35	46.4	99.8	1984.3	0.55	1.01	Id<1.8	5.64	SILTY CLAY
35	not known	not measured	0.66	2.2	259.0	Id>0.6	99.7	106.1	2028.0	0.59	1.13	Id<1.8	6.16	CLAYEY SILT
36	not known	not measured	0.40	2.2	57.5	502.52	61.6	99.8	2065.4	0.59	1.13	Id<1.8	5.74	SILTY CLAY
37	not known	not measured	0.34	2.3	57.5	551.13	57.8	99.8	2102.9	0.62	1.24	Id<1.8	5.95	SILTY CLAY
38	not known	not measured	0.34	2.8	81.5	703.94	69.2	106.1	2146.6	0.73	1.65	Id<1.8	7.73	SILTY CLAY
39	not known	not measured	0.56	2.3	94.0	564.86	95.9	106.1	2190.2	0.62	1.22	Id<1.8	6.99	SILTY CLAY
40	not known	not measured	1.09	0.5	128.6	Id>0.6	46.4	99.8	2227.7	0.02	0.13	Id<1.8	4.18	SILT
41	not known	not measured	0.81	4.0	666.0	Id>0.6	259.4	112.3	2277.6	0.99	3.00	Id<1.8	16.08	SILT
42	not known	not measured	0.97	3.3	673.0	Id>0.6	259.4	112.3	2327.5	0.85	2.19	Id<1.8	16.29	SILT
43	not known	not measured	0.36	3.5	148.2	1061.07	103.5	106.1	2371.2	0.90	2.43	Id<1.8	9.81	SILTY CLAY
44	not known	not measured	1.96	2.2	1007.0	Id>0.6	369.7	118.6	2427.4	Id>1.2	Id>1.2	32.9	11.17	SILTY SAND
45	not known	not measured	1.84	2.0	843.7	Id>0.6	308.9	112.3	2477.3	Id>1.2	Id>1.2	32.1	9.29	SILTY SAND

NOTE: 1) DMT sounding started at depth of 10 ft due to fill material consisting of construction debris, concrete, timber, etc. in upper 10 ft.
2) Sounding terminated at 45 ft due to obstruction. Boring log shows concrete at this depth.

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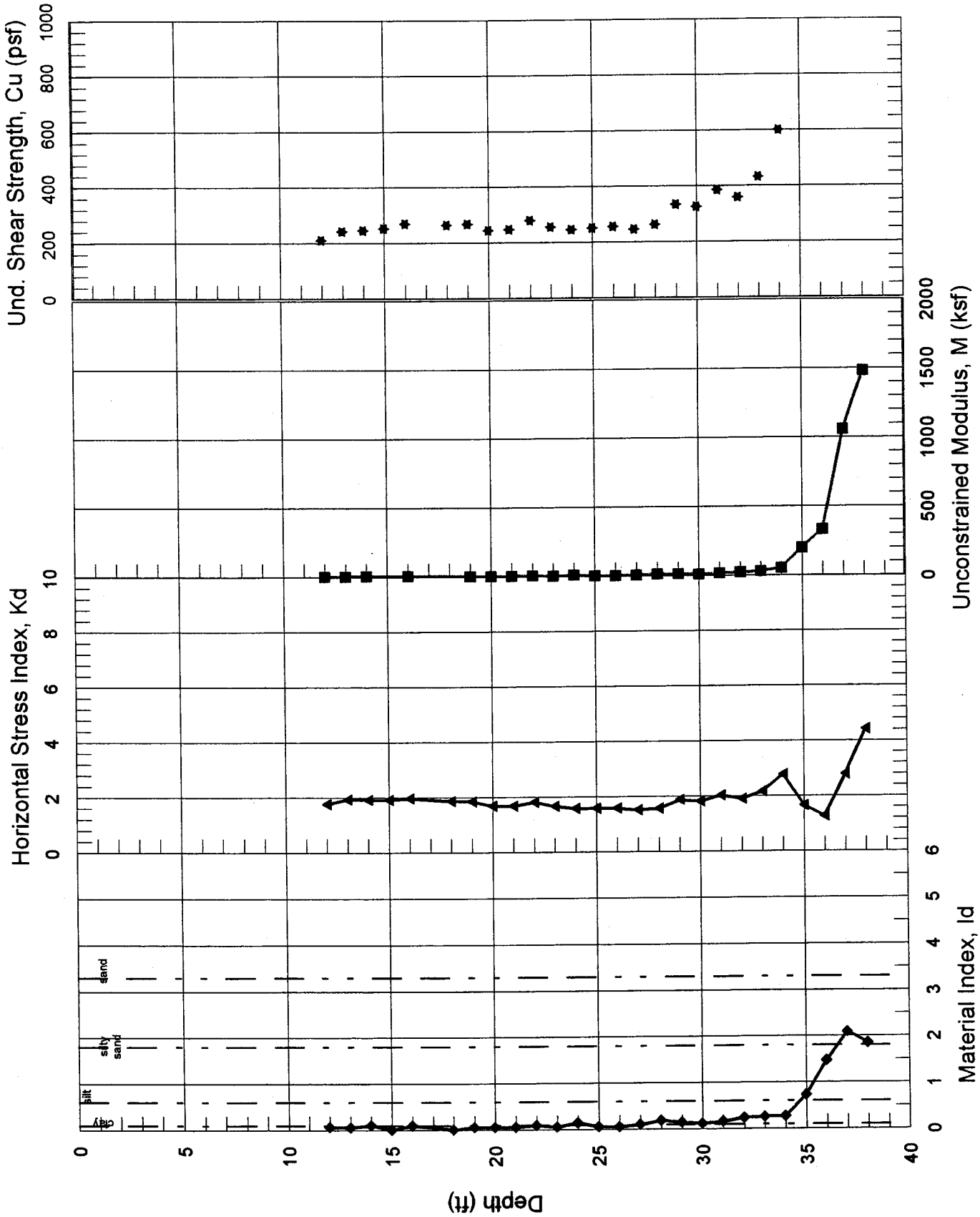
DMT Sounding D-B-4



D-B-4

JOB NAME International Paper
JOB NUMBER 1356-99-573
DATE 7/16/99
WATER DEPTH (FT) 12

Depth, z (ft)	Elev., v (ft)	Thrust (pounds)	Id	Kd	M (ksf)	Cu (psf)	Ed (ksf)	GAMMA (pcf)	Ovo' (psf)	Ko	OCR	PHI (deg)	Uo (ksf)	CLASSIFICATION
12	not known	not measured	0.07	1.8	3.9	210.68	4.6	93.6	1123.2	0.48	0.82	Id<1.8	2.82	CLAY
13	not known	not measured	0.06	1.9	3.9	242.95	4.6	93.6	1154.4	0.53	0.95	Id<1.8	2.92	CLAY
14	not known	not measured	0.11	1.9	7.1	246.35	8.4	93.6	1185.6	0.52	0.93	Id<1.8	3.03	CLAY
15	not known	not measured	0.01	1.9	0.6	251.88	0.8	93.6	1216.8	0.52	0.93	Id<1.8	3.03	CLAY
16	not known	not measured	0.10	2.0	7.1	268.80	8.4	93.6	1248.0	0.54	0.97	Id<1.8	3.34	CLAY
18	not known	not measured	0.01	1.9	0.6	264.24	0.8	93.6	1310.4	0.51	0.90	Id<1.8	3.34	CLAY
19	not known	not measured	0.05	1.8	3.9	267.67	4.6	93.6	1341.6	0.50	0.89	Id<1.8	3.45	CLAY
20	not known	not measured	0.06	1.7	3.9	243.99	4.6	93.6	1372.8	0.46	0.77	Id<1.8	3.34	CLAY
21	not known	not measured	0.06	1.7	3.9	248.16	4.6	93.6	1404.0	0.45	0.76	Id<1.8	3.34	CLAY
22	not known	not measured	0.09	1.8	7.1	279.37	8.4	93.6	1435.2	0.49	0.86	Id<1.8	3.55	CLAY
23	not known	not measured	0.05	1.7	3.9	256.51	4.6	93.6	1466.4	0.45	0.75	Id<1.8	3.55	CLAY
24	not known	not measured	0.15	1.6	10.3	245.70	12.2	93.6	1497.6	0.43	0.69	Id<1.8	3.86	CLAY
25	not known	not measured	0.05	1.6	3.9	251.24	4.6	93.6	1528.8	0.43	0.69	Id<1.8	3.76	CLAY
26	not known	not measured	0.05	1.6	3.9	255.43	4.6	93.6	1560.0	0.42	0.69	Id<1.8	3.86	CLAY
27	not known	not measured	0.10	1.5	7.1	245.50	8.4	93.6	1591.2	0.40	0.64	Id<1.8	4.07	CLAY
28	not known	not measured	0.18	1.6	13.6	261.79	16.0	93.6	1622.4	0.42	0.68	Id<1.8	4.28	CLAY
29	not known	not measured	0.15	1.9	13.6	335.03	16.0	93.6	1653.6	0.51	0.90	Id<1.8	4.70	CLAY
30	not known	not measured	0.12	1.8	10.3	325.81	12.2	93.6	1684.8	0.49	0.85	Id<1.8	4.70	CLAY
31	not known	not measured	0.16	2.0	17.2	385.32	19.8	93.6	1716.0	0.55	1.03	Id<1.8	5.43	CLAY
32	not known	not measured	0.24	1.9	23.3	359.09	27.4	99.8	1753.4	0.51	0.91	Id<1.8	5.43	CLAY
33	not known	not measured	0.26	2.2	32.5	433.36	35.0	99.8	1790.9	0.59	1.13	Id<1.8	6.47	CLAY
34	not known	not measured	0.27	2.8	54.7	600.74	46.4	99.8	1828.3	0.73	1.65	Id<1.8	7.83	CLAY
35	not known	not measured	0.72	1.6	201.7	Id>0.6	76.8	99.8	1865.8	0.44	0.73	Id<1.8	5.22	CLAYEY SILT
36	not known	not measured	1.46	1.3	335.9	Id>0.6	122.5	99.8	1903.2	Id>1.2	Id>1.2	Id<1.8	3.76	SANDY SILT
37	not known	not measured	2.09	2.8	1060.9	Id>0.6	392.6	118.6	1959.4	Id>1.2	Id>1.2	34.0	11.38	SILTY SAND
38	not known	not measured	1.84	4.4	1484.8	Id>0.6	567.5	118.6	2015.5	Id>1.2	Id>1.2	36.5	15.76	SILTY SAND

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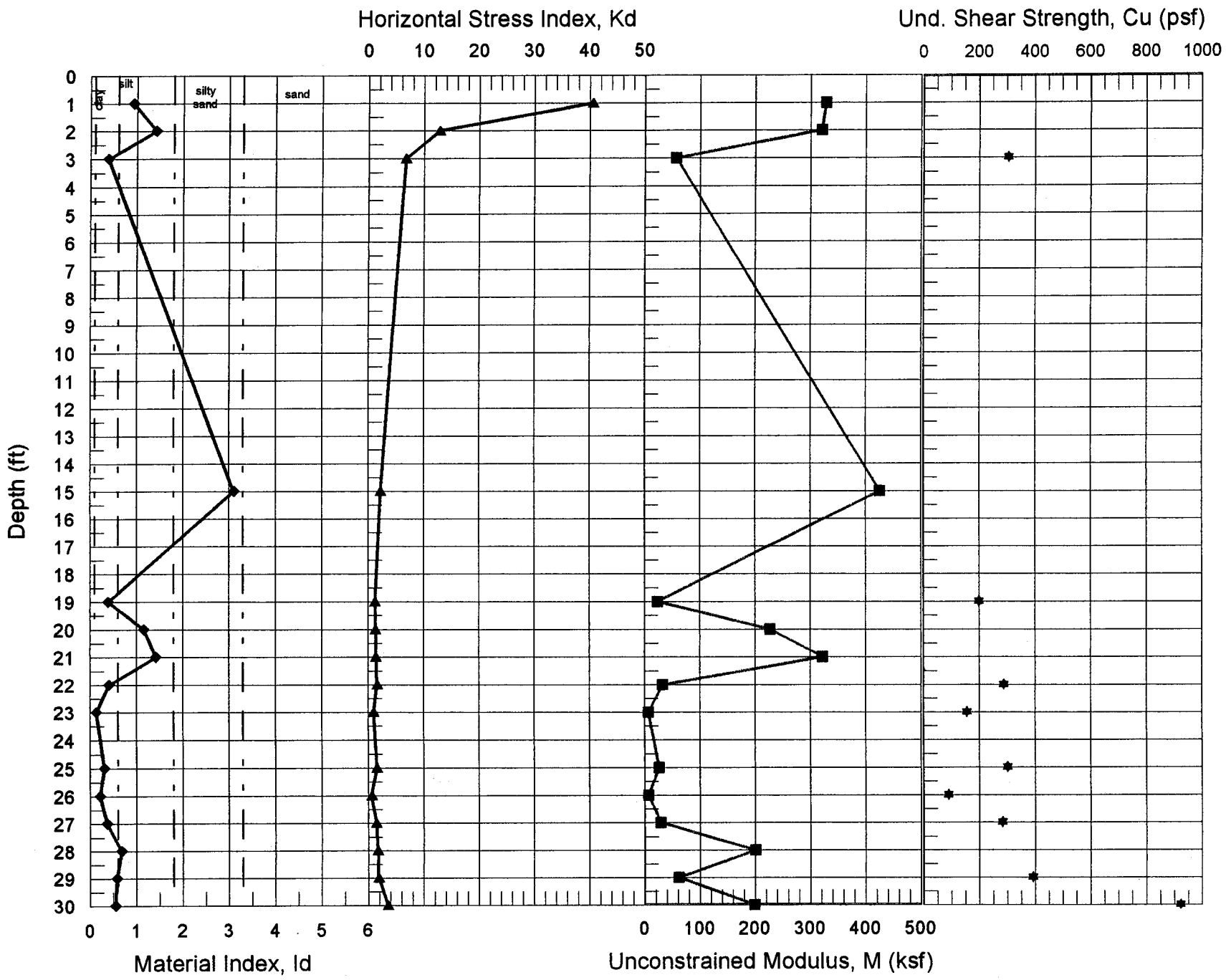


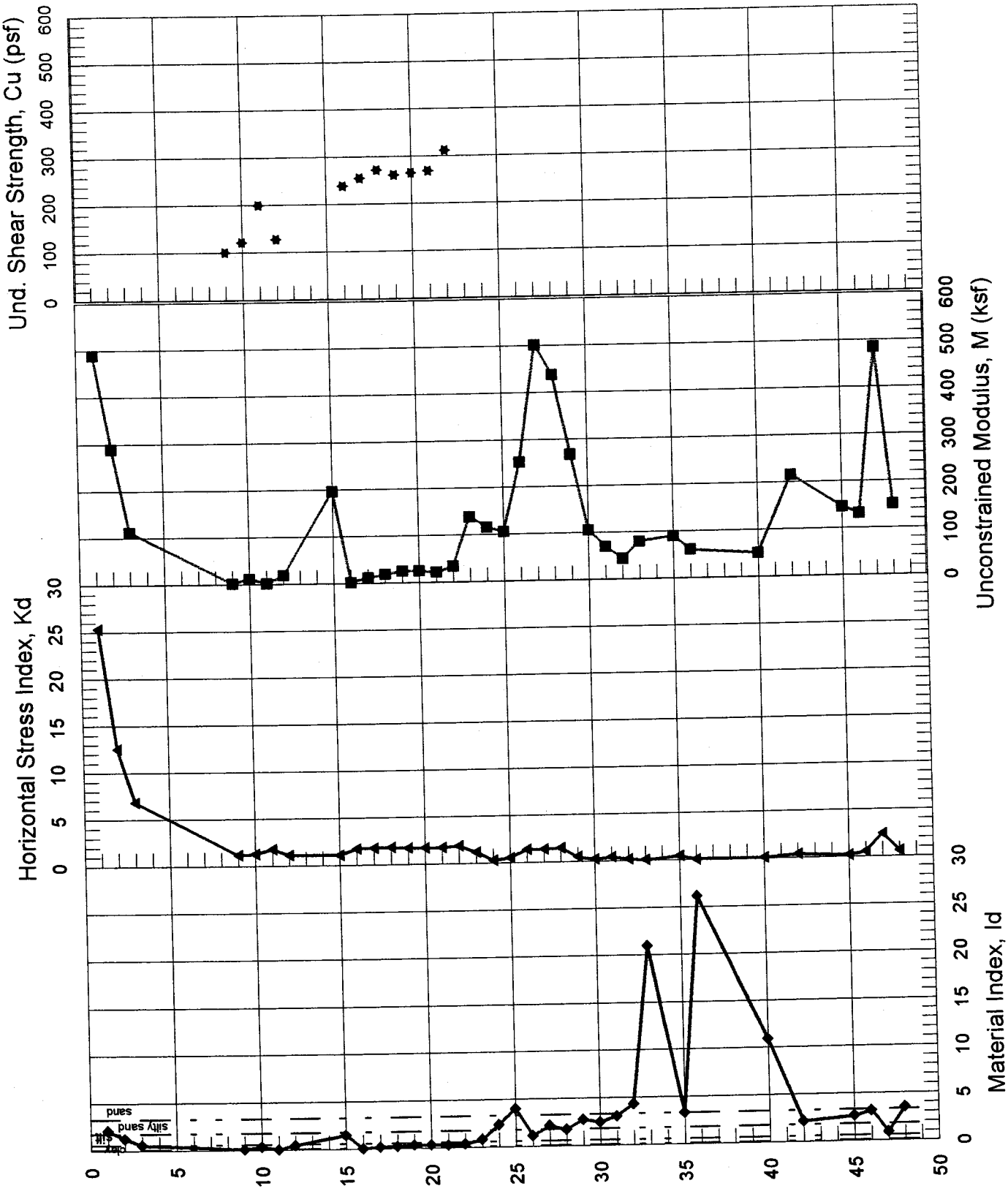
D-B-6

JOB NAME	International Paper
JOB NUMBER	1356-99-573
DATE	7/16/99
WATER DEPTH (FT)	12

Depth, z (ft)	Elev., v (ft)	Thrust (pounds)	Id	Kd	M (ksf)	Cu (psf)	Ed (ksf)	GAMMA (pcf)	Ovo' (psf)	Ko	OCR	PHI (deg)	Uo (ksf)	CLASSIFICATION
1	not known	not measured	0.92	40.5	328.5	Id>0.6	137.7	106.1	106.1	4.11	109.31	Id<1.8	7.10	SILT
2	not known	not measured	1.42	12.8	321.5	Id>0.6	130.1	99.8	205.9	Id>1.2	Id>1.2	Id<1.8	4.80	SANDY SILT
3	not known	not measured	0.38	6.7	57.3	305.21	27.4	99.8	305.8	1.42	6.60	Id<1.8	2.40	SILTY CLAY
15	not known	not measured	3.10	2.2	426.5	Id>0.6	354.5	112.3	1466.4	Id>1.2	Id>1.2	32.9	8.14	SILTY SAND
19	not known	not measured	0.39	1.3	23.3	199.09	27.4	99.8	1616.2	0.32	0.48	Id<1.8	3.24	SILTY CLAY
20	not known	not measured	1.16	1.3	228.0	Id>0.6	84.4	99.8	1653.6	0.32	0.49	Id<1.8	3.45	SILT
21	not known	not measured	1.42	1.4	323.1	Id>0.6	118.7	99.8	1691.0	Id>1.2	Id>1.2	Id<1.8	3.13	SANDY SILT
22	not known	not measured	0.40	1.6	33.0	288.25	38.8	99.8	1728.5	0.43	0.71	Id<1.8	3.76	SILTY CLAY
23	not known	not measured	0.14	1.0	7.1	156.50	8.4	93.6	1759.7	0.21	0.32	Id<1.8	2.51	CLAY
25	not known	not measured	0.31	1.6	26.5	301.65	31.2	99.8	1834.6	0.43	0.70	Id<1.8	4.28	CLAY
26	not known	not measured	0.22	0.6	7.1	89.26	8.4	93.6	1865.8	0.05	0.15	Id<1.8	2.30	CLAY
27	not known	not measured	0.36	1.5	29.7	282.32	35.0	99.8	1903.2	0.39	0.61	Id<1.8	4.49	SILTY CLAY
28	not known	not measured	0.67	1.7	201.1	Id>0.6	76.8	99.8	1940.6	0.46	0.77	Id<1.8	5.85	CLAYEY SILT
29	not known	not measured	0.58	1.8	62.1	392.74	73.0	99.8	1978.1	0.50	0.88	Id<1.8	6.06	SILTY CLAY
30	not known	not measured	0.55	3.6	199.5	923.13	137.7	106.1	2021.8	0.91	2.49	Id<1.8	9.81	SILTY CLAY

Notes: 1) Drill rig was lifting up and there were difficulties advancing the DMT blade at a depth of 31 ft.
2) DMT data was not collected from 4 to 14 ft. Boring logs show wood particles between 1 to 14 ft deep and sand/wood particles below 30 ft deep.

INTERNATIONAL PAPER
1356-99-573
DMT Sounding D-B-8

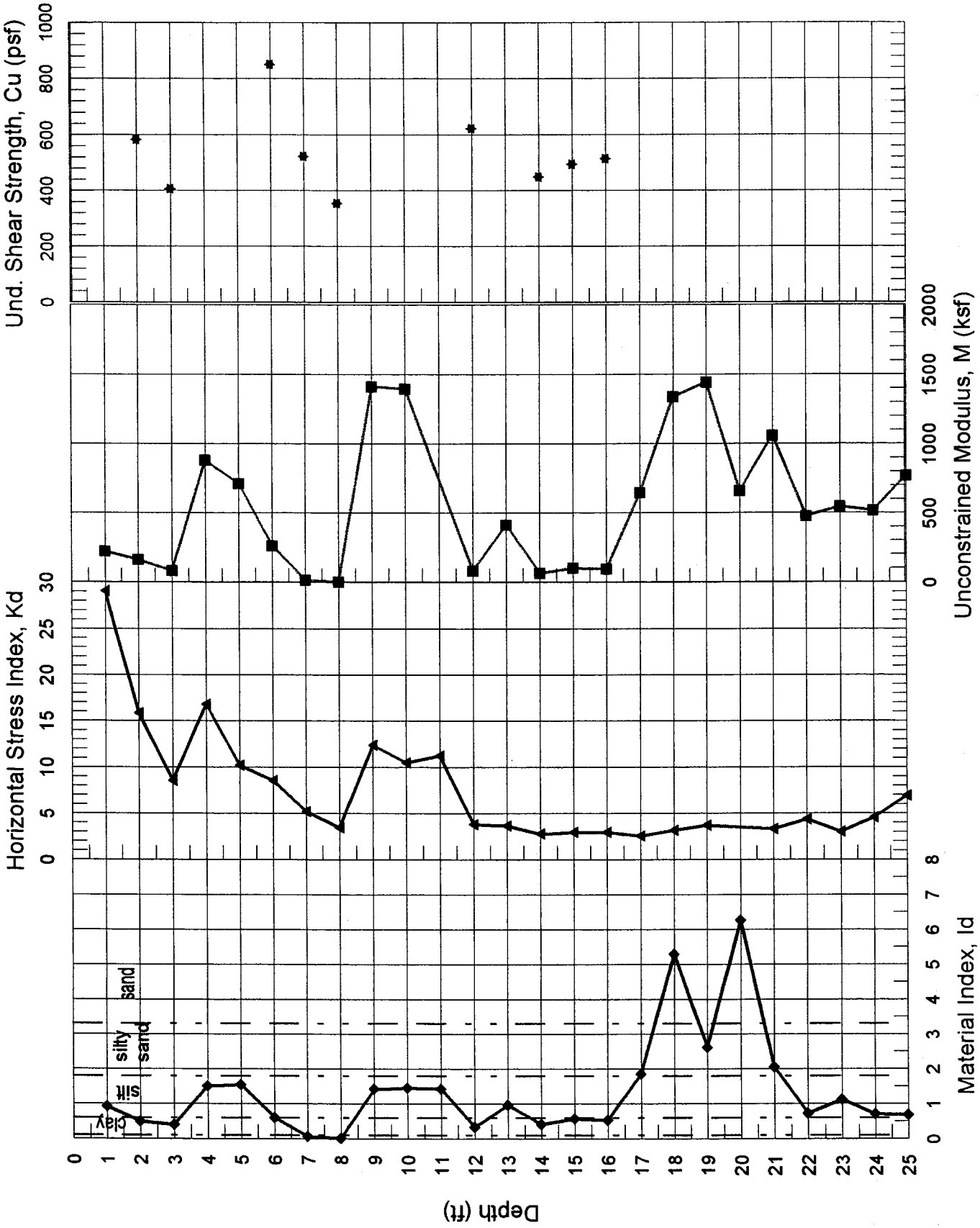


D-B-8

JOB NAME International Paper
JOB NUMBER 1356-99-573
DATE 7/15/99
WATER DEPTH (FT) 12

Depth, z (ft)	Elev., v (ft)	Thrust (pounds)	Id	Kd	M (ksf)	Cu (psf)	Ed (ksf)	GAMMA (pcf)	Ovo' (psf)	Ko	OCR	PHI (deg)	Uo (ksf)	CLASSIFICATION
1	not known	not measured	2.11	25.3	490.3	Id>0.6	208.4	112.3	112.3	Id>1.2	Id>1.2	44.4	6.79	SILTY SAND
2	not known	not measured	1.27	12.5	290.1	Id>0.6	117.2	99.8	212.2	Id>1.2	Id>1.2	Id<1.8	3.76	SANDY SILT
3	not known	not measured	0.61	6.8	113.3	Id>0.6	44.9	99.8	312.0	1.44	6.79	Id<1.8	2.19	CLAYEY SILT
9	not known	not measured	0.08	1.2	2.6	100.46	3.0	93.6	873.6	0.30	0.45	Id<1.8	1.67	CLAY
10	not known	not measured	0.34	1.3	12.3	121.18	14.5	93.6	967.2	0.33	0.50	Id<1.8	1.88	SILTY CLAY
11	not known	not measured	0.05	1.8	2.6	199.98	3.0	93.6	1060.8	0.48	0.82	Id<1.8	2.40	CLAY
12	not known	not measured	0.48	1.1	18.8	127.09	22.1	93.6	1154.4	0.28	0.42	Id<1.8	2.19	SILTY CLAY
15	not known	not measured	1.49	1.1	197.5	Id>0.6	71.5	99.8	1266.7	Id>1.2	Id>1.2	Id<1.8	2.82	SANDY SILT
16	not known	not measured	0.04	1.7	2.6	239.15	3.0	93.6	1297.9	0.47	0.80	Id<1.8	2.51	CLAY
17	not known	not measured	0.17	1.8	12.3	255.12	14.5	93.6	1329.1	0.49	0.84	Id<1.8	3.13	CLAY
18	not known	not measured	0.25	1.9	18.8	271.89	22.1	93.6	1360.3	0.50	0.89	Id<1.8	3.45	CLAY
19	not known	not measured	0.35	1.8	25.2	260.35	29.7	99.8	1397.8	0.48	0.81	Id<1.8	3.34	SILTY CLAY
20	not known	not measured	0.34	1.7	25.2	264.22	29.7	99.8	1435.2	0.47	0.80	Id<1.8	3.45	SILTY CLAY
21	not known	not measured	0.29	1.7	22.0	268.79	25.9	99.8	1472.6	0.47	0.79	Id<1.8	3.34	CLAY
22	not known	not measured	0.41	1.9	34.9	311.84	41.1	99.8	1510.1	0.52	0.92	Id<1.8	4.07	SILTY CLAY
23	not known	not measured	0.82	1.2	139.6	Id>0.6	52.5	99.8	1547.5	0.30	0.45	Id<1.8	2.92	SILT
24	not known	not measured	2.36	0.3	116.5	Id>0.6	37.3	106.1	1591.2	Id>1.2	Id>1.2	19.4	1.77	SILTY SAND
25	not known	not measured	4.00	0.5	106.1	Id>0.6	124.8	106.1	1634.9	Id>1.2	Id>1.2	24.1	4.59	SAND
26	not known	not measured	1.16	1.4	253.9	Id>0.6	94.3	99.8	1672.3	0.37	0.57	Id<1.8	4.59	SILT
27	not known	not measured	2.16	1.4	502.3	Id>0.6	178.0	106.1	1716.0	Id>1.2	Id>1.2	30.0	6.06	SILTY SAND
28	not known	not measured	1.73	1.5	438.0	Id>0.6	159.0	106.1	1759.7	Id>1.2	Id>1.2	Id<1.8	5.95	SANDY SILT
29	not known	not measured	2.74	0.5	268.7	Id>0.6	86.7	106.1	1803.4	Id>1.2	Id>1.2	23.5	3.55	SILTY SAND
30	not known	not measured	2.41	0.2	106.6	Id>0.6	33.5	106.1	1847.0	Id>1.2	Id>1.2	17.4	2.09	SILTY SAND
31	not known	not measured	3.02	0.4	70.5	Id>0.6	82.9	106.1	1890.7	Id>1.2	Id>1.2	22.2	3.34	SILTY SAND
32	not known	not measured	4.27	0.2	44.6	Id>0.6	52.5	106.1	1934.4	Id>1.2	Id>1.2	16.1	2.19	SAND
33	not known	not measured	20.93	0.1	80.2	Id>0.6	94.3	106.1	1978.1	Id>1.2	Id>1.2	7.8	3.13	SAND
35	not known	not measured	3.28	0.4	89.9	Id>0.6	105.7	106.1	2065.4	Id>1.2	Id>1.2	22.7	3.97	SILTY SAND
36	not known	not measured	26.11	0.0	60.8	Id>0.6	71.5	106.1	2109.1	Id>1.2	Id>1.2	2.9	2.51	SAND
40	not known	not measured	10.90	0.1	51.1	Id>0.6	60.1	106.1	2283.8	Id>1.2	Id>1.2	8.3	2.61	SAND
42	not known	not measured	2.15	0.4	215.9	Id>0.6	71.5	106.1	2371.2	Id>1.2	Id>1.2	21.9	3.55	SILTY SAND
45	not known	not measured	2.61	0.2	146.0	Id>0.6	44.9	106.1	2502.2	Id>1.2	Id>1.2	16.7	2.92	SILTY SAND
46	not known	not measured	3.13	0.6	131.9	Id>0.6	155.2	106.1	2545.9	Id>1.2	Id>1.2	24.2	4.80	SILTY SAND
47	not known	not measured	0.87	2.4	485.1	Id>0.6	185.6	106.1	2589.6	0.64	1.30	Id<1.8	8.77	SILT
48	not known	not measured	3.46	0.6	151.3	Id>0.6	178.0	106.1	2633.3	Id>1.2	Id>1.2	24.2	5.12	SAND

INTERNATIONAL PAPER
1356-99-573
DMT Sounding D-B-9



D-B-9

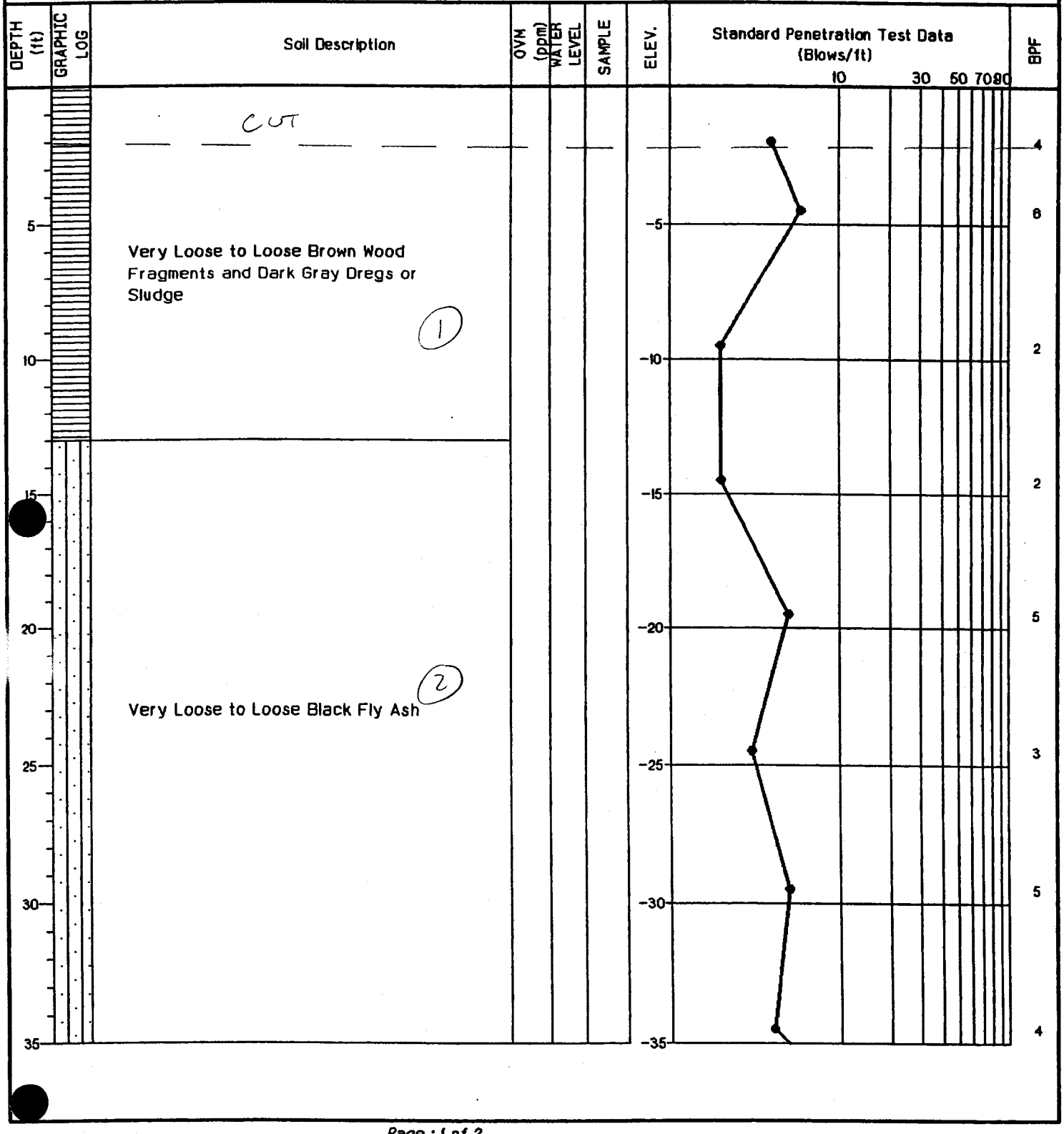
JOB NAME International Paper
JOB NUMBER 1356-99-573
DATE 7/15/99
WATER DEPTH (FT) 12

Depth, z (ft)	Elev., v (ft)	Thrust (pounds)	Id	Kd	M (ksf)	Cu (psf)	Ed (ksf)	GAMMA (pcf)	Ovo' (psf)	Ko	OCR	PHI (deg)	Uo (ksf)	CLASSIFICATION
1	not known	not measured	0.91	29.1	222.1	Id>0.6	92.1	99.8	99.8	3.43	65.03	Id<1.8	3.13	SILT
2	not known	not measured	0.49	15.8	160.5	583.51	54.0	99.8	199.7	2.43	25.23	Id<1.8	3.24	SILTY CLAY
3	not known	not measured	0.39	8.6	81.9	405.27	35.0	99.8	299.5	1.67	9.65	Id<1.8	2.71	SILTY CLAY
4	not known	not measured	1.51	16.8	882.8	Id>0.6	362.1	112.3	411.8	Id>1.2	Id>1.2	Id<1.8	9.81	SANDY SILT
5	not known	not measured	1.54	10.2	714.4	Id>0.6	286.0	112.3	524.2	Id>1.2	Id>1.2	Id<1.8	9.60	SANDY SILT
6	not known	not measured	0.59	8.5	259.7	850.78	111.1	106.1	630.2	1.66	9.62	Id<1.8	3.97	SILTY CLAY
7	not known	not measured	0.06	5.2	15.3	522.78	8.4	93.6	723.8	1.19	4.41	Id<1.8	3.45	CLAY
8	not known	not measured	0.01	3.4	1.1	355.14	0.8	93.6	817.4	0.88	2.34	Id<1.8	2.82	CLAY
9	not known	not measured	1.41	12.4	1414.4	Id>0.6	571.3	121.7	939.1	Id>1.2	Id>1.2	Id<1.8	12.84	SANDY SILT
10	not known	not measured	1.45	10.5	1396.7	Id>0.6	559.9	121.7	1060.8	Id>1.2	Id>1.2	Id<1.8	11.07	SANDY SILT
11	not known	not measured	1.43	11.2	1638.2	Id>0.6	658.8	121.7	1182.5	Id>1.2	Id>1.2	Id<1.8	15.35	SANDY SILT
12	not known	not measured	0.32	3.8	81.0	622.83	54.0	99.8	1282.3	0.94	2.69	Id<1.8	3.86	CLAY
13	not known	not measured	0.96	3.6	414.9	Id>0.6	160.5	106.1	1326.0	0.92	2.55	Id<1.8	5.22	SILT
14	not known	not measured	0.41	2.8	63.8	449.48	54.0	99.8	1363.4	0.73	1.66	Id<1.8	3.65	SILTY CLAY
15	not known	not measured	0.57	2.9	99.8	494.14	80.6	99.8	1400.9	0.77	1.80	Id<1.8	4.18	SILTY CLAY
16	not known	not measured	0.52	2.9	95.9	513.79	76.8	99.8	1438.3	0.77	1.83	Id<1.8	3.86	SILTY CLAY
17	not known	not measured	1.85	2.5	648.2	Id>0.6	240.4	112.3	1488.2	Id>1.2	Id>1.2	33.5	4.70	SILTY SAND
18	not known	not measured	5.29	3.2	1340.1	Id>0.6	894.7	118.6	1544.4	Id>1.2	Id>1.2	34.8	10.75	SAND
19	not known	not measured	2.61	3.7	1445.1	Id>0.6	537.1	118.6	1600.6	Id>1.2	Id>1.2	35.6	6.37	SILTY SAND
20	not known	not measured	6.27	1.8	662.3	Id>0.6	651.2	112.3	1650.5	Id>1.2	Id>1.2	31.6	7.93	SAND
21	not known	not measured	2.05	3.3	1059.7	Id>0.6	396.4	118.6	1706.6	Id>1.2	Id>1.2	35.0	7.93	SILTY SAND
22	not known	not measured	0.71	4.3	478.6	Id>0.6	187.1	112.3	1756.6	1.04	3.32	Id<1.8	6.99	CLAYEY SILT
23	not known	not measured	1.12	3.0	548.9	Id>0.6	210.0	106.1	1800.2	0.78	1.88	Id<1.8	6.79	SILT
24	not known	not measured	0.70	4.5	516.7	Id>0.6	202.4	112.3	1850.2	1.08	3.57	Id<1.8	7.83	CLAYEY SILT
25	not known	not measured	0.67	6.9	770.1	Id>0.6	305.1	112.3	1900.1	1.45	6.87	Id<1.8	16.29	CLAYEY SILT

TEST BORING RECORDS

PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD B-1

PROJECT NO.: 1061-98-682	ELEVATION: 0	NOTES:
LOGGED BY: PB	BORING DEPTH: 65 FEET	
DATE DRILLED: 5-12-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	



S&ME
Environmental Services
Engineering * Testing

PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD B-1
PROJECT NO.: 1081-98-682	ELEVATION: 0	NOTES:
GEO BY: PB	BORING DEPTH: 65 FEET	
DATE DRILLED: 5-12-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	Soil Description	SAMPLE	ELEV.	BPF
	See soil description on previous page.			
40	Medium Dense Black Fly Ash (2)		-40	13
45	Very Loose to Loose Black Fly Ash with Wood Fragments (2)		-45	1
50			-50	4
55			-55	10
60	Medium Dense Dark Gray Fine **SAND** - Some Silt (SM) (3)		-60	11
65	Dense Gray Fine to Medium **SAND** (SP) (4)		-65	32
70	Boring completed at 65'.		-70	

Standard Penetration Test Data (Blows/ft): 10, 30, 50, 70, 80

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PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-2

PROJECT NO.:	1061-98-682	ELEVATION:	0
LOGGED BY:	PB	BORING DEPTH:	75 FEET
DATE DRILLED:	5-13-98	WATER LEVEL:	
DRILLING METHOD:	WASH BORING	DRILL RIG:	CME45

NOTES:
Boring completed at a depth of 75'.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/1t) 10 30 50 70 90	BPF
5						-5		17
10						-10		10/0"
15		Brown Wood Fragments (a concrete obstruction was encountered at the original boring location and at 3 offset locations at a depth of 4', and a timber obstruction was encountered at a depth of 18.5')				-15		18
20						-20		37
25		CUT				-25		25/3"
30		(1)				-30		19
35						-35		12
								28

S&ME
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Engineering * Testing

PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD B-2
PROJECT NO.: 1061-98-682	ELEVATION: 0	NOTES: Boring completed at a depth of 75'.
LOGGED BY: PB	BORING DEPTH: 75 FEET	
DATE DRILLED: 5-13-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/1t) 10 30 50 70 90	BPF
40		See soil description on previous page. (1)				-40		23
45		Brown Wood Fragments, Cloth, and Paper (2)				-45		22
55		Brown Wood Fragments (2)				-50		27
60		Medium Dense Black Fly Ash (3)				-55		23
65		Wood Fragments (wood obstruction at a depth of 63.5') and Black Dregs or Sludge (4)				-60		20
70						-65		25/3"
						-70		

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Environmental Services
Engineering * Testing

PROJECT: INTERNATIONAL PAPER LANDFILL
RIEGELWOOD, N.C.

TEST BORING RECORD B-2

PROJECT NO.: 1061-98-682	ELEVATION: 0	NOTES: Boring completed at a depth of 75'.
LOGGED BY: PB	BORING DEPTH: 75 FEET	
DATE DRILLED: 5-13-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
75		See soil description on previous page.				-75		
		Medium Dense Gray Fine **SAND** - Some Clay (SC) (5)						21
80						-80		
85						-85		
90						-90		
95						-95		
100						-100		
105						-105		

S&ME
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Engineering * Testing

PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD B-3
PROJECT NO.: 1061-98-682	ELEVATION: 0	NOTES:
LOGGED BY: PB	BORING DEPTH: 55 FEET	
DATE DRILLED: 5-13 & 5-14-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
0		Loose Orange and Dark Gray Fine **SAND** – Some Clay and Construction Debris (SC) (1)				0		10
5		Concrete and Timber Obstructions with Brown Fine Sand (2)				-5		10/0"
10		Soft to Very Soft Dark Gray Dregs or Sludge – Some Fine Sand (Grits?) (3)				-10		3
15						-15		WOH/18
20						-20		3
25		Loose Tan Fine **SAND** – Some Clay and Brick Fragments (SC) (4)				-25		8
30		Soft to Very Soft Dark Gray Sludge or Dregs, Fine Gravel, and Fine Sand (Grits?) (5)				-30		4
35						-35		2

S&ME
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Engineering * Testing

PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-3

PROJECT NO.: 1061-98-682	ELEVATION: 0	NOTES:
LOGGED BY: PB	BORING DEPTH: 55 FEET	
DATE DRILLED: 5-13 & 5-14-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
		See soil description on previous page.						
40		Soft to Very Soft Dark Gray Sludge or Dregs				-40		3
45		Loose Tan and Dark Gray Fine **SAND** (SP)				-45		6
		Concrete Obstruction						
50		Firm Brown Wood Fragments and Black and Dark Gray Sludge or Dregs				-50		8
55		Medium Dense Gray Fine **SAND** – Some Clay (SC)				-55		19
		Boring completed at 55'.						
60						-60		
65						-65		
70						-70		

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Engineering * Testing

PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-4

PROJECT NO.: 1081-98-682	ELEVATION: 0	NOTES: A Shelby tube sample was obtained from a depth of 25' to 27'.
LOGGED BY: PB	BORING DEPTH: 75 FEET	
DATE DRILLED: 5-14-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME 45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
5		Dark Gray Fine Sand (Grits?), Brown Fine Sand, and Concrete and Wood Obstructions (1)				-5		5, 7
10						-10		2
15						-15		11
20		Very Soft to Firm Dark Gray Grits, Dregs or Sludge, and Wood Fragments (2)				-20		7
25						-25		5
30						-30		4
35						-35		3

S&ME
Environmental Services
Engineering * Testing

PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-4
PROJECT NO.:	1061-98-682	ELEVATION:	0
LOGGED BY:	PB	BORING DEPTH:	75 FEET
DATE DRILLED:	5-14-98	WATER LEVEL:	
DRILLING METHOD:	WASH BORING	DRILL RIG:	CME45

NOTES:
A Shelby tube sample was obtained from a depth of 25' to 27'.

DEPTH (ft)	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
	See soil description on previous page.						
40	Very Loose Gray Fine to Medium **SAND** (SP) (3)				-40		4
45	Soft to Very Soft Dark Gray Dregs or Sludge with Wood Fragments – Some Grits (4)				-45		3
50					-50		2
55	Medium Dense Black Fly Ash (5)				-55		10
60	Medium Dense Tan Fine **SAND** (SP) (6)				-60		19
65	Very Dense to Medium Dense Gray Fine to Medium **SAND** (SP) (7)				-65		47/7"
70					-70		20

S&ME
Environmental Services
Engineering * Testing

PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-4

PROJECT NO.: 1061-98-682	ELEVATION: 0	NOTES: A Shelby tube sample was obtained from a depth of 25' to 27'.
LOGGED BY: PB	BORING DEPTH: 75 FEET	
DATE DRILLED: 5-14-98	WATER LEVEL:	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
75		See soil description on previous page.				-75		
		Medium Dense Dark Gray Clayey Fine **SAND** (SC) [Pee Dee Formation] (8)						15
		Boring completed at 75'.						
80						-80		
85						-85		
90						-90		
95						-95		
100						-100		
105						-105		

S&ME
Environmental Services
Engineering * Testing

PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-5

PROJECT NO.: 1081-98-682	ELEVATION: 0	NOTES: Undisturbed Shelby tube samples were obtained from a depth of 5 to 7' at an offset location, and from 26 to 28' at Boring B-5. Borehole grouted.
LOGGED BY: PB	BORING DEPTH: 45 FEET	
DATE DRILLED: 6-2-98	WATER LEVEL: 15'	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
5						-5		1
10		Very Soft to Soft Gray and Dark Gray Sludge - Some Wood (1)				-10		2
15						-15		2
20						-20		3
25		Very Soft Gray and Dark Gray Sludge - Some Dregs and Wood (1)				-25		2
30						-30		2
35		Medium Dense Gray Fine to Medium **SAND** (SP) (2) (3)				-35		10

S&ME
Environmental Services
Engineering * Testing

PROJECT:	INTERNATIONAL PAPER LANDFILL RIEGELWOOD, N.C.	TEST BORING RECORD	B-5

PROJECT NO.: 1081-98-682	ELEVATION: 0	NOTES: Undisturbed Shelby tube samples were obtained from a depth of 5 to 7' at an offset location, and from 26 to 28' at Boring B-5. Borehole grouted.
LOGGED BY: PB	BORING DEPTH: 45 FEET	
DATE DRILLED: 6-2-98	WATER LEVEL: 15'	
DRILLING METHOD: WASH BORING	DRILL RIG: CME45	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
		Soft Dark Gray Dregs - Some Wood (3)						
40		Loose Brown Fine to Medium SAND - Some Clay (SC) (4)				-40		10
		Loose Dark Gray Clayey Fine SAND (SC) [Pee Dee Formation] (5)						10
45		Boring completed at 45'.				-45		
50						-50		
55						-55		
60						-60		
65						-65		
70						-70		

S&ME
Environmental Services
Engineering * Testing

PROJECT:	International Paper – Riegelwood Riegelwood, North Carolina	TEST BORING RECORD	B-6
PROJECT NO. :	1356-99-573	ELEVATION:	NOTES:
LOGGED BY:	MDP	BORING DEPTH: 75.0 FEET	
DATE DRILLED:	7-14-99	WATER LEVEL: 24.5 feet at termination	
DRILLING METHOD:	3-1/4 HSA	DRILL RIG: Diedrich D-50 Track	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
0		Very Dense to Loose Wood Chips and debris						
5		(1)						15
10								10
								50/0.4
								5
15		Firm to Very Soft Gray Fine to Medium Sandy **SILT** (Sludge)						4
		(2)						2
20								
25				▽				4
		Soft to Stiff Black Clayey Fine Sandy **SILT** (Fly Ash) with wood fragments						4
30		(3)						
								9
35								

S&ME
Environmental Services
Engineering * Testing

PROJECT:	International Paper – Riegelwood Riegelwood, North Carolina	TEST BORING RECORD	B-6

PROJECT NO.: 1356-99-573	ELEVATION:	NOTES:
LOGGED BY: MDP	BORING DEPTH: 75.0 FEET	
DATE DRILLED: 7-14-99	WATER LEVEL: 24.5 feet at termination	
DRILLING METHOD: 3-1/4 HSA	DRILL RIG: Diedrich D-50 Track	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
40		Soft to Stiff Black Clayey Fine Sandy **SILT** (Fly Ash) with wood fragments (3)						9
45		Loose Gray Silty Fine to Medium **SAND** (4) (Sludge or Dregs) with wood fragments						10
50		Loose to Medium Dense Wood Chips (5)						16
55								16
60								28
65		Loose Black Silty Fine to Coarse **SAND** (Sludge) (6)						10
70		Medium Dense to Loose Gray Silty Fine to Medium **SAND** (7)						13

S&ME
Environmental Services
Engineering * Testing

PROJECT:	International Paper – Riegelwood Riegelwood, North Carolina	TEST BORING RECORD	B-6

PROJECT NO.: 1356-99-573	ELEVATION:	NOTES:
LOGGED BY: MDP	BORING DEPTH: 75.0 FEET	
DATE DRILLED: 7-14-99	WATER LEVEL: 24.5 feet at termination	
DRILLING METHOD: 3-1/4 HSA	DRILL RIG: Diedrich D-50 Track	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
75		Medium Dense to Loose Gray Silty Fine to Medium **SAND**			X			9
		Boring terminated at 75.0 feet. Water was observed at 24.5 feet at termination of drilling. A temporary PVC standpipe was installed in the borehole to a depts of 65 feet below the groundsurface.						
80								
85								
90								
95								
100								
105								

S&ME
Environmental Services
Engineering * Testing

PROJECT:	International Paper – Riegelwood Riegelwood, North Carolina	TEST BORING RECORD	B-7

PROJECT NO.: 1356-99-573	ELEVATION:	NOTES:
LOGGED BY: MDP	BORING DEPTH: 40.0 FEET	
DATE DRILLED: 7-13-99	WATER LEVEL: 11.0 feet at termination	
DRILLING METHOD: 3-1/4 HSA	DRILL RIG: Diedrich D-50 Track	

DEPTH (ft)	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
	Medium Dense Gray Silty Fine **SAND** SM (1)						13
	Stiff Black Fine Sandy **SILT** (Sludge) with roots (2)						15
5	Medium Dense Gray Silty Fine to Medium **SAND** SM (3)						18
	Stiff Tan Black Silty Fine **SAND** (Sludge) with seams of clay and wood fragments (4)		▽				12
10							
	Medium Dense to Loose Gray Silty Fine to Medium **SAND** SM (5)						15
15							
							6
20							
							5
25							
	Very Loose Dark Gray Fine Sandy **SILT** (Sludge) (6)						2
30	Loose to Very Dense Gray to White Silty Fine **SAND** SM (7)						10
35							

S&ME
Environmental Services
Engineering * Testing

PROJECT:	International Paper – Riegelwood Riegelwood, North Carolina	TEST BORING RECORD	B-7

PROJECT NO.: 1356-99-573	ELEVATION:	NOTES:
LOGGED BY: MDP	BORING DEPTH: 40.0 FEET	
DATE DRILLED: 7-13-99	WATER LEVEL: 11.0 feet at termination	
DRILLING METHOD: 3-1/4 HSA	DRILL RIG: Diedrich D-50 Track	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/1t) 10 30 50 70 90	BPF
		Loose to Very Dense Gray to White Silty Fine **SAND**						
40		Very Dense Gray Clayey Fine **SAND** $_{SC}$ (8)						69
		Boring terminated at 40.0 feet. Water was observed at 11.0 feet at termination of drilling. A temporary PVC standpipe was installed in the borehole.						
45								
50								
55								
60								
65								
70								

S&ME
Environmental Services
Engineering * Testing

PROJECT:	International Paper – Riegelwood Riegelwood, North Carolina	TEST BORING RECORD	B-8

PROJECT NO.: 1356-99-573	ELEVATION:	NOTES:
LOGGED BY: MDP	BORING DEPTH: 60.0 FEET	
DATE DRILLED: 7-15-99	WATER LEVEL: 42.0 feet at termination	
DRILLING METHOD: 3-1/4 HSA	DRILL RIG: Diedrich D-50 Track	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
		Firm Black Clayey Fine Sandy **SILT** (Fly Ash) with rock and wood fragments (1)						5
		Loose to Very Loose Black Silty Fine **SAND** (Fly Ash) with wood fragments and debris (2)						6
5								4
								6
10								
								4
15								
		(3)						2
20								
		(4)						4
25								
		Very Soft to Firm Black Clayey Fine Sandy **SILT** (Fly Ash)						5
		(5)						
30								
								5
35								

S&ME
Environmental Services
Engineering * Testing

PROJECT:	International Paper – Riegelwood Riegelwood, North Carolina	TEST BORING RECORD	B-8

PROJECT NO.: 1356-99-573	ELEVATION:	NOTES:
LOGGED BY: MDP	BORING DEPTH: 60.0 FEET	
DATE DRILLED: 7-15-99	WATER LEVEL: 42.0 feet at termination	
DRILLING METHOD: 3-1/4 HSA	DRILL RIG: Diedrich D-50 Track	

DEPTH (ft)	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
40	Loose to Medium Dense Black Silty Fine to Medium **SAND** (Sludge and Dregs) with debris		▽				5
45							7
50							28
55	Stiff Gray Fine Sandy **SILT** ML-CL?						9
60	Dense Gray Silty Fine **SAND** SM *Boring terminated at 60.0 feet. Water was observed at 11.0 feet at termination of drilling. A temporary PVC standpipe was installed in the borehole to a depth of 52.0 feet below groundsurface.*						45
65							
70							

S&ME
Environmental Services
Engineering * Testing

PROJECT:	International Paper – Riegelwood Riegelwood, North Carolina	TEST BORING RECORD	B-9

PROJECT NO.: 1356-98-573	ELEVATION:	NOTES:
LOGGED BY: MDP	BORING DEPTH: 50.0 FEET	
DATE DRILLED: 7-15-99	WATER LEVEL: 11.0 feet at termination	
DRILLING METHOD: 3-1/4 HSA	DRILL RIG: Diedrich D-50 Track	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) - 10 30 50 70 90	BPF
0		Soft to Stiff Black Silty **CLAY** (Fly Ash) with wood fragments			1			4
					2			4
					3			4
10				▽	4			14
15								
		Loose Tan Black Silty Medium to Coarse **SAND** (Sludge or Dregs)			5			4
20								8
		Medium Dense Wood Chips			6			
25								13
		Loose Gray Silty Fine to Coarse **SAND** (Sludge or Dregs) with wood fragments			7			
30								6
		Loose Gray Fine to Medium Sandy **SILT** (Sludge)			8			
35								6
		Loose Gray Silty Fine to Coarse **SAND** (Sludge or Dregs) with wood fragments			9			

S&ME
Environmental Services
Engineering * Testing

PROJECT:	International Paper – Riegelwood Riegelwood, North Carolina	TEST BORING RECORD	B-9

PROJECT NO.: 1356-99-573	ELEVATION:	NOTES:
LOGGED BY: MDP	BORING DEPTH: 50.0 FEET	
DATE DRILLED: 7-15-99	WATER LEVEL: 11.0 feet at termination	
DRILLING METHOD: 3-1/4 HSA	DRILL RIG: Diedrich D-50 Track	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
40		(6)			X			8
45		Loose Black Fine Sandy **SILT** (Sludge) with wood fragments (7)			X			9
50		Medium Dense Tan Gray Silty Fine **SAND** SM (8)			X			29
		Boring terminated at 50.0 feet. Water was observed at 11.0 feet at termination of drilling. A temporary PVC standpipe was installed in the borehole.						
55								
60								
65								
70								

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Channel Design (Berms, Benches, Roadside Channels)

S&ME

JOB NO. 1356-99-573
SHEET NO. 1 OF 89
DATE 1/17/2000

JOB NAME INTERNATIONAL PAPER-RIEGELWOOD FAC. FINAL CLOSURE
COMPUTED BY DPM
SUBJECT CHANNEL DESIGN (BERMS, BENCHES, ROADSIDE CHANNELS)
CHECKED BY SRN

OBJECTIVE: Design the channels that shall collect the stormwater runoff from the Capping System for the International Paper Riegelwood Facility and convey it to the appropriate E&S structures.

REFERENCES: 1) "SEDCAD 4 for Windows 95," Civil Software Design, 1998 (computer application)

2) "Erosion and Sediment Control Planning and Design Manual," NCDENR

GIVEN: CN = 91 for Urban Areas, Class C hydrological soil group, newly graded areas that have pervious areas only, no vegetation. *[Ref. #1]*

For Straw w/ Net:

n = 0.065 for 0 - 0.5ft *[Ref. #2]*
n = 0.033 for 0.5ft - 2.0ft *[Ref. #2]*
n = 0.045 for 0.5ft [Assumed]
Permissible Shear Stress = 1.45 lb/ft^2 *[Ref. #2]*

For Concrete w/ Rubbles:

n = 0.022 *[Ref. #1]*

For 20 mil Plastic:

n = 0.013 *[Ref. #2]*

Chose Class C Vegetation based on Table 8.05c *[Ref. #2]*

For Bermudagrass:

For 0-5% slope and easily erodible soil -
Permissible Shear Stress = 5.0 ft/s [Ref. #2]

CONCLUSIONS: See Summary Chart attached.

CALCULATIONS:

See attached sheets.

INTERNATIONAL PAPER - RIEGELWOOD FACILITY FINAL CAP
CHANNEL SHEAR STRESS & DEPTH CHECK

Shear Stress = T = y x d x s

y = 62.4 (lb/ft^3)

Channel No.	E&S Control Material	Permissible Shear Stress (lb/ft^2) [Ref. #2]	Channel Gradient s (%)	Flow Depth d (ft) [REF. #1]	Calculated Shear Stress (lb/ft^2)	Matting Acceptable ?	Ditch Type	Left Side Slope	Right Side Slope	Grass Flow Depth (ft) [Ref. # 1]	Dictating Depth	Channel Depth Available (ft)	Depth Acceptable	Channel Detail
A1	Straw w/ net	1.45	1.00%	0.71	0.44	yes	V	2	20	1.10	1.1	1.5	yes	Berm
A2	Straw w/ net	1.45	1.00%	0.71	0.44	yes	V	20	2	1.10	1.1	1.5	yes	Berm
A3	Straw w/ net	1.45	1.00%	0.45	0.28	yes	V	2	20	0.66	0.66	1.5	yes	Berm
A4	20 mil Plastic	100	2.00%	0.39	0.49	yes	V	3	20	NA	0.39	0.5	yes	Bench
A5	Straw w/ net	1.45	1.00%	0.53	0.33	yes	V	20	2	0.74	0.74	1.5	yes	Berm
A6	20 mil Plastic	100	2.00%	0.42	0.52	yes	V	20	3	NA	0.42	0.5	yes	Bench
A7	Straw w/ net	1.45	0.70%	0.57	0.25	yes	V	2	3	0.99	0.99	2.0	yes	Misc.
A8	Straw w/ net	1.45	2.20%	0.54	0.74	yes	V	2	3	0.86	0.86	2.0	yes	Misc.
A9	Concrete	100	16.00%	0.58	5.79	yes	Trap.	2	2	NA	0.58	2.0	yes	Concrete
A10	20 mil Plastic	100	2.00%	0.31	0.39	yes	V	3	20	NA	0.31	0.5	yes	Bench
A11	20 mil Plastic	100	2.00%	0.21	0.26	yes	V	3	20	NA	0.21	0.5	yes	Bench
A12	Straw w/ net	1.45	0.40%	0.80	0.20	yes	V	2	2	1.32	1.32	2.0	yes	Misc.
B1	20 mil Plastic	100	9.40%	0.17	1.00	yes	V	3	3	NA	0.17	0.6	yes	Road Ch.
B2	20 mil Plastic	100	4.00%	0.25	0.62	yes	V	3	3	NA	0.25	0.6	yes	Road Ch.
B3	20 mil Plastic	100	2.30%	0.42	0.60	yes	V	3	3	NA	0.42	0.6	yes	Road Ch.
B4	20 mil Plastic	100	3.20%	0.45	0.90	yes	V	3	3	NA	0.45	0.6	yes	Road Ch.
B5	Straw w/ net	1.45	1.00%	0.76	0.47	yes	V	2	20	1.15	1.15	1.5	yes	Berm
B6	20 mil Plastic	100	2.80%	0.80	1.40	yes	V	3	3	NA	0.80	1.6	yes	Road Ch.
B7	20 mil Plastic	100	2.00%	0.99	1.24	yes	V	3	3	NA	0.99	1.6	yes	Road Ch.
B8	20 mil Plastic	100	2.60%	0.96	1.56	yes	V	3	3	NA	0.96	1.6	yes	Road Ch.
B9	20 mil Plastic	100	1.90%	1.06	1.26	yes	V	3	3	NA	1.06	1.6	yes	Road Ch.
B10	20 mil Plastic	100	10.00%	0.79	4.93	yes	V	3	3	NA	0.79	1.6	yes	Road Ch.
B11	20 mil Plastic	100	2.50%	1.02	1.59	yes	V	3	3	NA	1.02	1.6	yes	Road Ch.
B12	20 mil Plastic	100	10.00%	0.80	4.99	yes	V	3	3	NA	0.80	1.6	yes	Road Ch.

INTERNATIONAL PAPER - RIEGELWOOD FACILITY FINAL CAP
CHANNEL SHEAR STRESS & DEPTH CHECK

Shear Stress = T = y x d x s

y = 62.4 (lb/ft^3)

Channel No.	E&S Control Material	Permissible Shear Stress (lb/ft^2) [Ref. #2]	Channel Gradient s (%)	Flow Depth d (ft) [REF. #1]	Calculated Shear Stress (lb/ft^2)	Matting Acceptable ?	Ditch Type	Left Side Slope	Right Side Slope	Grass Flow Depth (ft) [Ref. # 1]	Dictating Depth	Channel Depth Available (ft)	Depth Acceptable	Channel Detail
B13	20 mil Plastic	100	1.10%	1.23	0.84	yes	V	3	3	NA	1.23	1.5	yes	Road Ch.
B14	Straw w/ net	1.45	0.60%	0.53	0.20	yes	V	3	3	0.94	0.94	2.0	yes	Misc.
C1	20 mil Plastic	100	1.50%	0.52	0.49	yes	V	3	20	NA	0.52	0.5	yes	Bench
C2	Straw w/ net	1.45	0.65%	0.51	0.21	yes	V	3	3	0.84	0.84	2.0	yes	Misc.
D1	20 mil Plastic	100	2.20%	0.20	0.27	yes	V	3	20	NA	0.20	0.5	yes	Bench
D2	20 mil Plastic	100	2.00%	0.39	0.49	yes	V	20	3	NA	0.39	0.5	yes	Bench

General Information

Storm Information:

Storm Type:	NRCS Type III
Design Storm:	25 yr - 24 hr
Rainfall Depth:	7.800 inches

[REF #1]

[REF. #2]

Storm Type

[REF # 1]

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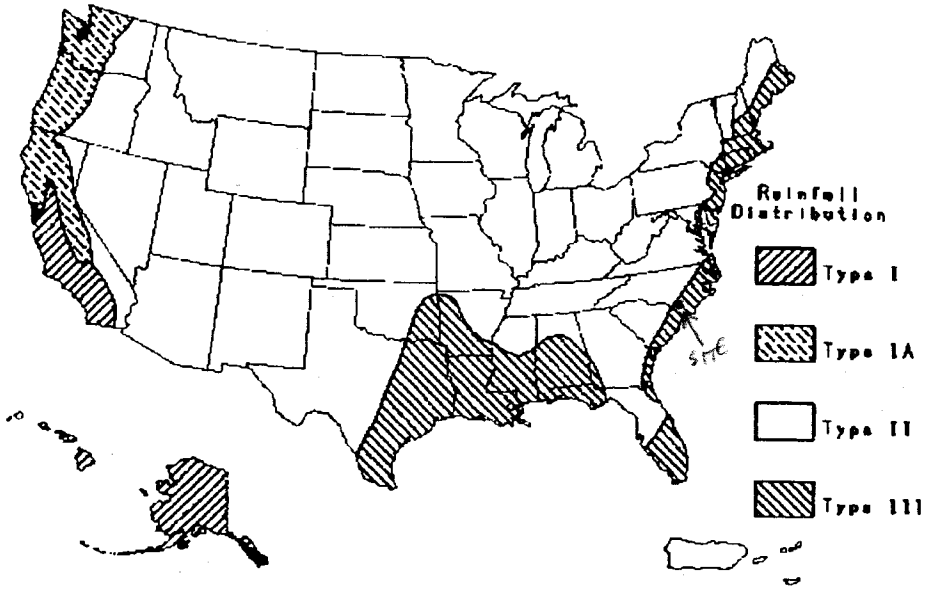
Click on the drop down button to obtain a listing of available type distributions. The geographic bounds for the Natural Resources C Service (NRCS), (formerly Soil Conservation Service, SCS) are shov



The NRCS Storm Type Distributions are considered very conservat peak flow predictions based on these Type Distributions will be hig almost any actual measured storm.

Two other options are available — User-defined distribution and ra

NRCS Distribution Determination

A very simplified description of the methodology to determine NR tions follows:

Assume that the incremental rainfall values are known for 10 years throughout the applicable region of a Type Distribution. For exam Type II distribution data would be available from parts or all of 40- The entire record is scanned to determine the highest 3-minute rainf Similarly the highest 5, 10, 15, 30 minute values are determined for t geographical area. Also, the highest 1, 2, 3 hour rainfall intensities

REF#2

6/89

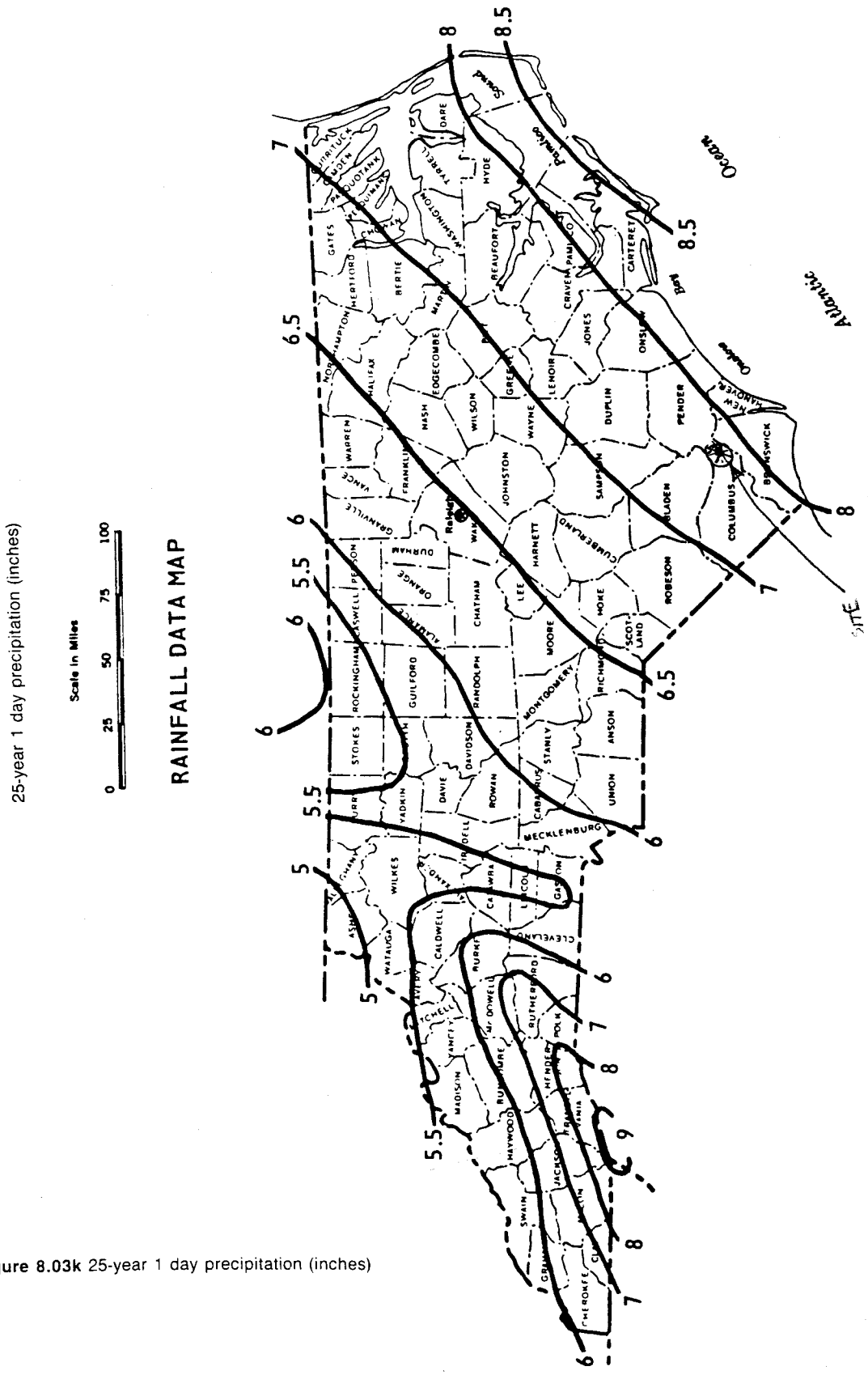


Figure 8.03k 25-year 1 day precipitation (inches)

7/89

International Paper Industrial Landfill
Riegelwood, North Carolina
Closure E&S Design

Channels A1-A12

Pipes AA1-AA5 (Pipes P1, P2, P3)

Channels Lined with Straw w/ net and 20 mil Plastic

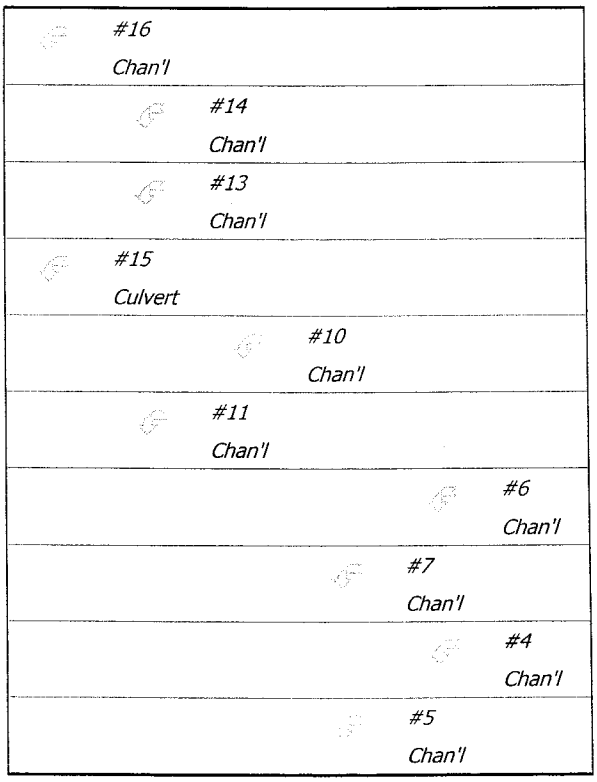
25 yr Storm used to design E&S structures.

Dan Moss

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, NC 28273

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#3	0.000	0.000	Channel A1
Channel	#2	==>	#3	0.000	0.000	Channel A2
Culvert	#3	==>	#8	0.000	0.000	Culvert AA1 - Pipe P1
Channel	#4	==>	#5	0.000	0.000	Channel A3
Channel	#5	==>	#8	0.000	0.000	Channel A4
Channel	#6	==>	#7	0.000	0.000	Channel A5
Channel	#7	==>	#8	0.000	0.000	Channel A6
Culvert	#8	==>	#9	0.000	0.000	Culvert AA2 - Pipe P2
Culvert	#9	==>	#12	0.000	0.000	Culvert AA3 - Pipe P2
Channel	#10	==>	#11	0.000	0.000	Channel A7
Channel	#11	==>	#12	0.000	0.000	Channel A8
Channel	#12	==>	#17	0.000	0.000	Channel A9
Channel	#13	==>	#15	0.000	0.000	Channel A10
Channel	#14	==>	#15	0.000	0.000	Channel A11
Culvert	#15	==>	#17	0.000	0.000	Culvert AA4 - Pipe P3 (AA4-1 Not Included)
Channel	#16	==>	#17	0.000	0.000	Channel A12
Null	#17	==>	End	0.000	0.000	Culvert AA5



	#2 Chan'l
	#1 Chan'l
#3 Culvert	
#8 Culvert	
#9 Culvert	
#12 Chan'l	
#17 Null	

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#16	0.630	0.630	1.95	0.35
#14	0.580	0.580	1.80	0.33
#13	1.680	1.680	5.20	0.94
#15	0.000	2.260	6.99	1.27
#10	0.410	0.410	1.27	0.23
#11	0.210	0.620	1.92	0.35
#6	0.920	0.920	2.85	0.52
#7	2.720	3.640	11.27	2.04
#4	0.620	0.620	1.92	0.35
#5	2.530	3.150	9.75	1.77
#2	3.990	3.990	12.50	2.24
#1	3.930	3.930	12.31	2.20
#3	0.000	7.920	24.81	4.44
#8	0.000	14.710	45.79	8.25
#9	0.000	14.710	45.79	8.25
#12	0.380	15.710	47.70	8.59
#17	0.000	18.600	56.65	10.21

Structure Detail:

Structure #1: Nonerodible Channel

Channel A1

Triangular Nonerodible Channel Inputs:

Material: Straw w/net

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.0:1	20.0:1	1.0	0.0330			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	12.31 cfs	
Depth:	0.71 ft	
Top Width:	15.52 ft	
Velocity:	2.25 fps	
X-Section Area:	5.48 sq ft	
Hydraulic Radius:	0.351	
Froude Number:	0.67	

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Structure Detail:

Channel A2

Triangular Nonerodible Channel Inputs:

Material: Straw w/ net

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
20.0:1	2.0:1	1.0	0.0330			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	12.50 cfs	
Depth:	0.71 ft	
Top Width:	15.61 ft	
Velocity:	2.26 fps	
X-Section Area:	5.54 sq ft	
Hydraulic Radius:	0.353	
Froude Number:	0.67	

Structure Detail:

Structure #4 (Nonerodible Channel)

Channel A3

Triangular Nonerodible Channel Inputs:

Material: Straw w/ net

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.0:1	20.0:1	1.0	0.0650			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.92 cfs	
Depth:	0.45 ft	
Top Width:	9.97 ft	
Velocity:	0.85 fps	
X-Section Area:	2.26 sq ft	
Hydraulic Radius:	0.226	
Froude Number:	0.31	

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Structure Detail:

Structure #5 - Nonerodible Channel

Channel A4

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	20.0:1	2.0	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	9.75 cfs	
Depth:	0.39 ft	
Top Width:	9.05 ft	
Velocity:	5.47 fps	
X-Section Area:	1.78 sq ft	
Hydraulic Radius:	0.196	
Froude Number:	2.17	

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Structure Detail:

Structure #5 (Nonerodible Channel)

Channel A5

Triangular Nonerodible Channel Inputs:

Material: Straw w/ net

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
20.0:1	2.0:1	1.0	0.0650			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.85 cfs	
Depth:	0.53 ft	
Top Width:	11.56 ft	
Velocity:	0.94 fps	
X-Section Area:	3.04 sq ft	
Hydraulic Radius:	0.262	
Froude Number:	0.32	

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Structure Detail:

Channel A6

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
20.0:1	3.0:1	2.0	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	11.27 cfs	
Depth:	0.42 ft	
Top Width:	9.56 ft	
Velocity:	5.67 fps	
X-Section Area:	1.98 sq ft	
Hydraulic Radius:	0.207	
Froude Number:	2.19	

Structure Detail:

Channel A7

Triangular Nonerodible Channel Inputs:

Material: Straw w/ Net

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.0:1	3.0:1	0.7	0.0330			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.27 cfs	
Depth:	0.57 ft	
Top Width:	2.86 ft	
Velocity:	1.55 fps	
X-Section Area:	0.82 sq ft	
Hydraulic Radius:	0.266	
Froude Number:	0.51	

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Structure Detail:

Structure #11 (Nonerodible Channel)

Channel A8

Triangular Nonerodible Channel Inputs:

Material: Straw w/ net

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.0:1	3.0:1	2.2	0.0330			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.92 cfs	
Depth:	0.54 ft	
Top Width:	2.69 ft	
Velocity:	2.66 fps	
X-Section Area:	0.72 sq ft	
Hydraulic Radius:	0.249	
Froude Number:	0.91	

Structure Detail:

Channel A9

Trapezoidal Nonerodible Channel Inputs:

Material: Concrete, Rubble

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.00	2.0:1	2.0:1	16.0	0.0220			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	47.70 cfs	
Depth:	0.58 ft	
Top Width:	6.32 ft	
Velocity:	15.98 fps	
X-Section Area:	2.99 sq ft	
Hydraulic Radius:	0.453	
Froude Number:	4.10	

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Structure Detail:

Channel A10

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	20.0:1	2.0	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	5.20 cfs	
Depth:	0.31 ft	
Top Width:	7.15 ft	
Velocity:	4.67 fps	
X-Section Area:	1.11 sq ft	
Hydraulic Radius:	0.155	
Froude Number:	2.09	

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Structure Detail:

Channel A11

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	20.0:1	2.0	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.80 cfs	
Depth:	0.21 ft	
Top Width:	4.80 ft	
Velocity:	3.58 fps	
X-Section Area:	0.50 sq ft	
Hydraulic Radius:	0.104	
Froude Number:	1.96	

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Structure Detail:

Channel A12

Triangular Nonerodible Channel Inputs:

Material: straw w/ net

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.0:1	2.0:1	0.4	0.0330			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.95 cfs	
Depth:	0.80 ft	
Top Width:	3.20 ft	
Velocity:	1.53 fps	
X-Section Area:	1.28 sq ft	
Hydraulic Radius:	0.358	
Froude Number:	0.43	

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Structure Detail:

Culvert AA1 - Pipe P1

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
60.00	33.33	0.0100	4.50	4.50	0.20

Culvert Results:

Design Discharge = 24.81 cfs

Minimum pipe diameter: 1 - 24 inch pipe(s) required

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Structure Detail:

Culvert AA2 - Pipe P2

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
84.00	33.33	0.0100	5.50	2.50	0.20

Culvert Results:

Design Discharge = 45.79 cfs

Minimum pipe diameter: 1 - 30 inch pipe(s) required

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Structure Detail:

Culvert AA3 - Pipe P2

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
40.00	15.00	0.0100	2.50	2.00	0.20

Culvert Results:

Design Discharge = 45.79 cfs

Minimum pipe diameter: 1 - 72 inch pipe(s) required

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Structure Detail:

Culvert AA4 - Pipe P3 (AA4-1 Not Included)

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
60.00	33.33	0.0100	4.00	2.00	0.90

Culvert Results:

Design Discharge = 6.99 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

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Structure Detail:

Culvert AA5 (PIPE P4)

Q= 56.65 cfs (SEE PAGE 28)

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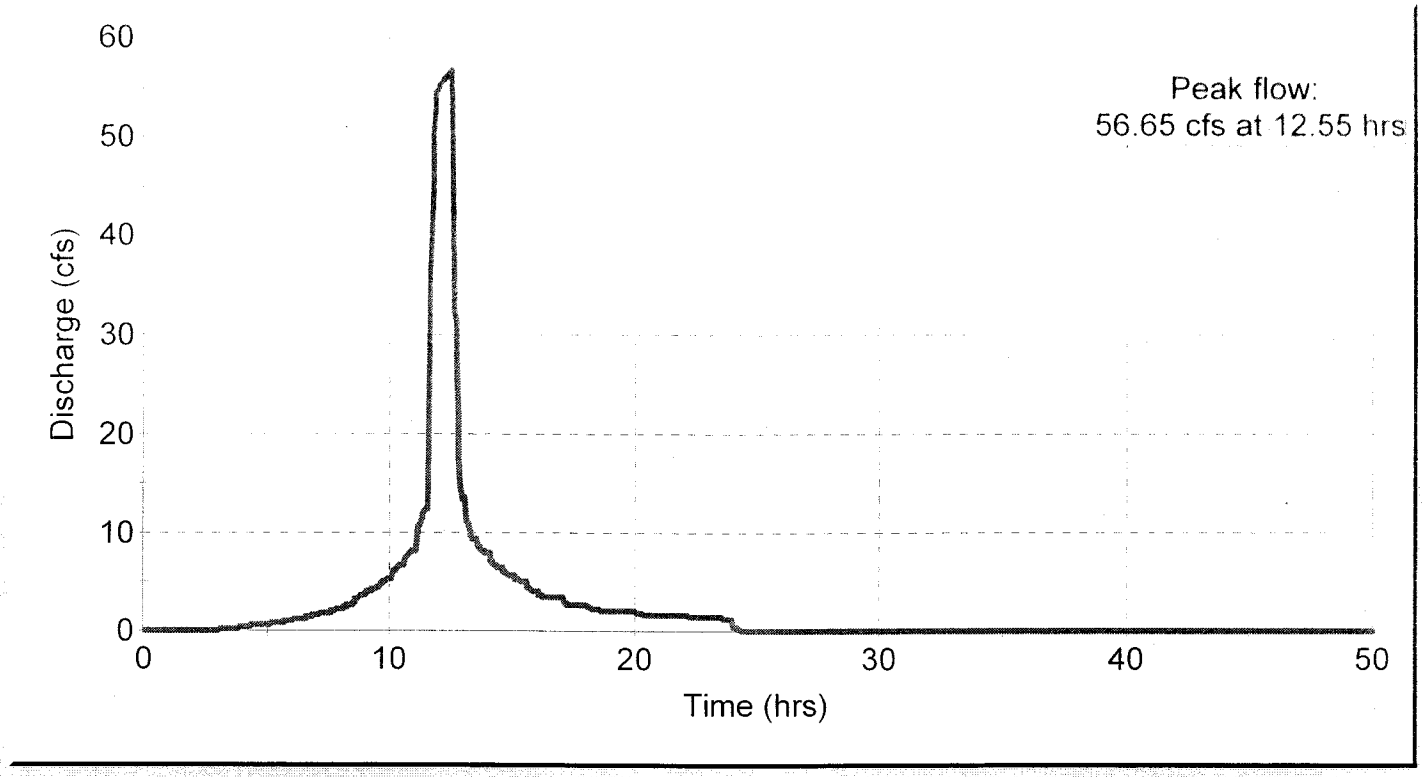
Total Inflow Hydrograph to Structure # 17 (includes all upstream flow)



CULVERT AA5 (PIPE P4)

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Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#16	1	0.630	0.043	0.000	0.000	91.000	TR55	1.95	0.353
		0.630						**1.95**	**0.353**
#14	1	0.580	0.019	0.000	0.000	91.000	TR55	1.80	0.325
		0.580						**1.80**	**0.325**
#13	1	1.680	0.049	0.000	0.000	91.000	TR55	5.20	0.942
		1.680						**5.20**	**0.942**
#15		**2.260**						**6.99**	**1.267**
#10	1	0.410	0.020	0.000	0.000	91.000	TR55	1.27	0.230
		0.410						**1.27**	**0.230**
#11	1	0.210	0.009	0.000	0.000	91.000	TR55	0.65	0.118
		0.620						**1.92**	**0.348**
#6	1	0.920	0.111	0.000	0.000	91.000	TR55	2.85	0.516
		0.920						**2.85**	**0.516**
#7	1	2.720	0.084	0.000	0.000	91.000	TR55	8.42	1.525
		3.640						**11.27**	**2.041**
#4	1	0.620	0.041	0.000	0.000	91.000	TR55	1.92	0.348
		0.620						**1.92**	**0.348**
#5	1	2.530	0.083	0.000	0.000	91.000	TR55	7.83	1.418
		3.150						**9.75**	**1.766**
#2	1	3.990	0.139	0.000	0.000	91.000	TR55	12.50	2.237
		3.990						**12.50**	**2.237**
#1	1	3.930	0.142	0.000	0.000	91.000	TR55	12.31	2.203
		3.930						**12.31**	**2.203**
#3		**7.920**						**24.81**	**4.440**
#8		**14.710**						**45.79**	**8.246**
#9		**14.710**						**45.79**	**8.246**
#12	1	0.380	0.001	0.000	0.000	1.000	0.00	0.000	
		15.710						**47.70**	**8.594**
#17		**18.600**						**56.65**	**10.214**

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Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.00	1.00	100.00	1.000	0.027
		5. Nearly bare and untilled, and alluvial valley fans	4.00	12.00	300.00	2.000	0.041
		8. Large gullies, diversions, and low flowing streams	1.00	8.00	800.00	3.000	0.074
#1	**1**	**Time of Concentration:**					**0.142**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	0.83	1.00	120.00	0.910	0.036
		5. Nearly bare and untilled, and alluvial valley fans	5.00	12.00	240.00	2.230	0.029
		8. Large gullies, diversions, and low flowing streams	1.00	8.00	800.00	3.000	0.074
#2	**1**	**Time of Concentration:**					**0.139**
#4	1	5. Nearly bare and untilled, and alluvial valley fans	3.75	6.00	160.00	1.930	0.023
		8. Large gullies, diversions, and low flowing streams	1.00	2.00	200.00	3.000	0.018
#4	**1**	**Time of Concentration:**					**0.041**
#5	1	5. Nearly bare and untilled, and alluvial valley fans	5.00	7.50	150.00	2.230	0.018
		8. Large gullies, diversions, and low flowing streams	2.00	20.00	1,000.00	4.240	0.065
#5	**1**	**Time of Concentration:**					**0.083**
#6	1	5. Nearly bare and untilled, and alluvial valley fans	1.00	4.00	400.00	1.000	0.111
#6	**1**	**Time of Concentration:**					**0.111**
#7	1	5. Nearly bare and untilled, and alluvial valley fans	5.00	8.00	160.00	2.230	0.019
		8. Large gullies, diversions, and low flowing streams	2.00	20.00	1,000.00	4.240	0.065
#7	**1**	**Time of Concentration:**					**0.084**
#10	1	5. Nearly bare and untilled, and alluvial valley fans	33.33	33.00	99.00	5.770	0.004
		8. Large gullies, diversions, and low flowing streams	0.69	1.00	145.00	2.490	0.016
#10	**1**	**Time of Concentration:**					**0.020**
#11	1	5. Nearly bare and untilled, and alluvial valley fans	33.33	28.00	84.00	5.770	0.004
		8. Large gullies, diversions, and low flowing streams	2.22	1.99	90.00	4.460	0.005
#11	**1**	**Time of Concentration:**					**0.009**
#12	1	9. Small streams flowing bankfull	16.00	24.00	150.00	36.000	0.001
#12	**1**	**Time of Concentration:**					**0.001**
#13	1	5. Nearly bare and untilled, and alluvial valley fans	33.33	35.00	105.01	5.770	0.005
		8. Large gullies, diversions, and low flowing streams	2.00	13.60	680.00	4.240	0.044

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Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#13	**1**	**Time of Concentration:**					**0.049**
#14	1	5. Nearly bare and untilled, and alluvial valley fans	33.33	27.00	81.00	5.770	0.003
		8. Large gullies, diversions, and low flowing streams	2.00	5.00	250.00	4.240	0.016
#14	**1**	**Time of Concentration:**					**0.019**
#16	1	5. Nearly bare and untilled, and alluvial valley fans	33.33	26.66	80.00	5.770	0.003
		5. Nearly bare and untilled, and alluvial valley fans	0.01	0.00	8.00	0.000	0.000
		8. Large gullies, diversions, and low flowing streams	0.45	1.30	290.00	2.000	0.040
#16	**1**	**Time of Concentration:**					**0.043**

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International Paper Industrial Landfill
Riegelwood, North Carolina
Closure E&S Design

Channels A1-A3, A5, A7-A8, A12

Channels Lined w/ Grass

25 yr Storm used to design E&S structures.

Dan Moss

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, NC 28273

Structure Detail:

Channel A1

Triangular Vegetated Channel Inputs:

Material: Bermuda grass

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	20.0:1	1.0	C, C				5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	12.31 cfs		12.31 cfs	
Depth:	1.10 ft		1.10 ft	
Top Width:	24.13 ft		24.13 ft	
Velocity:	0.93 fps		0.93 fps	
X-Section Area:	13.24 sq ft		13.24 sq ft	
Hydraulic Radius:	0.546		0.546	
Froude Number:	0.22		0.22	
Roughness Coefficient:	0.1070		0.1070	

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Structure Detail:

Channel A2

Triangular Vegetated Channel Inputs:

Material: Bermuda grass

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
20.0:1	2.0:1	1.0	C, C				5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	12.50 cfs		12.50 cfs	
Depth:	1.10 ft		1.10 ft	
Top Width:	24.24 ft		24.24 ft	
Velocity:	0.94 fps		0.94 fps	
X-Section Area:	13.36 sq ft		13.36 sq ft	
Hydraulic Radius:	0.549		0.549	
Froude Number:	0.22		0.22	
Roughness Coefficient:	0.1066		0.1066	

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Structure Detail:

Channel A3

Triangular Vegetated Channel Inputs:

Material: Bermuda grass

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	20.0:1	1.0	C, C				5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	1.92 cfs		1.92 cfs	
Depth:	0.66 ft		0.66 ft	
Top Width:	14.63 ft		14.63 ft	
Velocity:	0.39 fps		0.39 fps	
X-Section Area:	4.86 sq ft		4.86 sq ft	
Hydraulic Radius:	0.331		0.331	
Froude Number:	0.12		0.12	
Roughness Coefficient:	0.1807		0.1807	

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Structure Detail:

Channel A5

Triangular Vegetated Channel Inputs:

Material: Bermuda grass

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
20.0:1	2.0:1	1.0	C, C				5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	2.85 cfs		2.85 cfs	
Depth:	0.74 ft		0.74 ft	
Top Width:	16.28 ft		16.28 ft	
Velocity:	0.47 fps		0.47 fps	
X-Section Area:	6.02 sq ft		6.02 sq ft	
Hydraulic Radius:	0.368		0.368	
Froude Number:	0.14		0.14	
Roughness Coefficient:	0.1617		0.1617	

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Structure Detail:

Channel A7

Triangular Vegetated Channel Inputs:

Material: Bermuda grass

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	3.0:1	0.7	C, C				5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	1.27 cfs		1.27 cfs	
Depth:	0.99 ft		0.99 ft	
Top Width:	4.97 ft		4.97 ft	
Velocity:	0.51 fps		0.51 fps	
X-Section Area:	2.47 sq ft		2.47 sq ft	
Hydraulic Radius:	0.461		0.461	
Froude Number:	0.13		0.13	
Roughness Coefficient:	0.1436		0.1436	

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Structure Detail:

Channel A8

Triangular Vegetated Channel Inputs:

Material: Bermuda grass

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	3.0:1	2.2	C, C				5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	1.92 cfs		1.92 cfs	
Depth:	0.86 ft		0.86 ft	
Top Width:	4.30 ft		4.30 ft	
Velocity:	1.04 fps		1.04 fps	
X-Section Area:	1.85 sq ft		1.85 sq ft	
Hydraulic Radius:	0.399		0.399	
Froude Number:	0.28		0.28	
Roughness Coefficient:	0.1158		0.1158	

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Structure Detail:

Channel A12

Triangular Vegetated Channel Inputs:

Material: Bermuda grass

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	2.0:1	0.4	C, C				5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	1.95 cfs		1.95 cfs	
Depth:	1.32 ft		1.32 ft	
Top Width:	5.29 ft		5.29 ft	
Velocity:	0.56 fps		0.56 fps	
X-Section Area:	3.50 sq ft		3.50 sq ft	
Hydraulic Radius:	0.592		0.592	
Froude Number:	0.12		0.12	
Roughness Coefficient:	0.1265		0.1265	

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International Paper
Riegelwood, North Carolina
Closure E&S Design

Channels B1-B14

Culvets BB1-BB2 (Pipes P4, P5)

Channels Lined with Straw w/ Net and 20 mil Plastic

25 yr Storm used to design E&S structures.

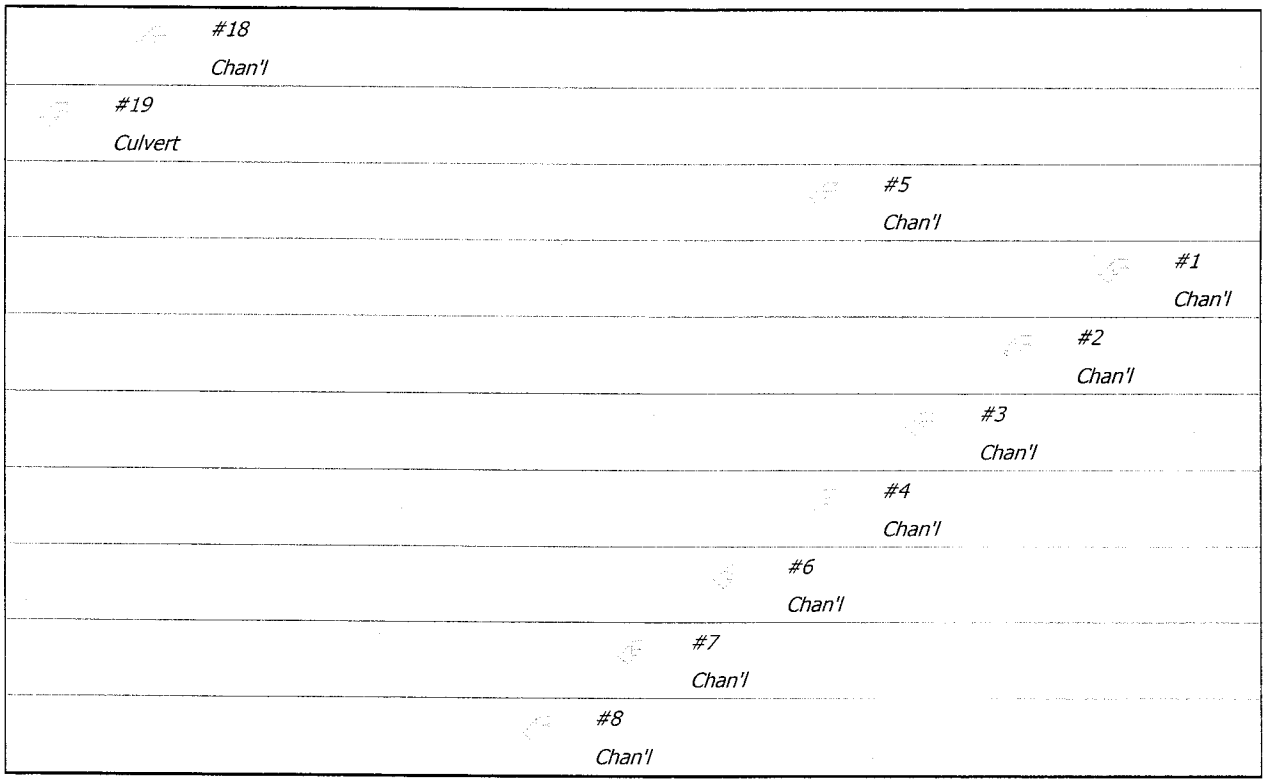
Dan Moss

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, NC 28273

4/1/97

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#2	0.000	0.000	Channel B1
Channel	#2	==>	#3	0.000	0.000	Channel B2 Channel B2
Channel	#3	==>	#4	0.000	0.000	Channel B3
Channel	#4	==>	#6	0.000	0.000	Channel B4
Channel	#5	==>	#6	0.000	0.000	Channel B5
Channel	#6	==>	#7	0.000	0.000	Channel B6
Channel	#7	==>	#8	0.000	0.000	Channel B7
Channel	#8	==>	#9	0.000	0.000	Channel B8
Channel	#9	==>	#14	0.000	0.000	Channel B9
Channel	#14	==>	#15	0.000	0.000	Channel B10
Channel	#15	==>	#16	0.000	0.000	Channel B11
Channel	#16	==>	#17	0.000	0.000	Channel B12
Channel	#17	==>	#20	0.000	0.000	Channel B13
Channel	#18	==>	#19	0.000	0.000	Channel B14
Culvert	#19	==>	#20	0.000	0.000	Culvert BB1 - Pipe P4
Null	#20	==>	End	0.000	0.000	Culvert BB2 - Pipe P5



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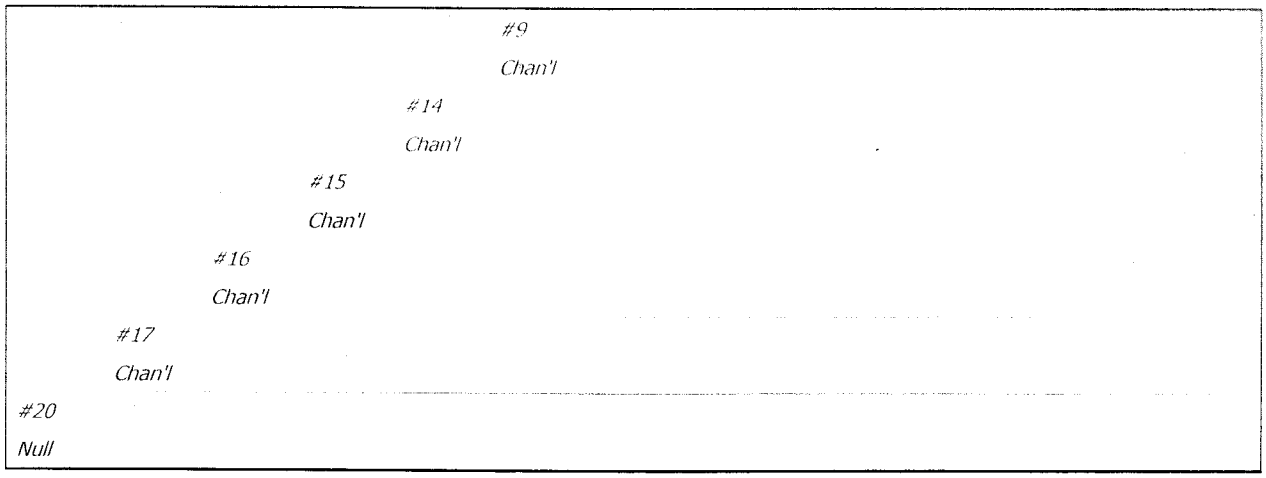

A3/99

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#18	0.390	0.390	1.21	0.22
#19	0.000	0.390	1.21	0.22
#5	4.740	4.740	14.85	2.66
#1	0.170	0.170	0.53	0.10
#2	0.160	0.330	1.02	0.18
#3	0.670	1.000	3.09	0.56
#4	0.420	1.420	4.39	0.80
#6	0.040	6.200	19.34	3.48
#7	2.980	9.180	28.57	5.15
#8	0.630	9.810	30.52	5.50
#9	0.900	10.710	33.30	6.00
#14	0.470	11.180	34.76	6.27
#15	0.090	11.270	35.03	6.32
#16	0.460	11.730	36.46	6.58
#17	0.510	12.240	38.04	6.86
#20	0.000	12.630	39.24	7.08

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Structure Detail:

Channel B1

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	9.4	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.53 cfs	
Depth:	0.17 ft	
Top Width:	1.00 ft	
Velocity:	6.49 fps	
X-Section Area:	0.08 sq ft	
Hydraulic Radius:	0.079	
Froude Number:	3.96	

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Structure Detail:

Channel B2

Channel B2

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	4.0	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.02 cfs	
Depth:	0.25 ft	
Top Width:	1.49 ft	
Velocity:	5.51 fps	
X-Section Area:	0.18 sq ft	
Hydraulic Radius:	0.118	
Froude Number:	2.75	

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Structure Detail:

Channel B3

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	2.3	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	3.09 cfs	
Depth:	0.42 ft	
Top Width:	2.50 ft	
Velocity:	5.94 fps	
X-Section Area:	0.52 sq ft	
Hydraulic Radius:	0.198	
Froude Number:	2.29	

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Structure Detail:

Channel B4

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	3.2	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	4.39 cfs	
Depth:	0.45 ft	
Top Width:	2.69 ft	
Velocity:	7.29 fps	
X-Section Area:	0.60 sq ft	
Hydraulic Radius:	0.212	
Froude Number:	2.71	

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Structure Detail:

Channel B5

Triangular Nonerodible Channel Inputs:

Material: Straw w/ net

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.0:1	20.0:1	1.0	0.0330			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	14.85 cfs	
Depth:	0.76 ft	
Top Width:	16.65 ft	
Velocity:	2.36 fps	
X-Section Area:	6.30 sq ft	
Hydraulic Radius:	0.377	
Froude Number:	0.67	

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Structure Detail:

Channel B6

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	2.8	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	19.34 cfs	
Depth:	0.80 ft	
Top Width:	4.80 ft	
Velocity:	10.06 fps	
X-Section Area:	1.92 sq ft	
Hydraulic Radius:	0.380	
Froude Number:	2.80	

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Structure Detail:

Channel B7

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	2.0	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	28.57 cfs	
Depth:	0.99 ft	
Top Width:	5.92 ft	
Velocity:	9.77 fps	
X-Section Area:	2.92 sq ft	
Hydraulic Radius:	0.468	
Froude Number:	2.45	

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Structure Detail:

Channel B8

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	2.6	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	30.52 cfs	
Depth:	0.96 ft	
Top Width:	5.77 ft	
Velocity:	10.98 fps	
X-Section Area:	2.78 sq ft	
Hydraulic Radius:	0.457	
Froude Number:	2.79	

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Structure Detail:

Channel B9

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	1.9	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	33.30 cfs	
Depth:	1.06 ft	
Top Width:	6.35 ft	
Velocity:	9.92 fps	
X-Section Area:	3.36 sq ft	
Hydraulic Radius:	0.502	
Froude Number:	2.40	

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Structure Detail:

Channel B10

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	10.0	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	34.76 cfs	
Depth:	0.79 ft	
Top Width:	4.72 ft	
Velocity:	18.77 fps	
X-Section Area:	1.85 sq ft	
Hydraulic Radius:	0.373	
Froude Number:	5.28	

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Structure Detail:

Channel B11

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	2.5	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	35.03 cfs	
Depth:	1.02 ft	
Top Width:	6.13 ft	
Velocity:	11.18 fps	
X-Section Area:	3.13 sq ft	
Hydraulic Radius:	0.485	
Froude Number:	2.76	

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Structure Detail:

Channel B12

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	10.0	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	36.46 cfs	
Depth:	0.80 ft	
Top Width:	4.80 ft	
Velocity:	18.99 fps	
X-Section Area:	1.92 sq ft	
Hydraulic Radius:	0.379	
Froude Number:	5.29	

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Structure Detail:

Channel B13

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	1.1	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	38.04 cfs	
Depth:	1.23 ft	
Top Width:	7.36 ft	
Velocity:	8.42 fps	
X-Section Area:	4.52 sq ft	
Hydraulic Radius:	0.582	
Froude Number:	1.89	

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Structure Detail:

Channel B14

Triangular Nonerodible Channel Inputs:

Material: Straw w/ net

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	0.6	0.0330			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.21 cfs	
Depth:	0.53 ft	
Top Width:	3.17 ft	
Velocity:	1.45 fps	
X-Section Area:	0.84 sq ft	
Hydraulic Radius:	0.250	
Froude Number:	0.50	

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Structure Detail:

~~Structure #1 (Culvert)~~

Culvert BB1 - Pipe P5

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
140.00	1.78	0.0100	2.00	1.50	0.20

Culvert Results:

Design Discharge = 1.21 cfs

Minimum pipe diameter: 1 - 8 inch pipe(s) required

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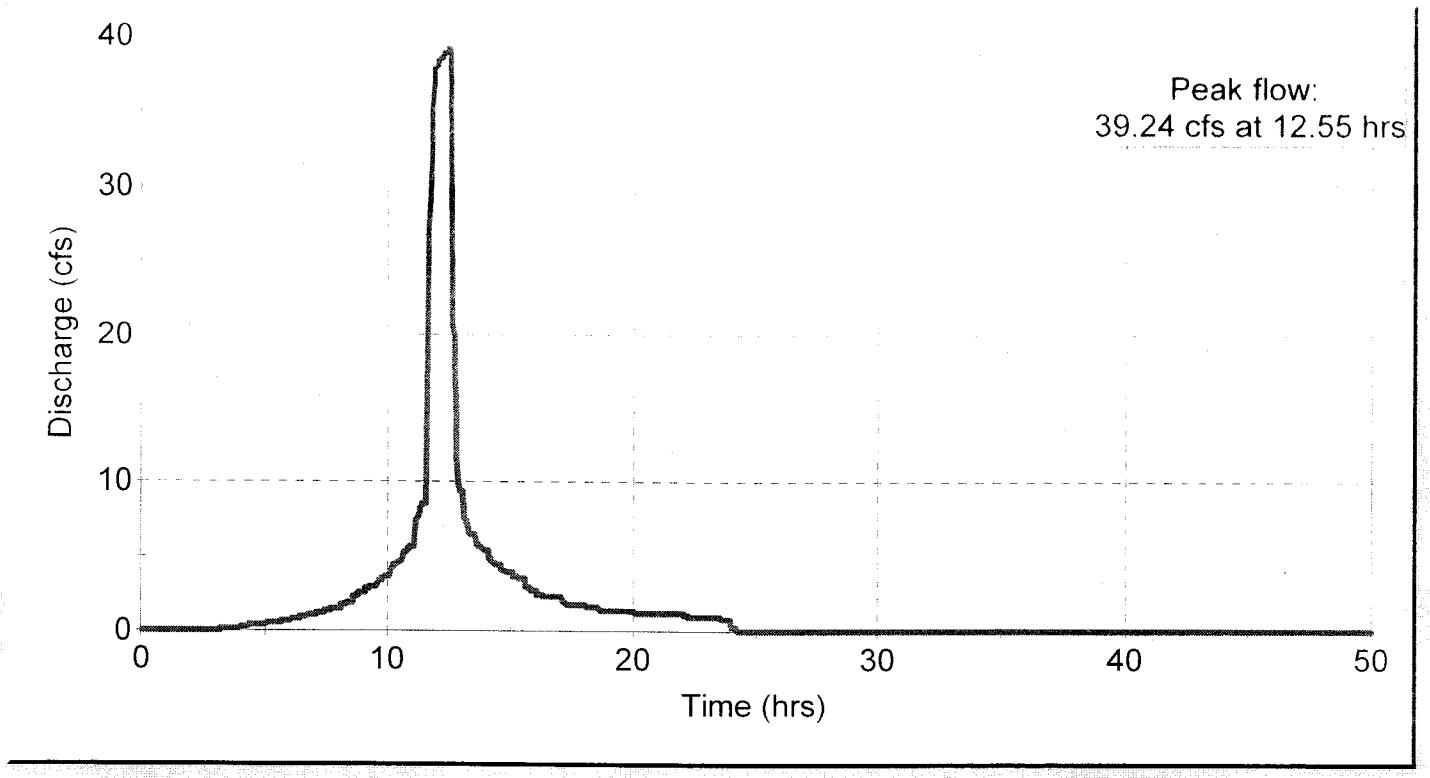
Structure Detail:

Culvert BB2 - Pipe P6

Q = 39.24 cfs (SEE PAGE 60)

Total Inflow Hydrograph to Structure # 20 (includes all upstream flow)



CULVERT BB2 (PIPE P6)

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Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#18	1	0.390	0.036	0.000	0.000	91.000	TR55	1.21	0.219
		0.390						**1.21**	**0.219**
#19		**0.390**						**1.21**	**0.219**
#5	1	4.740	0.140	0.000	0.000	91.000	TR55	14.85	2.657
		4.740						**14.85**	**2.657**
#1	1	0.170	0.034	0.000	0.000	91.000	TR55	0.53	0.095
		0.170						**0.53**	**0.095**
#2	1	0.160	0.005	0.000	0.000	91.000	TR55	0.50	0.090
		0.330						**1.02**	**0.185**
#3	1	0.670	0.027	0.000	0.000	91.000	TR55	2.07	0.376
		1.000						**3.09**	**0.561**
#4	1	0.420	0.025	0.000	0.000	91.000	TR55	1.30	0.235
		1.420						**4.39**	**0.796**
#6	1	0.040	0.006	0.000	0.000	91.000	TR55	0.12	0.022
		6.200						**19.34**	**3.476**
#7	1	2.980	0.056	0.000	0.000	91.000	TR55	9.22	1.671
		9.180						**28.57**	**5.146**
#8	1	0.630	0.022	0.000	0.000	91.000	TR55	1.95	0.353
		9.810						**30.52**	**5.499**
#9	1	0.900	0.028	0.000	0.000	91.000	TR55	2.79	0.505
		10.710						**33.30**	**6.004**
#14	1	0.470	0.008	0.000	0.000	91.000	TR55	1.45	0.263
		11.180						**34.76**	**6.267**
#15	1	0.090	0.005	0.000	0.000	91.000	TR55	0.28	0.050
		11.270						**35.03**	**6.318**
#16	1	0.460	0.006	0.000	0.000	91.000	TR55	1.42	0.258
		11.730						**36.46**	**6.576**
#17	1	0.510	0.018	0.000	0.000	91.000	TR55	1.58	0.286
		12.240						**38.04**	**6.862**
#20		**12.630**						**39.24**	**7.080**

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Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	0.91	1.00	110.00	0.950	0.032
		8. Large gullies, diversions, and low flowing streams	9.41	8.00	85.00	9.200	0.002
#1	**1**	**Time of Concentration:**					**0.034**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	20.00	6.00	30.00	4.470	0.001
		8. Large gullies, diversions, and low flowing streams	4.00	4.00	100.00	6.000	0.004
#2	**1**	**Time of Concentration:**					**0.005**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	22.50	4.50	20.00	4.740	0.001
		8. Large gullies, diversions, and low flowing streams	2.33	10.00	430.00	4.570	0.026
#3	**1**	**Time of Concentration:**					**0.027**
#4	1	5. Nearly bare and untilled, and alluvial valley fans	4.38	7.00	160.00	2.090	0.021
		5. Nearly bare and untilled, and alluvial valley fans	22.22	2.00	9.00	4.710	0.000
		8. Large gullies, diversions, and low flowing streams	3.19	2.87	90.00	5.350	0.004
#4	**1**	**Time of Concentration:**					**0.025**
#5	1	5. Nearly bare and untilled, and alluvial valley fans	1.00	1.00	100.00	1.000	0.027
		5. Nearly bare and untilled, and alluvial valley fans	4.14	12.00	290.00	2.030	0.039
		8. Large gullies, diversions, and low flowing streams	1.00	8.00	800.00	3.000	0.074
#5	**1**	**Time of Concentration:**					**0.140**
#6	1	5. Nearly bare and untilled, and alluvial valley fans	2.00	0.50	25.00	1.410	0.004
		8. Large gullies, diversions, and low flowing streams	2.80	1.12	40.00	5.010	0.002
#6	**1**	**Time of Concentration:**					**0.006**
#7	1	5. Nearly bare and untilled, and alluvial valley fans	2.00	0.50	25.00	1.410	0.004
		8. Large gullies, diversions, and low flowing streams	2.00	16.00	800.00	4.240	0.052
#7	**1**	**Time of Concentration:**					**0.056**
#8	1	5. Nearly bare and untilled, and alluvial valley fans	4.45	2.67	60.00	2.100	0.007
		5. Nearly bare and untilled, and alluvial valley fans	33.33	19.00	57.00	5.770	0.002
		8. Large gullies, diversions, and low flowing streams	2.61	6.00	230.00	4.840	0.013
#8	**1**	**Time of Concentration:**					**0.022**
#9	1	5. Nearly bare and untilled, and alluvial valley fans	5.00	2.00	40.00	2.230	0.004

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Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		5. Nearly bare and untilled, and alluvial valley fans	33.33	24.99	75.00	5.770	0.003
		8. Large gullies, diversions, and low flowing streams	1.88	6.00	320.00	4.100	0.021
#9	**1**	**Time of Concentration:**					**0.028**
#14	1	5. Nearly bare and untilled, and alluvial valley fans	33.33	26.66	80.00	5.770	0.003
		8. Large gullies, diversions, and low flowing streams	10.00	19.00	190.00	9.480	0.005
#14	**1**	**Time of Concentration:**					**0.008**
#15	1	5. Nearly bare and untilled, and alluvial valley fans	33.33	10.66	32.00	5.770	0.001
		8. Large gullies, diversions, and low flowing streams	2.50	2.00	80.00	4.740	0.004
#15	**1**	**Time of Concentration:**					**0.005**
#16	1	5. Nearly bare and untilled, and alluvial valley fans	33.33	11.66	35.00	5.770	0.001
		8. Large gullies, diversions, and low flowing streams	10.00	18.00	180.00	9.480	0.005
#16	**1**	**Time of Concentration:**					**0.006**
#17	1	5. Nearly bare and untilled, and alluvial valley fans	33.33	26.66	80.00	5.770	0.003
		8. Large gullies, diversions, and low flowing streams	1.11	2.00	180.00	3.160	0.015
#17	**1**	**Time of Concentration:**					**0.018**
#18	1	5. Nearly bare and untilled, and alluvial valley fans	7.50	3.00	40.00	2.730	0.004
		5. Nearly bare and untilled, and alluvial valley fans	23.33	14.00	60.00	4.830	0.003
		8. Large gullies, diversions, and low flowing streams	0.87	2.62	300.00	2.800	0.029
#18	**1**	**Time of Concentration:**					**0.036**

6/99

International Paper
Riegelwood, North Carolina
Closure E&S Design

Channels B5, B14

Channels Lined w/ Grass

25 yr Storm used to design E&S structures.

Dan Moss

Structure Detail:

Channel B5

Triangular Vegetated Channel Inputs:

Material: Bermuda grass

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	20.0:1	1.0	C, C				5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	14.85 cfs		14.85 cfs	
Depth:	1.15 ft		1.15 ft	
Top Width:	25.39 ft		25.39 ft	
Velocity:	1.01 fps		1.01 fps	
X-Section Area:	14.65 sq ft		14.65 sq ft	
Hydraulic Radius:	0.575		0.575	
Froude Number:	0.24		0.24	
Roughness Coefficient:	0.1015		0.1015	

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Structure Detail:

Channel B14

Triangular Vegetated Channel Inputs:

Material: Bermuda grass

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	3.0:1	0.6	C, C				5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	1.21 cfs		1.21 cfs	
Depth:	0.94 ft		0.94 ft	
Top Width:	5.62 ft		5.62 ft	
Velocity:	0.46 fps		0.46 fps	
X-Section Area:	2.63 sq ft		2.63 sq ft	
Hydraulic Radius:	0.444		0.444	
Froude Number:	0.12		0.12	
Roughness Coefficient:	0.1522		0.1522	

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International Paper
Riegelwood, North Carolina
Closure E&S Design

Channel C1-C2

Culvert CC1 (Pipe P6)

Channels Lined with Straw w/ Net and 20 mil Plastic

25 yr Storm used to design E&S structures.

Dan Moss

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Charlotte, NC 28273

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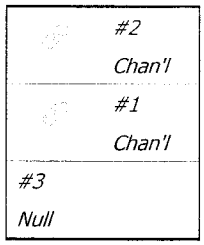
Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#3	0.000	0.000	Channel C1
Channel	#2	==>	#3	0.000	0.000	Channel C2
Null	#3	==>	End	0.000	0.000	Culvert CC1 - Pipe P6



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	0.260	0.260	0.80	0.15
#1	5.770	5.770	17.89	3.23
#3	0.000	6.030	18.66	3.38

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Structure Detail:

Channel C1

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	20.0:1	1.5	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	17.89 cfs	
Depth:	0.52 ft	
Top Width:	12.00 ft	
Velocity:	5.72 fps	
X-Section Area:	3.13 sq ft	
Hydraulic Radius:	0.260	
Froude Number:	1.97	

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Structure Detail:

Channel C2

Triangular Nonerodible Channel Inputs:

Material: Straw w/ net

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	0.6	0.0450			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.80 cfs	
Depth:	0.51 ft	
Top Width:	3.06 ft	
Velocity:	1.04 fps	
X-Section Area:	0.78 sq ft	
Hydraulic Radius:	0.242	
Froude Number:	0.36	

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Structure Detail:

Culvert CC1 - Pipe P6

Q = 18.66 cfs (SEE PAGE 73)

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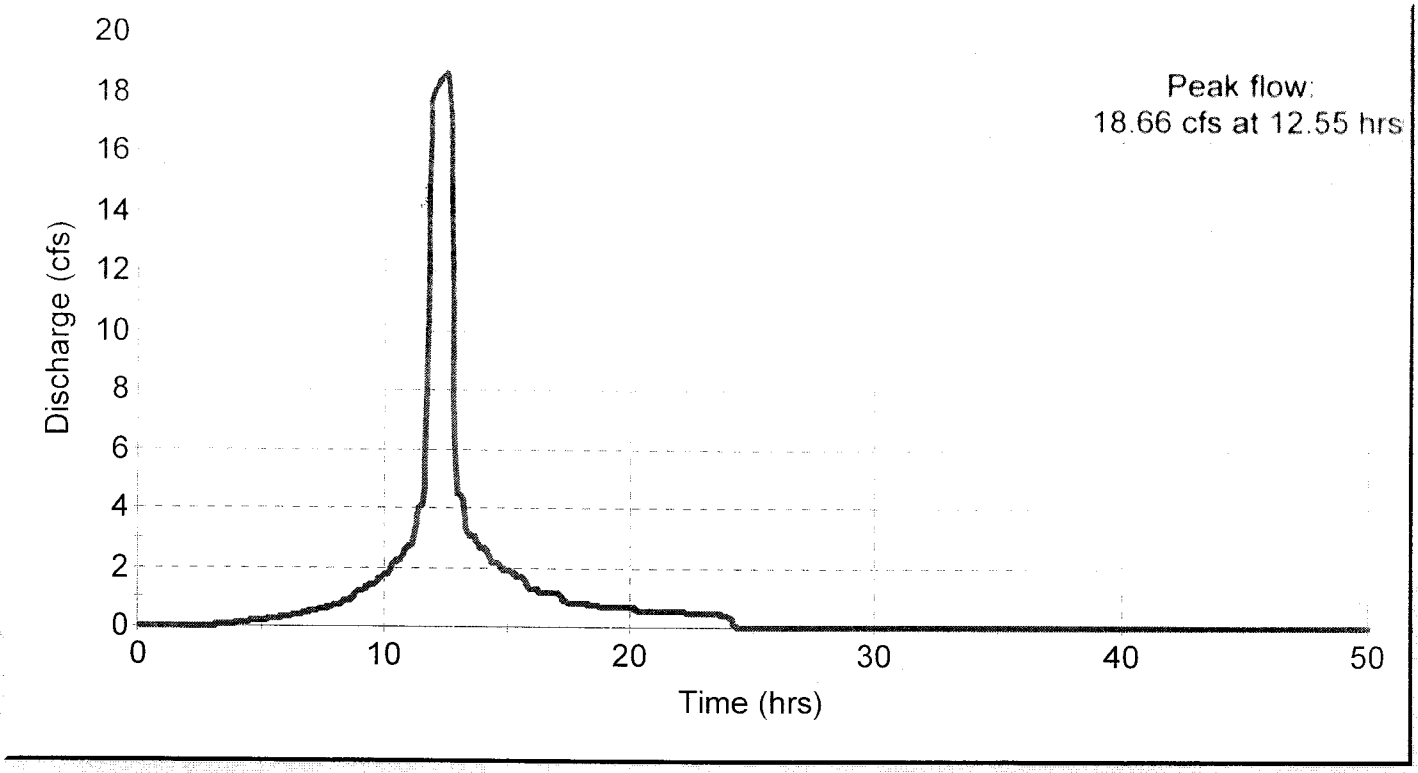
Total Inflow Hydrograph to Structure # 3 (includes all upstream flow)



CULVERT CC1 - (PIPE PC)

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Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	0.260	0.047	0.000	0.000	91.000	TR55	0.80	0.146
		0.260						**0.80**	**0.146**
#1	1	5.770	0.192	0.000	0.000	91.000	TR55	17.89	3.235
		5.770						**17.89**	**3.235**
#3		**6.030**						**18.66**	**3.380**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	5.00	3.75	75.00	2.230	0.009
		5. Nearly bare and untilled, and alluvial valley fans	33.33	30.00	90.00	5.770	0.004
		8. Large gullies, diversions, and low flowing streams	1.50	35.55	2,370.00	3.670	0.179
#1	**1**	**Time of Concentration:**					**0.192**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	6.67	2.00	30.00	2.580	0.003
		5. Nearly bare and untilled, and alluvial valley fans	10.00	2.00	20.00	3.160	0.001
		5. Nearly bare and untilled, and alluvial valley fans	0.10	0.01	10.01	0.310	0.008
		8. Large gullies, diversions, and low flowing streams	0.65	2.00	307.00	2.420	0.035
#2	**1**	**Time of Concentration:**					**0.047**

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Riegelwood, North Carolina
Closure E&S Design

Channel C2

Channel Lined w/ Grass

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Structure Detail:

Channel C2

Triangular Vegetated Channel Inputs:

Material: Bermuda grass

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	3.0:1	0.6	C, C				5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	0.80 cfs		0.80 cfs	
Depth:	0.84 ft		0.84 ft	
Top Width:	5.04 ft		5.04 ft	
Velocity:	0.38 fps		0.38 fps	
X-Section Area:	2.12 sq ft		2.12 sq ft	
Hydraulic Radius:	0.398		0.398	
Froude Number:	0.10		0.10	
Roughness Coefficient:	0.1707		0.1707	

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International Paper
Riegelwood, North Carolina
Closure E&S Design

Channels D1-D2

Culvert DD1 (Pipe P7)

Channels Lined with Straw w/ Net and 20 mil Plastic

25 yr Storm used to design E&S structures.

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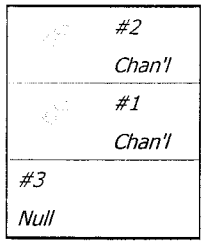
Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#3	0.000	0.000	Channel D1
Channel	#2	==>	#3	0.000	0.000	Channel D2
Null	#3	==>	End	0.000	0.000	Culvert DD1 - Pipe P7



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Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	3.150	3.150	9.75	1.77
#1	0.570	0.570	1.76	0.32
#3	0.000	3.720	11.51	2.09

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Structure Detail:

Channel D1

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	20.0:1	2.2	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.76 cfs	
Depth:	0.20 ft	
Top Width:	4.67 ft	
Velocity:	3.71 fps	
X-Section Area:	0.47 sq ft	
Hydraulic Radius:	0.101	
Froude Number:	2.05	

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Structure Detail:

Channel D2

Triangular Nonerodible Channel Inputs:

Material: 20 mil Plastic

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
20.0:1	3.0:1	2.0	0.0130			

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	9.75 cfs	
Depth:	0.39 ft	
Top Width:	9.05 ft	
Velocity:	5.47 fps	
X-Section Area:	1.78 sq ft	
Hydraulic Radius:	0.196	
Froude Number:	2.17	

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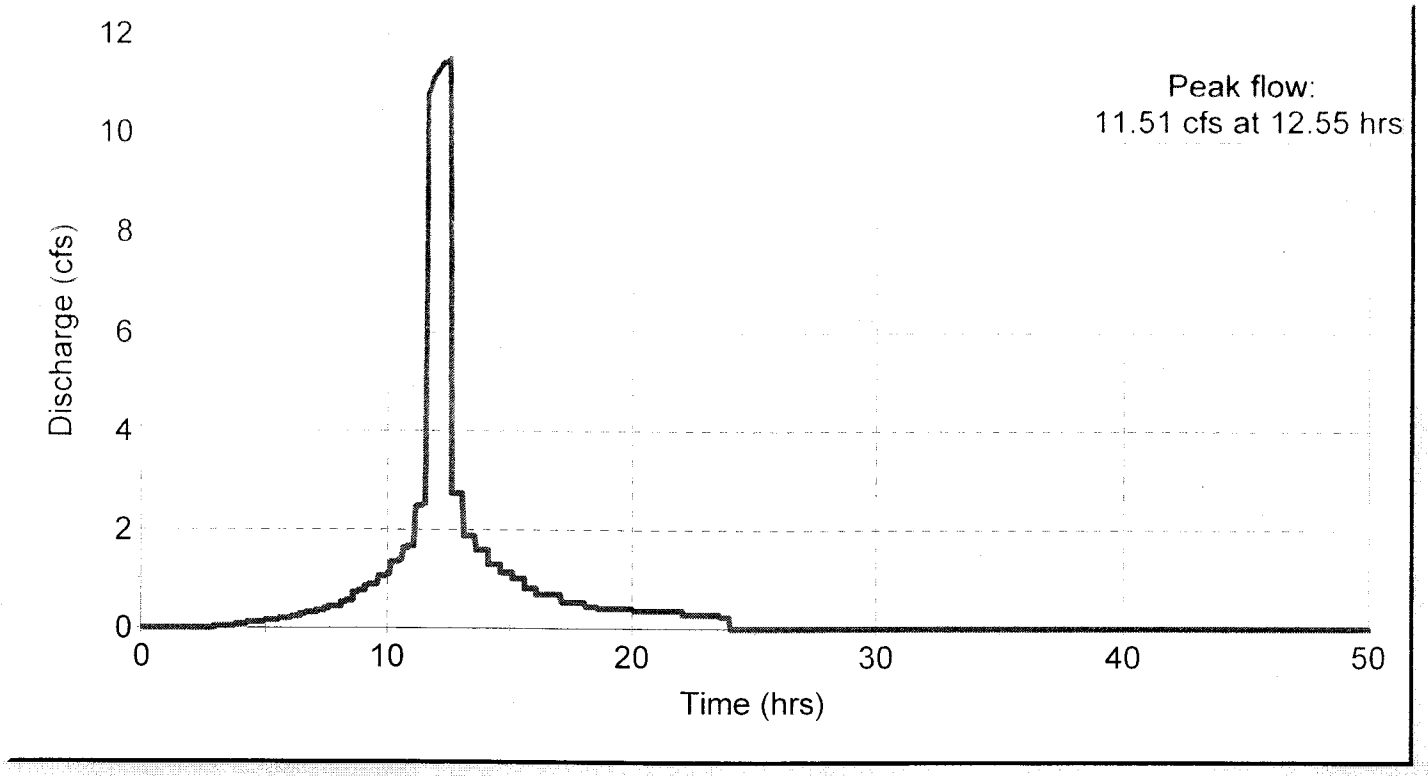
Structure Detail:

Culvert DD1 - Pipe P8

Q = 11.51 cfs (SEE PAGE 83)

Total Inflow Hydrograph to Structure # 3 (includes all upstream flow)



CULVERT DD1 (PIPE P8)

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Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	3.150	0.086	0.000	0.000	91.000	TR55	9.75	1.766
		3.150						**9.75**	**1.766**
#1	1	0.570	0.017	0.000	0.000	91.000	TR55	1.76	0.320
		0.570						**1.76**	**0.320**
#3		**3.720**						**11.51**	**2.085**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	33.33	36.66	109.99	5.770	0.005
		8. Large gullies, diversions, and low flowing streams	2.22	4.44	200.00	4.460	0.012
#1	**1**	**Time of Concentration:**					**0.017**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	5.00	3.75	75.00	2.230	0.009
		5. Nearly bare and untilled, and alluvial valley fans	33.33	30.00	90.00	5.770	0.004
		8. Large gullies, diversions, and low flowing streams	2.00	22.40	1,120.00	4.240	0.073
#2	**1**	**Time of Concentration:**					**0.086**

[REF #2]

8/5/89

(continued)
Sample Problem 8.05a
Design of a
grass-lined channel.

Channel summary:
Trapezoidal shape, Z=3, b=3 ft, d=1.5 ft, grade = 2%

Note: In Sample Problem 8.05a the "n-value" is first choosen based on a permissible velocity and not a design velocity criteria. Therefore the use of table 8.05c may not be as accurate as individual retardance class charts when a design velocity is the determining factor.

Tractive Force Procedure

The design of riprap-lined channels and temporary channel linings is based on analysis of tractive force.

NOTE: This procedure is for uniform flow in channels and is *not* to be used for design of deenergizing devices and may not be valid for larger channels

To calculate the required size of an open channel, assume the design flow is uniform and does not vary with time. Since actual flow conditions change through the length of a channel, subdivide the channel into design reaches as appropriate.

PERMISSIBLE SHEAR STRESS

The permissible shear stress, T_d, is the force required to initiate movement of the lining material. Permissible shear stress for the liner is not related to the erodibility of the underlying soil. However, if the lining is eroded or broken, the bed material will be exposed to the erosive force of the flow.

COMPUTING NORMAL DEPTH

The first step in selecting an appropriate lining is to compute the design flow depth (the normal depth) and determine the shear stress.

Normal depths can be calculated by Manning's equation as shown for trapezoidal channels in Figure 8.05d. Values of the Manning's roughness coefficient for different ranges of depth are provided in Table 8.05e for temporary linings and Table 8.05f for riprap. The coefficient of roughness generally decreases with increasing flow depth.

Table 8.05e
Manning's Roughness
Coefficients for Temporary
Lining Materials

	n value for Depth Ranges*		
	0-0.5 ft	0.5-2.0 ft	>2.0 ft
Lining Type			
Woven Paper Net	0.016	0.015	0.015
Jute Net	0.028	0.022	0.019
Fiberglass Roving	0.028	0.021	0.019
→ Straw with Net	→ 0.065	→ 0.033	0.025
Curled Wood Mat	0.066	0.035	0.028
Synthetic Mat	0.036	0.025	0.021

* Adapted from: FHWA-HEC 15, Pg. 37 - April 1988

{REF #27}

8/99

Design Procedure-Permissible Velocity

The following is a step-by-step procedure for designing a runoff conveyance channel using Manning's equation and the continuity equation:

Step 1. Determine the required flow capacity, Q, by estimating peak runoff rate for the design storm (*Appendix 8.03*).

Step 2. Determine the slope and select channel geometry and lining.

Step 3. Determine the permissible velocity for the lining selected, or the desired velocity, if paved. (see Table 8.05a, pg. 8.05.4)

Step 4. Make an initial estimate of channel size—divide the required Q by the permissible velocity to reach a "first try" estimate of channel flow area. Then select a geometry, depth and top width to fit site conditions.

Step 5. Calculate the hydraulic radius, R, from channel geometry (Figure 8.05b, pg. 8.05.5).

Step 6. Determine roughness coefficient *n*.

Structural Linings—see Table 8.05b, pg. 8.05.6.

Grass Lining:

a. Determine retardance class for vegetation from Table 8.05c, pg. 8.05.8. To meet stability requirement, use retardance for newly mowed condition (generally C or D). To determine channel capacity, use at least one retardance class higher.

b. Determine *n* from Figure 8.05c, pg. 8.05.7.

Step 7. Calculate the actual channel velocity, V, using Manning's equation (Figure 8.05a, pg. 8.05.3), and calculate channel capacity, Q, using the continuity equation.

Step 8. Check results against permissible velocity and required design capacity to determine if design is acceptable.

Step 9. If design is not acceptable, alter channel dimensions as appropriate. For trapezoidal channels, this adjustment is usually made by changing the bottom width.

Table 8.05b
Manning's *n* for Structural Channel Linings

Channel Lining	Recommended *n* values
Asphaltic concrete, machine placed	0.014
Asphalt, exposed prefabricated	0.015
Concrete	0.015
Metal, corrugated	0.024
Plastic	0.013
Shotcrete	0.017
Gabion	0.030
Earth	0.020

Source: American Society of Civil Engineers (modified)

Table 8.05g
Permissible Shear Stresses for Riprap and Temporary Liners

Lining Category	Lining Type	Permissible Unit Shear Stress, T_d (lb/ft^2)
Temporary	Woven Paper Net	0.15
	Jute Net	0.45
	Fiberglass Roving:	
	Single	0.60
	Double	0.85
	Straw with Net	1.45
	Curled Wood mat	1.55
	Synthetic Mat	2.00
	d_{50} Stone Size (inches)	
Gravel Riprap	1	0.33
	2	0.67
Rock Riprap	6	2.00
	9	3.00
	12	4.00
	15	5.00
	18	6.00
	21	7.80
	24	8.00

Adapted From: FHWA, HEC-15, April 1983, pgs. 17 & 37.

Design Procedure-Temporary Liners

The following is a step-by-step procedure for designing a temporary liner for a channel. Because temporary liners have a short period of service, the design Q may be reduced. For liners that are needed for six months or less, the 2-yr frequency storm is recommended.

Step 1. Select a liner material suitable for site conditions and application. Determine roughness coefficient from manufacturer's specifications or Table 8.05e, pg. 8.05.10.

Step 2. Calculate the normal flow depth using Manning's equation (Figure 8.05d). Check to see that depth is consistent with that assumed for selection of Manning's *n* in Figure 8.05d, pg. 8.05.11. For smaller runoffs Figure 8.05d is not as clearly defined. Recommended solutions can be determined by using the Manning equation.

Step 3. Calculate shear stress at normal depth.

Step 4. Compare computed shear stress with the permissible shear stress for the liner.

Step 5. If computed shear is greater than permissible shear, adjust channel dimensions to reduce shear or select a more resistant lining and repeat steps 1 through 4.

Design of a channel with temporary lining is illustrated in Sample Problem 8.05b, pg. 8.05.14.

[REF # 2]

8 of 8

Table 8.05c
Retardance Classification for Vegetal Covers

Retardance	Cover	Condition
A	Reed canarygrass	Excellent stand, tall (average 36")
	Weeping lovegrass	Excellent stand, tall (average 30")
B	Tall fescue	Good stand, uncut, (average 18")
	Bermudagrass	Good stand, tall (average 12")
	Grass-legume mixture (tall fescue, red fescue, sericea lespedeza)	Good stand, uncut
	Grass mixture (timothy, smooth bromegrass or orchardgrass)	Good stand, uncut (average 20")
	Sericea lespedeza	Good stand, not woody, tall (average 19")
	Reed canarygrass	Good stand, cut (average 12-15")
	Alfalfa	Good stand, uncut (average 11")
C	Tall fescue	Good stand (8-12")
	Bermudagrass	Good stand, cut (average 6")
	Bahiagrass	Good stand, uncut (6-8")
	Grass-legume mixture-- summer (orchardgrass, redtop and annual lespedeza)	Good stand, uncut (6-8")
	Centipedegrass	Very dense cover (average 6")
	Kentucky bluegrass	Good stand, headed (6-12")
	Redtop	Good stand, uncut (15-20")
D	Tall fescue	Good stand, cut (3-4")
	Bermudagrass	Good stand, cut (2.5")
	Bahiagrass	Good stand, cut (3-4")
	Grass-legume mixture-- fall-spring (orchard-grass, redtop, and annual lespedeza)	Good stand, uncut (4-5")
	Red fescue	Good stand, uncut (12-18")
	Centipedegrass	Good stand, cut (3-4")
	Kentucky bluegrass	Good stand, cut (3-4")
E	Bermudagrass	Good stand, cut (1.5")
	Bermudagrass	Burned stubble

Modified from: USDA-SCS, 1969. Engineering Field Manual.

[REF#2]

Table 8.05a
Maximum Allowable Design Velocities[1] for Vegetated Channels

Typical Channel Slope Application	Soil Characteristics[2]	Grass Lining	Permissible Velocity[3] for Established Grass Lining (ft/sec)
0-5%	Easily Erodible Non-plastic (Sands & Silts)	Bermudagrass	5.0
		Tall fescue	4.5
		Bahiagrass	4.5
		Kentucky bluegrass	4.5
		Grass-legume mixture	3.5
	Erosion Resistant Plastic (Clay mixes)	Bermudagrass	6.0
		Tall fescue	5.5
		Bahiagrass	5.5
		Kentucky bluegrass	5.5
		Grass-legume mixture	4.5
5-10%	Easily Erodible Non-plastic (Sands & Silts)	Bermudagrass	4.5
		Tall fescue	4.0
		Bahiagrass	4.0
		Kentucky bluegrass	4.0
		Grass-legume mixture	3.0
	Erosion Resistant Plastic (Clay Mixes)	Bermudagrass	5.5
		Tall fescue	5.0
		Bahiagrass	5.0
		Kentucky bluegrass	5.0
		Grass-legume mixture	3.5
>10%	Easily Erodible Non-plastic (Sands & Silts)	Bermudagrass	3.5
		Tall fescue	2.5
		Bahiagrass	2.5
		Kentucky bluegrass	2.5
	Erosion Resistant Plastic (Clay Mixes)	Bermudagrass	4.5
		Tall fescue	3.5
		Bahiagrass	3.5
		Kentucky bluegrass	3.5

Source: USDA-SCS Modified

NOTE: [1]Permissible Velocity based on 10-yr storm peak runoff
[2]Soil erodibility based on resistance to soil movement from concentrated flowing water.
[3]Before grass is established, permissible velocity is determined by the type of temporary liner used.

Selecting Channel Cross-Section Geometry

To calculate the required size of an open channel, assume the design flow is uniform and does not vary with time. Since actual flow conditions change throughout the length of a channel, subdivide the channel into design reaches, and design each reach to carry the appropriate capacity.

The three most commonly used channel cross-sections are "V"-shaped, parabolic, and trapezoidal. Figure 8.05b gives mathematical formulas for the area, hydraulic radius and top width of each of these shapes.

Piping Design

S&ME

JOB NO. 1356-99-573
SHEET NO. 1 OF 22
DATE 1/17/2000

JOB NAME INTERNATIONAL PAPER-RIEGELWOOD FAC. ' FINAL CLOSURE
SUBJECT PIPING DESIGN
COMPUTED BY DPM
CHECKED BY SRN

OBJECTIVE: Design the piping for the Drop Inlets that shall collect the stormwater runoff from the Capping System for the International Paper Riegelwood Facility.

REFERENCES:

1) "StormCAD v.1.5," Haestad Methods (computer application)

2) "ADS Specification Manual"

3) "Hancor Literature," 1997

4) "Channel Design Calculations," International Paper-Reigelwood Facility Final Closure S&ME Calculation, 1/17/2000 (Found in this E&S Plan)

GIVEN:

n = 0.010 for ADS N-12 HDPE pipe *[Ref. # 2]*

N = 0.010 for Hancor Sure-Lok HDPE pipe (Alternative to ADS pipe) *[Ref. #3]*

Flows obtained from "Channel Design Calculations" *[Ref. # 4]*

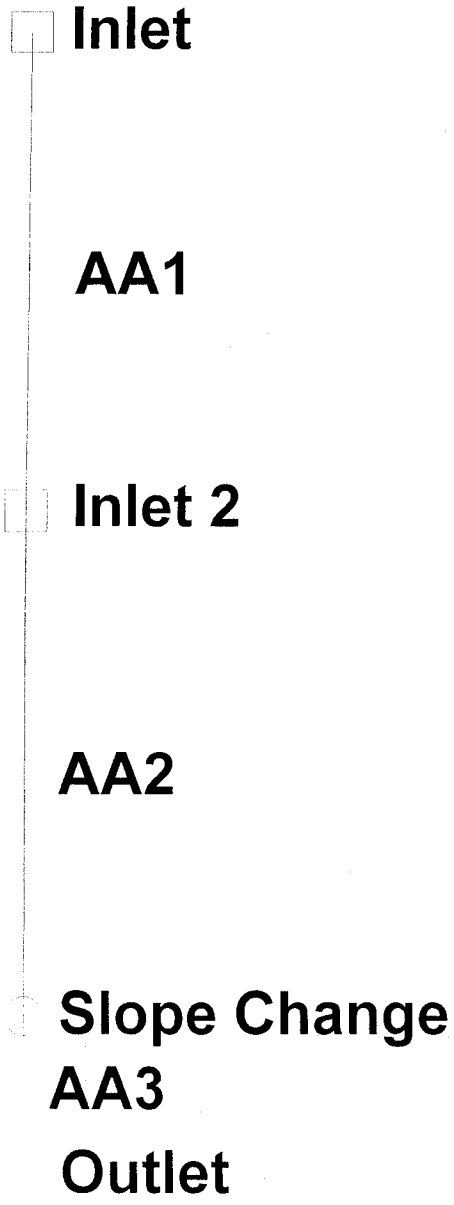
CONCLUSIONS: See Summary Chart attached for pipe locations, sizes designed, and sizes selected.

CALCULATIONS:

See attached sheets.

INTERNATIONAL PAPER - RIEGELWOOD FACILITY
FINAL CAP E&S
PIPE SIZING FOR DROP INLETS

PIPE NO.	PIPE SECTION	AREAS DRAINING TO PIPE	DRAINAGE AREA (Acres)	FLOW Q (cfs)	SLOPE (%)	LENGTH (ft)	PIPE SIZE DESIGNED (in.)	PIPE SIZE SELECTED (in.)
P1	AA1	A1, A2	7.92	24.81	33.33	60	12	15
P2	AA2	A1 - A6	14.71	45.83	33.33	84	15	18
P2	AA3	A1 - A6	14.71	45.83	15.00	40	18	18
P3	AA4	A10, A11	2.26	6.99	33.33	60	8	12
P3	AA4-1	A10, A11	2.26	6.99	16.67	12	10	12
P4	AA5	A1 - A12	18.60	56.65	2.11	3 @ 52	3 - 18	3 - 24
P5	BB1	B14	0.39	1.21	1.79	140	8	12
P6	BB2	B1 - B14	12.63	39.25	1.00	2 @ 50	2 - 24	2 - 24
P7	CC1	C1, C2	6.03	18.66	4.62	65	18	18
P8	DD1	D1, D2	3.72	11.51	30.23	86	10	18
P8	DD1-1	D1, D2	3.72	11.51	2.00	20	15	18


Inlet
AA1
Inlet 2
AA2
Slope Change
AA3
Outlet

DOT Report

Pipe Section	-Node- Upstream Downstream	Inlet Area (acres)	Inlet CA (acres)	Total CA (acres)	-Ground- Upstream Downstream (ft)	-HGL- Upstream Downstream (ft)	-Slope- Energy Constructed (ft/ft)	-Section- Discharge Capacity (cfs)	-Section- Shape Size	Length (ft)	Average Velocity (ft/s)	Pipe #
AA1	Inlet	0.00	0.00	0.00	112.50	111.04	0.309028	24.81	Circular	60.00	29.11	P1
	Inlet 2				92.50	92.50	0.333333	29.81	12 inch			
AA2	Inlet 2	0.00	0.00	0.00	92.50	91.25	0.330371	45.83	Circular	84.00	37.35	P2
	Slope Chang				64.50	63.50	0.333333	48.48	15 inch			
AA3	Slope Chang	N/A	N/A	0.00	64.50	63.50	0.101388	45.83	Circular	40.00	27.21	P2
	Outlet				55.66	57.28	0.150000	52.89	18 inch			

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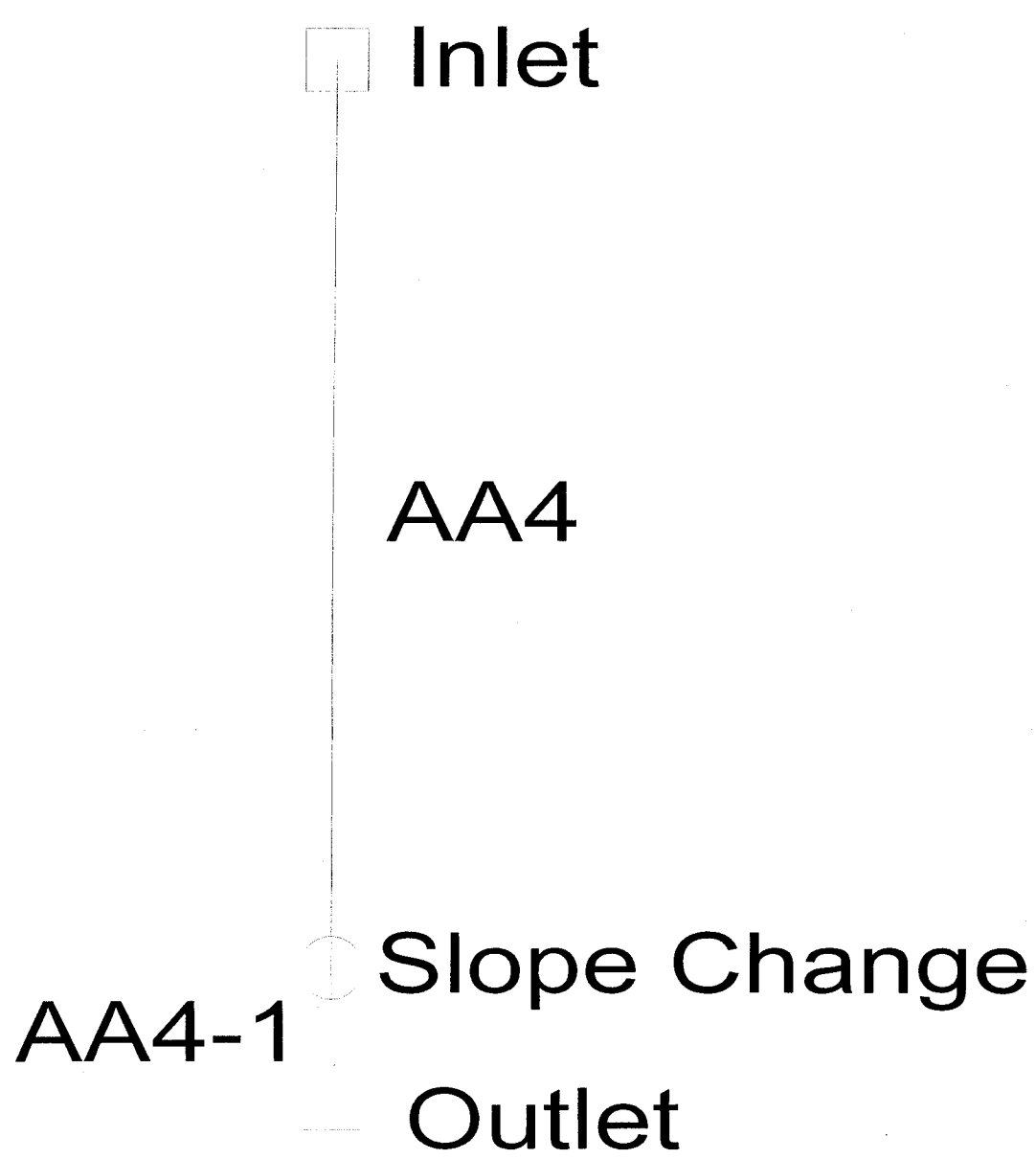
Pipe Report

Pipe Section	Upstream Node	Downstream Node	Discharge (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Roughness	Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream HGL (ft)	Upstream HGL (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)
AA1	Inlet	Inlet 2	24.81	60.00	0.333333	12 inch	0.010	29.81	110.00	90.00	112.50	92.50	111.04	92.50	1.46	1.46
AA2	Inlet 2	Slope Chan	45.83	84.00	0.333333	15 inch	0.010	48.48	90.00	62.00	92.50	63.50	91.25	64.50	1.25	1.25
AA3	Slope C	Outlet	45.83	40.00	0.150000	18 inch	0.010	52.89	62.00	56.00	64.50	57.28	63.50	55.66	1.00	-1.84


Inlet
AA4
AA4-1
Slope Change
Outlet

DOT Report

Pipe Section	-Node- Upstream Downstream	Inlet Area (acres)	Inlet CA (acres)	Total CA (acres)	-Ground- Upstream Downstream (ft)	-HGL- Upstream Downstream (ft)	-Slope- Energy Constructed (ft/ft)	-Section- Discharge Capacity (cfs)	-Section- Shape Size	Length (ft)	Average Velocity (ft/s)	Pipe #
AA4	Inlet	0.00	0.00	0.00	60.50	58.67	0.330616	6.99	Circular	60.00	20.03	P3
	Slope Chang				38.00	38.83	0.333333	9.07	8 inch			
AA4-1	Slope Chang	N/A	N/A	0.00	38.00	38.83	0.062024	6.99	Circular	12.00	14.45	P3
	Outlet				36.00	36.62	0.166667	11.63	10 inch			

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Pipe Report

Pipe Section	Upstream Node	Downstream Node	Discharge (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Roughness	Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream HGL (ft)	Upstream HGL (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)
AA4	Inlet	Slope Chan	6.99	60.00	0.333333	8 inch	0.010	9.07	58.00	38.00	60.50	38.83	58.67	38.00	1.83	-0.67
AA4-1	Slope C	Outlet	6.99	12.00	0.166667	10 inch	0.010	11.63	38.00	36.00	38.00	36.62	38.83	36.00	-0.83	-0.83

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Inlet AA5

AA5

Outlet

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DOT Report

Pipe Section	-Node- Upstream Downstream	Inlet Area (acres)	Inlet CA (acres)	Total CA (acres)	-Ground- Upstream Downstream (ft)	-HGL- Upstream Downstream (ft)	-Slope- Energy Constructed (ft/ft)	-Section- Discharge Capacity (cfs)	-Section- Shape Size	Length (ft)	Average Velocity (ft/s)	Pipe #
AA5	Inlet AA5	0.00	0.00	0.00	34.70	36.16	0.017324	56.65	Circular	52.00	11.33	[redacted]"
	Outlet				33.60	34.86	0.021154	59.58	18 inch			P4

3 PIPES IN PARALLEL

* ALREADY DESIGNED WITH 3-24" PIPES IN INTERIM BERM DESIGN, THUS CAPACITIES ARE OK ✓

Pipe Report

Pipe Section	Upstream Node	Downstream Node	Discharge (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Roughness	Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream HGL (ft)	Upstream HGL (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)
AA5	Inlet AA5	Outlet	56.65	52.00	0.021154	18 inch	0.010	59.58	34.70	33.60	34.70	34.86	36.16	33.60	-1.50	-1.50

3 PIPES IN PARALLEL

HEADWALL INLET

BB1

Inlet

BB2

Outlet

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DOT Report

Pipe Section	-Node- Upstream Downstream	Inlet Area (acres)	Inlet CA (acres)	Total CA (acres)	-Ground- Upstream Downstream (ft)	-HGL- Upstream Downstream (ft)	-Slope- Energy Constructed (ft/ft)	-Section- Discharge Capacity (cfs)	-Section- Shape Size	Length (ft)	Average Velocity (ft/s)	Pipe #
BB1	HEADWALL INL	0.00	0.00	0.00	37.50	38.02	0.013571	1.21	Circular	140.00	3.80	P5
	Inlet				37.00	36.20	0.017857	2.10	8 inch			
BB2	Inlet	0.00	0.00	0.00	37.00	36.09	0.006757	39.25	Circular	50.00	8.22	P6
	Outlet				34.00	35.30	0.010000	58.82	24 inch			

2 PIPES IN PARALLEL

3/22

Pipe Report

Pipe Section	Upstream Node	Downstream Node	Discharge (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Roughness	Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream HGL (ft)	Upstream HGL (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)
BB1	HEADW	Inlet	1.21	140.00	0.017857	8 inch	0.010	2.10	37.50	35.00	37.50	36.20	38.02	37.00	-0.67	1.33
BB2	Inlet	Outlet	39.25	50.00	0.010000	24 inch	0.010	58.82	34.50	34.00	37.00	35.30	36.09	34.00	0.50	-2.00

2 PIPES IN PARALLEL

1/4/22

Inlet C1

CC1

Outlet

DOT Report

Pipe Section	-Node- Upstream Downstream	Inlet Area (acres)	Inlet CA (acres)	Total CA (acres)	-Ground- Upstream Downstream (ft)	-HGL- Upstream Downstream (ft)	-Slope- Energy Constructed (ft/ft)	-Section- Discharge Capacity (cfs)	-Section- Shape Size	Length (ft)	Average Velocity (ft/s)	Pipe #
CC1	Inlet C1	0.00	0.00	0.00	41.00	39.46	0.024772	18.66	Circular	65.00	12.96	P1
	Outlet				34.00	35.98	0.046154	29.34	18 inch			

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Pipe Report

Pipe Section	Upstream Node	Downstream Node	Discharge (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Roughness	Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream HGL (ft)	Upstream HGL (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)
CC1	Inlet C1	Outlet	18.66	65.00	0.046154	18 inch	0.010	29.34	38.00	35.00	41.00	35.98	39.46	34.00	1.50	-2.50

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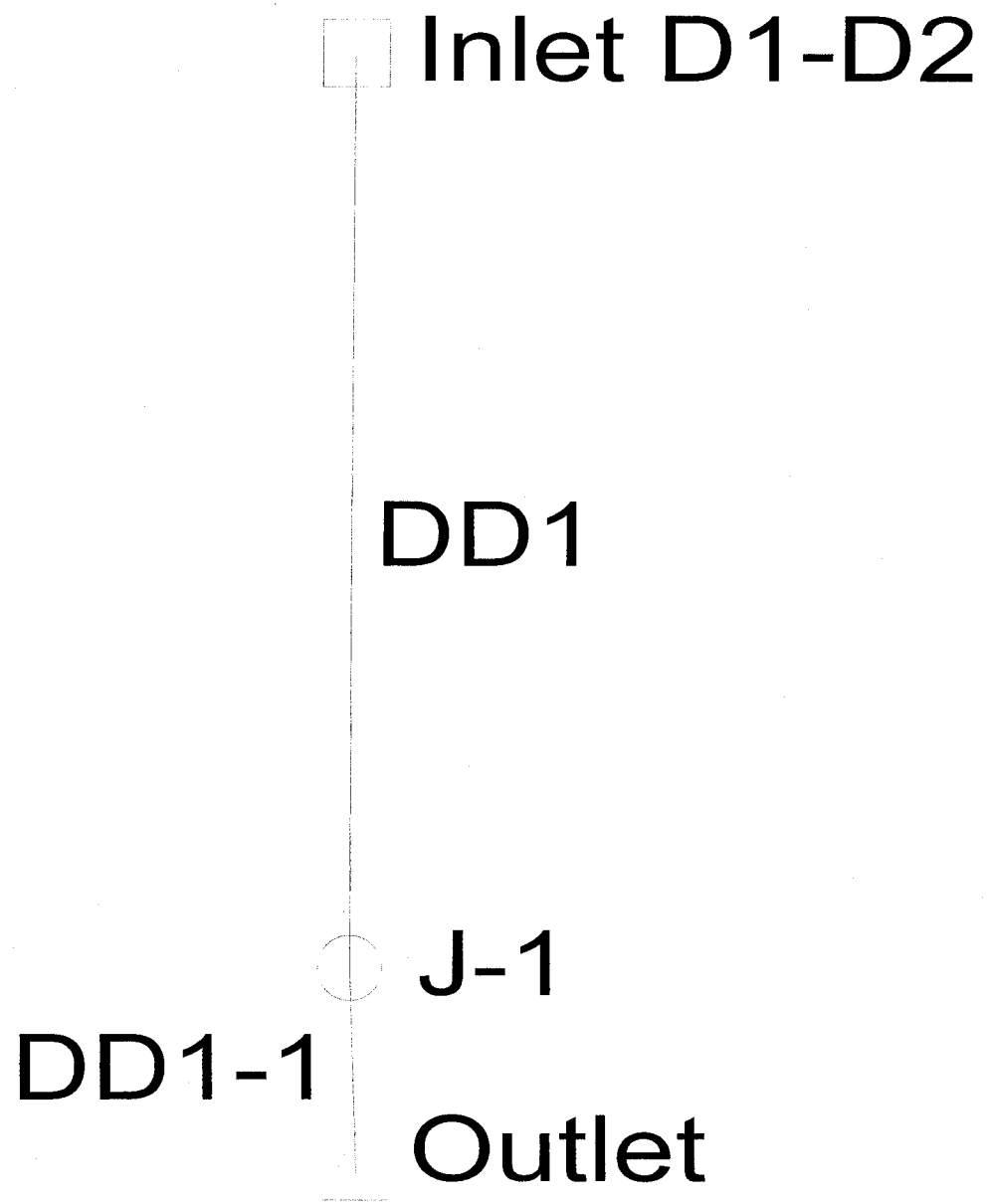
1/1/22


Inlet D1-D2
DD1
J-1
DD1-1
Outlet

DOT Report

Pipe Section	-Node- Upstream Downstream	Inlet Area (acres)	Inlet CA (acres)	Total CA (acres)	-Ground- Upstream Downstream (ft)	-HGL- Upstream Downstream (ft)	-Slope- Energy Constructed (ft/ft)	-Section- Discharge Capacity (cfs)	-Section- Shape Size	Length (ft)	Average Velocity (ft/s)	Pipe #
DD1	Inlet D1-D2	0.00	0.00	0.00	60.50	58.83	0.297936	11.51	Circular	86.00	21.10	P[illegible]
	J-1				34.50	33.21	0.302326	15.66	10 inch			
DD1-1	J-1	N/A	N/A	0.00	34.50	33.21	0.016527	11.51	Circular	20.00	9.76	P[illegible]
	Outlet				31.60	32.70	0.020000	11.88	15 inch			

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Pipe Report

Pipe Section	Upstream Node	Downstream Node	Discharge (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Roughness	Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream HGL (ft)	Upstream HGL (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)
DD1	Inlet D1-	J-1	11.51	86.00	0.302326	10 inch	0.010	15.66	58.00	32.00	60.50	33.21	58.83	34.50	1.67	1.67
DD1-1	J-1	Outlet	11.51	20.00	0.020000	15 inch	0.010	11.88	32.00	31.60	34.50	32.70	33.21	31.60	1.25	-1.25

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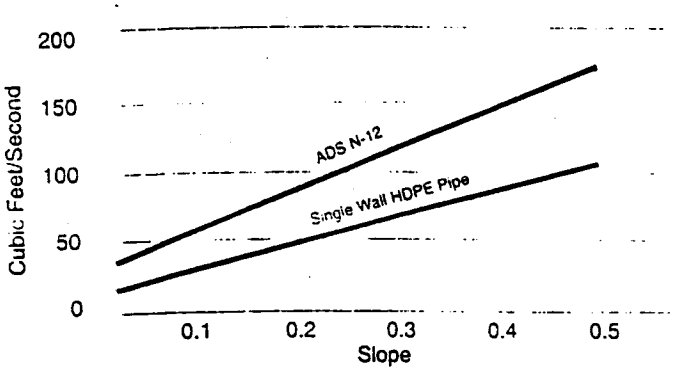
Specifications

Flow Capacity



Pipe Stiffness

Pipe Diameter	Minimum Pipe Stiffness (psi)
4", 6", 8"	50
10"	50
12"	50
15"	42
18"	40
24"	34
30"	28
36"	22
42"	19
48"	17

Weight Comparison

	Pounds per Foot		
Pipe Dia.	N-12/N-12 HC	Concrete	Corrugated Steel
10"	2.0	50	9.0
12"	3.2	79	10.5
15"	4.6	103	12.9
18"	6.4	131	15.8
24"	11.5	217	19.4
30"	15.4	384	30.4
36"	18.1	524	36.0
42"	26.5	650	57.0
48"	32.0	780	65.0

Manning's "n" for Design

Pipe Dia.	N-12 & N-12 HC	Std. Corrugated HDPE Pipe	Concrete	Corrugated Steel
4"—15"	.010—.012	.018	.011—.015	.022—.026
15"—48"	.010—.012	.020	.011—.015	.022—.026

Applicable Standards

AASHTO M 294, Standard Specification for Corrugated Polyethylene Pipe

AASHTO MP6, Standard Specification for Corrugated Polyethylene Pipe, 1050 and 1200 mm Diameter (42" and 48")

ASTM F 667, Standard Specification for Large Diameter Corrugated Polyethylene Pipe and Fittings

ASTM D 2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Application

Height of Cover

Minimum Cover:
H-20 loads: 12" E-80 loads: 24"

Maximum Cover: Typically 50-60 feet but will vary depending on application and engineering design.

Notes:
1. Cover heights are measured from the top of the pipe.
2. Calculations based on load factor design per AASHTO procedures.
3. Assume soil density of 100 lbs./cu. ft.
4. Backfill compacted to 90% density per AASHTO T-99.
5. If a hydro-hammer is used for compaction, at least 48" of cover must be provided.

Fast, Easy, Cost-Effective and Structurally Solid

Hancor's Sure-Lok® annular pipe in 36", 42", 54" and 60" diameters provides all the strength, versatility and installation benefits of polyethylene in a wider range of sizes. This means significant money savings, thanks to the reduction in time, labor and equipment. Plus, an easy joining system is built right into the pipe with silt-tight gasketed couplers. Created using proprietary machinery designed and built by Hancor engineers, this technology expands Hancor's Sure-Lok line, which includes diameters starting at 12".*

Contact your Hancor Field Sales Representative for availability in your area.

Hancor Sure-Lok Pipe Specifications

Scope

This specification describes 12- to 60-inch (300 to 1500 mm) Hancor Sure-Lok pipe for use in nonpressure drainage applications.

Pipe Requirements

Sure-Lok pipe shall have a smooth interior and annular exterior corrugations and shall meet the following requirements:

12- to 36-inch (300 to 900 mm) shall meet the requirements of AASHTO M294 Type S.

42- and 48-inch (1050 and 1200 mm) shall meet the requirements of AASHTO MP6-95.

54- and 60-inch (1350 and 1500 mm) diameters shall have minimum pipe stiffness of 16 and 14 pii (110 and 97 kPa), respectively, and shall meet all other requirements of AASHTO M294.

→ *Manning's "n" value for use in design for all diameters shall not exceed 0.010.*

						New Diameters*				
Pipe I.D. in. (mm)	*12 (300)*	*15 (375)*	*18 (450)*	*24 (600)*	*30 (750)*	***36* (900)***	***42* (1050)***	***48* (1200)***	***54* (1350)***	***60* (1500)***
Pipe O.D. in. (mm)	*14.2 (360)*	*17.7 (450)*	*21.5 (546)*	*28.4 (721)*	*36.0 (914)*	*41.4 (1052)*	*48.0 (1219)*	*54.2 (1377)*	*60.9 (1547)*	*67.1 (1704)*
Bell O.D. in. (mm)	*14.8 (376)*	*18.4 (467)*	*22.1 (561)*	*29.2 (742)*	*36.4 (925)*	*42.2 (1072)*	*48.8 (1240)*	*55.0 (1397)*	*62.0 (1575)*	*68.0 (1727)*
Flare O.D. in. (mm)	*15.4 (391)*	*19.6 (498)*	*23.9 (607)*	*29.9 (759)*	*37.9 (963)*	*43.6 (1107)*	*50.8 (1290)*	*57.4 (1458)*	*66.0 (1676)*	*73.7 (1872)*
Pitch in. (mm)	*2.0 (51)*	*2.4 (61)*	*3.0 (76)*	*4.0 (102)*	*4.0 (102)*	*4.8 (122)*	*6.0 (152)*	*6.0 (152)*	*8.0 (203)*	*8.0 (203)*
Approx. Weight lb/ft, (N/m)	*3.3 (48.2)*	*4.7 (68.6)*	*6.7 (97.8)*	*12.0 (175.2)*	*16.0 (233.5)*	*18.7 (272.9)*	*23.5 (342.9)*	*29.0 (423.2)*	*34.6 (504.9)*	*42.0 (612.9)*
Perforations	*All diameters available with or without perforations*									

***Check with field sales representative for availability**

This product is solely intended for the conveyance of fluids. Access into this product for maintenance, inspection, or other reasons should be done in strict accordance with OSHA recommendations for confined space entry.

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Drop Inlet Grate Sizing

S&ME

JOB NO. 1356-99-537
SHEET NO. 1/4
DATE 1/17/2000
COMPUTED BY SRN
CHECKED BY DPM

JOB NAME International Paper - Riegelwood Mill Facility
SUBJECT Drop Inlet Grate Sizing

OBJECTIVE

Size a proper grating for the drop inlets, to not impede flow.

REFERENCE

1. East Jordan Iron Works, Inc.; Catalog No. 14.
2. "Piping Design," S&ME, 1/17/2000.
3. Construction Castings, Catalog "R"; Neenah Foundry Company, 12th edition.

GIVEN

- Maximum depth, d, over the grates will be 12-in.

	Drainage Areas	Surface Flow, Q (cfs)	
Drop Inlet 1	A1, A2	24.81	[Ref. 2]
Drop Inlet 2	A3, A4, A5, A6	11.27	[Ref. 2]
Drop Inlet 3	A10, A11	6.99	[Ref. 2]
Drop Inlet 4	B1-B13	38.04	[Ref. 2]
Drop Inlet 5	C1, C2	18.66	[Ref. 2]
Drop Inlet 6	D1, D2	11.51	[Ref. 2]

CALCULATIONS

1. Determine Minimum Clear Opening

Select a suitable grate to handle the flows given above with a maximum depth over the grate of 12-inches.

Q = 0.0108*A*SQRT(d) [Ref. 1]
Where: Q = flow, cfs
A = clear opening of grate, sq. in.
d = depth of water over grate, in.

Therefore: A = Q / (0.0108*SQRT(d))

	Surface Flow, Q (cfs)	Minimum Open Area of Grate	
		sq. in.	sq. ft.
Drop Inlet 1	24.81	663.15	4.61
Drop Inlet 2	11.27	301.24	2.09
Drop Inlet 3	6.99	186.84	1.30
Drop Inlet 4	38.04	1016.78	7.06
Drop Inlet 5	18.66	498.77	3.46
Drop Inlet 6	11.51	307.65	2.14

← 2 grates will be used
∴ Min. Area/grate = 3.53 ft²

CONCLUSIONS

Neenah Grate Model 4349-D meets the minimum open area specifications.

Grate Type: Neenah 4349-D
Grate Area [Ref. 3]= 5.40 ft.^2
Weir Perimeter [Ref. 3]= 10.20 ft.

[Ref. 1] 2/4

FLOW CAPACITY OF INLET GRATES

Selecting and specifying the proper type of inlet grates for drainage is an important part of a storm water management design plan. East Jordan Iron Works manufactures many different types and sizes of inlet drainage grates to meet your design requirement. The flow capacity of any inlet grate in a sump or ponded condition is a function of the depth of water over the grate and the clear opening area of the grate.

$Q = CA\sqrt{2gd}$ where, Q = flow
C = orifice coefficient
A = clear opening area
g = gravity (32.2 ft./sec²) Acceleration
d = depth of water over grate

Using an orifice coefficient of .67 and correcting for clear opening area given in square inches and depth of water given in inches, this equation simplifies to:

$Q = .0108A\sqrt{d}$ where, Q = flow, CFS (cu. ft./sec.)
A = clear opening of grate, in.²
d = depth of water over grate, in.

Note: This equation is valid for inlet grates in a sump condition where water depths are 4" or greater. At water depths less than 4" an inlet grate acts as a weir to incoming flow and requires different analysis to determine flow capacity.

It is important to note that the above calculations do not compensate for any reduction in flow capacity due to clogging by debris. This adjustment may vary and is left up to the discretion of the specifying engineer. In traveled portions of roadways, inlets should be placed at low points and along slopes to prevent ponding which will cause a hazard to traffic. Follow recommendations of local governing authority for poinding limits.

EXAMPLE 1:
Calculate the flow capacity of an EJIW model 5105 Type M1 Inlet Grate with 6 in. of water over it.

Recall, $Q = .0108A\sqrt{d}$ $A = 255$ in.²
$d = 6$ in.

$Q = .0108A \times 225 \times \sqrt{6}$

$Q = 5.95$ CFS

EXAMPLE 2:
Select a suitable EJIW manhole catch basin unit with grate to handle 8 CFS. Depth of water is 4 in.

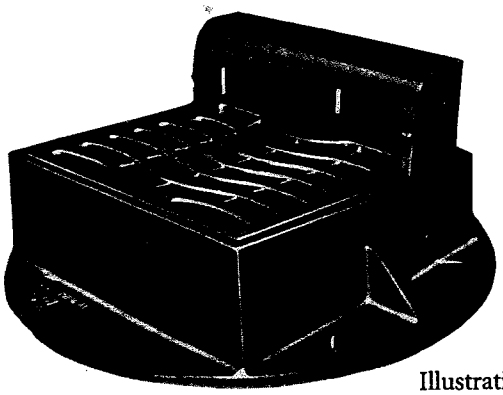
Recall, $Q = .0108A\sqrt{d}$ $Q = 8$ CFS
$d = 4$ in.

Solve for A, $A = \dfrac{Q}{.0108A\sqrt{d}}$

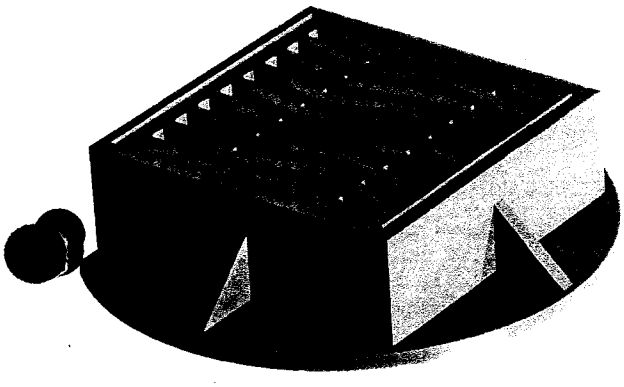
$A = \dfrac{8}{.0108\sqrt{4}}$

$A = 370$ in.²

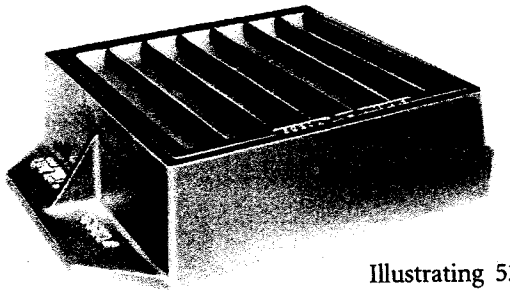
Choose EJIW model 1320 Type M Grate with 375 in.²



Illustrating 7045



Illustrating 5105



Illustrating 5380

NOTE: When specifying or ordering grates–
Please refer to "CHOOSING THE PROPER INLET GRATE" on pages 108 and 109.

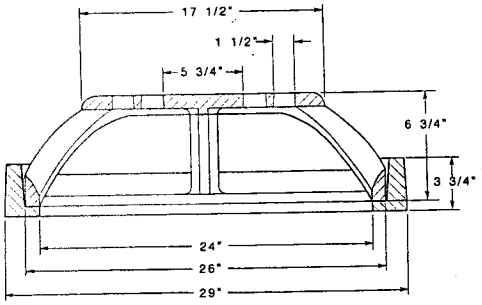
3/4

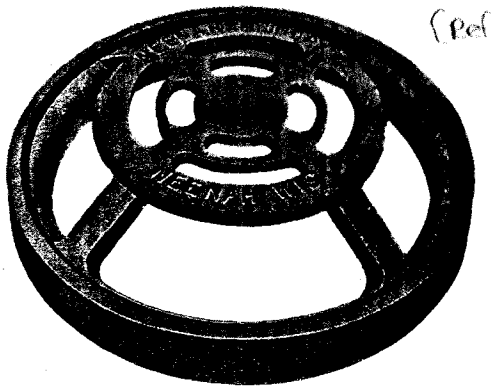
(Ref 3)

R-4349-C
Median Drain Frame and Grate

Heavy Duty

For use in narrow median on divided highways, freeways or expressways. Provides large capacity drainage when required during heavy rainfalls.

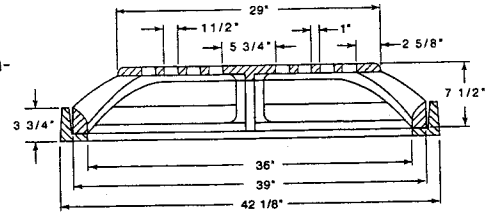


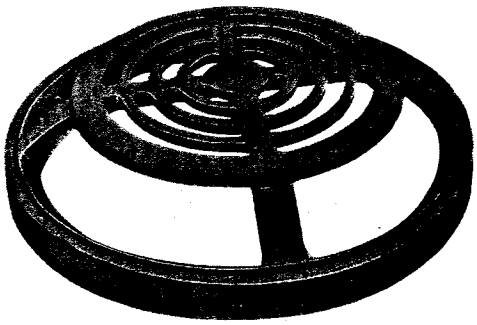


R-4349-D
Median Drain Frame and Grate

Heavy Duty

Same as **R-4349-C** except made to fit 36" opening.





Opening 5.4 ft²
Perimeter 10.2 ft

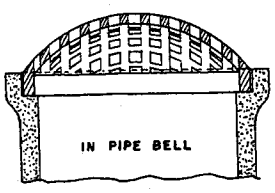
R-4350 Series
Beehive Grates to Fit Sewer Pipe Bells

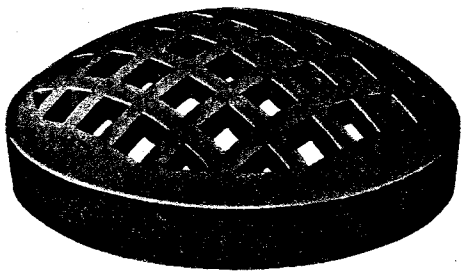
Heavy Duty

Bell and spigot vitrified clay and concrete pipe are made under many specifications and dimensions vary. Check the grate sizes in the table to be sure they will fit the pipe you are using.

Catalog No.	Size Pipe	Dimensions in inches Diameter	Thickness at Rim	Overall Height
R-4350-1	8	10 3/8	2	4
R-4350-A*	10	12	1	4
R-4350-B	12	14 3/4	2 1/2	5 1/2
R-4350-C	15	18 1/4	2 1/2	6 1/4
R-4350-D	18	22	3	7 1/2
R-4350-E	24	29	3	9

*Vertical radial slots.





FREE OPEN AREAS OF NEENAH GRATES (Continued)

[Ref.3] 4/4

CATALOG NUMBER	GRATE TYPE	SQ. FT. OPEN	WEIR PERIMETER LINEAL FEET
R-4030-27	G	2.8	3.0
R-4030-30	G	3.5	3.3
R-4040-6	E	0.1	2.1
R-4040-8	E	0.2	2.7
R-4040-10	E	0.3	3.3
R-4040-12	E	0.4	3.7
R-4040-15	E	0.7	4.8
R-4040-18	E	1.2	5.8
R-4040-21	G	1.4	6.7
R-4040-24	G	1.6	7.6
R-4040-27	G	2.3	3.0
R-4040-30	G	2.9	3.3
R-4215-A	Beehive	2.0	9.0
R-4215-C	Beehive	3.3	11.3
R-4216-B	Beehive	2.2	4.1
R-4216-D	Beehive	3.0	3.8
R-4340-A	Beehive	1.5	6.2
R-4340-B	Beehive	1.1	6.0
R-4340-C	Beehive	1.2	6.0
R-4340-F	Beehive	1.6	6.5
R-4340-F1	Beehive	0.7	4.5
R-4340-G	Beehive	0.6	5.0
R-4340-H	Beehive	0.5	4.5
R-4341-A	Beehive	2.5	6.0
R-4342	Beehive	2.0	6.0
R-4343	Beehive	2.4	8.4
R-4344	Beehive	0.2	2.9
R-4345	Beehive	2.0	8.6
R-4346	Beehive	2.0	8.6
R-4349-A	Beehive	2.4	11.1
R-4349-B	Beehive	5.4	15.5
R-4349-C	Beehive	2.4	6.9
R-4349-D	Beehive	5.4	10.2
R-4350-1	Beehive	0.3	2.7
R-4350-A	Beehive	0.3	3.1
R-4350-B	Beehive	0.4	3.9
R-4350-C	Beehive	0.6	4.8
R-4350-D	Beehive	1.0	5.8
R-4350-E	Beehive	1.7	7.6
R-4351-B	Beehive	0.5	3.9
R-4351-D	Beehive	1.6	5.8
R-4351-E	Beehive	1.5	5.8
R-4352	Beehive	1.3	5.8
R-4353	Beehive	1.8	6.7
R-4360-A	Beehive	0.6	4.3
R-4360-B	Beehive	0.8	4.7
R-4360-C	Beehive	1.4	4.5
R-4360-D	Beehive	0.7	6.3
R-4370-1	C	0.1	1.7
R-4370-2	G	0.2	2.5
R-4370-3	E	0.4	3.9
R-4370-4	G	0.6	3.9
R-4370-5	G	0.8	4.7
R-4370-6	G	0.8	5.1
R-4370-7	G	0.8	5.2
R-4370-8	E	1.0	5.5
R-4370-9	C	1.3	5.8
R-4370-10	G	1.1	5.8
R-4370-12	F	0.9	5.8
R-4370-13	G	1.3	5.8
R-4370-15	D	1.0	5.9
R-4370-17	D	0.9	6.0
R-4370-18	E	1.3	6.0
R-4370-21	D	0.9	6.0
R-4370-22	D	1.1	6.0
R-4370-23	G	0.9	6.3
R-4370-25	G	2.0	7.6
R-4370-26	G	1.7	8.6
R-4370-27A	G	2.4	9.9
R-4373-2	K	1.0 sq. in.	0.7
R-4373-3	K	1.0 sq. in.	1.0
R-4373-4	K	3.0 sq. in.	1.2
R-4373-6	K	3.0 sq. in.	1.8
R-4373-8	K	4.0 sq. in.	2.4
R-4373-10	K	5.0 sq. in.	2.9
R-4373-12	K	8.0 sq. in.	3.4
R-4373-15	K	20.0 sq. in.	4.2
R-4380-AA1	E	2.8 sq. in.	1.0
R-4380-A	E	3.7 sq. in.	1.1
R-4380-A1	E	6.0 sq. in.	1.2
R-4380-B1	E	4.8 sq. in.	1.3
R-4380-1	E	5.4 sq. in.	1.4
R-4380-3	E	6.0 sq. in.	1.6
R-4380-4	E	0.1	2.1
R-4380-4A1	E	0.1	2.2
R-4380-4A	E	0.2	2.6
R-4380-6	G	0.2	2.8
R-4380-7	G	0.3	3.1
R-4380-8	E	0.3	3.3
R-4380-9	E	0.4	3.7
R-4380-10	E	0.5	3.9
R-4380-11	E	0.5	3.9
R-4380-12	E	0.6	4.0
R-4380-13	G	0.7	4.2
R-4380-13A	E	0.9	4.7
R-4380-14	E	0.7	4.7
R-4380-15	E	0.6	4.7
R-4380-16	E	0.8	5.0
R-4380-17	E	0.8	5.0
R-4380-18	G	0.7	5.2
R-4380-21	G	1.3	6.3
R-4380-22	G	1.5	7.0
R-4380-23	G	1.1	7.3
R-4380-24	G	1.7	7.9
R-4380-25	G	2.5	8.4
R-4380-26	G	2.7	8.8
R-4385-B	E	0.1	2.1
R-4385-C	E	0.3	2.7
R-4385-E	E	0.5	3.9
R-4385-F	E	0.5	4.8
R-4385-G	E	1.0	5.8
R-4385-H	G	1.6	7.6
R-4385-J	G	2.5	8.6
R-4385-K	G	2.7	9.4
R-4389-O	B	0.2	3.0
R-4390	B	0.3	5.0
R-4400	B	0.1	2.7
R-4401	A	0.1	2.7
R-4403	A	0.3	3.7
R-4404-C	B	0.5	5.3
R-4406	B	0.5	5.3
R-4406-C	A	0.4	5.5
R-4406-1	A	0.5	5.3
R-4406-2	C	0.6	5.3
R-4407-2A	B	0.6	5.6
R-4408	B	0.3	3.4
R-4409	A	0.4	4.6
R-4409-A	C	0.7	5.7
R-4409-C	B	0.5	5.7
R-4409-E	A	0.5	5.7
R-4409-G	B	0.8	5.7
R-4410	B	0.8	6.5
R-4421	C	1.0	8.3
R-4423-A	A	1.2	9.7
R-4424	A	0.6	5.6
R-4430-A	A	0.6	6.0
R-4430-B	C	0.7	5.9
R-4435-1	C	0.8	4.3
R-4441-1	Q	0.2	4.0
R-4443	A	0.4	4.3
R-4449	A	0.8	6.0
R-4450	A	0.8	6.0
R-4450-A	A	0.6	6.0
R-4451	C	0.7	6.0
R-4454	C	0.9	6.3
R-4460	A	0.8	7.0
R-4462	B	0.9	7.8
R-4470	A	1.5	10.0
R-4511	A	0.5	4.7
R-4525	A	0.8	6.3
R-4530	A	0.8	6.1
R-4531	A	0.8	6.4
R-4540	C	1.0	6.8
R-4541	A	1.0	7.1
R-4544	A	1.8	8.7
R-4545	A	1.6	10.4
R-4548	A	1.0	5.9
R-4550	C	0.8	5.0
R-4552	A	0.6	5.3
R-4557	A	0.8	5.3
R-4558	C	1.1	5.9
R-4570-1	A	0.9	6.3
R-4570-2	A	0.9	6.5
R-4573	A	1.1	7.5
R-4575-A	A	1.7	8.5
R-4579	A	0.8	6.4
R-4583	A	0.9	6.3
R-4584	A	1.3	4.3
R-4585	A	1.9	9.1
R-4586	A	1.5	8.6
R-4600	A	0.9	6.5
R-4603-A	A	0.8	6.7
R-4604	C	1.3	6.7
R-4604-C	A	0.7	6.7
R-4604-D	A	1.5	6.7
R-4608	A	0.8	6.0
R-4610	A	1.0	6.4
R-4620	A	0.8	6.0
R-4630	C	0.9	6.2
R-4632	C	1.1	6.3
R-4640	A	1.3	6.4
R-4641-A	A	1.2	6.8
R-4641-C	C	1.1	6.8
R-4641-F	A	1.8	8.5
R-4649	A	1.1	6.9
R-4649-1	C	2.2	10.0
R-4652	A	1.5	7.9
R-4660	C	1.1	6.0
R-4662	A	1.3	6.6
R-4670-A	A	1.1	7.0
R-4671	A	1.1	7.0
R-4672	C	1.1	7.0
R-4689	C	1.4	7.5
R-4692-A	D	2.0	8.7
R-4698	A	1.7	9.0
R-4710	C	1.5	9.0
R-4711	C	1.1	9.5
R-4718	A	2.7	9.3
R-4720	C	0.9	6.7
R-4721-A	A	1.2	7.0
R-4725	C	1.6	7.0
R-4730	A	2.0	8.6
R-4731	A	2.5	9.8
R-4732	A	2.0	9.8
R-4736	C	1.1	7.3
R-4738	A	1.1	7.3
R-4739	C	1.3	7.3
R-4740	C	2.1	8.0
R-4750	C	2.4	8.3
R-4750-1	A	2.8	11.3
R-4751	C	1.9	7.9
R-4752	C	2.3	9.4
R-4755-B	A	2.8	10.5
R-4755-C	C	2.9	10.5
R-4759	C	1.5	7.5
R-4760	C	1.7	7.3
R-4762	C	2.4	8.7
R-4765	A	1.4	7.7
R-4780	C	3.1	9.8
R-4781	C	3.0	11.7
R-4795	A	3.2	11.3
R-4798	C	2.4	9.9
R-4808-A	Q	0.8	8.0
R-4810	C	1.5	8.0
R-4820	C	1.5	8.0
R-4821-A	C	1.7	8.3
R-4825	C	1.8	9.0
R-4825-A	A	2.1	9.0
R-4825-B	C	2.0	9.0
R-4826	A	1.3	8.0
R-4828	A	1.9	9.5
R-4829	C	2.2	9.5
R-4832	C	1.5	8.0
R-4832-B	C	1.8	8.7
R-4833	A	2.3	8.7
R-4837	A	2.2	9.8
R-4839	A	2.1	9.9
R-4840	C	2.8	10.0
R-4843	A	2.6	10.0
R-4850	C	2.7	9.0

• NOTE: On catalog #'s R-4990-AA thru R-4999-L9, SQ.FT. OPEN and WEIR PERIMETER are per lineal foot.
Type K indicates "Special" grate style and is not among standard types illustrated.
Type M indicates roll-type or mountable curb.

APPENDIX II

TECHNICAL SPECIFICATIONS

CLOSURE PLAN
TECHNICAL SPECIFICATIONS

INTERNATIONAL PAPER
RIEGELWOOD MILL FACILITY
RIEGELWOOD, NORTH CAROLINA
S&ME PROJECT NO. 1356-99-573

Prepared by:

S&ME, Inc.

June, 2000

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1.0 INTRODUCTION

1.1 Scope of Work

The Work consists of furnishing all labor, materials, supervision, equipment and services necessary to complete the closure of International Paper Industrial Landfill as presented within these Technical Specifications and Documents.

1.2 Definitions

The following list of definitions is provided for reference.

- Authorized Representative: shall mean the following named individuals, any of whom has the authority to execute a Change Order on behalf of International Paper: David Stewart and Ed Kreul.
- Atterberg Limits: the liquid limit and plastic limit, (ASTM D4318-84).
- Classification System: the soil classification system shall be in accordance with the standard test method for classification of soils for engineering purposes (ASTM D2487-83).
- Compaction: the process of increasing the density or unit weight of soil by rolling, tamping, vibrating, or other mechanical means. Compaction tests are determined by the Sand Cone Method (ASTM D1556), Drive Cylinder Method (ASTM D2937), or Nuclear Density Gauge (ASTM D2922).
- Density: mass density of a soil is its weight per unit volume; usually reported in pounds per cubic foot. Maximum dry density as determined by Standard Proctor Test (ASTM D698) or Modified Proctor Test (ASTM D1557).
- Dewatering: process of lowering ground water level(s) to permit construction activities to be made "in the dry" (not drying of fill material).
- In-Situ: "As is", or as it exists in-place natural.
- Moisture Content: ratio of quantity of water in the soil (by weight) to the weight of the soil solids (dry soil), expressed in percentage; also referred to as water content (ASTM D2216).
- Optimum Moisture Content (OMC): moisture content corresponding to maximum dry density as determined in the Standard Proctor Test (ASTM D698-78) or Modified Proctor Test (ASTM D-1557).

- Permeability: ability of pore fluid to travel through a soil mass via interconnected voids. "High" permeability indicates relatively rapid flow of pore fluid and vice versa. Coefficients of permeability are generally reported in centimeters per second (cm/sec) and are determined by a flexible wall permeameter test (ASTM D5084-90).

- Plasticity: ability of a soil mass to be remolded without raveling or breaking apart. The plasticity index, numerically equal to the difference between the liquid and plastic limit, is a comparative number that describes the range of moisture contents over which a soil behavior is plastic.

- Soil Liner System: a low permeable soil material consisting of on-site or off-site borrow material.

1.3 Construction

1.3.1 Closure of the landfill will consist of construction of the "NCDENR" regulatory minimum soil cover, i.e., 24-inches of suitable compacted earth. In the case of the International Paper Industrial Landfill, the 24-inches shall consist of 18-inches of soil liner and 6-inches of vegetative cover that will be topsoil enriched with sludge capable of plant growth. Included as integral parts of the final cover will be erosion and sedimentation control and access roadway(s).

Actual lines and grades are expected to follow those shown on the Closure Plan Drawing. Any deviations from the Drawings or Technical Specifications require the prior written approval of the ENGINEER and the Solid Waste Section and must be documented by "as-built" revisions to the Drawings and/or Technical Specifications. Further, any portion(s) of the above final cover may be constructed by International Paper prior to the Notice to Proceed. Initial (prior to beginning placement of the 18-inch soil liner layer) and final ("as-built") surveys will be required of the Contractor.

1.3.2 During all phases, construction will be tested, monitored, and evaluated prior to approval.

1.4 Surveying

The CONTRACTOR will be responsible for all surveying necessary for construction including as-built drawings. The ENGINEER shall determine the as-built finished grades based on survey data provided by the CONTRACTOR.

CONTRACTOR shall be responsible for as-built survey drawings certified by a state of North Carolina licensed surveyor that verify the finished lines and grades of the sub-grade and storm water management system.

2.0 EARTHWORK

2.1 Site Preparation

2.1.1 Scope of Work

The CONTRACTOR shall furnish all labor, materials, supervision, and equipment to complete the site preparation for the closure of International Paper Industrial Landfill.

Site preparation includes the clearing and grubbing and stripping of temporarily vegetated areas designated for the Soil Liner System.

2.1.2 Specification

2.1.2.1 Clearing and Grubbing

Clear and grub to provide access to soil liner areas, construction areas, and other areas where grade is to be rid of shrubs, trees, stumps, vegetation, rubbish, and other perishable or objectionable matter. Dispose of materials removed by clearing and grubbing within the landfill limits.

2.1.2.2 Stripping

In areas to be stripped, all materials shall be removed to a depth of 6 inches or as determined necessary by the ENGINEER and/or OWNER to eliminate soils containing rubbish, vegetable matter, roots, small stones and all other perishable or objectionable matter. Stripped material will be disposed of within the landfill limits.

2.1.2.3 Undercutting

Materials determined unsuitable by the ENGINEER shall be excavated to the lateral extent and required depth as determined by the ENGINEER. If necessary, the area of undercutting shall be dewatered to a depth of at least 2 ft. below the bottom of the excavation and shall be maintained in the dewatered condition until compacted fill is placed to at least 3 ft. above the original water level or to original ground level, whichever is higher.

The excavated material shall be stockpiled or disposed of as directed by the ENGINEER.

2.1.3 Measurement and Payment

2.1.3.1 Measurement of clearing and grubbing and stripping will be the surface area of the original ground surface that is cleared and grubbed and stripped. Computation of the quantities will be based on surveyed surface areas (provided by the CONTRACTOR) cleared and grubbed and stripped and will be mutually agreed to in writing by the ENGINEER and CONTRACTOR for each particular area.

Payment will be made at the contract price per acre for clearing and grubbing and stripping. This price will include excavation, hauling, stockpiling and/or disposing of the stripped material.

2.1.3.2 The quantity of undercutting will be based upon the volume between the stripped surface and the undercut surface as determined by surveys after completion of the undercutting and before placement of the earth fill. In the case of small volume areas of undercutting, it will be acceptable to use an average depth times area volume computation, if both the CONTRACTOR and OWNER agree prior to measurement. Both the CONTRACTOR and OWNER should be represented when average depth measurements are made.

Payment will be made at the contract price per cubic yard for undercutting. This price will include the excavation, hauling and stockpiling of the undercut material, replacement with compacted structural fill and any dewatering associated with the undercutting.

2.2 Structural Fill

2.2.1 Scope of Work

The CONTRACTOR shall furnish all labor, materials, supervision, and equipment to complete earthwork for the International Paper Industrial Landfill including, but not limited to excavation, hauling, stockpiling, placement, and compaction.

2.2.2 Materials

Structural fill material shall consist of on-site sources that are free all topsoil, roots, stumps, brush, vegetation, and other deleterious material. Structural fill shall have a maximum size aggregate of 4 inches with no more than 15% retained on the No. 4 sieve.

Excavated material that does not meet the above criteria for structural fill shall be termed non-select material and shall be segregated from structural fill material and stockpiled at the ENGINEER's direction on the landfill.

The ENGINEER will assist the CONTRACTOR in the determination of structural fill and non-select material. The CONTRACTOR will be responsible for excavating, transporting, stockpiling, placing and compacting the structural fill.

2.2.3 Construction

Excavation of structural fill shall be from on-site source area(s) designated by the OWNER.

Structural fill, as defined above, if stockpiled, shall be so in a designated area free of contaminating soil, clearing debris, or other objectionable materials. Stockpiles that will remain inactive for a period greater than six months shall be stabilized with seed. All reconditioning of structural fill to obtain the required compaction will be the responsibility of the CONTRACTOR.

The CONTRACTOR shall protect all existing facilities, including, but not limited to existing scales, access controls, electrical lines and poles, and monitoring wells during excavation hauling and stockpiling. Damaged facilities shall be promptly replaced at the CONTRACTOR'S expense.

Structural fill shall be compacted in not greater than 8 inch thick loose lifts to a minimum of 95 percent of the soil standard Proctor maximum dry density at plus or minus 3 percent wet of the soils OMC, ASTM D-698, or as specified on the Drawings.

2.2.4 Measurement and Payment

A grid pattern as approved by the ENGINEER of waste surface elevations in the construction areas shall be surveyed and reference points installed by the CONTRACTOR prior to excavation and prior to placement. The ENGINEER shall check the as-built finished grades and determine the excavated and compacted volume of soil based on survey data provided by the CONTRACTOR.

Requested payment quantities will be submitted by the CONTRACTOR with final approval by the ENGINEER.

If a dispute exists relative to payment quantities, the CONTRACTOR at his expense will uncover any buried or covered material for re-evaluation.

Payment for structural fill will be based on the volume in cubic yards filled times the unit price for structural fill.

2.3 Soil Liner System

2.3.1 Scope of Work

The landfill closure shall include a 18-inch relatively low permeable Soil Liner System. The CONTRACTOR shall furnish all labor, material, supervision, and equipment to complete the Soil Liner System, including excavation, hauling, sieving, raking, discing, compacting, drying, wetting, removal of rainwater, removal of all previously placed material rendered unsuitable due to weather conditions or construction operations, final grading, sealing and all necessary and incidental items as detailed or required to complete the soil liner cover, all in accordance with these Documents.

2.3.2 Materials

On-site soil material that meets all of the following requirements shall be classified as "soil liner" material for use in construction of the Soil Liner System.

The soil liner material when tested for permeability in accordance with ASTM D5084-90 must achieve a coefficient of permeability not greater than $1.0x10^{-5}$ cm/sec. Bulk samples will be taken at intervals of 1 sample per 10,000 cubic yards of material to be placed. The samples will be transported to a soils laboratory for recompaction and permeability testing. The samples will be compacted to at least 95 percent of the soils standard Proctor maximum dry density at moisture content at plus or minus 3 percent above optimum and/or as subsequently specified based on the test pad and laboratory testing results.

2.3.3 Construction

2.3.3.1 The waste surface shall be graded in accordance with the Closure Plan.

A test pad 35 ft x 50 ft on an existing 3H:1V side slope of landfill shall be constructed using the same construction methods, equipment and material to be used for the Soil Liner System. Compaction and soil moisture content shall be as specified above. Field moisture and field density tests will be performed by the ENGINEER to verify the construction method, equipment and material achieve the required specifications. Bulk samples will be collected to confirm field permeability in the completed test pad. Laboratory constant head permeability tests will be performed on the disturbed samples to verify that the material, construction methods and equipment can achieve a permeability of no greater than $1.0x10^{-5}$ cm/sec. Shelby tubes may be pushed in the completed test pad as an alternative to the bulk samples.

The CONTRACTOR shall allow sufficient time for construction and testing of the test pad prior to placement of the Soil Liner System. If the initial subsequent test pad does not meet the required permeability ($1.0x10^{-5}$ cm/sec), additional test pad(s) shall be constructed until successful construction and testing is accomplished.

2.3.3.3 Construction methods, sampling and testing will be recommended by the ENGINEER. Typical tests (listed below) to be included will be in-place density, moisture content, Atterberg limits, grain size distribution, and permeability testing.

Test	ASTM Method	Frequency
Field Density	D-2937	3 per lift
Natural Moisture Content	D-2216	3 per lift
Atterberg Limits	D-4318	1 per lift
Grain Size with Hydrometer	D-422	1 per lift
Remolded Permeability	D-5084	1 per lift
Undisturbed Permeability (Alternative)	D-5084	1 per lift

2.3.3.4 Based on the classification, density, moisture, and permeability testing performed on the test pad, the ENGINEER will determine the specified range of acceptable densities and moisture contents required to achieve a permeability of less than or equal to $1.0x10^{-5}$ cm/sec.

2.3.3.5 If the soil liner fill material differs in consistency to the material used in the test pad, the ENGINEER will require construction of another test pad with additional laboratory classification and permeability testing prior to placement.

2.3.3.6 Soil liner loose lift thickness, prior to compaction, shall not exceed 12 inches.

2.3.3.7 After the lift to be compacted is conditioned, representative samples will be taken by the ENGINEER and tested for moisture content prior to any compactive efforts. If the moisture content is within the range specified, compaction may begin. If the moisture content is outside of this range, the soil liner fill material will be wetted or dried and reworked accordingly. The soil liner fill material should be sprinkled or sprayed with water, utilizing equipment creating a uniform application and dozed, wind-rowed, and/or disc-plowed to uniformly increase the moisture content of the soil liner if the material moisture content is too low. The soil liner fill shall be dozed, wind-rowed, and/or disc-plowed to help air dry the soil if the moisture content is too high.

2.3.3.8 Compaction of lifts shall be as follows:

The daily work area shall extend a distance so as to maintain moist soil conditions (facilitate bonding) and continuous operations. Desiccation, crusting, or cracking of the lift surface shall be avoided. Each lift shall be protected, at all times after placement, from desiccation, crusting, or cracking.

2.3.3.9 During compaction of the soil liner material, the soil moisture content and dry density shall be maintained within the limits specified below.

To determine if the moisture content and dry density requirements of the soil liner are being satisfied, field and laboratory tests shall be made at intervals and locations designated by the ENGINEER.

Compaction moisture content shall be at plus or minus 3 percent wet of OMC or as determined by the results of the soil liner test pad.

The soil liner shall be compacted to a minimum dry density of 95 percent (or as determined by the results of the soil liner test pad) of the soil maximum dry density as determined from the Standard Proctor Compaction test (ASTM D-698). To achieve the minimum density, each lift is to be compacted with a bulldozer. Where densities less than the specified compaction of the maximum dry density as determined from the standard Proctor test are measured, the soil liner shall be recompacted and/or removed and reworked to meet density objectives.

2.3.3.10 Each lift shall be thoroughly compacted and satisfy moisture and density controls through field testing before a subsequent lift is placed.

2.3.3.11 Soil liner fill material shall not be placed or compacted during sustained periods with air temperature below 32°F. Soil liner fill material may be placed and compacted during periods of early morning and early evening freezing temperatures with warming trends above 45°F during the day. No fill shall be placed on frozen subgrade. At the discretion of the ENGINEER, if the soil liner material freezes or ices, the frozen fill shall be "bladed off" and cleaned out of the way for reconditioning. Soil liner fill placement may continue on the exposed non-frozen subgrade.

2.3.3.12 During construction, finished lifts or sections of Soil Liner System shall be sprinkled with water as if needed to prevent drying and cracking.

At the end of each construction day's activities, completed lifts or sections of the Soil Liner System shall be sealed by rolling with a rubber tired or smooth drum rollers and sprinkled with water as needed to avoid drying cracking.

The surface of the Soil Liner System shall be smooth drum rolled and maintained free of rocks, organics, and voids.

2.3.3.13 During construction of the Soil Liner System, the ENGINEER will collect representative "disturbed" samples of the completed the Soil Liner Sysytem for permeability testing. The void created by sample collection will be promptly backfilled with soil liner by the CONTRACTOR. The collected specimens will be tested in a soil laboratory to verify a permeability of no greater than $1.0x10^{-5}$ cm/sec (ASTM D5084-90). The CONTRACTOR will assist the ENGINEER as needed in collection of the samples, and the sampled area shall not be covered by the CONTRACTOR until test results are final.

One sample will be collected for every 10,000 cubic yards of soil liner placed. Locations will be distributed throughout the landfill closure.

2.3.3.14 The Soil Liner System shall be a minimum of 24 inches thick. Thickness of the Soil Liner System on the side slopes shall be measured perpendicular to the slope face.

2.3.3.15 Prior to beginning construction of the Soil Liner System, the CONTRACTOR will survey and establish lines and grades of the waste. Following completion of the Soil Liner System, the CONTRACTOR will survey and establish lines and grades of the Soil Liner System. Comparison of these two surveys will be used to verify the in-place thickness of the Soil Liner System.

To supplement the survey, for comparison the ENGINEER may also verify the as-built thickness of the Soil Liner System by hand auger probes and measurements. Hand auger penetrations will be promptly backfilled with Bentonite and soil liner mixture by the CONTRACTOR.

2.3.3.16 Rework Areas

Areas of the Soil Liner System meeting moisture and density specifications but failing permeability will be excavated and replaced at the OWNER's expense.

Areas of the Soil Liner System not meeting moisture or density specifications, or failing permeability due to insufficient moisture or compaction, will be excavated and replaced at the CONTRACTOR's expense, and documented as part of the "as-built" conditions.

In both cases, the limits of rework will be defined by the ENGINEER, surveyed by the CONTRACTOR, and documented as part of the "as-built" conditions.

2.3.5 Measurement and Payment

A grid pattern as approved by the ENGINEER of ground surface elevations on the closure area shall be surveyed and reference points installed by the CONTRACTOR prior to and following placement of the Soil Liner System. This grid shall also establish the perimeter limits of construction. The ENGINEER shall verify the as-built finished grades and quantities based on survey data provided by the CONTRACTOR.

A net thickness of 18-inches shall be used for establishing quantities and payment.

The entire Soil Liner System must meet or exceed the specified thickness, density and permeability requirements prior to payment. Payment for work shall be made on the unit price bid per cubic yard of in-place soil liner material. Quantities shall not include overbuild or replacement volume of defective areas resulting from erosion, insufficient moisture, or insufficient density. Quantities shall include previously defined rework areas meeting moisture and density requirements but failing permeability.

If a dispute exists relative to payment quantities, the OWNER may require an additional final grade topographic survey at the CONTRACTOR's expense.

2.4 Vegetative Cover

2.4.1 Scope of Work

The CONTRACTOR shall furnish all labor, materials, supervision, and equipment to complete the final cover including, but not limited to, excavation, transporting, stockpiling, placing, spreading, and compacting 6 inches of vegetative cover soil.

2.4.2 Materials

The final cover vegetative "erosion" layer shall consist of 6 inches of vegetative cover soil capable of supporting vegetative growth. The 6 inches of vegetative cover soil will be free of roots, stumps, brush, vegetation, and other deleterious material. The vegetative cover material shall have a maximum size aggregate of 2 inches with no more than 15% retained on the No. 4 sieve.

The 6 inches of vegetative cover soil will be comprised of available existing topsoil enriched with with sludge from the on-site borrow sources. The ENGINEER will assist the CONTRACTOR in the selection of final vegetative cover soil and non-select material.

2.4.3 Construction

The final vegetative cover layer will consist of 6 inches of material suitable for establishing a vibrant grass cover. The vegetative cover soil enriched with sludge will be blended as necessary, spread, and lightly compacted to prevent sloughing and erosion. The specified mixture amendments of fertilizer and seed will be applied to the surface soil to rapidly establish a continuous dense cover of grass. This seeding and fertilizing shall be done in accordance with the Drawings and with the recommendations of the North Carolina Erosion and Sediment Control Manual for permanent grass cover in the coastal area. Areas will be mulched to protect the grass until growth has been established.

2.4.4 Measurement and Payment

A grid pattern as approved by the ENGINEER of ground surface elevations shall be surveyed and reference points installed by the CONTRACTOR prior to and following placement of the final vegetative cover. The ENGINEER shall verify the as-built finished grades based on survey data provided by the CONTRACTOR.

Quantities shall not include overbuilt or replacement volumes of defective areas resulting from erosion or lack of vegetation growth. A net thickness of 6 inches shall be used for establishing quantities and payment for the surveyed area.

Requested payment quantities will be submitted by the CONTRACTOR with final approval by the ENGINEER.

If a dispute exists relative to payment quantities, the CONTRACTOR at his expense will uncover any buried or covered material for re-evaluation.

Payment for final cover soil will be based on the volume filled times the unit price for final vegetative cover soil.

Payment for seeding will be made at the contract price per acre. This price shall include all labor, equipment and materials required to establish a permanent grass cover on all graded surfaces and maintain this grass cover until acceptance by the ENGINEER. This price shall also include any maintenance and protection required to control erosion fill surfaces prior to beginning permanent grassing operations.

2.5 Access Road

2.5.1 Geosynthetic Clay Liner (GCL)

2.5.1.2 Material

The (GCL) shall be "Bentomat" as manufactured by Colloid Environmental Technologies Company (CETCO), or equivalent.

"Bentomat DN" shall consist of high quality swelling sodium bentonite contained by two nonwoven needle punched geotextile. Bentomat DN shall be used in the construction of the proposed access road as shown on the Drawings.

The geosynthetic clay liner shall consist of a minimum of 0.75 lb. of bentonite per square foot.

Two 15 ft. wide geosynthetic clay liner rolls shall be placed parallel with the access road with 1' overlap and anchored as shown on the Drawings.

The CONTRACTOR shall submit proposed GCL panel layouts to the ENGINEER at least 2 weeks prior to installation. Once the panel layout is approved, the CONTRACTOR may not change the layout without written permission of the ENGINEER.

The GCL shall be shipped rolled with a protective wrap around each roll, labeled with a roll number. Manufacturers quality control documentation shall be included with each roll.

The GCL shall be dry and free of holes or any sign of contamination by foreign matter. The ENGINEER may reject all or portions of the GCL if significant quantities of production flaws are observed.

2.5.1.2 Construction

Areas to receive GCL installation shall be relatively smooth and even, free or ruts, voids, etc., to the extent required by the ENGINEER. This shall be accomplished by final dressing of the road subgrade with a smooth drum roller.

Installation of the GCL shall be as follows:

Unroll only those sections that are to be overlain by ABC stone in one day. Panels should be positioned with the 1' overlap.

Bentomat GCL panels shall be placed so that the white nonwoven geotextile side is placed down onto the access road subgrade. Granular bentonite of the same type as the bentonite within the GCL shall be placed along on seams for the entire seam width at an application rate of a minimum of 0.25 lbs. per foot.

After panels are initially in place, remove wrinkles as directed by the ENGINEER. Unroll several panels and allow the GCL to "relax" before beginning adjacent panels. The purpose of this is to make the edges that are to be overlapped as smooth and free of wrinkles as possible.

The panels shall be placed from the upgradient end of the access road and progress downgradient in order to keep runoff from accumulating under the GCL.

Once panels are in place and smooth, commence placement of the ABC Stone.

The CONTRACTOR'S Superintendent shall complete the Daily Report Form (enclosed in the "Supplement to Technical Specifications") at the end of each day and submit the form daily to the ENGINEER.

If exposed GCL panels cannot be covered by ABC stone before the end of a working day, the panels or sections of panels shall be temporarily covered with plastic and ballasted until geomembrane placement can commence.

If GCL panels become saturated from rainfall or other surface water run-on and exhibit any bentonite swelling prior to placement of the ABC stone, the saturated section of GCL shall be immediately removed and replaced at the CONTRACTOR'S expense.

Cut edges of the GCL encountered around Drop Inlets or stormwater piping shall be packed with a soil-bentonite mixture (3 parts soil to 1 part bentonite) below and above the edge. This can be accomplished by placing a notch sloped to the edge of the drop inlet or pipe, tucking the GCL onto the notch and backfilling over the notch with soil-bentonite.

Any damaged areas exhibiting rips or tears shall be patched with a minimum 12-inch overlap and fastened with construction adhesive.

2.5.1.3 Measurement and Payment

Payment for work shall be made at the contract unit price per square foot of in-place GCL. This price shall exclude scrap and overlay. Measurements shall be the responsibility of the CONTRACTOR with observation and approval by the ENGINEER.

All patches, repairs, and material beyond the required pay limits will be considered incidental to the construction and will be excluded from payment.

Requested payment quantities of in-place GCL will be submitted by the CONTRACTOR with final approval by the ENGINEER.

2.5.2 ABC Stone

2.5.2.1 Material

ABC stone shall conform to ABC Stone NCDOT standards.

2.5.2.2 Construction

ABC stone shall be placed in a 12" thick layer on top of the Geosynthetic Clay Liner (GCL) as shown on the Drawings.

2.5.2.3 Measurement and Payment

Payment for work shall be made at the contract unit price per ton of in-place ABC stone. This price shall exclude scrap. Measurements shall be the responsibility of the CONTRACTOR with observation and approval by the ENGINEER.

Requested payment quantities of in-place ABC Stone will be submitted by the CONTRACTOR with final approval by the ENGINEER.

3.0 STORMWATER MANAGEMENT

3.1 Scope of Work

The CONTRACTOR shall furnish all labor, materials, supervision and equipment necessary to complete the construction of the Stormwater Management System for the International Paper Industrial Landfill including but not limited to supply and installation.

Site preparation includes the installation of stormwater management structures and erosion/sediment controls as designated on the Drawings.

3.2 Materials

Stormwater management structures shall include but not be limited to erosion control benches, channels, drop inlets, diversion berms, and drainage piping.

3.2.1 Erosion Control Berms

Erosion control berms shall be constructed to divert run-off flowing down the capped landfill to the erosion/sediment control structures as specified on the Drawings.

The erosion control berms shall be lined with straw with net until vegetation can be established along these berms for erosion protection as shown on the Drawings.

3.2.2 Channels

Channels (permanent or temporary) shall be constructed to divert run-on from the landfill and/or route run-off to the erosion/sediment control structures as specified on the Drawings.

The diversion benches and proposed access road channel shall be lined with non-spec 20-mil HDPE liner as shown on the Drawings. The liner panels shall be shingled in the direction of the flow in the channel, with the upstream panel overlapping the downstream panel a minimum of 2 feet. The panels may also be heat tacked together at the discretion of the engineer.

3.2.3 Drop Inlets

Drop inlets shall have nominal diameters and dimensions as noted on the Drawings.

Drop Inlets shall be precast concrete drop inlets or equivalent as noted on the Drawings.

Grates for drop inlets shall have NCDOT H-20 loading capacity and shall be sized as noted on the Drawings. Grate shall be Neenah Foundry Company R-4349-D, or approved equivalent.

Proposed drop inlets and grates shall be submitted to the ENGINEER for review and approval prior to installation.

3.2.4 Drainage Piping

Drainage pipes as shown on the Drawings shall consist of smooth lined high density polyethylene pipe or equivalent.

The piping shall be placed in an excavated trench and covered with compacted on-site structural fill materials from on-site source areas within the landfill or structural fill (excavated material) from outside the landfill footprint. Backfill of the piping shall be placed and compacted in 6 inch thick lifts around the drop inlets and up to 2 feet above the piping. Compaction shall be performed by hand tampers or small hand operated compactors such as a Rammax. Compaction shall be at a minimum 95 percent of the Standard Proctor maximum dry density. Additional compaction of lifts 2 feet or greater above the piping shall conform to Section 2.2 of these Technical Specifications.

Piping shall be laid to the lines and grades shown on the Drawings. The subgrade for the piping shall conform with Section 2.2 of these Technical Specifications. Unsuitable subgrade material shall be replaced with sand.

All pipe and fitting connections shall be watertight.

3.2.5 Erosion/Sediment Control

Erosion/sediment control shall include but not be limited to installation of outlet protection, silt fencing, and seeding as specified on the Drawings. Seeding shall be installed as specified in Section 2.4.3 of these Technical Specifications.

The CONTRACTOR shall be responsible to clean out all collected sediment from the channels prior to completion of the contract.

3.3 Measurement and Payment

3.3.1 The quantity of channels and diversion berms will be based on their measured lengths. Payment will be made at the contract price per linear foot of channels and diversion berms. This price will include excavation or structural fill and establishment of an erosion-resistant cover for grass-lined and geomembrane-lined channels.

3.3.2 Payment for drop inlets will be based on the contract unit price per each unit, excavation, installation, culvert connection, grate, and backfill and compaction around the inlet.

3.3.3 Payment for the drainage piping will be made at the contract unit price per linear foot. This price will include trench excavation, placement of the pipe, backfill around the pipe and outlet protection.

3.3.4 Payment for seeding will be made as described in Section 2.4.4 of these Technical Specifications.

APPENDIX III

INTERIM CLOSURE PLAN

INDUSTRIAL LANDFILL
INTERIM CLOSURE PLAN

INTERNATIONAL PAPER
RIEGELWOOD MILL
RIEGELWOOD, NORTH CAROLINA
S&ME PROJECT NO. 1356-99-573

Prepared for:

International Paper
Riegelwood Mill
Riegelwood, North Carolina

Prepared by:

S&ME, Inc.

June, 2000

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APPENDIX

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1.0 INTERIM CLOSURE PLAN

The purpose of the Interim Closure Plan is to outline the steps for closing the landfill in preparation for final closure. Interim Closure is designed to minimize the need for long term maintenance and to control the post-closure release of contaminants. The Interim Closure includes modifications to the existing slopes and the reinforcing of areas that are currently in an unstable condition. These modifications will also assure your ability to reasonably maintain the facility during long-term post-closure activities.

1.1 Existing Landfilling Sequence

The development of the International Paper Landfill has been sequenced in phases by the operator of the landfill. Landfilling operations generally proceeded from the landfill's up gradient towards the down gradient forming the footprint of the landfill. Waste material has generally been pushed and placed in random method in order develop a radial mound and operational space at the top of the landfilling area.

This Interim Closure Plan will addresses the construction of a foundation berm to allow establishment of stable closure grades, delineate the footprint of the landfill and allow for stable cap construction. Stormwater and leachate management are also addressed in this Interim Closure Plan.

1.2 Interim Closure Construction

The construction of a landfill requires that the foundation of the facility is stable and the slopes are prepared to accommodate long term maintenance. The interim closure construction activities are essential for this landfill to provide that foundation and stability for closure of this facility. The proposed interim construction phasing of the landfill perimeter berms provides that foundation for final closure. The interim closure construction is providing the slope preparation and develops the first stormwater bench for the final closure plan.

1.3 Erosion and Sedimentation Control

Erosion and sedimentation control structures include diversion ditches and silt fences as shown on the drawings. Diversion ditches and silt fences shall be inspected for damage after each significant runoff event. Riprap-lined channels and outlet protection aprons used to prevent damage to channel vegetation shall be inspected for wash-outs. Riprap shall be added to these areas as needed to maintain the integrity of the structure.

Embankment slopes shall be periodically inspected for erosion. The damaged areas shall be stabilized, reseeded, fertilized and mulched immediately. Seeding, fertilizing and mulching shall be in accordance with the North Carolina Erosion and Sedimentation Control Guidelines.

1.4 Stormwater Management

The berms will provide collection of stormwater for these operational areas until waste placement promotes positive drainage. Phase I and II berms will be constructed with a bark chip drainage layer for dewatering stormwater. The bark chips will be sloped through the berm and daylight to provide positive drainage. Phases III through VII will be constructed with a piping system to dewater behind the berms.

Permanent high density polyethylene (HDPE) pipes located at the toe of the inside berms of each area will provide stormwater collection and removal during operations. The surface water collection and removal system will consist of a submersible pump lowered into a HDPE riser pipe and pumping the stormwater to the facility's wastewater treatment system. Stormwater/leachate will discharged to the "South Bay" of the wastewater treatment system or the wastewater channel located on the southwest and west side of the landfill.

The HDPE pipe at the toe of the slope and riser will be 12-inch diameter smooth lined (doubled wall) with perforations and wrapped with 3.5 ounce per squared yard knitted geotextile. The surface water within the berm's operational area will infiltrate through geotextile and flow to the low point of the berm. This surface water that has contacted the waste will then flow into the leachate collection and removal system and will be treated as leachate.

Landfilling will progress from upgradient to downgradient; therefore, surface water will drain downgradient on to the active face and flow into the stormwater/leachate collection system. Landfilled areas upgradient of the active face will be graded so that surface water drains around the active face. Temporary diversion berms shall be placed to divert surface runoff from the active face.

1.5 Leachate Collection and Removal System

The leachate collection and removal system is the same apparatus as the stormwater system that consists of a perforated high density polyethylene (HDPE) pipe wrapped in a geotextile placed at the toe of the proposed perimeter berms with a several collection riser pipes. The collection riser pipes will be solid wall HDPE and extend to the top of the berm for leachate removal. The leachate will be pumped out of the collection pipe using a submersible pump and discharged into the existing wastewater treatment system.

1.6 Interim Closure Waste Placement

The waste shall be compacted as densely as practical using landfill dozer. Waste placement will be in lifts not greater than 10 feet in vertical thickness for the initial fill placement. Based on the type of waste, additional passes may be required to achieve higher compaction rates. Initially the waste shall be placed from upgradient to downgradient, but as higher waste elevations are achieved, the waste may be placed from downgradient to upgradient on the active face slope as long as landfill surfaces are graded to allow proper drainage. A minimum five percent slope shall be graded on the landfill surface to promote surface water runoff. Solid waste shall not be disposed of in water, and

surface water shall not be impounded on the solid waste. Also, the landfill active face should be as small as possible to reduce the amount of cover.

An approved 120-day biweekly cover demonstration was performed during the months of July through November 1997 and the observations of the demonstration was submitted to the Solid Waste Section in November 1997. Cover material placement will continue biweekly cover demonstration as a permanent operational procedure for the remaining life of the facility. Wood waste, soil, or other suitable material will be placed for biweekly cover and compacted at least 6 inches thick to control odor, vectors, and litter as necessary. After the interim closure construction and final disposal operations of the landfill, a final cover system will be placed on the landfill as discussed in the Closure Plan.

1.7 Waste Acceptance and Disposal Requirements

The procedural requirements for waste acceptance at the International Paper Industrial Landfill will generally be the same as those currently in practice for the faciltiy. The landfill will accept industrial waste and sludge generated at the facility and may accept special wastes upon proper approval for disposal. Special waste shall be handled in accordance with local, state and federal guidelines. The landfill shall only accept those solid wastes which it is permitted to receive. The waste stream generally consists of wood yard waste, boiler ash, grits, dregs, general mill waste, sawmill waste (ash and bark/wood), and sludge.

The landfill owner or operator shall notify the Division of Waste within 24 hours of attempted disposal of any waste the landfill is not permitted to receive, including waste from outside the area the landfill is permitted to serve. No hazardous, liquid, or infectious waste shall be accepted or disposed of in the landfill. Wastes prohibited for disposal include those hazardous wastes defined in 15A NCAC 13A (including hazardous waste from conditionally exempt small quantity generators), polychlorinated biphenyls as defined in 40 CFR 761, septic waste, and waste oil.

Management of asbestos shall be in accordance with 40 CFR 61. Asbestos shall be disposed of at the landfill on the bottom of the active face of the landfill, apart from other wastes, and immediate covered with soil.

Barrels and drums shall not be disposed of unless they are empty and perforated sufficiently to ensure that they do not contain liquid (except for household wastes in small containers of original packaging) or hazardous waste.

If hazardous or liquid wastes are identified in the load the landfill operator shall immediately notify the Operations Manager. If hazardous waste is identified, the hazardous materials emergency response team for International Paper shall also be notified. If liquid waste is discovered, it shall be contained on the pad (either with curb for asphalt or concrete pad, with a soil berm or with other suitable measures) temporarily until an absorbent can be placed with the liquid or until proper containers are available for filling. The saturated absorbent or containers will then be disposed of at an appropriate facility. If hazardous waste is discovered, it shall be maintained in the same manner as the liquid waste and will be disposed of at a suitable facility for hazardous waste as determined by the emergency response team or a qualified environmental/hazardous waste consultant.

APPENDIX I
INTERIM CLOSURE DRAWINGS

"Under Seperate Cover"

APPENDIX IV

EROSION & SEDIMENTATION CONTROL PLAN

EROSION & SEDIMENTATION CONTROL PLAN
INTERNATIONAL PAPER
RIEGELWOOD MILL FACILITY
RIEGELWOOD, NORTH CAROLINA
S&ME JOB NO. 1356-99-573

Prepared For:

North Carolina Department of Environment and Natural Resources
Wilmington Regional Office - Land Quality Section
Wilmington, North Carolina

Prepared By:

S&ME, Inc.

June, 2000

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Sheet 3 of 7 – Stormwater Management Plan
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II. Erosion & Sedimentation Control Calculations (Closure Plan Appendix I)
- Channel Design (Berms, Benches, Roadside Channels)
- Piping Design
- Drop Inlet Grate Sizing

1.0 PROJECT INFORMATION

1.1 Site and Project Description

The purpose of the Erosion & Sedimentation Control Plan is to outline the measures to be used to prevent sediment from leaving the site during closure construction activities for the landfill as well as when final closure grades are achieved. Closure is designed to minimize the need for long term maintenance and to control the post-closure release of contaminants. Final operational contours are illustrated on the drawing in Appendix I, Closure Plan, Sheet 2 of 7.

Phasing of the landfill development is designed so that final cover can be established as soon as possible. The waste grades will be at 3H:1V for the side slopes and 5 percent on top with a maximum elevation of 131 feet mean sea level (MSL). The final landfill contours will have erosion control channels, berms, and benches and exterior side slopes at a maximum of 3H:1V with minimum 5 percent slopes. Final closure system contours will be the operational grade plus a 24 inch. The final closure grade will be 133 feet in elevation.

Following closure construction, the landfill will not be used for industrial purposes, but will be inspected for maintenance purposes. If the landfill must be closed prior to reaching the final contours, the surface of the landfill will be sloped to a minimum grade of 5 percent and maximum grade slope of 3H:1V. A final cover will be established over the landfill unit being closed.

1.2 Soils Information

The soil liner will consist of on-site or off-site borrow material meeting 1.0×10^{-5} cm/sec permeability or less. The vegetative layer will consist of a 6-inch thick soil that is enriched with sludge suitable for establishing a grass cover and controlling erosion. This layer will protect the soil liner from damage due to desiccation (drying), freeze-thaw, erosion, and vectors.

2.0 EROSION AND SEDIMENTATION CONTROL MEASURES

Various temporary and permanent erosion and sedimentation control measures will be required during the closure construction activities at the Riegelwood facility. These measures are illustrated on the drawings in Appendix I. The various erosion and sedimentation control measures have been designed in accordance with the North Carolina Erosion and Sediment Control Planning and Design Manual, 1988.

2.1 Final Cover

The waste will be prepared for placement of the soil liner layer by stabilizing soft or loose areas, with compacted structural fill. The soil liner layer will be constructed as required by the Technical Specifications. The soil liner layer will be a minimum of 18 inches thick with permeability not greater than 1.0×10^{-5} cm/sec. The installation and compaction of the soil liner system will require full time, on-site inspection and testing to verify conformance with the drawings and Technical Specifications. Soil liner material will be obtained from on-site sources.

A 6-inch vegetative layer that is suitable for establishing a grass cover will be placed on top of the soil liner. The vegetative layer will be constructed as required by the Technical Specifications. The placement of the soil liner layer and vegetative layer will require comprehensive full time on-site inspection.

2.2 Permanent Channels

Both grass-lined and plastic-lined channels will be used to convey runoff. The grass-lined channel will be lined with temporary straw with net liners to prevent erosion of bare soils prior to the establishment of grass in the channel. The grass-lined channel locations are shown on the drawings in Appendix I. A grass-lined channel detail is included on Sheet 6. Channel sizing calculations are included in Appendix II.

Channels to be lined with a synthetic liner will be constructed the same as grass-lined channels, but instead of lining them with straw with net they will be constructed using a non-spec 20-mil synthetic liner. The liner will be used to prevent erosion along the diversion berms and in the channels along the access road that runs to the top of the landfill. The locations of the synthetic-lined channels are shown on the drawings in Appendix I. The channel sizing calculations are included in Appendix II.

2.3 Stormwater Management

Stormwater management structures will be used to convey stormwater from the channels to the outlet devices. The structures include drop inlets and a subsurface piping system. Locations of the structures on the drawing Stormwater Management Plan, Sheet 3 of 7 in Appendix I.

2.4 Riprap Protection

The outlets of the proposed culverts will be protected from erosion by riprap protection along the slopes. The riprap protection will dissipate the energy of the flow by reducing its velocity. The riprap protection should be installed prior to or immediately following the culvert construction.

2.5 Surface Preparation

All cut and fill slopes will be roughened by discing or tracking with a tracked loader or dozer prior to vegetating. Surface stabilization will be accomplished with vegetation and mulch as soon as possible as specified in the seeding schedule on Sheet 6 of 7.

2.6 Permanent Seeding

Following grading and all new construction, all disturbed areas including areas on the landfill cap, will be permanently seeded. Seeding shall be performed according to the seeding specifications as shown on Sheet 6 of 7. Disturbed areas within the Borrow Source Location that will not be used for 60 days will be seeded according to the seeding

schedule on Sheet 2.

3.0 CONSTRUCTION SEQUENCE

1. Obtain plan approval and permits prior to beginning work.

2. Flag the work limits to prevent unnecessary clearing.

3. Hold pre-construction meeting at least one week prior to starting construction.

4. Clear and grub areas to be closed of all existing vegetation. Bring the closure area to the operational grades as outlined in the Closure Plan.

5. Install the 18 inch soil liner layer and 6 inch vegetative layer. Install all stormwater management accessories including piping, drop inlets, grass-lined channels, synthetic lined channels, etc.

6. Once final grading is complete, leave slopes slightly roughened, vegetate, and mulch in accordance with the seeding specifications on Sheet 6 of 7 in Appendix I. Grass-lined channels shall be vegetated as soon as possible.

7. All stormwater management structures will be inspected weekly and after each rainfall event during construction. Maintain all stormwater management structures according to the attached maintenance plan.

4.0 MAINTENANCE PLAN

The following maintenance plan shall be followed until the site is completely stabilized after construction. During construction, the Contractor shall be responsible for inspection and maintenance of all stormwater management structures.

1. All stormwater management structures will be checked for stability and operation following any runoff producing rainfall and at least once every week. Any needed repairs will be made immediately so that all stormwater management structures are maintained as designed.

2. Sediment will be cleaned out of the stormwater management structures when the level of sediment impedes the flow and functioning capabilities of the stormwater structures.

3. All seeded areas will be fertilized and re-seeded as necessary and mulched according to the seeding specifications in order to maintain a dense vegetative cover.

5.0 FINANCIAL RESPONSIBILITY/OWNERSHIP FORM

FINANCIAL RESPONSIBILITY/OWNERSHIP FORM
SEDIMENTATION POLLUTION CONTROL ACT

No person may initiate a land-disturbing activity on one or more acres as covered by the Act before this form and an acceptable erosion and sedimentation control plan have been completed and approved by the Land Quality Section, North Carolina Department of Environment and Natural Resources. (Please type or print and, if question is not applicable, place N/A in the blank).

Part A.

1. Project Name Closure Plan – International Paper Riegelwood Mill Facility

2. Location of land-disturbing activity: County Columbus
   City or Township Riegelwood and Highway/Street John L Riegel Road

3. Approximate date land-disturbing activity will be commenced: 2003

4. Purpose of development (residential, commercial, industrial, etc.): Industrial

5. Total acreage disturbed or uncovered (including off-site borrow and waste areas): 50

6. Amount of fee enclosed $_____

7. Has an erosion and sedimentation control plan been filed? Yes____No____Enclosed__X__

8. Person to contact should sediment control issues arise during land-disturbing activity.
   Name Edward J. Kreul, P.E. Telephone (910) 655-6229

9. Landowner(s) of Record (Use blank page to list additional owners):

International Paper	_____
Name(s)	
865 John L Riegel Road	_____
Current Mailing Address	Current Street Address
Riegelwood NC 28456	_____
City State Zip	City State Zip

10. Recorded in Deed Book No._____ Page No._____

Part B.

1. Person(s) or firm(s) who are financially responsible for this land-disturbing activity (Use a blank page to list additional persons or firms):

International Paper	_____
Name of Persons(s) or Firm(s)	
865 John L Riegel Road	_____
Mailing Address	Street Address
Riegelwood NC 28456	_____
City State Zip	City State Zip
(910) 655-6229	_____
Telephone	Telephone

2. (a) If the Financially Responsible Party is not a resident of North Carolina give name and address of a North Carolina Agent:

Name	
Mailing Address	Street Address
City State Zip	City State Zip
Telephone	Telephone

(b) If the Financially Responsible Party is a Partnership or other person engaging in business under an assumed name, attach a copy of the certificate of assumed name. If the Financially Responsible Party is a Corporation give name and street address of the Registered Agent.

Name	
Mailing Address	Street Address
City State Zip	City State Zip
Telephone	Telephone

The above information is true and correct to the best of my knowledge and belief and was provided by me under oath. (This form must be signed by the financially responsible person if an individual or his attorney-in-fact or if not an individual by an officer, director, partner, or registered agent with authority to execute instruments for the financially responsible person). I agree to provide corrected information should there be any changes in the information provided herein.

Edward J. Kreul, P.E.	
Type or print name	Title or Authority
Signature	Date

****

I, _____ , a Notary Public of the County of_____ State of North Carolina, hereby certify that_____ appeared personally before me this day and being duly sworn acknowledged that the above form was executed by him.

Witness my hand and notarial seal, this_____day of _____, 20_____

Seal

_____
Notary

My commission expires_____

APPENDIX V

CLOSURE INSPECTION CHECKLIST

INTERNATIONAL PAPER LANDFILL
CLOSURE INSPECTION CHECKLIST

		Inspection Frequency
1.	FINAL COVER SYSTEM	Quarterly*
_	Final Cover Settlement Comments:_____	
_	Erosion Damage Comments:_____	
_	Drop Inlets in Operable Condition Comments:_____	
_	Grass Condition Comments:_____	
_	Removal of Woody Vegetation Comments:_____	
2.	EROSION AND SEDIMENT CONTROL	Quarterly*
_	Culvert Outfalls Comments:_____	
_	Channels Comments:_____	
_	Benches, Berms, and Downchutes Comments:_____	

* And after large storm events

APPENDIX VI

CLOSURE/POST-CLOSURE COST ESTIMATE

CLOSURE AND POST-CLOSURE CARE
INTERNATIONAL PAPER
COST ESTIMATES FOR RIEGELWOOD MILL FACILITY (50 acres)

SUMMARY:

Closure Costs	$2,579,735*
Post-Closure Care Costs (for 30-year period)	$1,695,000
Corrective Action	$56,850
TOTAL COST	**$4,331,585***

* Closure cost does not include cost for interim phasing.

CLOSURE AND POST-CLOSURE CARE
INTERNATIONAL PAPER
COST ESTIMATES FOR RIEGELWOOD MILL FACILITY (50 acres)

A. CLOSURE COSTS

1. FINAL CAP SYSTEM	
a. Soil Liner	
1. 24" of compacted soil liner	$1,936,000
2. 6" of vegetative cover	$127,050
b. Road Materials	
1. Geosynthetic Clay Liner (GCL)	$29,295
2. 12" ABC Stone	$57,120
c. Stormwater Management Materials	
1. Piping	
• 12-inch dia. ADS	$3,300
• 15-inch dia. ADS	$3,600
• 18-inch dia. ADS	$5,000
• 24-inch dia. ADS	$7,800
2. Pre-Cast Concrete	
• 4' x 4' Drop Inlets (w/ Grates)	$6,250
• 4' x 8' Drop Inlet (w/ Grates)	$2,500
• Wingwall	$1,500
d. CQA Testing/Documentation (TBD)	
2. SEDIMENTATION/EROSION CONTROL MEASURES (not included in Section 1 costs above)	$184,500
3. GAS CONTROL SYSTEM Gas Vents, installed	NA
4. FINAL LANDSCAPING Seeding, fertilizing, mulching ($1200/acre)	$60,000
5. MOBILIZATION/DEMOBILIZATION	$100,000
6. ENGINEERING CONSTRUCTION MANAGEMENT AND CONSTRUCTION QUALITY ASSURANCE (Included in 1d above)	N/A
7. ADMINISTRATION	$3,000

8. LABOR
   Labor costs are included in line item costs shown above

ESTIMATED TOTAL CLOSURE COST **$2,579,735**

B. POST-CLOSURE CARE COSTS

1. INSPECTIONS/RECORD-KEEPING
   Yearly inspections and reporting to DSWM. $1,920/yr.

2. MONITORING
   a. Explosive Gases
      Quarterly monitoring NA

   b. Ground Water
      Collection and Analysis $22,000/yr.

   c. Surface Water
      Analytical Costs $3,000/yr.
      (Field Sampling costs included in 2b above)

   d. Leachate
      Assume two sampling events will be needed per year. $3,600/yr.

   e. Air Quality
      Sampled at time of methane monitoring.
      Additional cost $1,000/yr.

3. LEACHATE COLLECTION AND TREATMENT

   Not Applicable $0/yr.

4. MAINTENANCE (Preventive/Corrective)
   a. Gas system operation NA
   b. Ground-water and gas monitoring wells $1,000/yr.
   c. Final cover (mowing, replace plantings, fill for erosion, etc.) $2,500/yr.

B. POST-CLOSURE CARE COSTS (continued)

5. FEES	
a. License	$500/yr.
b. Inspection/regulatory charges	$500/yr.
6. ADMINISTRATION	$14,400/yr.
7. LABOR COSTS	
Miscellaneous repairs	$2,000/yr.
Total Annual Cost	$56,500/yr.

ESTIMATED TOTAL POST-CLOSURE CARE COSTS OVER 30-YEAR PERIOD **$1,695,000**

C. CORRECTIVE ACTION **$56,850**

CALCULATIONS

FINAL CLOSURE COST ESTIMATE
INTERNATIONAL PAPER - RIEGELWOOD MILL FACILITY
RIEGELWOOD, NORTH CAROLINA

TOTAL AREA	50 ACRES	2,178,000 FT^2
AREA TO BE CLOSED	50 ACRES	2,178,000 FT^2

1. FINAL CAP SYSTEMS					**TOTAL COST**
a. SOIL	THICKNESS (FT)	AREA (FT^2)	VOLUME (CY)	COST / CY	
1. SOIL LINER	2.0	2,178,000	161,333	$12.00	$1,936,000
2. VEGETATIVE LAYER	0.5	2,178,000	40,333	$3.15	$127,050
b. ROAD MATERIALS	COST / FT^2 (INSTALLED)		AREA (FT^2)		
1. GEOSYNTHETIC CLAY LINER (ROAD)	$0.35		83,700		$29,295
	COST / CY		VOLUME (CY)		
2. ABC STONE	$24.00		2,380		$57,120
c. STORMWATER MANAGEMENT MATERIALS					
1. PIPING	COST / FT		LENGTH (FT)		
12-INCH DIA. ADS PIPE	$15.00		220		$3,300
15-INCH DIA. ADS PIPE	$20.00		180		$3,600
18-INCH DIA. ADS PIPE	$25.00		200		$5,000
24-INCH DIA. ADS PIPE	$30.00		260		$7,800
2. PRE-CAST CONCRETE	UNIT COST		NO. UNITS		
4' X 4' DROP INLETS (W/ GRATES)	$1,250.00		5		$6,250
4' X 8' DROP INLETS (W/ GRATES)	$2,500.00		1		$2,500
WINGWALL	$1,500.00		1		$1,500
d. TESTING / DOCUMENTATION (TBD)					
1. CQA / ENGINEERING	RATE		HOURS / WEEK	NO. WEEKS	
a. ENGINEER					
b. TECHNICIAN					
c. LAB TESTING					

2. EROSION & SEDIMENT CONTROL STRUCTURES			**TOTAL COST**
	COST / FT	LENGTH (FT)	
a. GRASS LINED DITCHES (STRAW W/ NET)	$5.00	3,730	$18,650
	COST / FT	LENGTH (FT)	
b. SYNTHETIC LINED DITCHES (20-mil NON-SPEC)	$3.00	9,390	$28,170
	COST / CY (PLACED)	VOL. CONCRETE (CY)	
c. CONCRETE CHANNEL	$100.00	60	$6,000
	COST / CY (PLACED)	CY	
d. RIP RAP	$150.00	1,230	$184,500

3. GAS CONTROLS (NA)			**TOTAL COST**
	COST / VENT	NO. VENTS	
a. GAS VENTS			$0

4. LANDSCAPING			TOTAL COST
	COST / ACRE	AREA (ACRES)	
a. SEEDING / FERTILIZING / MULCHING	$1,200.00	50.0	$60,000

5. MOBILIZATION / DEMOBILIZATION		TOTAL COST
a. GRADING CONTRACTOR	LUMP SUM	$100,000
b. GEOMEMBRANE CONTRACTOR (INCLUDED IN ABOVE COSTS)		$0

6. ENGINEERING, TESTING, & DOCUMENTATION (TBD)		TOTAL COST
a. DRAWINGS / REPORTS	LUMP SUM	

7. ADMINISTRATION		TOTAL COST
(ANNOUNCEMENTS, DEEDS, FEES)	AS NEEDED	$3,000

8. LABOR	TOTAL COST
INCLUDED IN ABOVE COSTS	$0

TOTAL COST $2,579,735

POST CLOSURE COST ESTIMATE
INTERNATIONAL PAPER - RIEGELWOOD MILL FACILITY
RIEGELWOOD, NORTH CAROLINA

1. INSPECTIONS / RECORD KEEPING

TECHNICIAN (HOURLY)	HOURS PER QUARTER	COST PER YEAR
$40.00	12	$1,920

2. MONITORING

ANALYSIS	COST (EACH)	NO. OF LOCATIONS	SAMPLING EVENTS PER YEAR	COST	
a. EXPLOSIVE GAS MONITORING	NA	N/A		NA	PER YEAR
b. GROUNDWATER	$1,000	11	2	$22,000	PER YEAR
c. SURFACE WATER	$1,000	3	1	$3,000	PER YEAR
d. LEACHATE SAMPLING	$1,800	N/A	2	$3,600	PER YEAR
e. AIR QUALITY				$1,000	PER YEAR

3. LEACHATE TREATMENT

Not Applicable	$0	PER YEAR

4. MAINTENANCE

a. OPERATE GAS REMOVAL SYSTEMS	NA	PER YEAR
b. WELLS (GROUNDWATER))	$1,000	PER YEAR
c. FINAL COVER (MOWING, FILL FOR EROSION, ETC.)	$2,500	PER YEAR

5. FEES

a. LICENSE	$500	PER YEAR
b. INSPECTIONS / REGULATORY CHANGES	$500	PER YEAR

6. ADMINISTRATION AND MISCELLANEOUS REPAIRS

	RATE	HOURS	MONTHLY COST	ANNUAL COST
PROJECT MANAGER	$85.00	4	$340	$4,080
PROJECT ENGINEER	$75.00	8	$600	$7,200
TECHNICIAN	$40.00	8	$320	$3,840
CLERICAL	$35.00	8	$280	$3,360

7. LABOR

a. MISCELLANEOUS REPAIRS, MAINTENANCE, AND OPERATIONS NOT INCLUDED ABOVE	$2,000	PER YEAR

ANNUAL COST: $56,500

TOTAL COST (30 YEARS): $1,695,000

REMEDIATION COST ESTIMATE
CLOSURE / POST-CLOSURE PLAN
INTERNATIONAL PAPER - RIEGELWOOD MILL FACILITY
RIEGELWOOD, NORTH CAROLINA

ASSUMPTION: Leachate break out on a side slope

Cubic Yards of contaminated soil:	300 CY
No. of Assessment Monitoring Wells to be added:	2
No. of Monitoring Events:	2
No. of Occurrences (assumed):	3

1.) WELL INSTALLATION					
	2	wells @	$2,500	per well	**$5,000**
2.) EXCAVATION OF CONTAMINATED SOIL WITH ON-SITE PLACEMENT					
	300	CY @	$3.00	per CY	**$900**
3.) REPLACEMENT OF EXCAVATED SOIL (BACKFILL AND COMPACT)					
	300	CY @	$3.50	per CY	**$1,050**
4.) ENGINEERING / DOCUMENTATION OF REPAIRS					
				Lump Sum	**$5,000**
5.) GROUNDWATER SAMPLING					
	2	events @	$1,000	per event	**$2,000**
6.) GROUNDWATER ASSESSMENT REPORT / STATISTICAL ANALYSIS					
				Lump Sum	**$5,000**
				SUBTOTAL PER OCCURRENCE	**$18,950**
			3	**OCCURRENCES IN 30 YEARS**	**$56,850**