Part A and Part B Permit Renewal Application for the

TRIASSIC PARK
WASTE DISPOSAL FACILITY

RCRA Permit No. NM0001002484

Chaves County, New Mexico

Volume 5
Permit Attachments

October 17, 2011
Revision 1 - April 30, 2012

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Laboratory Test Results

GEOTECHNICAL TEST PITS

The proposed landfill site is located in a remote portion of eastern Chaves County, New Mexico. The land surface gently slopes to the west. This sloping plain is characterized by low-relief hummocky wind-blown deposits, sand ridges, and dunes.

A geotechnical field investigation involving the excavation of test pits was conducted by a TerraMatrix/Montgomery Watson field engineer on August 18, 1997. Five test pits were excavated to characterize the geotechnical conditions of the surficial sands and Upper Dockum claystone. Soil samples were also collected from the test pits to conduct soil characterization tests, recompacted permeability tests, and interface shear strength tests.

Four of the five test pits were excavated within the proposed footprint of the cell and one test pit was excavated in the area of the proposed evaporation ponds. Figure 1 displays the general location of the geotechnical field investigation. All test pits were located in the field by onsite personnel. The upper 6 to 10 feet of each pit was excavated by a D8 CAT dozer. A John Deere 310D backhoe with an extended boom was then used to excavate the test pits to their total depth. Total depth of the test pits ranged from 17 to 24 feet. Material types were noted, as was the presence or absence of moisture or water. Bag and bucket samples were collected from the backhoe cuttings at various depths as chosen by the field engineer. None of the test pits encountered a water table. The geotechnical field investigation test pit logs are attached.

Soil samples collected from each of the five test pits were submitted to the laboratory for material property analysis. The laboratory tests performed included:

- Moisture Content (ASTM D2216)
- Atterberg (ASTM D4318)
- Moisture/Density Relationship (ASTM D1557, D698)
- Sieve Analysis (ASTM D422)
- Recompacted Permeability (ASTM 5084)
- Interface Shear - Direct Shear

Table 1 summarizes the geotechnical field investigation and includes the test pit identification number, approximate location, sample type, and depth.

TABLE 1 GANDY GEOTECHNICAL TEST PITS				
Test Pit ID	Pit Location (approx.) Northing/Easting	Elevation (feet)	Sample Type	Sample Depth
TP-1	N859650/E645460		Bag	2 to 3
TP-1			Bag	15
TP-1			Bucket	17
TP-2	N861150/E646860		Bag	3 to 4
TP-2			Bag	16 to 18
TP-2			Bucket	17
TP-3	N859150/E646360		Bag	2
TP-3			Bag	3 to 4
TP-3			Bag	6.5
TP-3			Bucket	7.5
TP-4	N858850/E645060		Bag	5 to 7
TP-4			Bag	6 to 9
TP-4			Bucket	14
TP-5	N861750/E645660		Bag	6
TP-5			Bag	17
TP-5			Bucket	18

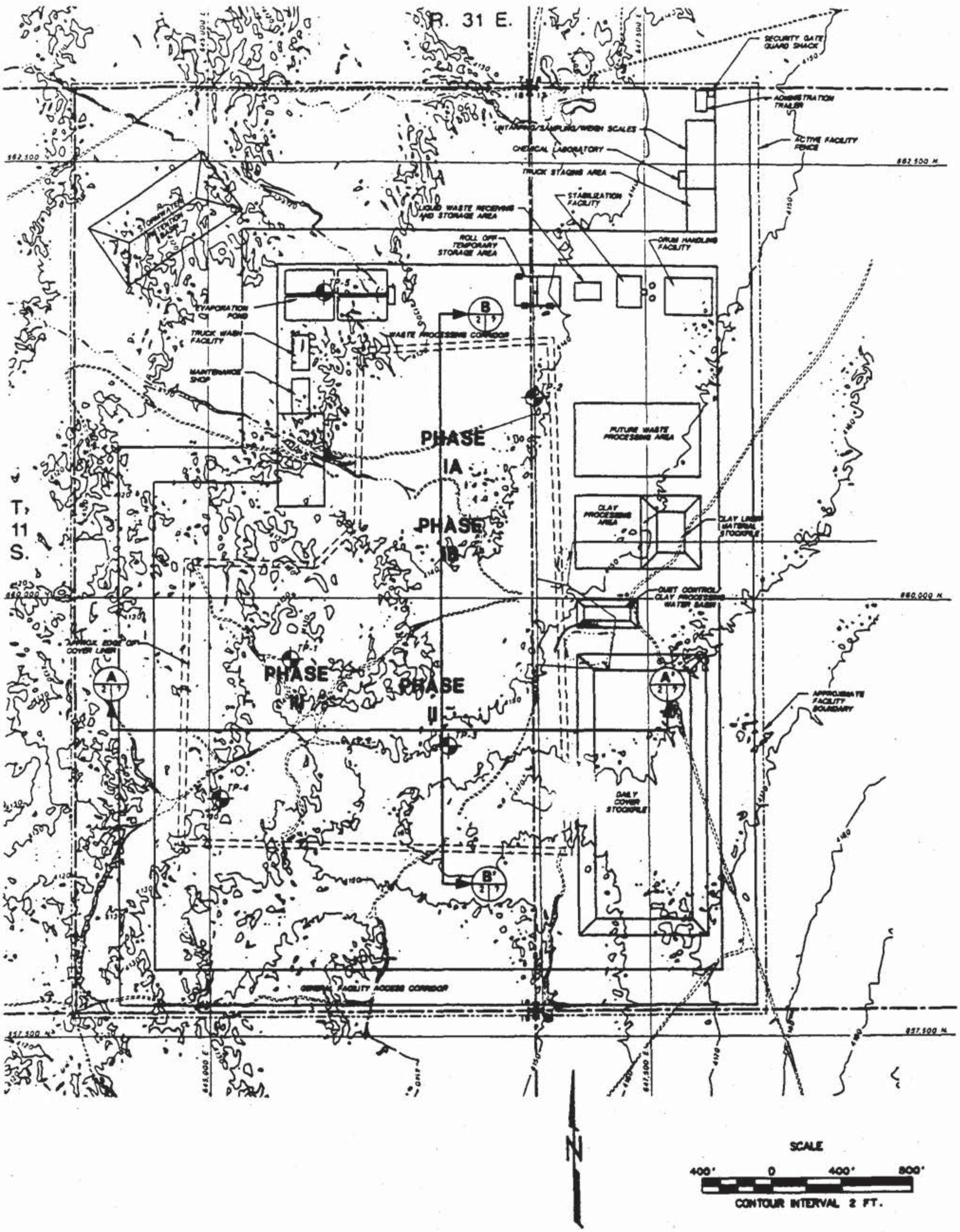
SUMMARY OF LABORATORY TEST RESULTS

A total of eight samples, one from each test pit and three from test pit number 4, and a composite sample from test pit 1-4 for the surficial silty sands were tested. All laboratory testing was conducted by TerraMatrix/Montgomery Watson Laboratories in Steamboat Springs, Colorado.

Natural moisture content ranged from 7.0% to 12.3%. Atterberg limits indicated a range of liqid limits of 37% to 46% and plasticity limits of 19% to 40% for the upper Dockum. The surficial silty sand was found to be non-plastic. The grain size analysis indicated the upper Dockum is predominantly fine grained with fines ranging from 65% to 99% and sands from 1% to 35%. The surficial sands had 17% fine material and no gravel sized material. The Caliche was found to have 5% gravel, 35% sand, and 60% fines which have a liquid limit of 34% and a plasticity index of 17%. These test results are summarized on the following page, Summary of Laboratory Test Results.

BEARING CAPACITY

The surficial silty sands were estimated to have a bearing capacity of 4000 psf using the table presented on page 4.



REV No	REVISIONS	REV DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY

TerraMatrix
MONTGOMERY WATSON
Mining Group

PROJECT No. 602-0206
AutoCAD FILE testpitloc.dwg
SCALE 1=1000
FIGURE No. 1

TRIASSIC PARK
WASTE DISPOSAL FACILITY

TEST PIT LOCATION

SUMMARY OF LABORATORY TEST RESULTS

Sample Location		Natural Moisture Content (%)	Natural Dry Density (%)	Atterberg Limits		Gradation			Unconfined Compressive Strength (psf)	Soil/Bedrock Description	Unified Soil Classification (USCS)
Test Pit Hole No.	Depth (Feet)			Liquid Limit (%)	Plasticity Index (%)	Gravel (%)	Sand (%)	Fines (%)			
1	17	9.9		37	19		5	95		Slightly weathered, dark reddish brown, CLAYSTONE, trace sand, trace calcareous, (sr), dry	CL
2	17	12.1		54	40		27	73		Fresh to slightly weathered, reddish brown weak, CLAY and CLAYSTONE, trace calcareous (sr), trace organics	CH
3	7.5	9.7		36	20		2	98		Fresh to slightly weathered, reddish brown and grayish green, extremely weak, CLAYSTONE, trace calcareous (mr), damp.	CL
4	14	8.6		39	27		13	87		Slightly weathered, dark reddish brown, weak, stratified, CLAYSTONE, little calcareous (sr), damp	CL
4	20	7.0		-	-		1	99 –		Fresh to slightly weathered, dark reddish brown, weak to medium strong, CLAYSTONE, little silt, damp to moist	CL
5	18	12.3		46	32		35	65		Fresh to slightly weathered, reddish brown, extremely weak, SILTY CLAYSTONE, trace fine sand, trace calcareous (sr), trace organics, damp	CL
1-4	comp			NP	NV		83	17		Orange Brown, non stratified homogeneous, fine SAND little to some silt, damp	SM
4	6-9			34	17	5	35	60		Whitish Pink, non-statified calcium carbonate, clayey silt, dry to damp	CL

Project Name: Triassic Park
Project Location:
Project No.: 790-12101 **Technician:** DCP **Date:** 9/10/97

TerraMatrix
Engineering & Materials Testing Services
[illegible] Moffat Avenue
Steamboat Springs, Colorado 80487

SUMMARY OF LABORATORY TEST RESULTS

TABLE 1 (continued)

Presumptive Values of Allowable Bearing Pressures for Spread Foundations

		Allowable Bearing Pressure Tons Per sq ft.	
Type of Bearing Material	Consistency In Place	Range	Recommended Value for Use
Homogeneous inorganic clay, sandy or silty clay (CL, CH)	Very stiff to hard	3 to 6	4.0
	Medium to stiff	1 to 3	2.0
	Soft	.5 to 1	0.5
Inorganic silt, sandy or clayey silt, varved silt-clay-fine Sand	Very stiff to hard	2 to 4	3.0
	medium to stiff	1 to 3	1.5
	Soft	.5 to 1	0.5

Notes:

1. Variations of allowable bearing pressure for size, depth and arrangement of footings are given in Table 2.

2. Compacted fill, placed with control of moisture, density, and lift thickness, has allowable bearing pressure of equivalent natural soil.

3. Allowable bearing pressure on compressible fine grained soils is generally limited by considerations of overall settlement of structure.

4. Allowable bearing pressure on organic soils or uncompacted fills is determined by investigation of individual case.

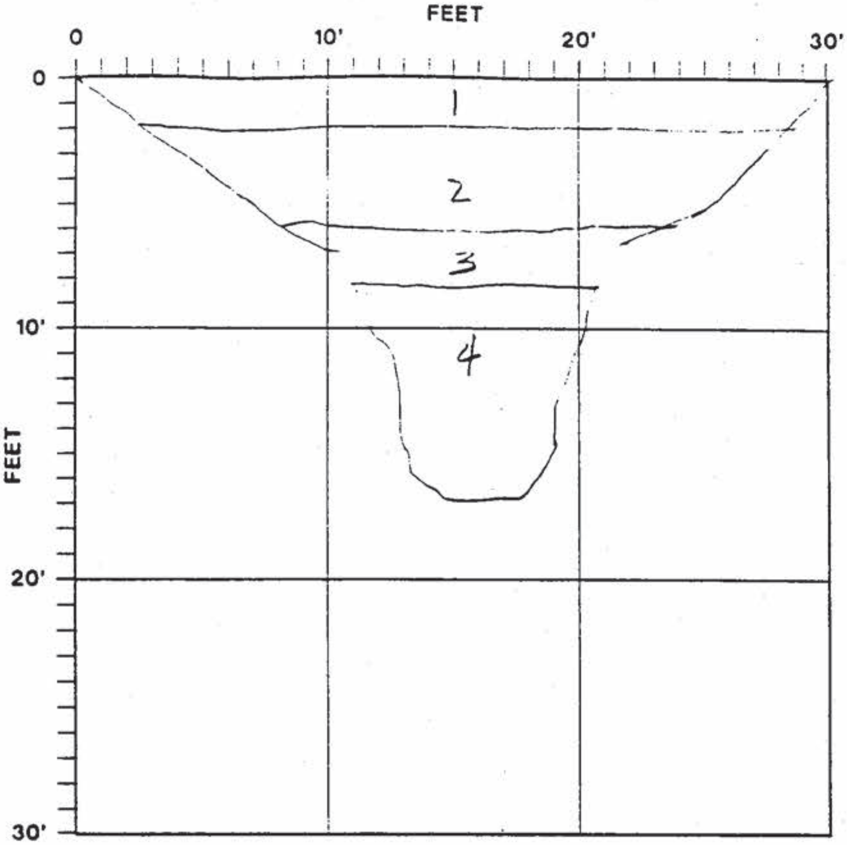
5. If tabulated recommended value for rock exceeds unconfined compressive strength of intact specimen, allowable pressures equals unconfined compressive strength.

GENERAL LOCATION: TP-1

PIT TREND:

DATE: 8/18/97

ENGINEER: D. Gleason



LEGEND

SOIL HORIZON
SAMPLE LOCATION
HORIZON CONTACT

SAMPLE No.	DEPTH
Baggie	2 to 3
Baggie	15'
Bucket	17'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
1	0-2' Loose tan, fine, SAND, some silt, with roots, moist
2	2'-6 Compact, reddish brown, SAND, some clay and silt, slightly calcareous, slightly moist, some gravelly lenses
3	6'-8' Hard, brownish red, weathered mudstone, slightly moist
4	8'-17' Hard to very hard, brownish red, mudstone/claystone, traces of olive claystone, slightly moist

SPECIAL NOTES:

No water encountered
Pocket penetrometer maxed out at 7'-8'

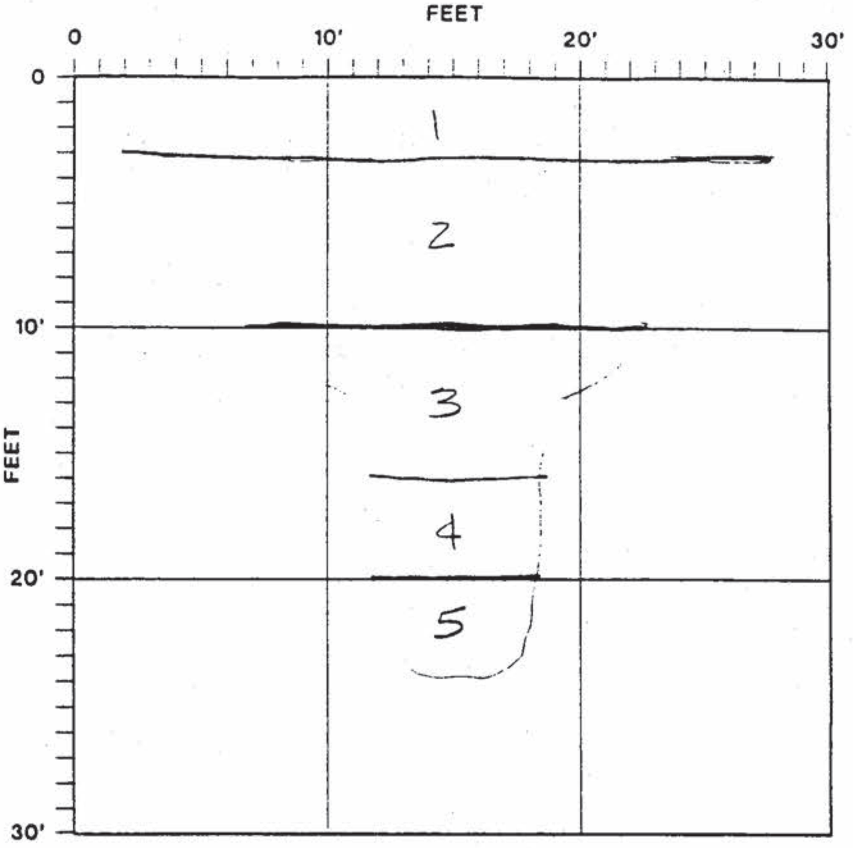
Project No.: 602	Design By:	Scale:
File:	Drawn By:	Date:
TerraMatrix Engineering & Environmental Services 1475 Pine Grove Road, P.O. Box 774018 Steamboat Springs, Colorado 80477	Test Pit No: 1 Figure No.	

Triassic Park Landfill

TEST PIT #1

GENERAL LOCATION: TP-2
PIT TREND:

DATE: 8/18/97
ENGINEER: D Gleason



LEGEND

SOIL HORIZON
SAMPLE LOCATION
HORIZON CONTACT

SAMPLE No.	DEPTH
Baggie	3' to 4'
Baggie	16' to 18'
Bucket	17'

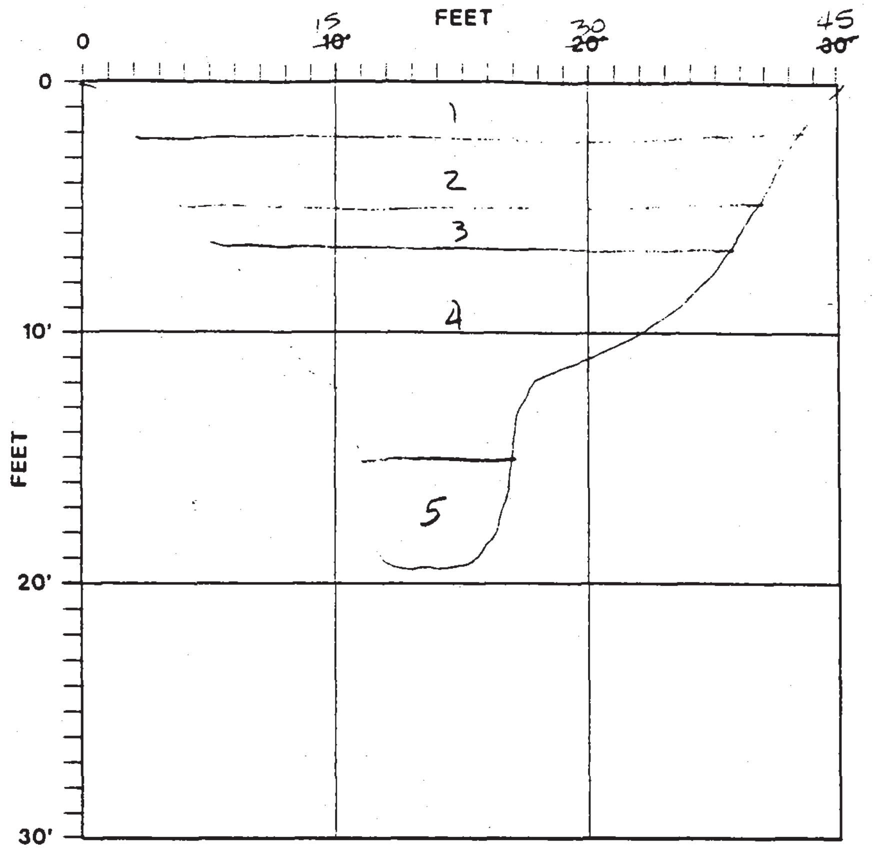
SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
1	0-3' Loose, tan, fine, SAND, some silt, with roots, moist
2	3'-10' stiff, tan, calcareous, CLAY, with silt and sand, slightly moist
3	10'-16' Dense, brown, medium to fine, SAND, some silt, trace coarse sand lenses, slightly moist
4	16'-20' Slightly stiff to stiff, brown, silty CLAY, moist
5	20'-24' Hard, brown, clayey, sandy, SILT, moist

SPECIAL NOTES:

No water encountered

Project No. 602	Design By:	Scale:	Triassic Park Landfill
File:	Drawn By:	Date:	
TerraMatrix Engineering & Environmental Services 1475 Pine Grove Road, P.O. Box 774018 Steamboat Springs, Colorado 80477		Test Pit No: 2 Figure No.	TEST PIT # 2

GENERAL LOCATION: TP-3
PIT TREND:
DATE: 8/18/97
ENGINEER: D Gleason



LEGEND

SOIL HORIZON
SAMPLE LOCATION
HORIZON CONTACT

SAMPLE No.	DEPTH
Baggie	2
Baggie	3' & 4'
Baggie	6.5'
Bucket	7.5
Baggie	5

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
1	0-2' Loose, tan, fine SAND, some silt, w/ roots, moist
2	2'-5' stiff, whitish tan, very calcareous CLAY, with silt and sand, some gravel and cobbles, slightly moist
3	5'-6.5' stiff, reddish brown, sandy CLAY, some silt
4	6.5'-15' slightly hard, reddish brown slightly weathered, CLAYSTONE/SILTSTONE, slightly moist, blocky, greenish-grey siltstone lenses
5	15'-19' Very hard, brownish red, SILTSTONE, slightly moist

SPECIAL NOTES:

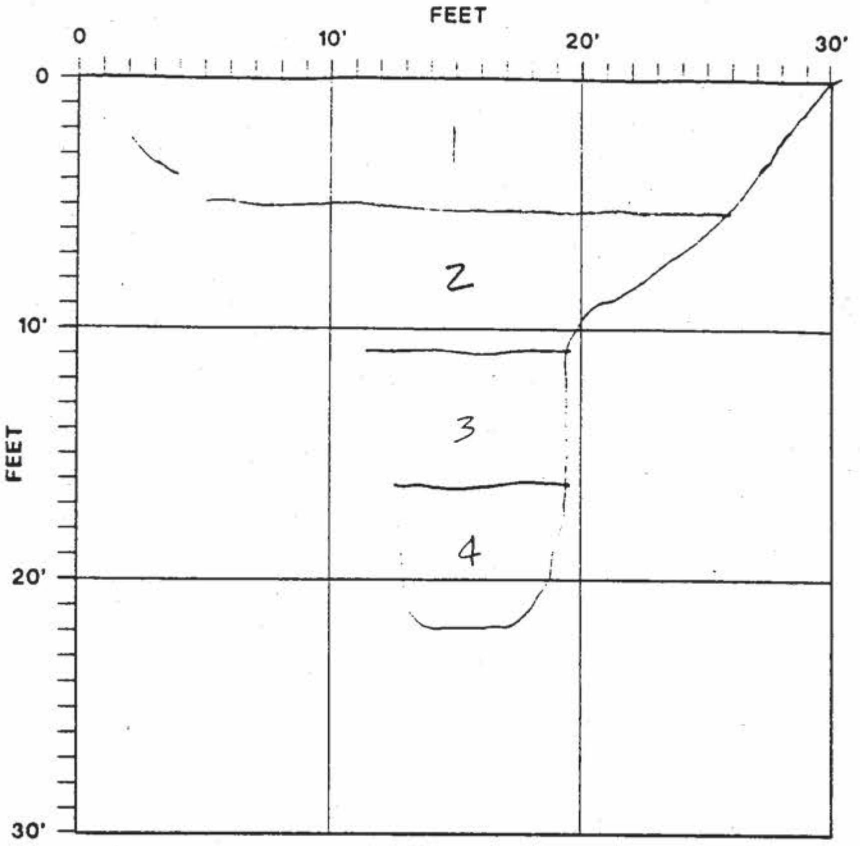
No water encountered
Pocket penetrometer maxed out at 10'-15'

Project No.: 602	Design By:	Scale:
File:	Drawn By:	Date:
TerraMatrix Engineering & Environmental Services 1475 Pine Grove Road, P.O. Box 774018 Steamboat Springs, Colorado 80477	Test Pit No: 3 Figure No.	

Triassic Park Landfill

TEST PIT # 3

GENERAL LOCATION: TP-4
PIT TREND:
DATE: 8/18/97
ENGINEER: D Gleason



LEGEND

SOIL HORIZON
SAMPLE LOCATION
HORIZON CONTACT

SAMPLE No.	DEPTH
Baggie	5' to 7'
Baggie	6' to 9'
Bucket	14'
Baggie	20'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
1	0-6' Loose to dense, tan, fine, SAND, some silt, roots to 3', moist
2	6'-11' slightly stiff to stiff, whitish tan, calcareous, CLAY, with sand and gravels some cobbles, slightly moist
3	11'-16' slightly hard, reddish brown, CLAYSTONE/MUDSTONE, slightly moist
4	16'-22' Hard to very hard, reddish brown, SILTSTONE, trace clay. greenish-grey SILTSTONE lenses

SPECIAL NOTES:

No Water encountered
Pocket penetrometer maxed out at 5'-6.5'

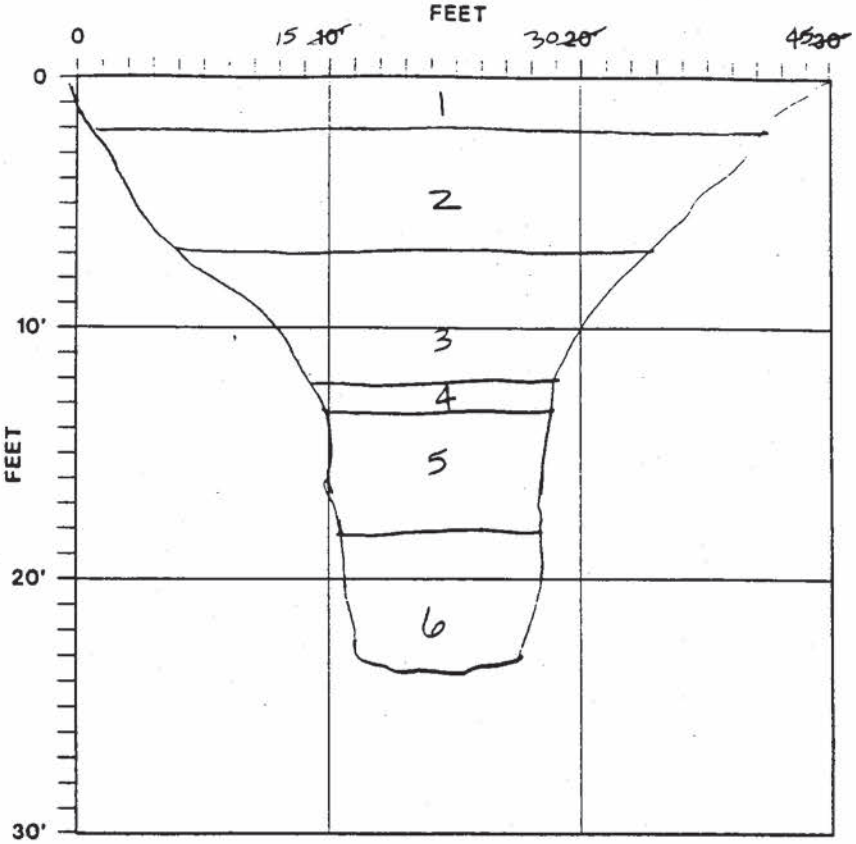
Project No.: 602	Design By:	Scale:	Triassic Park Landfill
File:	Drawn By:	Date:	
TerraMatrix Engineering & Environmental Services 1475 Pine Grove Road, P.O. Box 774018 Steamboat Springs, Colorado 80477	Test Pit No: 4 Figure No.		TEST PIT #4

GENERAL LOCATION: TP-5

PIT TREND:

DATE: 8/18/97

ENGINEER: D. Gleason



LEGEND

SOIL HORIZON
SAMPLE LOCATION
HORIZON CONTACT

SAMPLE No.	DEPTH
Bucket	6'
Baggie	17'
Bucket	18'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
1	0-2' Loose, tan, fine SAND, some silt, moist, w/ roots
2	2'-7' Dense, brownish red, fine, silty SAND, slightly moist
3	7'-12' stiff, brown, calcareous CLAY, with SAND, slightly moist.
4	12'-13' Gravely, clay lense
5	13'-18' Hard, dark brown, mudstone/CLAYstone, slightly moist
6	18'-23' slightly hard, reddish brown, sandy SILTSTONE

SPECIAL NOTES:

No water encountered
Pocket penetrometer maxed out at 13'-17'

Project No.: 602	Design By:	Scale:	Triassic Park Landfill
File:	Drawn By:	Date:	
TerraMatrix Engineering & Environmental Services 1475 Pine Grove Road, P.O. Box 774018 Steamboat Springs, Colorado 80477	Test Pit No: 5 Figure No.		TEST PIT # 5

INTERFACE TESTING

An interface shear testing program was conducted as outlined below:

The testing program consisted of the following:

- Three direct shear tests of the entire liner section run at three different normal loads of 2000 psf, 8,000 psf, and 14,000 psf.
- The liner section consists of the following (from top to bottom, see attached figure):
    - Protective soil
    - Geocomposite
    - Textured HDPE Geomembrane
    - GCL (non woven side up, in contact with textured HDPE)
    - Recompacted clay subgrade

- The GCL was be saturated for a minimum of 72 hours under a normal load of 200 psf prior to testing.
- The protective soil was be compacted at a moisture content of approximately 7% and to a dry density of approximately 95 pcf.
- The recompacted clay subgrade was compacted at a moisture content of 12.2% and to a dry density of 114.3 pcf.
- The liner section was assembled and allowed to sit for 1 to 2 hours under the normal loads specified prior to shearing.
- The shear rate was 0.04 cm/sec.

The results of the testing program are presented on pages 2 and 3.

GEOSYNTEC CONSULTANTS

Soil-Geosynthetic Interaction
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Tel. (404) 705-9500 • Fax (404) 705-9300

11 December 1997

Mr. Paul Pellicer
TerraMatrix Montgomery Watson
1475 Pine Grove Road, Suite 109
P.O. Box 774018
Steamboat Springs, Colorado 80477

Subject: Final Report
Interface Direct Shear Testing
TerraMatrix Project No. 602

Dear Mr. Pellicer:

GeoSyntec Consultants (GeoSyntec) is pleased to present the enclosed final report on the interface direct shear testing performed for TerraMatrix Montgomery Watson (TerraMatrix) for the TerraMatrix Project No. 602. The testing program was conducted in accordance with the test procedures defined in the 3 October 1997 letter prepared by Mr. Paul Pellicer of TerraMatrix and transmitted to Mr. Robert H. Swan, Jr. of GeoSyntec. All of the interface direct shear testing was conducted at GeoSyntec's Soil-Geosynthetic Interaction Testing Laboratory located in Atlanta, Georgia.

GeoSyntec appreciates the opportunity to provide laboratory testing services to TerraMatrix for the TerraMatrix Project No. 602. Should you have any questions regarding the enclosed report, please do not hesitate to contact any of the undersigned.

Sincerely,

Zehong Yuan, Ph.D., P.E. (Georgia)
Assistant Program Manager

Robert H. Swan Jr.

Robert H. Swan, Jr.
Laboratory Manager

Gary R. Schmertmann, P.E. (Georgia)
Senior Project Engineer

Enclosure

GLI0406/SGI97133

Prepared for

TerraMatrix Montgomery Watson
1475 Pine Grove Road, Suite 109
P.O. Box 774018
Steamboat Springs, Colorado 80477

FINAL REPORT
INTERFACE DIRECT SHEAR TESTING
TERRAMATRIX PROJECT NO. 602

Prepared by

GEOSYNTEC CONSULTANTS
Soil-Geosynthetic Interaction Testing Laboratory
5775 Peachtree Dunwoody Road, Suite 11D
Atlanta, Georgia 30342

Project Number GLI0406

11 December 1997

1. INTRODUCTION

This report was prepared by Mr. Robert H. Swan, Jr. and Dr. Zehong Yuan, P.E. (Georgia), both of GeoSyntec Consultants (GeoSyntec), Atlanta, Georgia. The report was reviewed by Dr. Gary R. Schmertmann, P.E. (Georgia), also of GeoSyntec, in accordance with the internal peer review policy of the firm. The laboratory testing program described in this report was performed at the request and authorization of Mr. Paul Pellicer of TerraMatrix Montgomery Watson (TerraMatrix), Steamboat Springs, Colorado.

TerraMatrix authorized GeoSyntec to undertake a laboratory testing program to evaluate the interface shearing resistance between two site soils (i.e., protective soil and clay subgrade soil) and three geosynthetic materials (i.e., geomembrane, geocomposite, and geosynthetic clay liner (GCL)) for the TerraMatrix Project No. 602. GeoSyntec understands that the sample preparation procedures and testing conditions used in the testing program were selected by Mr. Pellicer of TerraMatrix to model anticipated field conditions. All of the interface direct shear testing was conducted at GeoSyntec's Soil-Geosynthetic Interaction Testing Laboratory located in Atlanta, Georgia.

2. TESTING PROGRAM

2.1 Scope

The testing program consisted of two interface direct shear test series. Each interface direct shear test series consisted of three tests.

2.2 Testing Methods

The interface direct shear tests were performed in accordance with the American Society for Testing and Materials (ASTM) Standard Test Method D 5321, "*Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method*". The tests were conducted in a large direct shear device containing an upper and lower shear box. The upper shear box measured 12 in. by 12 in. (300 mm by 300 mm) in plan and 3 in. (75 mm) in depth. The lower shear box measured 12 in. by 14 in. (300 mm by 350 mm) in plan and 3 in. (75 mm) in depth.

2.3 Geosynthetic and Soil Materials

The geosynthetic and soil materials used in the testing program are presented in Appendix A. The soil materials were provided to GeoSyntec by TerraMatrix. TerraMatrix arranged to have each geosynthetic manufacturer ship their geosynthetic materials directly to GeoSyntec for testing.

2.4 Test Configuration and Procedures

The configuration of the test specimens and the specific test procedures used to conduct the interface direct shear tests are presented in Appendix B. GeoSyntec understands that the test procedures and test conditions were selected by TerraMatrix to model anticipated field conditions.

3. TEST RESULTS

3.1 Failure Modes

For Test Series 1, sliding (i.e., shear failure) was observed to occur at the interface between the nonwoven geotextile of the GCL and the geomembrane for the test conducted at the normal stress of 14 psi (98 kPa), and within the GCL for the tests conducted at normal stresses of 56 and 100 psi (392 and 700 kPa). For Test Series 2, shear failure was observed to occur at the interface between the protective soil and the geocomposite for the test conducted at the normal stress of 100 psf (5 kPa), and at the interface between the woven geotextile of the GCL and the clay subgrade soil for the tests conducted at normal stresses of 300 and 500 psf (15 and 24 kPa).

3.2 Data Presentation

For each of the interface direct shear tests, the total-stress shearing resistance was evaluated for each applied normal stress. The test data were plotted on a graph of shear force versus horizontal displacement. The resulting plots are presented in Appendix C. The peak value of shear force was used to calculate the peak shear strength. For this report, the large displacement shear strength (τ_{LD}) was calculated using the shear force measured at the end of each test. No area correction was used when computing normal and shear stresses because each test was performed using a constant effective sample area (i.e., the area of the geosynthetic specimen and/or lower shear box was larger than that of the upper shear box).

The calculated shear strengths were plotted on a graph of shear stress versus normal stress and the results were used to evaluate total-stress peak and large displacement shear strength envelopes. A best-fit straight line was drawn through the data points from each test series to obtain the corresponding total-stress peak and large displacement shear strength friction angles and adhesions. The coefficient of correlation (R^2), a standard statistical indicator of how well the best-fit line matches the test data, was obtained for each best-fit line. The summary plots of shear stress versus normal stress for each test series are also presented in Appendix C. The friction angles, adhesions, and R^2 values derived from the plotted test results are presented in Table 1.

For each test series, it is noted that the reported total-stress shear strength parameters of friction angle and adhesion were determined based on the best-fit straight line drawn through the test data on a plot of shear stress versus normal stress. Caution should be exercised in using these shear strength parameters for applications involving normal stresses outside the range of stresses covered by each test series.

4. CLOSURE

The reported results apply only to the materials and test conditions used in the laboratory testing program. The results do not necessarily apply to other materials or test conditions. The test results should not be used in engineering analyses unless the test conditions model the anticipated field conditions. The testing was performed in accordance with general engineering testing standards and requirements. This testing report is submitted for the exclusive use of TerraMatrix.

TABLE 1

INTERFACE DIRECT SHEAR TEST RESULTS
MEASURED TOTAL STRESS SHEAR STRENGTH PARAMETERS
TERRAMATRIX MONTGOMERY WATSON
TERRAMATRIX PROJECT NO. 602

Test Series Number	Interfaces Tested(1)	Normal Stress	Peak Strength(2)			Large Displacement Strength(2,3)			Reference Appendix Figure Numbers
			Friction Angle	Adhesion (psf)	R^2	Friction Angle	Adhesion (psf)	R^2	
1	Protective Soil/NSC TN3002-1125 Geocomposite/60-mil NSC Textured HDPE Geomembrane/Hydrated Bentofix NS GCL with Nonwoven Geotextile Against Geomembrane/Clay Subgrade Soil Under Consolidated Conditions	14 to 100 psi	9°	650	0.951	2°	440	0.977	C-1 and C-2
2	Protective Soil/NSC TN3002-1125 Geocomposite/60-mil NSC Textured HDPE Geomembrane/Hydrated Bentofix NS GCL with Nonwoven Geotextile Against Geomembrane/Clay Subgrade Soil Under Consolidated Conditions	100 to 500 psf	33°	18	0.999	31°	15	1.000	C-3 and C-4

Notes: (1) See Appendix B for detailed test conditions and procedures. For each test, sliding (i.e., shear failure) was observed to occur at a specific interface or within the GCL as described in Section 3 of the report.

(2) The reported total-stress shear strength parameters for each test series were determined from a best-fit line drawn through the test data. Caution should be exercised in using these shear strength parameters for applications involving normal stresses outside the range of stresses covered by each test series. The value of R^2, the coefficient of correlation, provides an indication of how well the best-fit shear strength parameters match the test data.

(3) The large displacement shear strength (τ_{LD}) was calculated using the shear force measured at the end of each test.

APPENDIX A

GEOSYNTHETIC AND SOIL MATERIALS

Geosynthetic Materials

Three geosynthetic materials were used in the testing program. These materials are referenced by name in this report, and include:

- 60-mil (1.5-mm) thick National Seal Company (NSC) textured high density polyethylene (HDPE) geomembrane, referred to as 60-mil NSC textured HDPE geomembrane;
- NSC TN3002-1125 geocomposite consisting of a Trevira 1125 nonwoven geotextile heat-bonded to each side of a NSC PN3000 geonet component, referred to as NSC TN3002-1125 geocomposite; and
- NSC Bentofix NS GCL consisting of a woven geotextile on one side of the bentonite component and a nonwoven geotextile on the other side of the bentonite component, needle-punched and thermally-locked together forming the finished product, referred to as Bentofix NS GCL.

TerraMatrix arranged to have NSC ship the bulk samples of the three geosynthetic materials directly to GeoSyntec for testing.

Soil Materials

Two site soil materials (i.e., protective soil and clay subgrade soil) were used in the testing program. Bulk samples of the two soil materials were obtained from the project by TerraMatrix and provided to GeoSyntec for testing.

APPENDIX B

TEST PROCEDURES AND TEST CONDITIONS

TEST PROCEDURES AND CONDITIONS
TEST SERIES NUMBER: 1

Test Specimen Configuration (from top to bottom) and Placement Conditions:

- upper shear box: protective soil initially placed at a dry unit weight of 94.9 to 95.0 pcf and a moisture content of 6.7 to 6.8%. Final moisture content ranged from 6.2 to 6.5% for the test series;

- NSC TN3002-1125 geocomposite;

- 60-mil NSC textured HDPE geomembrane;

- Bentofix NS GCL with nonwoven geotextile against geomembrane. GCL's initial moisture content was 13.0%. GCL's final moisture content ranged from 73% to 90% for the test series; and

- lower shear box: clay subgrade soil initially placed at a dry unit weight of 114.1 to 114.8 pcf and a moisture content of 12.3 to 12.6%. Final moisture content ranged from 12.6 to 13.8% for the test series.

Test Interface: upper soil against geocomposite against geomembrane against GCL against lower soil.

Test Procedures for Each Normal Stress Condition:

- GCL Hydration: a fresh specimen of GCL was trimmed from the bulk sample and hydrated in tap water for 72 hours under a normal stress of 200 psf.

- A fresh specimen of the lower soil was compacted into the lower shear box. The initial target dry unit weight and moisture content were 114.3 pcf and 12.2%, respectively, as specified by TerraMatrix.

- The hydrated GCL specimen, and fresh specimens of geomembrane and geocomposite trimmed from each bulk sample were placed on top of the lower soil, but not attached to either of the lower or upper shear boxes. The GCL was oriented so that the nonwoven geotextile component of the GCL was in contact with the geomembrane. With this method of specimen preparation, shear failure would likely occur at the weakest interface within the test cross section.

- A fresh specimen of the upper soil was compacted directly on top of the geocomposite. The initial target dry unit weight and moisture content were 95.0 pcf and 7.0%, respectively, as specified by TerraMatrix.

- Consolidation conditions: the entire test specimen was consolidated for 1 hour under each test normal stress prior to being sheared.

- Test normal stresses: 14, 56, and 100 psi.

- Constant shear displacement rate: 0.04 in/min.

- The direction of shear for each interface direct shear test was in the direction of manufacture (machine direction) of the geosynthetic samples.

- Each test was sheared until a minimum total shear displacement of 2 in. was achieved.

TEST PROCEDURES AND CONDITIONS
TEST SERIES NUMBER: 2

Test Specimen Configuration (from top to bottom) and Placement Conditions:

- upper shear box: protective soil initially placed at a dry unit weight of 95.1 to 95.5 pcf and a moisture content of 6.5 to 6.9%. Final moisture content ranged from 6.2 to 6.3% for the test series;
- NSC TN3002-1125 geocomposite;
- 60-mil NSC textured HDPE geomembrane;
- Bentofix NS GCL with nonwoven geotextile against geomembrane. GCL's initial moisture content was 12.8%. GCL's final moisture content ranged from 86% to 98% for the test series; and
- lower shear box: clay subgrade soil initially placed at a dry unit weight of 113.9 to 114.3 pcf and a moisture content of 12.0 to 12.5%. Final moisture content ranged from 12.8 to 13.5% for the test series.

Test Interface: upper soil against geocomposite against geomembrane against GCL against lower soil.

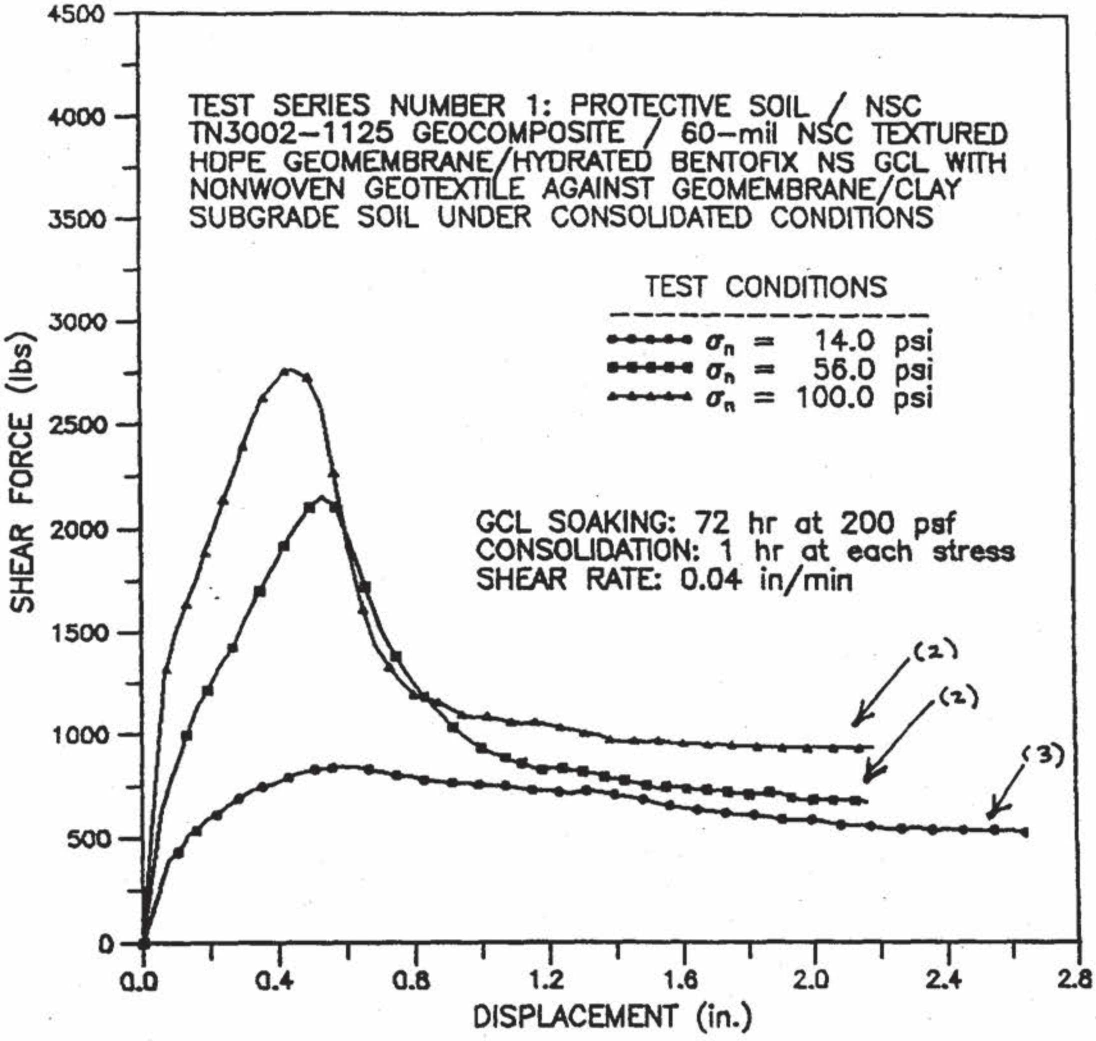
Test Procedures for Each Normal Stress Condition:

- GCL Hydration: a fresh specimen of GCL was trimmed from the bulk sample and hydrated in tap water for 45 hours under a normal stress of 200 psf.
- A fresh specimen of the lower soil was compacted into the lower shear box. The initial target dry unit weight and moisture content were 114.3 pcf and 12.2%, respectively, as specified by TerraMatrix.
- The hydrated GCL specimen, and fresh specimens of geomembrane and geocomposite trimmed from each bulk sample were placed on top of the lower soil, but not attached to either of the lower or upper shear boxes. The GCL was oriented so that the nonwoven geotextile component of the GCL was in contact with the geomembrane. With this method of specimen preparation, shear failure would likely occur at the weakest interface within the test cross section.
- A fresh specimen of the upper soil was compacted directly on top of the geocomposite. The initial target dry unit weight and moisture content were 95.0 pcf and 7.0%, respectively, as specified by TerraMatrix.
- Consolidation conditions: the entire test specimen was consolidated for 1 hour under each test normal stress prior to being sheared.
- Test normal stresses: 100, 300, and 500 psf.
- Constant shear displacement rate: 0.04 in/min.
- The direction of shear for each interface direct shear test was in the direction of manufacture (machine direction) of the geosynthetic samples.
- Each test was sheared until a minimum total shear displacement of 2 in. was achieved.

APPENDIX C

TEST RESULTS

TERRAMATRIX MONTGOMERY WATSON
INTERFACE DIRECT SHEAR TESTING



NOTES: (1) The shear box size was 12 in. by 12 in. (300 mm by 300 mm), and the contact area remained constant throughout the entire test.

(2) Shear failure was observed to occur within the GCL.

(3) Shear failure was observed to occur at the interface between the GCL and the geomembrane.

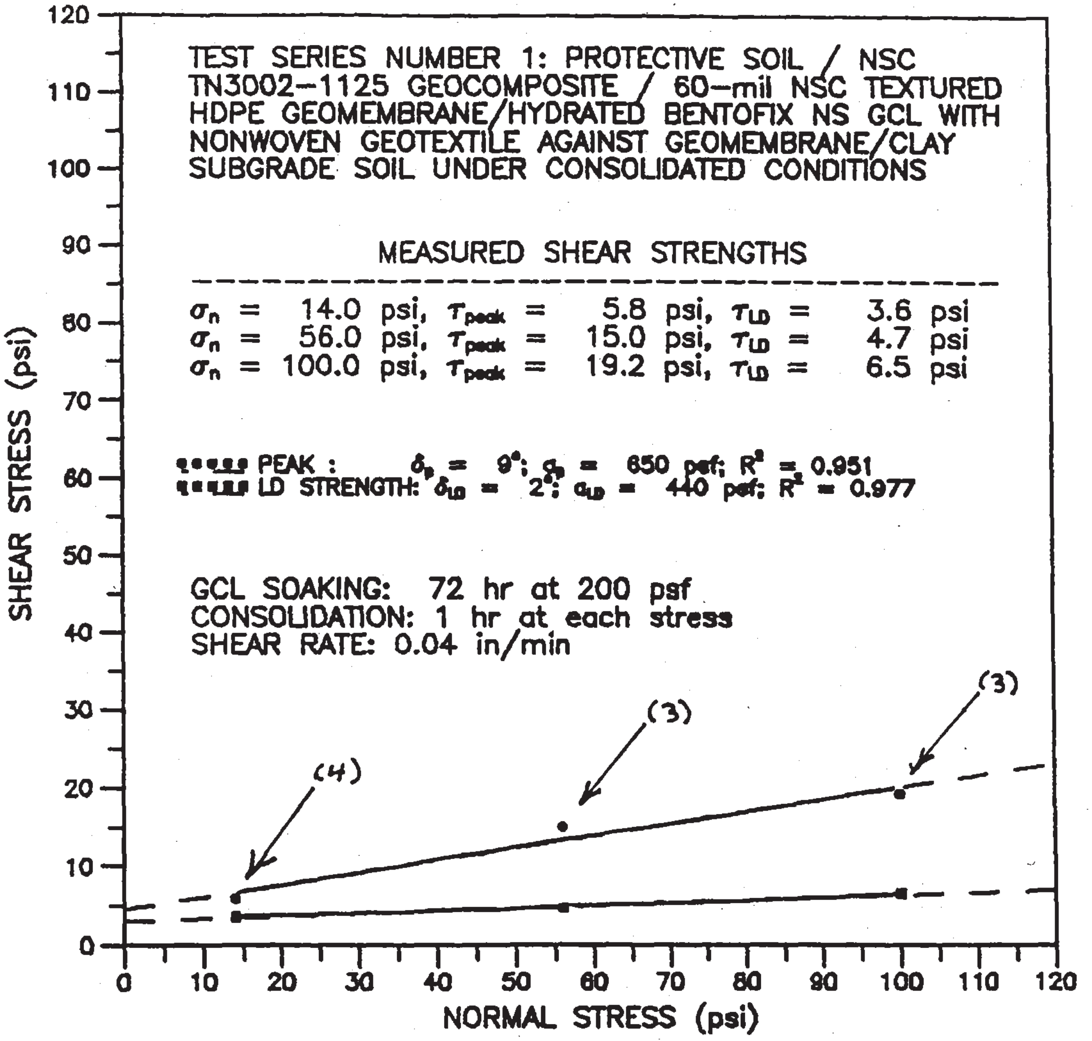
DATE TESTED: 4 TO 7 OCTOBER 1997

GEOSYNTEC CONSULTANTS

SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

FIGURE NO.	C-1
PROJECT NO.	GL10406
DOCUMENT NO.	SGI97133
FILE NO.	

TERRAMATRIX MONTGOMERY WATSON
INTERFACE DIRECT SHEAR TESTING



TEST SERIES NUMBER 1: PROTECTIVE SOIL / NSC TN3002-1125 GEOCOMPOSITE / 60-mil NSC TEXTURED HDPE GEOMEMBRANE/HYDRATED BENTOFIX NS GCL WITH NONWOVEN GEOTEXTILE AGAINST GEOMEMBRANE/CLAY SUBGRADE SOIL UNDER CONSOLIDATED CONDITIONS

MEASURED SHEAR STRENGTHS

σ_n = 14.0 psi, τ_{peak} = 5.8 psi, τ_{LD} = 3.6 psi
σ_n = 56.0 psi, τ_{peak} = 15.0 psi, τ_{LD} = 4.7 psi
σ_n = 100.0 psi, τ_{peak} = 19.2 psi, τ_{LD} = 6.5 psi

● PEAK : $\delta_p = 9°$; a_p = 650 psf; $R^2 = 0.951$
■ LD STRENGTH: $\delta_{LD} = 2°$; a_{LD} = 440 psf; $R^2 = 0.977$

GCL SOAKING: 72 hr at 200 psf
CONSOLIDATION: 1 hr at each stress
SHEAR RATE: 0.04 in/min

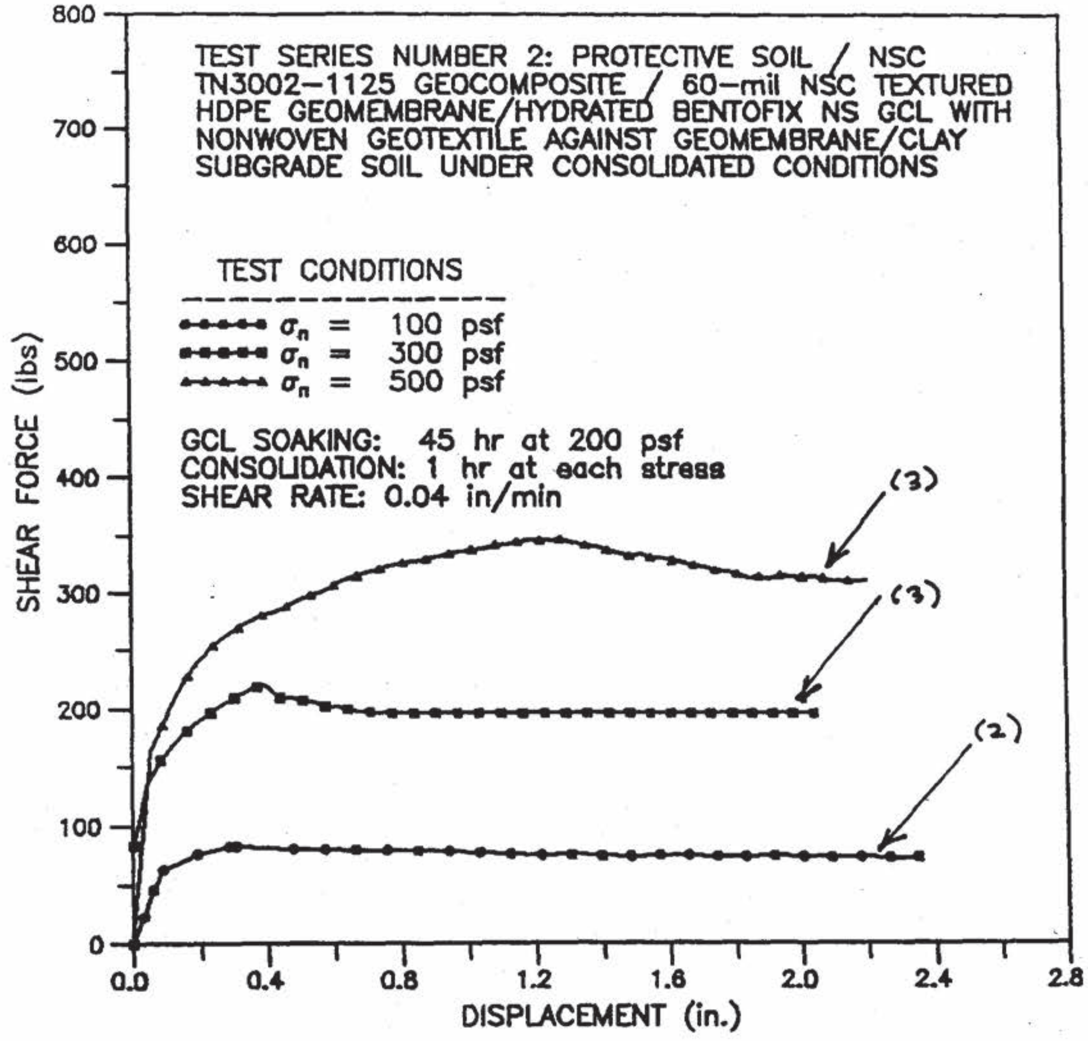
NOTES: (1) The reported total-stress shear strength parameters of friction angle and adhesion were determined from a best-fit line drawn through the test data. Caution should be exercised in using the strength parameters for applications involving normal stresses outside the range of stresses covered by the test series.
(2) The large displacement shear strength (τ_{LD}) was calculated using the shear force at the end of each test.
(3) Shear failure was observed to occur within the GCL.
(4) Shear failure was observed to occur at the interface between the GCL and the geomembrane.

DATE TESTED: 4 TO 7 OCTOBER 1997

GEOSYNTEC CONSULTANTS
SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

FIGURE NO.	C-2
PROJECT NO.	GL10406
DOCUMENT NO.	SG197133
FILE NO.	

TERRAMATRIX MONTGOMERY WATSON
INTERFACE DIRECT SHEAR TESTING



NOTES: (1) The shear box size was 12 in. by 12 in. (300 mm by 300 mm), and the contact area remained constant throughout the entire test.

(2) Shear failure was observed to occur at the interface between the protective soil and the geocomposite.

(3) Shear failure was observed to occur at the interface between the GCL and the clay subgrade soil.

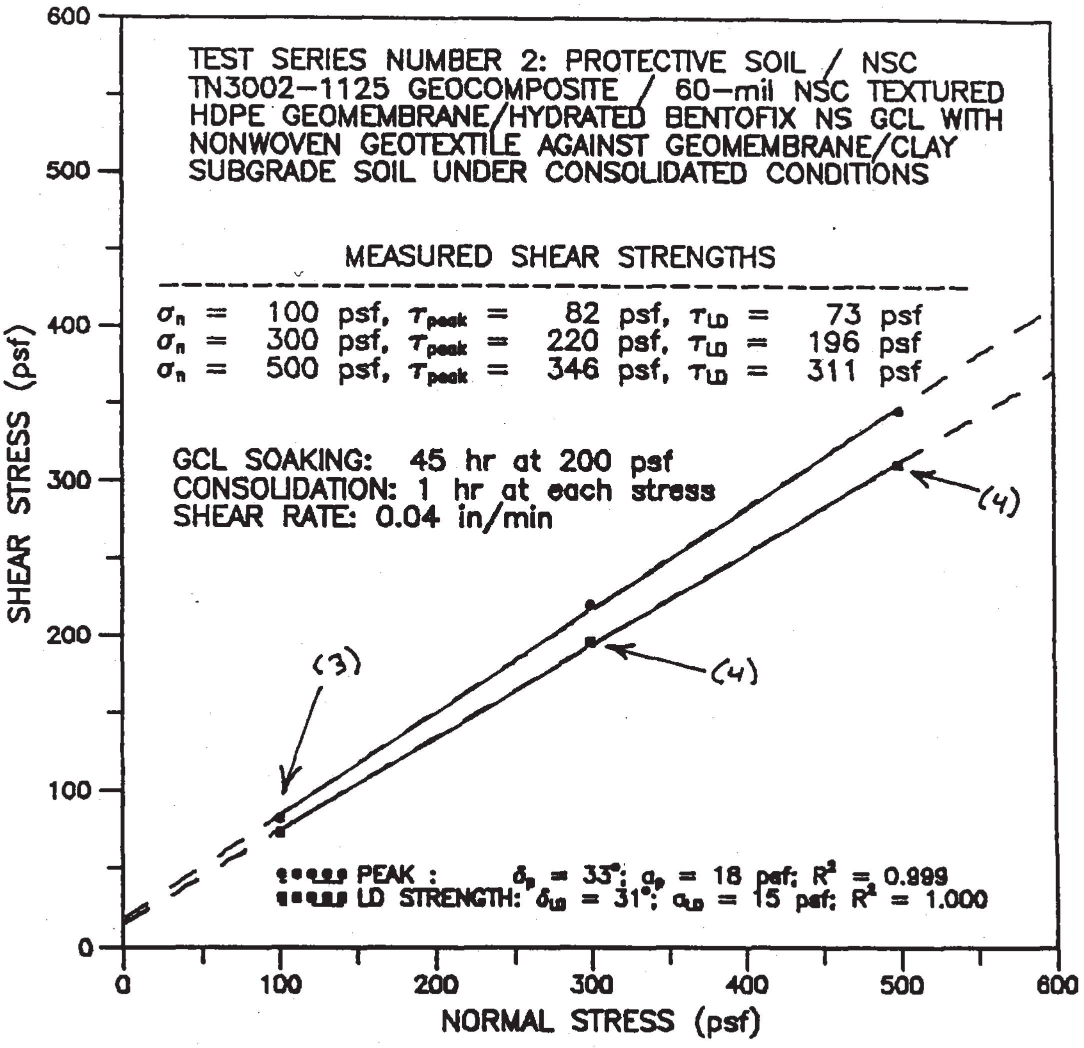
DATE TESTED: 7 TO 9 OCTOBER 1997

GeoSyntec Consultants

SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

FIGURE NO.	C-3
PROJECT NO.	GL10406
DOCUMENT NO.	SGI97133
FILE NO.	

TERRAMATRIX MONTGOMERY WATSON
INTERFACE DIRECT SHEAR TESTING


TEST SERIES NUMBER 2: PROTECTIVE SOIL / NSC TN3002-1125 GEOCOMPOSITE / 60-mil NSC TEXTURED HDPE GEOMEMBRANE/HYDRATED BENTOFIX NS GCL WITH NONWOVEN GEOTEXTILE AGAINST GEOMEMBRANE/CLAY SUBGRADE SOIL UNDER CONSOLIDATED CONDITIONS

MEASURED SHEAR STRENGTHS

σ_n = 100 psf, τ_{peak} = 82 psf, τ_{LD} = 73 psf
σ_n = 300 psf, τ_{peak} = 220 psf, τ_{LD} = 196 psf
σ_n = 500 psf, τ_{peak} = 346 psf, τ_{LD} = 311 psf

GCL SOAKING: 45 hr at 200 psf
CONSOLIDATION: 1 hr at each stress
SHEAR RATE: 0.04 in/min

PEAK : δ_p = 33°; a_p = 18 psf; R^2 = 0.999
LD STRENGTH: δ_{LD} = 31°; a_{LD} = 15 psf; R^2 = 1.000

NOTES: (1) The reported total-stress shear strength parameters of friction angle and adhesion were determined from a best-fit line drawn through the test data. Caution should be exercised in using the strength parameters for applications involving normal stresses outside the range of stresses covered by the test series.
(2) The large displacement shear strength (τ_{LD}) was calculated using the shear force at the end of each test.
(3) Shear failure occurred at the protective soil-geocomposite interface.
(4) Shear failure occurred at the GCL-clay subgrade soil interface.

DATE TESTED: 7 TO 9 OCTOBER 1997

GEOSYNTEC CONSULTANTS
SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

FIGURE NO.	C-4
PROJECT NO.	GL0406
DOCUMENT NO.	SG97133
FILE NO.	

Attachment BB

Engineering Calculations

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-1

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Cut Slope Stability

	Name	Date
Prepared By:	Paul Pellicer	11/3/97
Checked By:	John Pellicer	11/12/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

TerraMatrix
Engineering & Environmental Services
P.O. Box 774018, 1475 Pine Grove Road
Steamboat Springs, Colorado 80477
Phone 970.879.6260 Fax 970.879.9048

Project Name: Tra[illegible] Park
Project Number: 602
Sheet: 1 Of 34
Prepared By: P. Pellicer
Date: Nov 3, 1997
Checked By: J - Pellicer
Date: 12-Nov-97

Cut Slope Stability

Objective Evaluate Cut slope stability for 3H:1V Side slopes.

Method Use XSTABL (ver 5.200) to analyze cut slope stability.

Assumptions:
- Cut slopes are unsaturated
- Cut slopes are in the Upper Dockum
- Strength propertes for the Upper Dockum will be used for the Lower Dockum which is a tighter formation (therefore Conservative)
- The upper silty sands will be assumed to be Upper Dockum since this is primarily Driving force only.

Calculation: Use Cross-section cut through the North end of the Cell (see pg. 3+4).

C/p RATIO IS FOR NORMALLY CONSOLIDATED SOIL THEREFORE, THESE SHEAR STRENGTHS ARE CONSERVATIVE. ALSO, FIELD TESTING w/ POCKET PENETROMETER INDICATED C ≈ 2,000-3,000 PSF

Using an average plasticity index for the Upper Dockum = 27 (see pg 5) use figure 18.4 from Terzaghi + Peck (pg 6) to Corralate to a c/p value for the upper Dockum material = 0.2.

Next the slope was layered using an arbitrary layer thickness of 20 ft to below the base of the excavation. (see pg 4)

The average Normal stress for each slice was then determined assuming an in-situ unit weight of the upper dockum of 110 pcf and an average c was calculated for each layer

average Layer Depth	Normal Stress (p)	C
10'	1100 psf	220 p
30'	3300 psf	660 ps
50'	5500 psf	1100 ps
70'	7700 psf	1540 p
90'	9900 psf	1980 p
110'	12,100 psf	2420 p
130'	14300 psf	2860 ps

Project Name: Triassic Park
Project Number: 602
Sheet: 2 Of 34
Prepared By: P. Pellicer
Date: Nov 3 1997
Checked By: J - Pullin
Date: 12-Nov-97

These strength parameters were entered into the XSTABL program and a Janbu Circular failure search was initiated.

The Minimum Static factor of safety found = 1.4 (see pg 9-21)

Dynamic analysis.

Using the United States Department of the interior Geological Survey "Probabilistic estimates of Maximum Acceleration and velocity in rock in the Contiguous united states" Algermissen S.T. et. al, 1982 (see pg 7+8)

The Maximum ground acceleration for the site associated w/ 90% Probability of not being exceeded in 250 yrs earthquake = 0.04 g.

Using a ground acceleration = 0.09 g Results in a pseudo-static factor of safety = 1.2. (see pg 22-34)

Conclusion: The parameters in This calculation are very conservative. The static F.S. = 1.4 and the pseudo static F.S. = 1.2. Therefore the cut slopes should be considered stable. Due to the temporary nature of the cut slope, a safety less than 1.5 was accepted.

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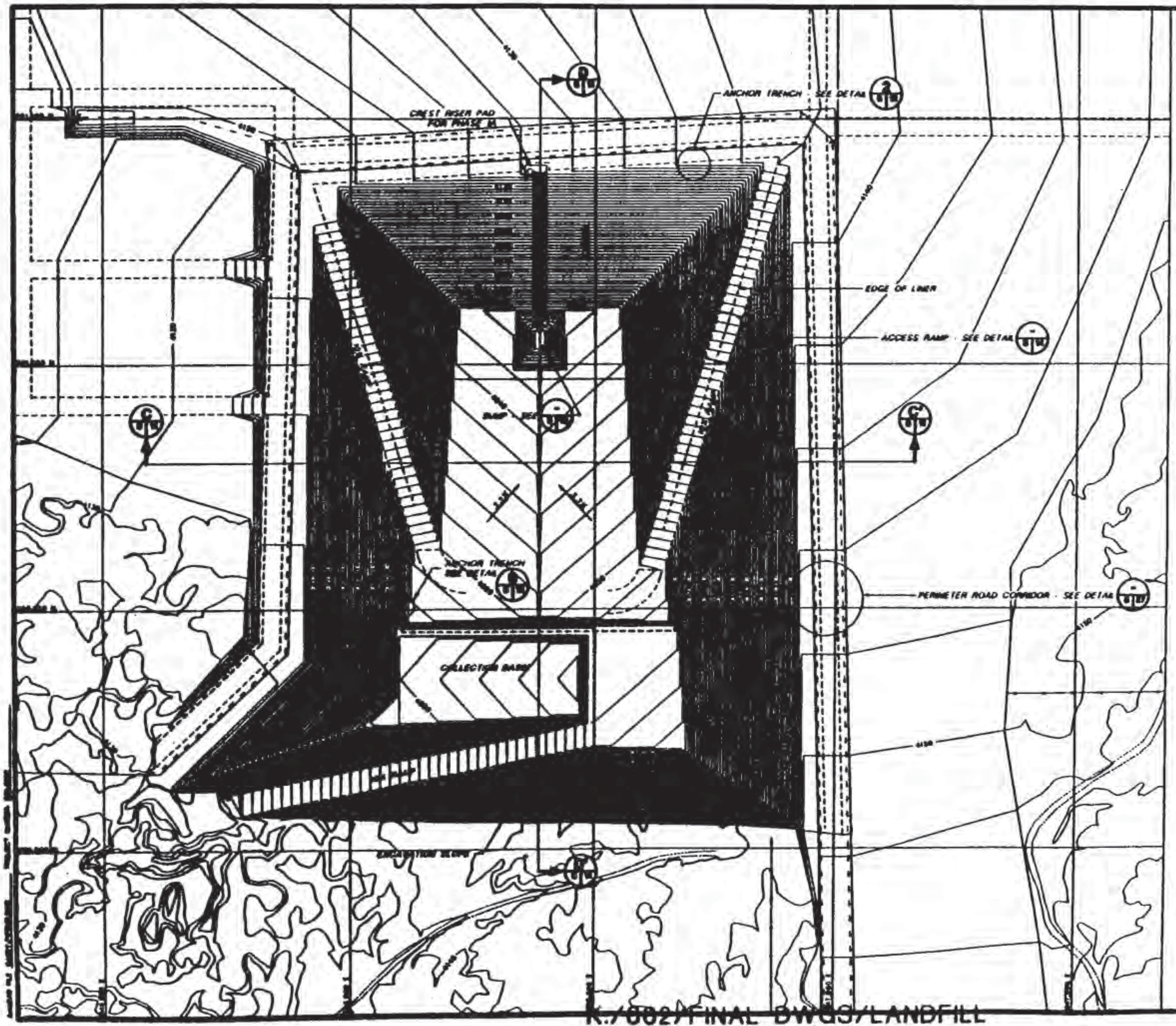
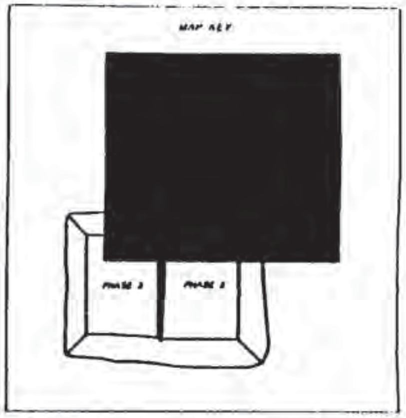
602.0200
PMP

E-1

3-NOV-97



K:/002/FINAL DWGS/LANDFILL



NOTES
1 FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 1 "INDEX, LEGEND AND GENERAL NOTES"
2 TOPOGRAPHY FROM AERIAL SURVEYS PERFORMED AUGUST 1997 BY KOOGLE AND POULS ENGINEERING

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date
Patrick G. Corser, NM P.E. 12236

SCALE
100' 0 100' 200'

Not For Construction

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE
DETAILED EXCAVATION PLAN - PHASE 1A

TerraMatrix

Sheet 1 Of 1 Sheets
DRAWING No.
8

Case 3 -
602-0200
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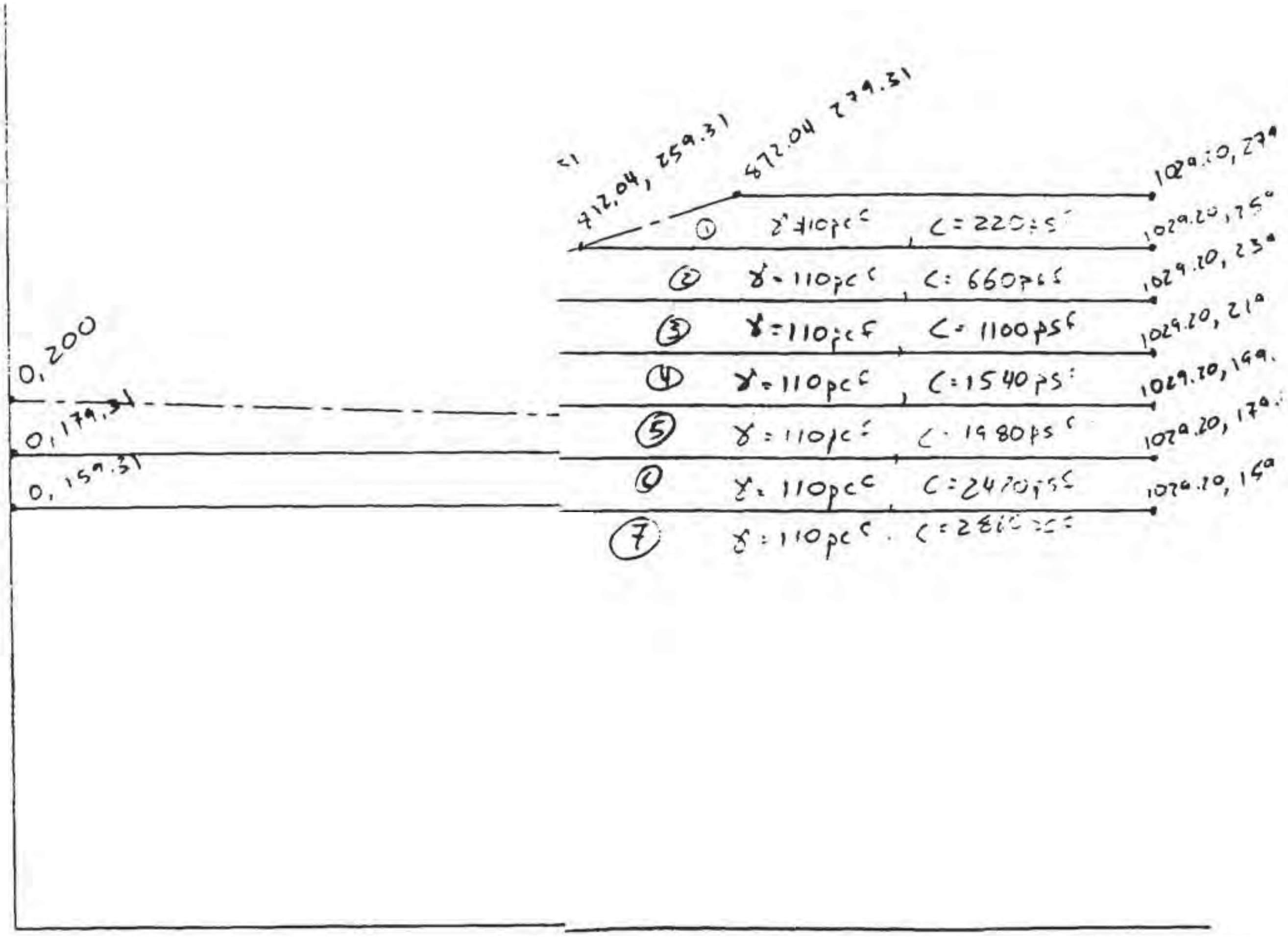
3-Nov-07



SUMMARY OF LABORATORY TEST RESULTS

Sample Location		Natural Moisture Content (%)	Natural Dry Density (%)	Atterberg Limits		Gradation			Unconfined Compressive Strength (psf)	Soil/Bedrock Description	Unified Soil Classification (USCS)
Test Pit Hole No.	Depth (Feet)			Liquid Limit (%)	Plasticity Index (%)	Gravel (%)	Sand (%)	Fines (%)			
1	17	9.9		37	19		5	95		upper Dockum	
2	17	12.1		54	40		27	73		Upper Dockum	
3	7.5	9.7		36	20		2	98		Upper Dockum	
4	14	8.6		39	27		13	87		upper Dockum	
~~4~~	~~20~~	~~7.0~~					~~1~~	~~99~~			
5	18	12.3		46	32		35	65		upper Dockum	
				Avg =	27.6						

Project Name: Gandy
Project Location:
Project No.: 790-12101 **Technician:** DCP **Date:** 9-10-97

TerraMatrix
Engineering & Materials Testing Services
[illegible] Moffat Avenue
Steamboat Springs, Colorado [illegible]

SUMMARY OF LABORATORY
TEST RESULTS

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3-Nov-97

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602-0200
3-Nov-97
pmf

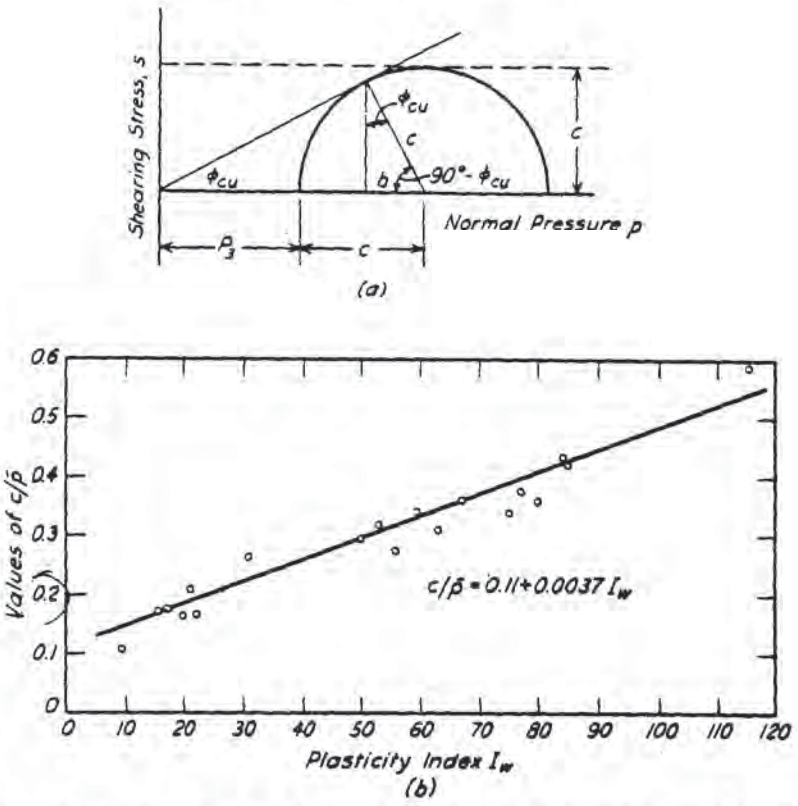


Fig. 18.4. (*a*) Mohr rupture diagram for calculating relation between c and $\bar{p}_3$ for consolidated-undrained test. (*b*) Statistical relation between $c/\bar{p}$ ratio and plasticity index (after Skempton 1957).

tivity. Some natural clay deposits, moreover, consist of a mixture of particles of fairly uniform fine sand and clay. While sedimentation proceeds, the simultaneous deposition of the flaky constituents of the finest fraction and of the equidimensional sand grains interferes with the rolling of the sand grains into stable arrangements. Therefore, if the sand grains touch each other, their configuration may be as metastable as that of true quicksands. However, the interstices between the sand grains are occupied by the clay-size materials which acquire, as a result of such physico-chemical processes as thixotropy and syneresis, appreciable strength as sedimentation proceeds. As a consequence, although the clay is sensitive, it does not exhibit the properties of true quicksands. In many respects, the states of transition from loose sand

United States Department of the Interior

Geological Survey

PROBABILISTIC ESTIMATES OF MAXIMUM ACCELERATION AND VELOCITY IN ROCK IN THE CONTIGUOUS UNITED STATES

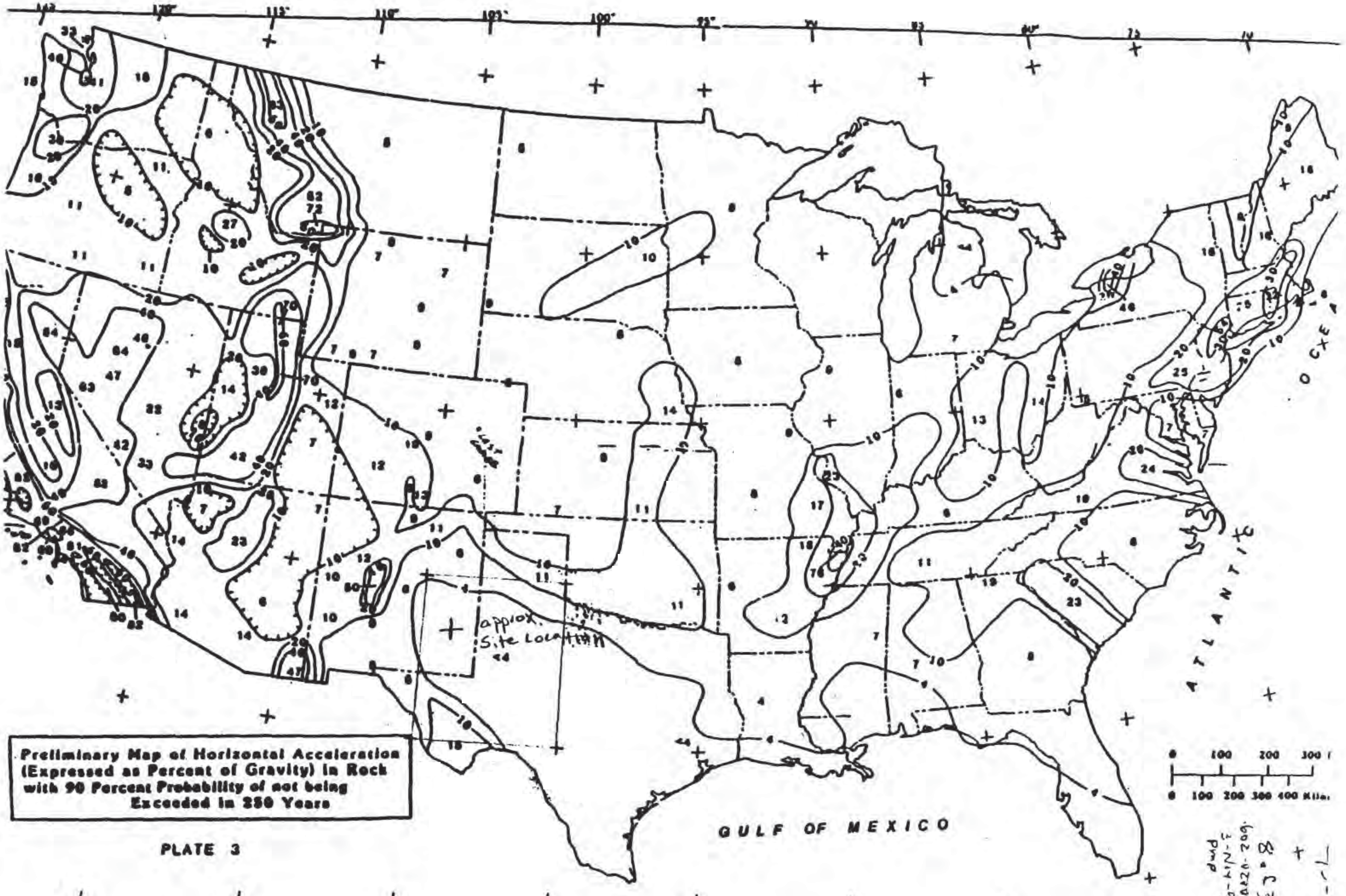
by

S. T. Algermissen, D. M. Perkins, P. C. Thenhaus,
S. L. Hanson and B. L. Bender

Open-File Report 82-1033

1982

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards.



Preliminary Map of Horizontal Acceleration (Expressed as Percent of Gravity) in Rock with 90 Percent Probability of not being Exceeded in 250 Years

PLATE 3

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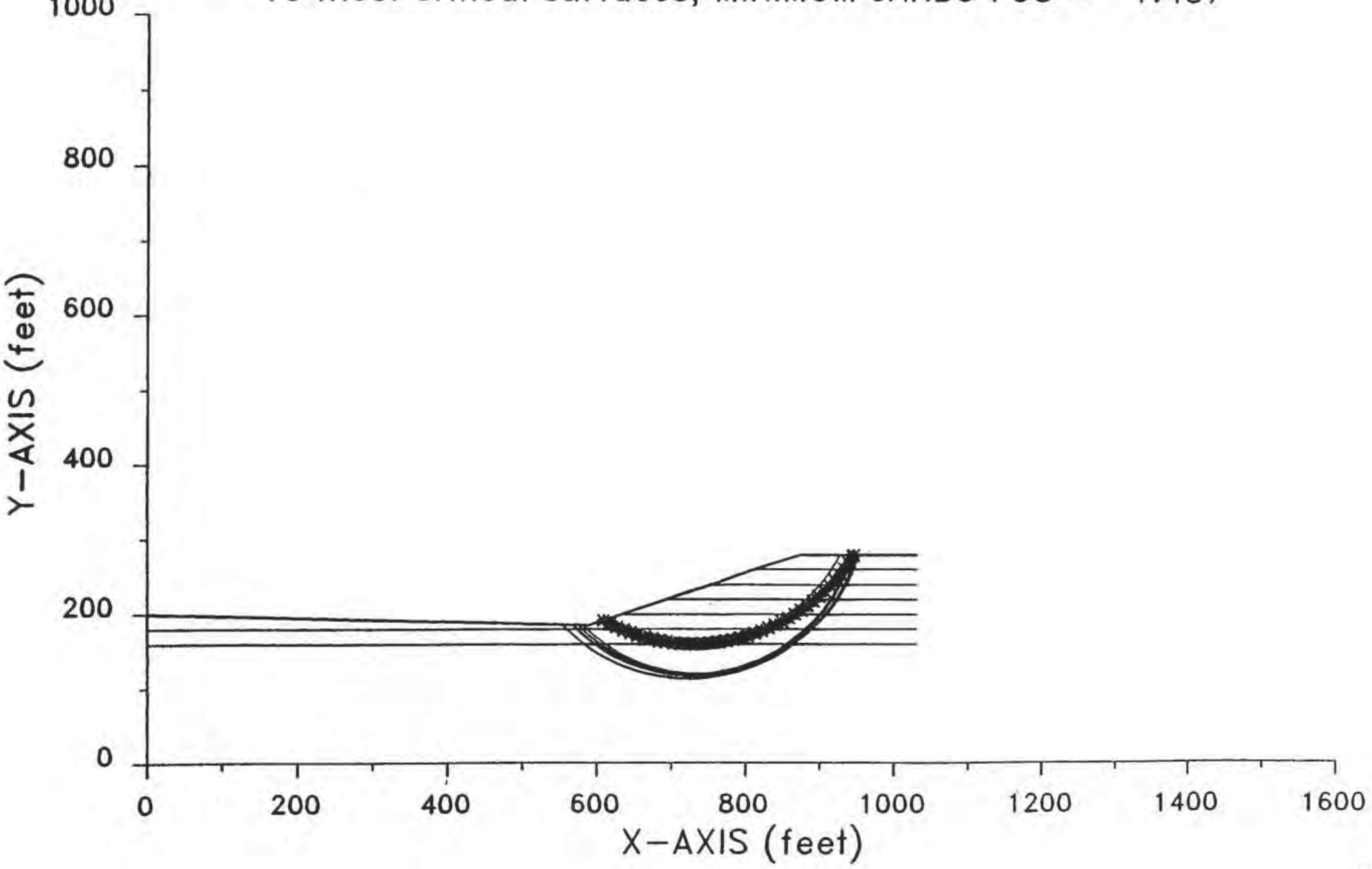
Gandy Excavated Slopes Stability
10 most critical surfaces, MINIMUM JANBU FOS = 1.437



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3-Nov-9

```
XSTABL File: GANSUB2   11-04-97   10:13

          *******************************************
          *              X S T A B L                *
          *                                         *
          *        Slope Stability Analysis         *
          *               using the                 *
          *           Method of Slices              *
          *                                         *
          *          Copyright (C) 1992 á 96        *
          *    Interactive Software Designs, Inc.   *
          *        Moscow, ID 83843, U.S.A.         *
          *                                         *
          *           All Rights Reserved           *
          *                                         *
          *  Ver. 5.200                 96 á 1216   *
          *******************************************

    Problem Description : Gandy Excavated Slopes Stability



    ------------------------------
    SEGMENT BOUNDARY COORDINATES
    ------------------------------

        7 SURFACE boundary segments

    Segment    x-left     y-left     x-right    y-right     Soil Unit
      No.       (ft)       (ft)       (ft)       (ft)     Below Segment

       1          .0      200.0      589.1      185.0          5
       2       589.1      185.0      632.0      199.3          5
       3       632.0      199.3      692.0      219.3          4
       4       692.0      219.3      752.0      239.3          3
       5       752.0      239.3      812.0      259.3          2
       6       812.0      259.3      872.0      279.3          1
       7       872.0      279.3     1029.2      279.3          1

        6 SUBSURFACE boundary segments

    Segment    x-left     y-left     x-right    y-right     Soil Unit
      No.       (ft)       (ft)       (ft)       (ft)     Below Segment

       1       812.0      259.3     1029.2      259.3          2
       2       752.0      239.3     1029.2      239.3          3
       3       692.0      219.3     1029.2      219.3          4
       4       632.0      199.3     1029.2      199.3          5
       5          .0      179.3     1029.2      179.3          6
       6          .0      159.3     1029.2      159.3          7


    --------------------------
    ISOTROPIC Soil Parameters
    --------------------------
```

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```
 7 Soil unit(s) specified

Soil   Unit Weight    Cohesion  Friction    Pore Pressure         Water
Unit   Moist    Sat.  Intercept   Angle   Parameter  Constant    Surfac
 No.   (pcf)   (pcf)    (psf)     (deg)      Ru        (psf)       No.

  1    110.0   110.0    220.0      .00      .000          .0        0
  2    110.0   110.0    660.0      .00      .000          .0        0
  3    110.0   110.0   1100.0      .00      .000          .0        0
  4    110.0   110.0   1540.0      .00      .000          .0        0
  5    110.0   110.0   1980.0      .00      .000          .0        0
  6    110.0   110.0   2420.0      .00      .000          .0        0
  7    110.0   110.0   2860.0      .00      .000          .0        0


A critical failure surface searching method, using a random
technique for generating CIRCULAR surfaces has been specified.


  900 trial surfaces will be generated and analyzed.


  30 Surfaces initiate from each of  30 points equally spaced
along the ground surface between  x =    450.0 ft
                              and  x =    650.0 ft


Each surface terminates between    x =    800.0 ft
                             and   x =    950.0 ft


Unless further limitations were imposed, the minimum elevation
at which a surface extends is  y =       .0 ft


* * * * *  DEFAULT SEGMENT LENGTH SELECTED BY XSTABL  * * * * *

   10.0 ft line segments define each trial failure surface.


---------------------
ANGULAR RESTRICTIONS
---------------------

  The first segment of each failure surface will be inclined
  within the angular range defined by :

          Lower angular limit :=   -45.0 degrees
          Upper angular limit :=  (slope angle - 5.0) degrees


**********************************************************************
  --  WARNING -- WARNING -- WARNING -- WARNING --  (# 48)
**********************************************************************
Negative effective stresses were calculated at the base of a slice.
```

```
This warning is usually reported for cases where slices have low self
weight and a relatively high "c" shear strength parameter.  In such
cases, this effect can only be eliminated by reducing the "c" value.
**********************************************************************

    ------------------------------------------------------------
    USER SELECTED option to maintain strength greater than zero
    ------------------------------------------------------------


    Factors of safety have been calculated by the :

    * * * * *   SIMPLIFIED JANBU METHOD    * * * * *


    The 10 most critical of all the failure surfaces examined
    are displayed below - the most critical first

    Failure surface No. 1 specified by 40 coordinate points

           Point        x-surf       y-surf
            No.          (ft)         (ft)

             1          608.62       191.51
             2          617.47       186.84
             3          626.49       182.53
             4          635.68       178.58
             5          645.01       175.01
             6          654.49       171.80
             7          664.08       168.98
             8          673.78       166.54
             9          683.56       164.48
            10          693.43       162.82
            11          703.35       161.55
            12          713.31       160.68
            13          723.30       160.21
            14          733.30       160.13
            15          743.29       160.45
            16          753.26       161.17
            17          763.20       162.28
            18          773.09       163.79
            19          782.90       165.70
            20          792.64       167.99
            21          802.27       170.66
            22          811.80       173.72
            23          821.19       177.16
            24          830.43       180.96
            25          839.52       185.13
            26          848.44       189.66
            27          857.17       194.54
            28          865.69       199.76
            29          874.01       205.32
            30          882.09       211.21
            31          889.94       217.41
            32          897.53       223.92
            33          904.85       230.73
            34          911.90       237.82
            35          918.66       245.19
```

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```
         36          925.13        252.82
         37          931.28        260.70
         38          937.12        268.82
         39          942.62        277.17
         40          943.91        279.30

  **   Corrected JANBU FOS =    1.437   **       (Fo factor = 1.099)

 Failure surface No. 2 specified by 39 coordinate points

       Point         x-surf         y-surf
        No.           (ft)           (ft)

         1           615.52        193.81
         2           624.16        188.78
         3           633.01        184.13
         4           642.06        179.87
         5           651.29        176.01
         6           660.67        172.56
         7           670.20        169.52
         8           679.85        166.90
         9           689.61        164.71
        10           699.45        162.94
        11           709.36        161.60
        12           719.32        160.70
        13           729.31        160.23
        14           739.31        160.20
        15           749.30        160.61
        16           759.27        161.45
        17           769.18        162.72
        18           779.04        164.43
        19           788.81        166.57
        20           798.47        169.13
        21           808.02        172.11
        22           817.43        175.50
        23           826.67        179.30
        24           835.75        183.50
        25           844.63        188.09
        26           853.31        193.07
        27           861.75        198.42
        28           869.96        204.14
        29           877.91        210.20
        30           885.59        216.61
        31           892.98        223.35
        32           900.07        230.40
        33           906.84        237.76
        34           913.29        245.40
        35           919.40        253.32
        36           925.15        261.50
        37           930.54        269.92
        38           935.56        278.57
        39           935.95        279.30

  **   Corrected JANBU FOS =    1.438   **       (Fo factor = 1.103)

 Failure surface No. 3 specified by 38 coordinate points

       Point         x-surf         y-surf
```

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G12-0204
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3-Nov-97

```
       No.         (ft)        (ft)

        1         615.52      193.81
        2         624.11      188.69
        3         632.93      183.97
        4         641.95      179.67
        5         651.17      175.78
        6         660.55      172.32
        7         670.08      169.29
        8         679.74      166.71
        9         689.51      164.57
       10         699.36      162.88
       11         709.29      161.65
       12         719.26      160.88
       13         729.25      160.56
       14         739.25      160.71
       15         749.23      161.31
       16         759.18      162.37
       17         769.06      163.89
       18         778.87      165.86
       19         788.57      168.28
       20         798.15      171.14
       21         807.59      174.44
       22         816.87      178.16
       23         825.97      182.32
       24         834.87      186.88
       25         843.54      191.85
       26         851.98      197.21
       27         860.17      202.96
       28         868.08      209.07
       29         875.71      215.54
       30         883.02      222.36
       31         890.02      229.50
       32         896.68      236.96
       33         903.00      244.72
       34         908.94      252.75
       35         914.52      261.06
       36         919.70      269.61
       37         924.49      278.39
       38         924.94      279.30

 **  Corrected JANBU FOS =   1.439  **     (Fo factor = 1.105)


Failure surface No. 4 specified by 49 coordinate points

      Point       x-surf      y-surf
       No.         (ft)        (ft)

        1         567.24      185.56
        2         574.40      178.57
        3         581.86      171.91
        4         589.60      165.58
        5         597.61      159.60
        6         605.87      153.96
        7         614.37      148.70
        8         623.10      143.81
        9         632.03      139.31
       10         641.14      135.20
       11         650.43      131.49
```

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```
          12           659.87          128.19
          13           669.45          125.31
          14           679.14          122.85
          15           688.93          120.81
          16           698.80          119.20
          17           708.73          118.03
          18           718.70          117.29
          19           728.70          116.98
          20           738.70          117.12
          21           748.68          117.68
          22           758.63          118.69
          23           768.53          120.13
          24           778.35          122.00
          25           788.08          124.29
          26           797.71          127.01
          27           807.20          130.14
          28           816.55          133.69
          29           825.74          137.64
          30           834.74          141.99
          31           843.55          146.73
          32           852.14          151.85
          33           860.50          157.34
          34           868.61          163.19
          35           876.46          169.38
          36           884.03          175.92
          37           891.31          182.77
          38           898.28          189.94
          39           904.93          197.41
          40           911.25          205.16
          41           917.23          213.18
          42           922.85          221.45
          43           928.10          229.96
          44           932.98          238.69
          45           937.47          247.62
          46           941.57          256.75
          47           945.26          266.04
          48           948.54          275.48
          49           949.69          279.30

  **  Corrected JANBU FOS =   1.442  **    (Fo factor = 1.118)

Failure surface No. 5 specified by 48 coordinate points

         Point         x-surf          y-surf
          No.           (ft)            (ft)

           1           574.14          185.38
           2           581.32          178.43
           3           588.81          171.80
           4           596.59          165.51
           5           604.64          159.58
           6           612.94          154.00
           7           621.48          148.80
           8           630.25          143.99
           9           639.22          139.57
          10           648.38          135.55
          11           657.70          131.95
          12           667.18          128.76
          13           676.79          126.00
```

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PMP
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```
             14         686.52       123.67
             15         696.33       121.77
             16         706.23       120.31
             17         716.18       119.29
             18         726.16       118.71
             19         736.16       118.58
             20         746.15       118.89
             21         756.12       119.65
             22         766.05       120.85
             23         775.92       122.49
             24         785.70       124.57
             25         795.38       127.07
             26         804.94       130.01
             27         814.36       133.37
             28         823.62       137.14
             29         832.70       141.32
             30         841.59       145.90
             31         850.27       150.88
             32         858.71       156.23
             33         866.92       161.95
             34         874.85       168.03
             35         882.51       174.46
             36         889.88       181.22
             37         896.94       188.31
             38         903.68       195.69
             39         910.08       203.38
             40         916.14       211.34
             41         921.83       219.55
             42         927.15       228.02
             43         932.10       236.71
             44         936.65       245.62
             45         940.80       254.71
             46         944.54       263.99
             47         947.87       273.42
             48         949.65       279.30

    **  Corrected JANBU FOS =   1.443  **     (Fo factor = 1.118)


  Failure surface No. 6 specified by 40 coordinate points

           Point        x-surf       y-surf
            No.          (ft)         (ft)

             1          608.62       191.51
             2          617.53       186.97
             3          626.61       182.78
             4          635.84       178.94
             5          645.22       175.45
             6          654.72       172.33
             7          664.33       169.58
             8          674.04       167.19
             9          683.84       165.18
            10          693.70       163.54
            11          703.62       162.29
            12          713.59       161.41
            13          723.57       160.92
            14          733.57       160.81
            15          743.57       161.09
            16          753.55       161.74
```

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```
      17          763.49        162.78
      18          773.39        164.20
      19          783.23        166.00
      20          792.99        168.17
      21          802.66        170.71
      22          812.23        173.63
      23          821.67        176.91
      24          830.99        180.55
      25          840.16        184.54
      26          849.17        188.88
      27          858.00        193.56
      28          866.65        198.58
      29          875.10        203.92
      30          883.34        209.59
      31          891.36        215.57
      32          899.14        221.85
      33          906.68        228.42
      34          913.96        235.28
      35          920.97        242.41
      36          927.70        249.80
      37          934.15        257.45
      38          940.29        265.34
      39          946.13        273.46
      40          950.00        279.30

 **  Corrected JANBU FOS =   1.444  **    (Fo factor = 1.098)


Failure surface No. 7 specified by 47 coordinate points

     Poir         x-surf        y-surf
      No.          (ft)          (ft)

       1          574.14        185.38
       2          581.22        178.32
       3          588.61        171.59
       4          596.31        165.20
       5          604.29        159.18
       6          612.55        153.54
       7          621.05        148.27
       8          629.79        143.41
       9          638.74        138.95
      10          647.89        134.91
      11          657.21        131.30
      12          666.69        128.11
      13          676.31        125.37
      14          686.04        123.07
      15          695.87        121.23
      16          705.77        119.84
      17          715.73        118.90
      18          725.72        118.42
      19          735.72        118.41
      20          745..71       118.85
      21          755.66        119.76
      22          765.57        121.12
      23          775.41        122.94
      24          785.14        125.20
      25          794.77        127.92
      26          804.26        131.07
      27          813.59        134.66
```

[illegible]
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3-Nov

```
          28          822.75         138.67
          29          831.72         143.10
          30          840.47         147.94
          31          848.99         153.17
          32          857.26         158.80
          33          865.26         164.79
          34          872.98         171.15
          35          880.40         177.86
          36          887.50         184.90
          37          894.27         192.26
          38          900.69         199.93
          39          906.75         207.88
          40          912.44         216.10
          41          917.75         224.58
          42          922.66         233.29
          43          927.16         242.22
          44          931.25         251.35
          45          934.91         260.65
          46          938.14         270.12
          47          940.81         279.30

  **  Corrected JANBU FOS =   1.444  **    (Fo factor = 1.119)


Failure surface No. 8 specified by 50 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1           553.45         185.91
          2           560.52         178.84
          3           567.89         172.08
          4           575.53         165.63
          5           583.45         159.52
          6           591.61         153.74
          7           600.01         148.32
          8           608.64         143.26
          9           617.47         138.57
         10           626.49         134.26
         11           635.69         130.33
         12           645.04         126.80
         13           654.54         123.67
         14           664.16         120.94
         15           673.89         118.62
         16           683.71         116.72
         17           693.60         115.24
         18           703.54         114.17
         19           713.52         113.53
         20           723.52         113.31
         21           733.52         113.52
         22           743.50         114.15
         23           753.44         115.20
         24           763.33         116.68
         25           773.15         118.57
         26           782.88         120.88
         27           792.50         123.59
         28           802.00         126.71
         29           811.36         130.24
         30           820.56         134.15
         31           829.59         138.46
```

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```
           32          838.43         143.14
           33          847.06         148.19
           34          855.47         153.60
           35          863.64         159.37
           36          871.56         165.47
           37          879.21         171.91
           38          886.58         178.67
           39          893.66         185.73
           40          900.44         193.08
           41          906.89         200.72
           42          913.02         208.62
           43          918.81         216.78
           44          924.24         225.17
           45          929.32         233.79
           46          934.02         242.61
           47          938.35         251.63
           48          942.29         260.82
           49          945.83         270.17
           50          948.86         279.30

  **   Corrected JANBU FOS =   1.445  **    (Fo factor = 1.118)


Failure surface No. 9 specified by 48 coordinate points

         Point         x-surf         y-surf
          No.           (ft)           (ft)

            1          567.24         185.56
            2          574.44         178.62
            3          581.94         172.00
            4          589.73         165.73
            5          597.79         159.82
            6          606.11         154.27
            7          614.67         149.09
            8          623.45         144.31
            9          632.44         139.92
           10          641.61         135.94
           11          650.95         132.37
           12          660.44         129.22
           13          670.06         126.49
           14          679.80         124.20
           15          689.62         122.35
           16          699.52         120.94
           17          709.48         119.97
           18          719.46         119.45
           19          729.46         119.37
           20          739.46         119.74
           21          749.42         120.56
           22          759.34         121.82
           23          769.20         123.52
           24          778.97         125.66
           25          788.63         128.24
           26          798.17         131.24
           27          807.56         134.67
           28          816.79         138.51
           29          825.85         142.76
           30          834.70         147.41
           31          843.33         152.45
           32          851.74         157.88
```

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pmp
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602-02

```
     33          859.89        163.67
     34          867.77        169.82
     35          875.38        176.31
     36          882.68        183.14
     37          889.67        190.29
     38          896.34        197.75
     39          902.67        205.49
     40          908.64        213.51
     41          914.25        221.79
     42          919.48        230.31
     43          924.33        239.05
     44          928.79        248.01
     45          932.84        257.15
     46          936.48        266.47
     47          939.69        275.93
     48          940.67        279.30

 **  Corrected JANBU FOS =   1.445  **    (Fo factor = 1.118)


Failure surface No.10 specified by 47 coordinate points

    Point        x-surf        y-surf
     No.          (ft)          (ft)

      1          581.03        185.21
      2          588.21        178.24
      3          595.70        171.61
      4          603.48        165.33
      5          611.54        159.42
      6          619.87        153.88
      7          628.44        148.72
      8          637.23        143.97
      9          646.24        139.62
     10          655.43        135.68
     11          664.80        132.17
     12          674.31        129.10
     13          683.96        126.46
     14          693.71        124.27
     15          703.56        122.52
     16          713.48        121.23
     17          723.44        120.39
     18          733.43        120.01
     19          743.43        120.08
     20          753.42        120.62
     21          763.37        121.61
     22          773.26        123.05
     23          783.08        124.95
     24          792.81        127.29
     25          802.41        130.07
     26          811.88        133.29
     27          821.19        136.94
     28          830.32        141.02
     29          839.26        145.50
     30          847.98        150.39
     31          856.47        155.68
     32          864.71        161.35
     33          872.68        167.38
     34          880.37        173.78
     35          887.75        180.52
```

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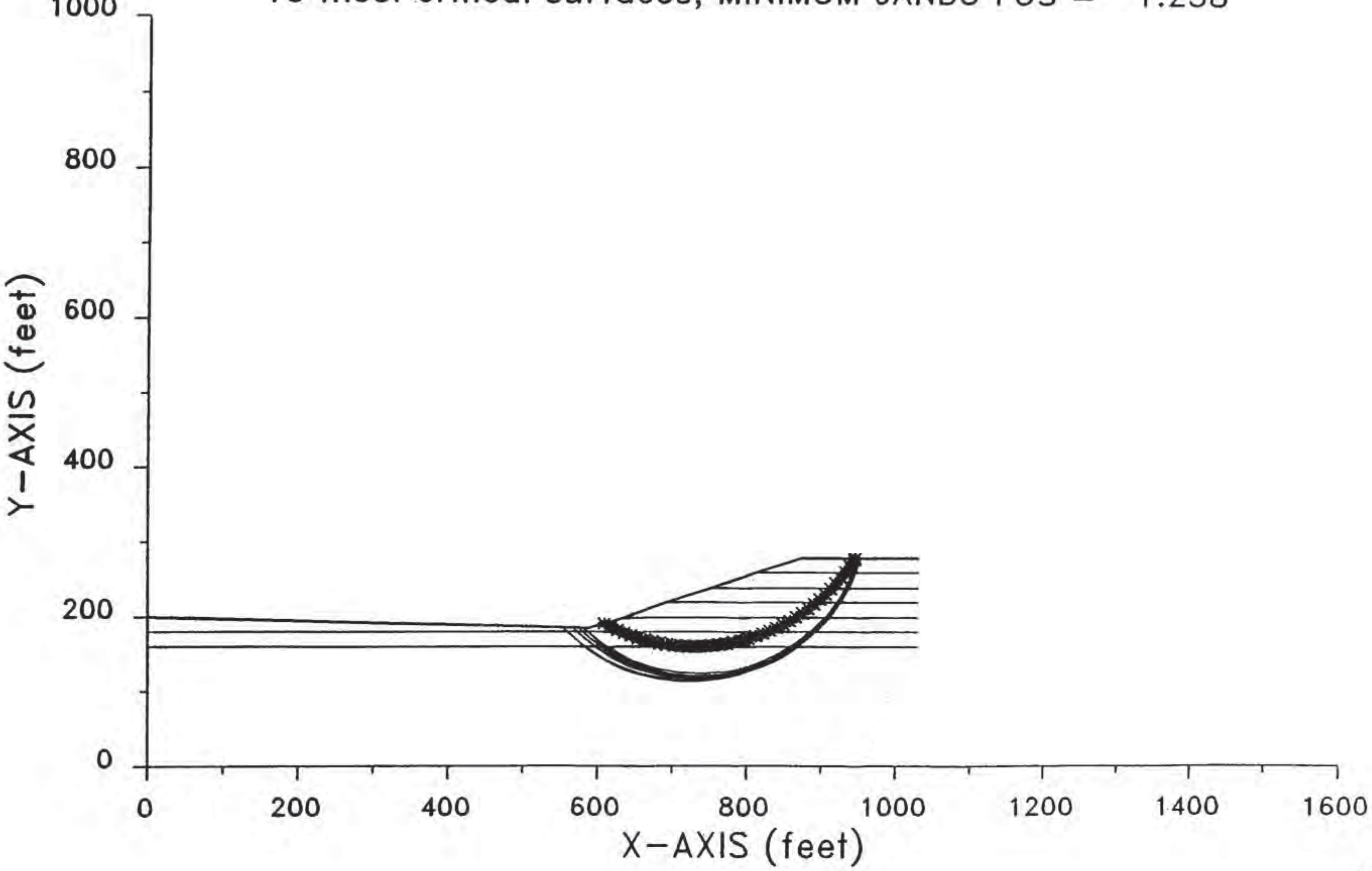
```
  36          894.82       187.60
  37          901.56       194.98
  38          907.95       202.67
  39          913.99       210.65
  40          919.65       218.89
  41          924.93       227.38
  42          929.82       236.10
  43          934.30       245.04
  44          938.37       254.18
  45          942.02       263.49
  46          945.24       272.96
  47          947.08       279.30

 **  Corrected JANBU FOS =   1.445  **    (Fo factor = 1.119)



The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Excavated Slopes Stability

      Modified       Correction     Initial     Terminal    Available
     JANBU FOS         Factor       x-coord      x-coord     Strength
                                     (ft)         (ft)        (lb)

 1.      1.437          1.099       608.62       943.91     7.264E+05
 2.      1.438          1.103       615.52       935.95     7.035E+05
 3.      1.439          1.105       615.52       924.94     6.830E+05
 4.      1.442          1.118       567.24       949.69     1.117E+06
 5.      1.443          1.118       574.14       949.65     1.095E+06
 6.      1.444          1.098       608.62       950.00     7.332E+05
 7.      1.444          1.119       574.14       940.81     1.079E+06
 8.      1.445          1.118       553.45       948.86     1.162E+06
 9.      1.445          1.118       567.24       940.67     1.087E+06
10.      1.445          1.119       581.03       947.08     1.069E+06

                    * * *  END OF FILE  * * *
```

C SUB2Q 11-04-97 10:14

Gandy Excavated Slopes Stability Q
10 most critical surfaces, MINIMUM JANBU FOS = 1.258



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602-02
pmr
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23 - [illegible]
502-0200
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```
XSTABL File: GANSUB2Q  11-04-97   10:14

          ******************************************
          *              X S T A B L               *
          *                                        *
          *       Slope Stability Analysis         *
          *              using the                 *
          *          Method of Slices              *
          *                                        *
          *        Copyright (C) 1992 á 96         *
          *   Interactive Software Designs, Inc.   *
          *       Moscow, ID 83843, U.S.A.         *
          *                                        *
          *          All Rights Reserved           *
          *                                        *
          *  Ver. 5.200                96 á 1216   *
          ******************************************

    Problem Description : Gandy Excavated Slopes Stability Q



    -----------------------------
    SEGMENT BOUNDARY COORDINATES
    -----------------------------

        7 SURFACE boundary segments

    Segment    x-left    y-left    x-right    y-right     Soil Unit
      No.       (ft)      (ft)      (ft)       (ft)     Below Segment

       1          .0     200.0     589.1      185.0          5
       2       589.1     185.0     632.0      199.3          5
       3       632.0     199.3     692.0      219.3          4
       4       692.0     219.3     752.0      239.3          3
       5       752.0     239.3     812.0      259.3          2
       6       812.0     259.3     872.0      279.3          1
       7       872.0     279.3    1029.2      279.3          1

        6 SUBSURFACE boundary segments

    Segment    x-left    y-left    x-right    y-right     Soil Unit
      No.       (ft)      (ft)      (ft)       (ft)     Below Segment

       1       812.0     259.3    1029.2      259.3          2
       2       752.0     239.3    1029.2      239.3          3
       3       692.0     219.3    1029.2      219.3          4
       4       632.0     199.3    1029.2      199.3          5
       5          .0     179.3    1029.2      179.3          6
       6          .0     159.3    1029.2      159.3          7


    --------------------------
    ISOTROPIC Soil Parameters
    --------------------------
```

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602-0200
PMP
3-Nov-0

```
 7 Soil unit(s) specified

Soil    Unit Weight    Cohesion  Friction     Pore Pressure        Water
Unit  Moist    Sat.   Intercept   Angle   Parameter  Constant    Surfac
 No.  (pcf)    (pcf)    (psf)     (deg)       Ru        (psf)       No.

  1   110.0   110.0     220.0      .00       .000          .0        0
  2   110.0   110.0     660.0      .00       .000          .0        0
  3   110.0   110.0    1100.0      .00       .000          .0        0
  4   110.0   110.0    1540.0      .00       .000          .0        0
  5   110.0   110.0    1980.0      .00       .000          .0        0
  6   110.0   110.0    2420.0      .00       .000          .0        0
  7   110.0   110.0    2860.0      .00       .000          .0        0


A horizontal earthquake loading coefficient
of   .040 has been assigned

A vertical earthquake loading coefficient
of   .000 has been assigned


A critical failure surface searching method, using a random
technique for generating CIRCULAR surfaces has been specified.


  900 trial surfaces will be generated and analyzed.


  30 Surfaces initiate from each of  30 points equally spaced
along the ground surface between   x =     450.0 ft
                              and  x =     650.0 ft


Each surface terminates between    x =     800.0 ft
                             and   x =     950.0 ft


Unless further limitations were imposed, the minimum elevation
at which a surface extends is  y =       .0 ft


* * * * *  DEFAULT SEGMENT LENGTH SELECTED BY XSTABL  * * * * *

   10.0 ft line segments define each trial failure surface.


---------------------
ANGULAR RESTRICTIONS
---------------------

  The first segment of each failure surface will be inclined
  within the angular range defined by :

          Lower angular limit :=   -45.0 degrees
          Upper angular limit :=  (slope angle - 5.0) degrees
```

25a
602-0200
3-Nov-9
PMP

```
***********************************************************************
   --  WARNING  --  WARNING  --  WARNING  --  WARNING  ---  (# 48)
***********************************************************************
Negative effective stresses were calculated at the base of a slice.
This warning is usually reported for cases where slices have low self
weight and a relatively high "c" shear strength parameter.  In such
cases, this effect can only be eliminated by reducing the "c" value.
***********************************************************************

    ------------------------------------------------------------
    USER SELECTED option to maintain strength greater than zero
    ------------------------------------------------------------



    Factors of safety have been calculated by the :

    * * * * *   SIMPLIFIED JANBU METHOD   * * * * *


    The 10 most critical of all the failure surfaces examined
    are displayed below - the most critical first

    Failure surface No. 1 specified by 40 coordinate points

           Point       x-surf       y-surf
            No.         (ft)         (ft)

             1         608.62       191.51
             2         617.47       186.84
             3         626.49       182.53
             4         635.68       178.58
             5         645.01       175.01
             6         654.49       171.80
             7         664.08       168.98
             8         673.78       166.54
             9         683.56       164.48
            10         693.43       162.82
            11         703.35       161.55
            12         713.31       160.68
            13         723.30       160.21
            14         733.30       160.13
            15         743.29       160.45
            16         753.26       161.17
            17         763.20       162.28
            18         773.09       163.79
            19         782.90       165.70
            20         792.64       167.99
            21         802.27       170.66
            22         811.80       173.72
            23         821.19       177.16
            24         830.43       180.96
            25         839.52       185.13
            26         848.44       189.66
            27         857.17       194.54
```

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602-020
3-Nov-
PMP

```
        28           865.69          199.76
        29           874.01          205.32
        30           882.09          211.21
        31           889.94          217.41
        32           897.53          223.92
        33           904.85          230.73
        34           911.90          237.82
        35           918.66          245.19
        36           925.13          252.82
        37           931.28          260.70
        38           937.12          268.82
        39           942.62          277.17
        40           943.91          279.30

  **  Corrected JANBU FOS =   1.258  **      (Fo factor = 1.099)

Failure surface No. 2 specified by 49 coordinate points

       Point         x-surf          y-surf
        No.           (ft)            (ft)

         1           567.24          185.56
         2           574.40          178.57
         3           581.86          171.91
         4           589.60          165.58
         5           597.61          159.60
         6           605.87          153.96
         7           614.37          148.70
         8           623.10          143.81
         9           632.03          139.31
        10           641.14          135.20
        11           650.43          131.49
        12           659.87          128.19
        13           669.45          125.31
        14           679.14          122.85
        15           688.93          120.81
        16           698.80          119.20
        17           708.73          118.03
        18           718.70          117.29
        19           728.70          116.98
        20           738.70          117.12
        21           748.68          117.68
        22           758.63          118.69
        23           768.53          120.13
        24           778.35          122.00
        25           788.08          124.29
        26           797.71          127.01
        27           807.20          130.14
        28           816.55          133.69
        29           825.74          137.64
        30           834.74          141.99
        31           843.55          146.73
        32           852.14          151.85
        33           860.50          157.34
        34           868.61          163.19
        35           876.46          169.38
        36           884.03          175.92
        37           891.31          182.77
        38           898.28          189.94
```

22.5
GV2-02
PMP
3-Nov-

```
       39          904.93         197.41
       40          911.25         205.16
       41          917.23         213.18
       42          922.85         221.45
       43          928.10         229.96
       44          932.98         238.69
       45          937.47         247.62
       46          941.57         256.75
       47          945.26         266.04
       48          948.54         275.48
       49          949.69         279.30

  **  Corrected JANBU FOS =   1.261  **     (Fo factor = 1.118)

 Failure surface No. 3 specified by 40 coordinate points

      Point        x-surf         y-surf
       No.          (ft)           (ft)

        1          608.62         191.51
        2          617.53         186.97
        3          626.61         182.78
        4          635.84         178.94
        5          645.22         175.45
        6          654.72         172.33
        7          664.33         169.58
        8          674.04         167.19
        9          683.84         165.18
       10          693.70         163.54
       11          703.62         162.29
       12          713.59         161.41
       13          723.57         160.92
       14          733.57         160.81
       15          743.57         161.09
       16          753.55         161.74
       17          763.49         162.78
       18          773.39         164.20
       19          783.23         166.00
       20          792.99         168.17
       21          802.66         170.71
       22          812.23         173.63
       23          821.67         176.91
       24          830.99         180.55
       25          840.16         184.54
       26          849.17         188.88
       27          858.00         193.56
       28          866.65         198.58
       29          875.10         203.92
       30          883.34         209.59
       31          891.36         215.57
       32          899.14         221.85
       33          906.68         228.42
       34          913.96         235.28
       35          920.97         242.41
       36          927.70         249.80
       37          934.15         257.45
       38          940.29         265.34
       39          946.13         273.46
       40          950.00         279.30
```

28.C
312-V
pmP
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```
**  Corrected JANBU FOS =   1.261  **     (Fo factor = 1.098)

Failure surface No. 4 specified by 48 coordinate points

      Point        x-surf       y-surf
       No.          (ft)         (ft)

        1          574.14       185.38
        2          581.32       178.43
        3          588.81       171.80
        4          596.59       165.51
        5          604.64       159.58
        6          612.94       154.00
        7          621.48       148.80
        8          630.25       143.99
        9          639.22       139.57
       10          648.38       135.55
       11          657.70       131.95
       12          667.18       128.76
       13          676.79       126.00
       14          686.52       123.67
       15          696.33       121.77
       16          706.23       120.31
       17          716.18       119.29
       18          726.16       118.71
       19          736.16       118.58
       20          746.15       118.89
       21          756.12       119.65
       22          766.05       120.85
       23          775.92       122.49
       24          785.70       124.57
       25          795.38       127.07
       26          804.94       130.01
       27          814.36       133.37
       28          823.62       137.14
       29          832.70       141.32
       30          841.59       145.90
       31          850.27       150.88
       32          858.71       156.23
       33          866.92       161.95
       34          874.85       168.03
       35          882.51       174.46
       36          889.88       181.22
       37          896.94       188.31
       38          903.68       195.69
       39          910.08       203.38
       40          916.14       211.34
       41          921.83       219.55
       42          927.15       228.02
       43          932.10       236.71
       44          936.65       245.62
       45          940.80       254.71
       46          944.54       263.99
       47          947.87       273.42
       48          949.65       279.30

**  Corrected JANBU FOS =   1.261  **     (Fo factor = 1.118)
```

29.5
612-02rv
PmP
3-Nov-9

```
Failure surface No. 5 specified by 39 coordinate points

          Point        x-surf        y-surf
           No.          (ft)          (ft)

            1          615.52        193.81
            2          624.16        188.78
            3          633.01        184.13
            4          642.06        179.87
            5          651.29        176.01
            6          660.67        172.56
            7          670.20        169.52
            8          679.85        166.90
            9          689.61        164.71
           10          699.45        162.94
           11          709.36        161.60
           12          719.32        160.70
           13          729.31        160.23
           14          739.31        160.20
           15          749.30        160.61
           16          759.27        161.45
           17          769.18        162.72
           18          779.04        164.43
           19          788.81        166.57
           20          798.47        169.13
           21          808.02        172.11
           22          817.43        175.50
           23          826.67        179.30
           24          835.75        183.50
           25          844.63        188.09
           26          853.31        193.07
           27          861.75        198.42
           28          869.96        204.14
           29          877.91        210.20
           30          885.59        216.61
           31          892.98        223.35
           32          900.07        230.40
           33          906.84        237.76
           34          913.29        245.40
           35          919.40        253.32
           36          925.15        261.50
           37          930.54        269.92
           38          935.56        278.57
           39          935.95        279.30

 **  Corrected JANBU FOS =   1.262  **     (Fo factor = 1.103)


Failure surface No. 6 specified by 50 coordinate points

          Point        x-surf        y-surf
           No.          (ft)          (ft)

            1          553.45        185.91
            2          560.52        178.84
            3          567.89        172.08
            4          575.53        165.63
            5          583.45        159.52
            6          591.61        153.74
```

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PMP

```
          7          600.01        148.32
          8          608.64        143.26
          9          617.47        138.57
         10          626.49        134.26
         11          635.69        130.33
         12          645.04        126.80
         13          654.54        123.67
         14          664.16        120.94
         15          673.89        118.62
         16          683.71        116.72
         17          693.60        115.24
         18          703.54        114.17
         19          713.52        113.53
         20          723.52        113.31
         21          733.52        113.52
         22          743.50        114.15
         23          753.44        115.20
         24          763.33        116.68
         25          773.15        118.57
         26          782.88        120.88
         27          792.50        123.59
         28          802.00        126.71
         29          811.36        130.24
         30          820.56        134.15
         31          829.59        138.46
         32          838.43        143.14
         33          847.06        148.19
         34          855.47        153.60
         35          863.64        159.37
         36          871.56        165.47
         37          879.21        171.91
         38          886.58        178.67
         39          893.66        185.73
         40          900.44        193.08
         41          906.89        200.72
         42          913.02        208.62
         43          918.81        216.78
         44          924.24        225.17
         45          929.32        233.79
         46          934.02        242.61
         47          938.35        251.63
         48          942.29        260.82
         49          945.83        270.17
         50          948.86        279.30

  **  Corrected JANBU FOS =   1.263  **    (Fo factor = 1.118)


Failure surface No. 7 specified by 48 coordinate points

        Point        x-surf        y-surf
         No.          (ft)          (ft)

          1          581.03        185.21
          2          588.11        178.14
          3          595.51        171.41
          4          603.20        165.02
          5          611.18        158.99
          6          619.42        153.33
          7          627.92        148.06
```

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602-0207
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```
     8            636.65         143.18
     9            645.59         138.70
    10            654.73         134.64
    11            664.04         130.99
    12            673.51         127.78
    13            683.12         125.01
    14            692.84         122.67
    15            702.66         120.79
    16            712.56         119.35
    17            722.51         118.37
    18            732.49         117.84
    19            742.49         117.77
    20            752.49         118.16
    21            762.45         119.01
    22            772.37         120.30
    23            782.21         122.06
    24            791.97         124.26
    25            801.61         126.90
    26            811.12         129.98
    27            820.49         133.49
    28            829.68         137.43
    29            838.68         141.78
    30            847.48         146.54
    31            856.04         151.70
    32            864.37         157.25
    33            872.43         163.17
    34            880.21         169.45
    35            887.69         176.08
    36            894.87         183.04
    37            901.72         190.33
    38            908.23         197.92
    39            914.38         205.80
    40            920.17         213.96
    41            925.58         222.37
    42            930.60         231.02
    43            935.22         239.88
    44            939.43         248.96
    45            943.21         258.21
    46            946.58         267.63
    47            949.50         277.19
    48            950.05         279.30

 **  Corrected JANBU FOS =   1.263  **    (Fo factor = 1.119)

Failure surface No. 8 specified by 47 coordinate points

    Point          x-surf          y-surf
     No.            (ft)            (ft)

     1            581.03         185.21
     2            588.45         178.50
     3            596.16         172.13
     4            604.14         166.10
     5            612.38         160.44
     6            620.87         155.15
     7            629.58         150.24
     8            638.51         145.73
     9            647.62         141.61
    10            656.91         137.91
```

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```
        11          666.35        134.62
        12          675.93        131.75
        13          685.63        129.31
        14          695.43        127.30
        15          705.30        125.74
        16          715.24        124.61
        17          725.21        123.92
        18          735.21        123.68
        19          745.21        123.88
        20          755.19        124.53
        21          765.13        125.62
        22          775.01        127.15
        23          784.82        129.11
        24          794.52        131.51
        25          804.11        134.34
        26          813.57        137.60
        27          822.87        141.26
        28          832.00        145.34
        29          840.94        149.82
        30          849.68        154.70
        31          858.18        159.95
        32          866.45        165.58
        33          874.45        171.57
        34          882.19        177.91
        35          889.63        184.59
        36          896.77        191.59
        37          903.59        198.91
        38          910.08        206.51
        39          916.23        214.40
        40          922.02        222.56
        41          927.44        230.96
        42          932.48        239.60
        43          937.13        248.45
        44          941.39        257.50
        45          945.24        266.73
        46          948.68        276.12
        47          949.68        279.30

  **  Corrected JANBU FOS =   1.264  **     (Fo factor = 1.117)

Failure surface No. 9 specified by 50 coordinate points

      Point        x-surf        y-surf
       No.          (ft)          (ft)

        1          553.45        185.91
        2          560.57        178.89
        3          567.98        172.17
        4          575.67        165.78
        5          583.62        159.71
        6          591.82        153.99
        7          600.25        148.62
        8          608.91        143.61
        9          617.77        138.97
       10          626.81        134.70
       11          636.03        130.83
       12          645.40        127.35
       13          654.92        124.26
       14          664.55        121.58
```

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```
        15           674.29          119.31
        16           684.12          117.46
        17           694.01          116.02
        18           703.96          115.00
        19           713.94          114.40
        20           723.94          114.22
        21           733.94          114.47
        22           743.92          115.14
        23           753.86          116.23
        24           763.74          117.74
        25           773.55          119.66
        26           783.28          122.00
        27           792.89          124.74
        28           802.38          127.89
        29           811.73          131.44
        30           820.92          135.38
        31           829.94          139.71
        32           838.77          144.41
        33           847.39          149.48
        34           855.78          154.91
        35           863.94          160.69
        36           871.85          166.81
        37           879.49          173.26
        38           886.86          180.03
        39           893.93          187.10
        40           900.69          194.46
        41           907.14          202.10
        42           913.26          210.01
        43           919.04          218.17
        44           924.48          226.57
        45           929.55          235.19
        46           934.25          244.01
        47           938.57          253.03
        48           942.52          262.22
        49           946.06          271.57
        50           948.63          279.30

  **  Corrected JANBU FOS =   1.264  **     (Fo factor = 1.118)

 Failure surface No.10 specified by 47 coordinate points

      Point          x-surf          y-surf
       No.            (ft)            (ft)

        1            581.03          185.21
        2            588.21          178.24
        3            595.70          171.61
        4            603.48          165.33
        5            611.54          159.42
        6            619.87          153.88
        7            628.44          148.72
        8            637.23          143.97
        9            646.24          139.62
       10            655.43          135.68
       11            664.80          132.17
       12            674.31          129.10
       13            683.96          126.46
       14            693.71          124.27
       15            703.56          122.52
```

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```
      16          713.48        121.23
      17          723.44        120.39
      18          733.43        120.01
      19          743.43        120.08
      20          753.42        120.62
      21          763.37        121.61
      22          773.26        123.05
      23          783.08        124.95
      24          792.81        127.29
      25          802.41        130.07
      26          811.88        133.29
      27          821.19        136.94
      28          830.32        141.02
      29          839.26        145.50
      30          847.98        150.39
      31          856.47        155.68
      32          864.71        161.35
      33          872.68        167.38
      34          880.37        173.78
      35          887.75        180.52
      36          894.82        187.60
      37          901.56        194.98
      38          907.95        202.67
      39          913.99        210.65
      40          919.65        218.89
      41          924.93        227.38
      42          929.82        236.10
      43          934.30        245.04
      44          938.37        254.18
      45          942.02        263.49
      46          945.24        272.96
      47          947.08        279.30

 **  Corrected JANBU FOS =   1.264   **     (Fo factor = 1.119)



The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Excavated Slopes Stability Q

      Modified      Correction     Initial     Terminal     Available
     JANBU FOS        Factor       x-coord     x-coord      Strength
                                    (ft)         (ft)         (lb)

 1.     1.258          1.099       608.62       943.91     7.264E+05
 2.     1.261          1.118       567.24       949.69     1.117E+06
 3.     1.261          1.098       608.62       950.00     7.332E+05
 4.     1.261          1.118       574.14       949.65     1.095E+06
 5.     1.262          1.103       615.52       935.95     7.035E+05
 6.     1.263          1.118       553.45       948.86     1.162E+06
 7.     1.263          1.119       581.03       950.05     1.087E+06
 8.     1.264          1.117       581.03       949.68     1.054E+06
 9.     1.264          1.118       553.45       948.63     1.157E+06
10.     1.264          1.119       581.03       947.08     1.069E+06

                   * * *  END OF FILE  * * *
```

MONTGOMERY WATSON

Calculation Cover Sheet — Appendix E-2

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Protective Soil Layer Stability

	Name	Date
Prepared By:	Paul Pellicer	11/3/97
Checked By:	John Pellicer	11/13/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

Project Name: [illegible]
Project Number: 602 Sheet: 1 of 16
Prepared By: P. Peller Date: Nov 3, 1997
Checked By: J. Pullman Date: 13-Nov-97

Protective Soil Layer Stability

Objective: Determine the stability of the protective Soil layer over the Geocomposite Slopes.

Assumptions:
- D6 Dozer will be used to place and operate on the Slopes.
- A Dozer will not be on the slope for pseudo-Static conditions.

Calculation:

Use infinite slope analysis to evaluate the stability of the protective soil cover.

Controlling Strength of the slope liner system as determined by direct shear test i.e.
a = 15 psf, δ = 31° (residual strengths) (saturated condition) (see pg 3)

Dozer load was simulated by increasing the Thickness of the protective soil

- D6 Dozer (Cat handbook see pg 4)

Track pressure = 9.8 psi = 1411 psf

equivalent Soil Thickness = $\frac{1411 \text{ psf}}{112 \text{ pcf}}$ = 12.6 ft.

Maximum ground acceleration = 0.04g (see pg 5+6)

Static F.S. = 2.0 (see pg. 7)

Psuedo-static F.S. = 1.8 (see pg 8)

Static F.S. w/ simulated Dozer on slope = 1.8 (see pg. 9)
XSTABL w/ surcharg equal to Dozer ⇒ Static F.S. = 1.8

Conclusions: Protective Soil layer on 3H:1V side slopes should be stable. Assuming saturated strength for the side slopes is very conservative.
DOZER WILL NOT OPERATE ON SLOPES DURING RAIN STORM THEREFORE, SATURATED CONDITIONS WERE NOT CONSIDERED.

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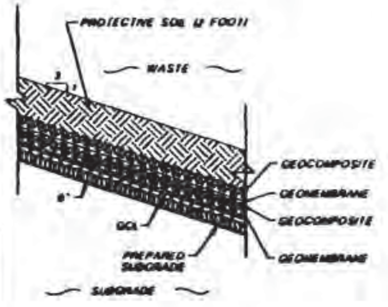
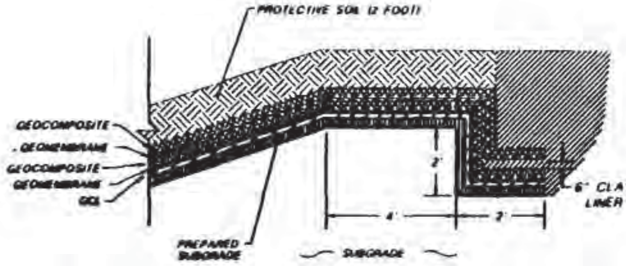
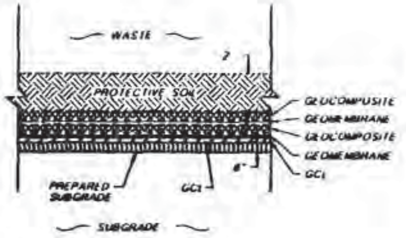


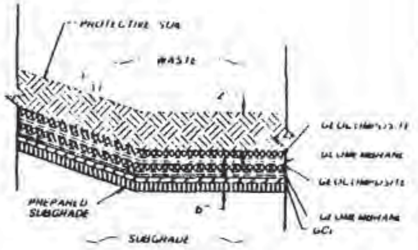
1 (1/12) **SLOPE DETAIL**
Not To Scale



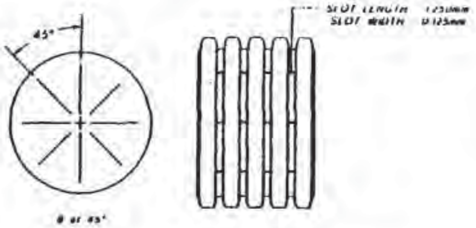
2 (6/12) 2 (8/12) 2 (10/12) 2 (33/12) 2 (24/12) **LINER ANCHOR TRENCH DETAIL**
Not To Scale



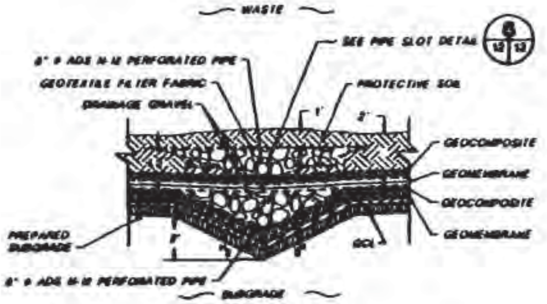
3 (7/12) 3 (24/12) **FLOOR DETAIL**
Not To Scale



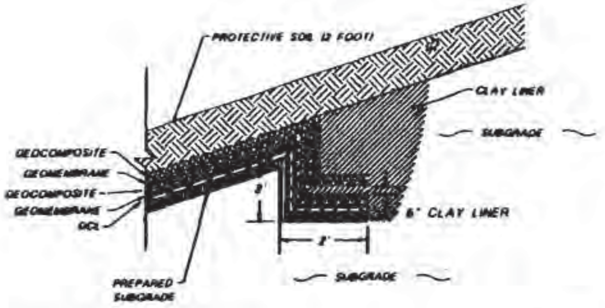
4 (7/12) **TOE OF SLOPE DETAIL**
Not To Scale



8 (12/12) **ADS N-12 PIPE SLOT DETAIL**
Not To Scale



5 (8/12) **FLOOR PIPE DETAIL**
Not To Scale



6 (8/12) 6 (13/12) **SLOPE ANCHOR TRENCH**
Not To Scale

PROFESSIONAL ENGINEER'S STATEMENT
I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date ____ Patrick G. Corser, NM P.E. [illegible]

NOTE:
FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 1 "INDEX, LEGEND AND GENERAL NOTES".

Not For Construction

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE
LINER DETAILS

TerraMatrix
ENGINEERING SERVICES
[illegible]

K:/002/FINAL DWGS/LANDFILL
LNRDTLS.dwg

GEOSYNTEC CONSULTANTS

SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

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602-0200
PMP
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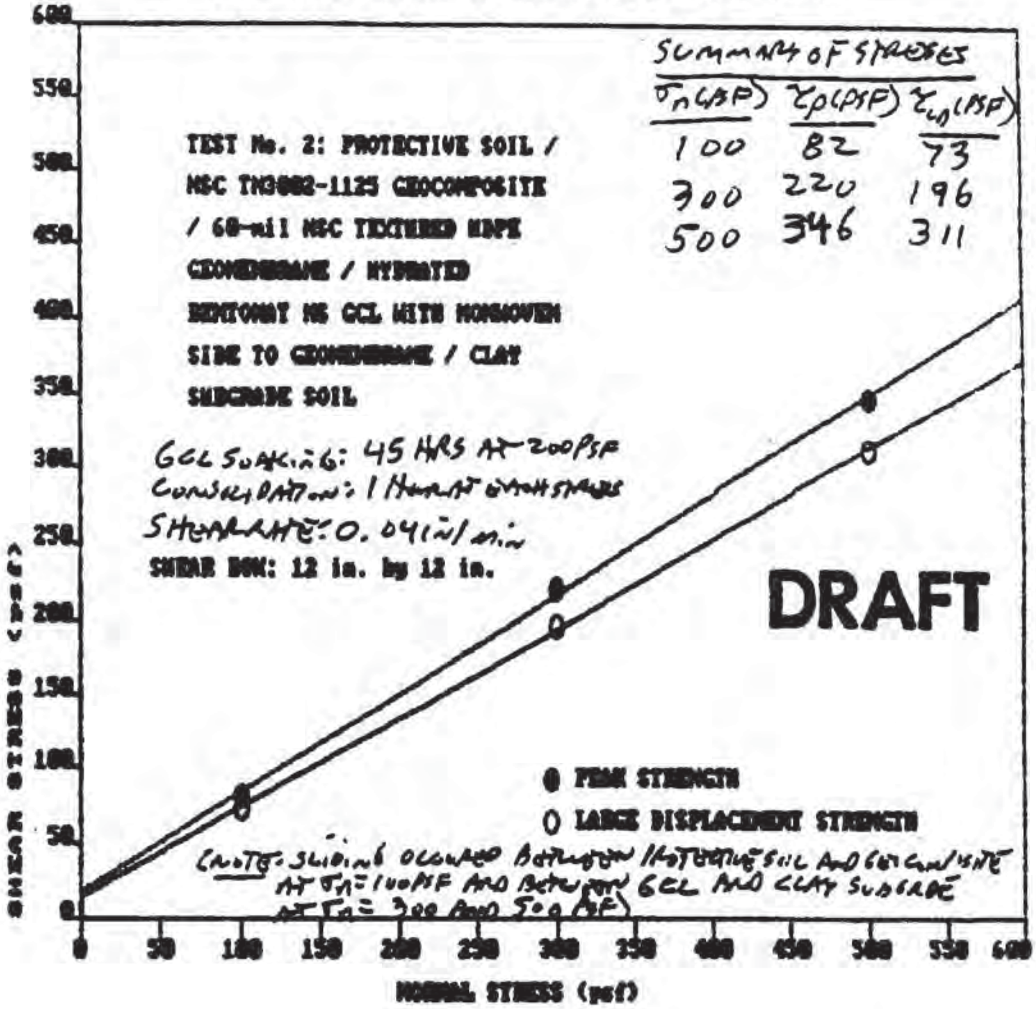
TERRAMATRIX MONTGOMERY WATSON - ASTM D 5321 TESTS



TEST No. 2: PROTECTIVE SOIL / NSC TN3002-1125 GEOCOMPOSITE / 60-mil NSC TEXTURED HDPE GEOMEMBRANE / HYDRATED BENTOMAT NS GCL WITH NONWOVEN SIDE TO GEOMEMBRANE / CLAY SUBGRADE SOIL

GCL SOAKING: 45 HRS AT 200PSF
CONSOLIDATION: 1 HOUR AT EACH STRESS
SHEAR RATE: 0.04in/min
SHEAR BOX: 12 in. by 12 in.

SUMMARY OF STRESSES

σ_n(PSF)	τ_p(PSF)	τ_{LD}(PSF)
100	82	73
300	220	196
500	346	311

(NOTE: SLIDING OCCURRED BETWEEN PROTECTIVE SOIL AND GEOCOMPOSITE AT σ_n = 100PSF AND BETWEEN GCL AND CLAY SUBGRADE AT σ_n = 300 AND 500 PSF)

THE REGRESSION POLYNOMIAL OF LINE 9 - PEAK STRENGTH

(1.800E+01) + (6.600E-01)*X
THE VARIANCE - 8.000E+00

a = 18 PSF δ = 33°

THE REGRESSION POLYNOMIAL OF LINE 10 - LARGE DISPLACEMENT STRENGTH

(1.483E+01) + (5.950E-01)*X
THE VARIANCE - 3.556E+00

a = 15 PSF δ = 31°

Reviewed By: Robert H Swan Jr Date: 10-10-97

ı Trans.		
D7H		
ı/h	MPH	
2.7	1.7	
3.5	2.2	
4.6	2.8	
5.8	3.6	
7.6	4.7	
ı0.0	6.2	
3.3	2.1	
4.3	2.7	
5.6	3.5	
7.1	4.4	
9.2	5.7	
12.2	7.6	

ıted for transmission
ıechanical efficiency
ents, and weight and

ıt Rated RPM		
	kg	lb
	16 380	37,110
	12 857	28,350
	9700	21,380
	7433	16,390
	5519	12,170
	3940	8,690
Max. at Lug		
	22 158	48,850
	16 993	37,470
	12 884	28,410
	9941	21,920
	7451	16,430
	5392	11,890

Pressures computed from operating weights given earlier in this section in the specifications tables.

MODEL	SHOE WIDTH		CONTACT AREA		GROUND PRESSURE	
	mm	in.	m²	Sq. in.	kPa	psi
D3B** ***	305	12◄	1.11	1723	59	8.6
	356	14	1.30	2016	51	7.4
	406	16*	1.48	2296	44	6.4
D3B LGP	635	25◄	2.61	4050	29	4.2
D4E** standard undercarriage	406	16◄	1.49	2304	59	8.6
	457	18	1.67	2592	52	7.6
	508	20	1.86	2880	47	6.8
D4E*** standard undercarriage	406	16◄	1.49	2304	60	8.7
	457	18	1.67	2592	53	7.7
	508	20	1.86	2880	47	6.8
D4E LGP**	762	30◄	3.37	5220	29.5	4.28
D4E LGP***	762	30◄	3.37	5220	29.7	4.31
D5B***	406	16◄	1.79	2784	67	9.8
	457	18	2.02	3132	60	8.7
	508	20	2.24	3480	54	7.8
	559	22	2.47	3828	49	7.1
D5B LGP	864	34◄	4.87	7548	30	4.3

*D3B Custom 75 standard shoe.

**Direct drive.
***Power shift.

◄Standard shoe.

NOTE: Ground contact area = width of track shoe × length of track on ground × 2.

$$\text{Ground pressure} = \frac{\text{operating weight}}{\text{ground contact area}}$$

MODEL	SHOE WIDTH		CONTACT AREA		GROUND PRESSURE	
	mm	in.	m²	Sq. in.	kPa	psi
D6D***	457	18◄	2.16	3348	67	9.8
	508	20	2.40	3720	60	8.8
	559	22	2.64	4092	55	8.0
	610	24	2.88	4464	51	7.4
D6D LGP	914	36◄	5.25	8136	32	4.6
D7G***	508	20◄	2.76	4280	73	10.6
	559	22	3.04	4708	66	9.6
	610	24	3.31	5136	60	8.8
D7G LGP	864	34◄	5.26	8160	44	6.4
D7H***	508	20◄	2.94	4565	75	10.9
	559	22	3.24	5022	68	9.9
	610	24	3.53	5478	62	9.0
	660	26	3.83	5935	61	8.9
D7H LGP	914	36◄	5.82	9030	42	6.1
D8L	560	22◄	3.59	5566	101	14.7
	610	24	3.92	6072	93	13.5
	660	26	4.24	6578	86	12.5
	710	28	4.57	7084	80	11.6
D9L	610	24◄	4.32	6696	118	17.1
	686	27	4.86	7533	105	15.2
	762	30	5.40	8370	94	13.7
D10	711	28◄	5.56	8624	139	20.2
	810	32	6.36	9856	122	17.7

**Direct drive.
***Power shift.

◄Standard shoe.

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United States Department of the Interior

Geological Survey

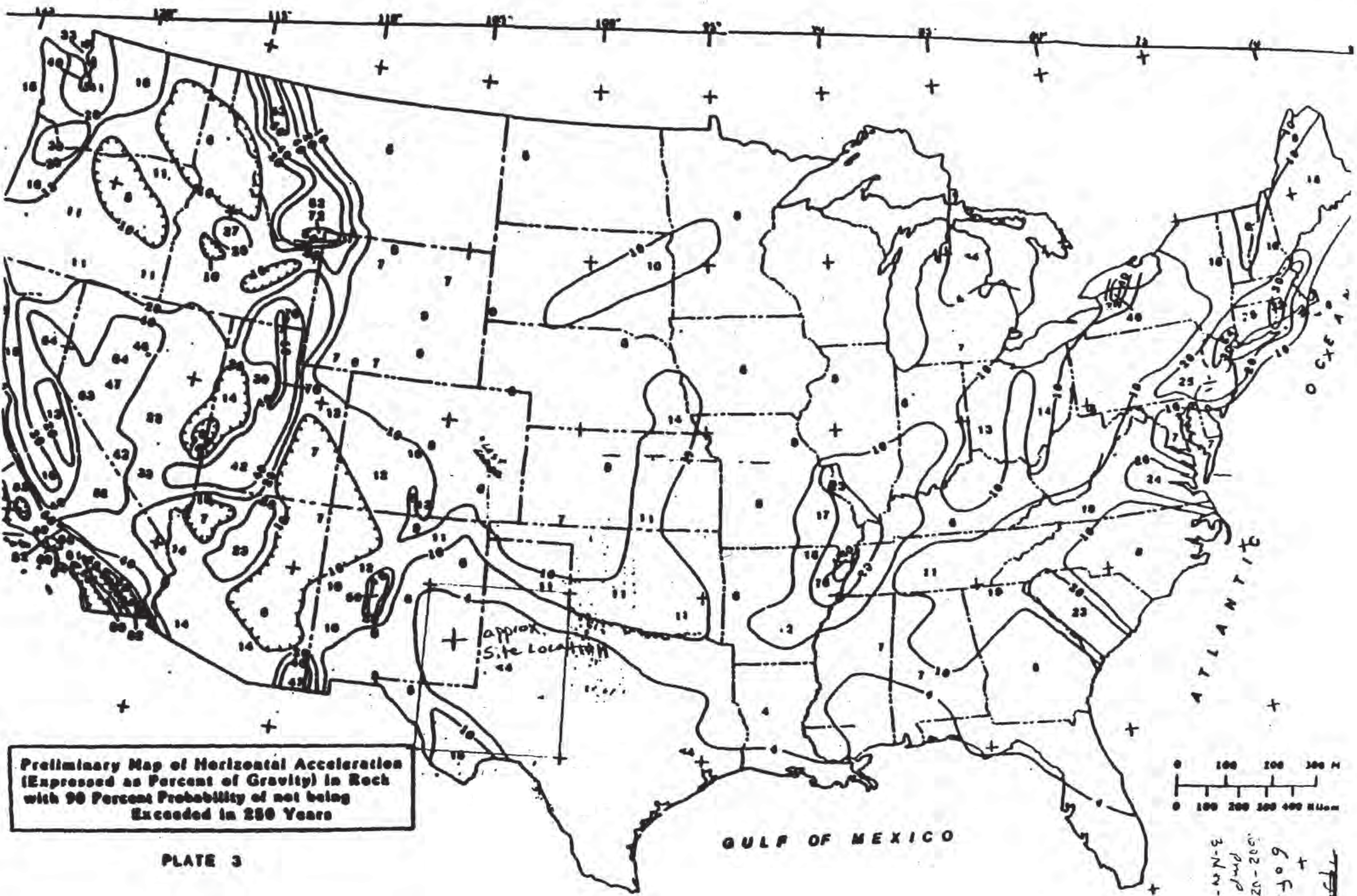
PROBABILISTIC ESTIMATES OF MAXIMUM ACCELERATION AND VELOCITY IN ROCK IN THE CONTIGUOUS UNITED STATES

by

S. T. Algermissen, D. M. Perkins, P. C. Thenhaus,
S. L. Hanson and B. L. Bender

Open-File Report 82-1033

1982



Preliminary Map of Horizontal Acceleration (Expressed as Percent of Gravity) in Rock with 90 Percent Probability of not being Exceeded in 250 Years

PLATE 3

TJO
6 of 16
.602-0227-206
pmp
3-Nov-9-

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002-0200
3-Nov-9
PMP

Infinite slope analysis spreadsheet
Date: 03-Nov-97
By: Paul Pellicer
Filename: Protective cover stability.wq1

Soil Parameters

Cohesion:	15 psf		0.07185535
Friction Angle:	31 degrees	tangent	0.600860619
Gamma Moist:	110 pcf		

Slope Geometry:

Slope Angle:	18.4 degrees	cosine	0.948876012 sine
Failure Plane Depth:	2 ft		

Groundwater Parameters

Height of water in failure mass:	0 ft
Pore Pressure Ratio:	0 no units

Seismic Parameters

Ground Acceleration:	0 g's

Safety Factor: 2.0339

8.C.1
602-025
pmp
3-Nov-9

Infinite slope analysis spreadsheet
Date: 04-Nov-97
By: Paul Pellicer
Filename: Protective cover stability.wq1

Soil Parameters

Cohesion:	15 psf		0.07185535
Friction Angle:	31 degrees	tangent	0.600860619
Gamma Moist:	110 pcf		

Slope Geometry:

Slope Angle:	18.4 degrees	cosine	0.948876012 sine
Failure Plane Depth:	2 ft		

Groundwater Parameters

Height of water in failure mass:	0 ft
Pore Pressure Ratio:	0 no units

Seismic Parameters

Ground Acceleration:	0.04 g's

Safety Factor: 1.79413

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PMP
3-Nov-9

Infinite slope analysis spreadsheet
Date: 13-Nov-97
By: Paul Pellicer
Filename: Protective cover stability.wq1

Soil Parameters

Cohesion:	15 psf		0.009710182
Friction Angle:	31 degrees	tangent	0.600860619
Gamma Moist:	110 pcf		

Slope Geometry:

Slope Angle:	18.4 degrees	cosine	0.948876012 sine
	14.8 ft		

Groundwater Parameters

Height of water in failure mass:	0 ft
Pore Pressure Ratio:	0 no units

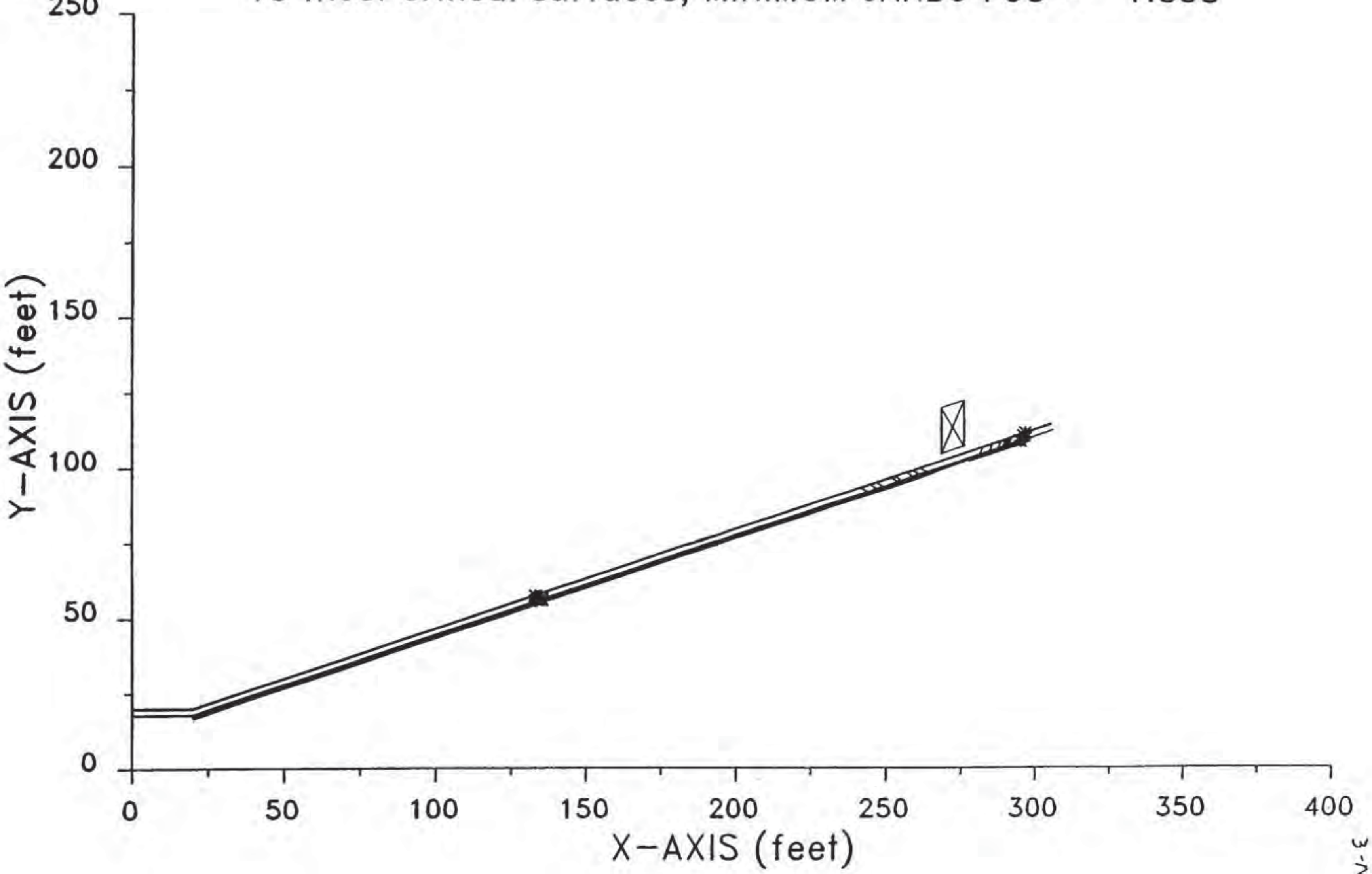
Seismic Parameters

Ground Acceleration:	0 g's

Safety Factor: 1.83702

GrSWD 11-13-97 12:27

Protective soil with Dozer
10 most critical surfaces, MINIMUM JANBU FOS = 1.858



602-0200
pmp
3-Nov-97

1102 10

GW2-0200
PMP
3-Nov-97

```
XSTABL File: GPSWD      11-13-97   12:27

          *****************************************
          *              X S T A B L              *
          *                                       *
          *       Slope Stability Analysis        *
          *              using the                *
          *           Method of Slices            *
          *                                       *
          *        Copyright (C) 1992 á 96        *
          *    Interactive Software Designs, Inc. *
          *        Moscow, ID 83843, U.S.A.       *
          *                                       *
          *          All Rights Reserved          *
          *                                       *
          *  Ver. 5.200                96 á 1216  *
          *****************************************

    Problem Description : Protective soil with Dozer



    -----------------------------
    SEGMENT BOUNDARY COORDINATES
    -----------------------------

        2 SURFACE boundary segments

    Segment     x-left    y-left    x-right   y-right     Soil Unit
      No.        (ft)      (ft)      (ft)      (ft)     Below Segment

       1           .0      20.0      20.0      20.0           1
       2         20.0      20.0     304.6     114.7           1

        2 SUBSURFACE boundary segments

    Segment     x-left    y-left    x-right   y-right     Soil Unit
      No.        (ft)      (ft)      (ft)      (ft)     Below Segment

       1           .0      18.0      20.3      18.0           2
       2         20.3      18.0     305.3     112.8           2


    --------------------------
    ISOTROPIC Soil Parameters
    --------------------------

     2 Soil unit(s) specified

    Soil   Unit Weight   Cohesion  Friction    Pore Pressure      Water
    Unit  Moist    Sat.  Intercept   Angle  Parameter  Constant  Surface
     No.  (pcf)   (pcf)    (psf)     (deg)      Ru       (psf)     No.

      1   110.0   110.0       .0     29.00     .000         .0       0
      2   110.0   110.0     15.0     31.00     .000         .0       0
```

ICO+ -
GV2-V240
PMA
3-Nov-97

```
---------------
BOUNDARY LOADS
---------------

    1 load(s) specified

Load        x-left      x-right     Intensity     Direction
 No.         (ft)        (ft)         (psf)          (deg)

  1          267.6       275.2       1411.0            .0

NOTE - Intensity is specified as a uniformly distributed
       force acting on a HORIZONTALLY projected surface.


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.


The active and passive portions of the sliding surfaces
are generated according to the Rankine theory.


 1000 trial surfaces will be generated and analyzed.


  2 boxes specified for generation of central block base


Length of line segments for active and passive portions of
sliding block is       2.0 ft


Box         x-left     y-left    x-right    y-right      Width
no.          (ft)       (ft)      (ft)       (ft)         (ft)

 1           20.3       17.5     265.1       98.9         1.0
 2          277.1      102.9     297.1      109.6         1.0


Factors of safety have been calculated by the :

* * * * *    SIMPLIFIED JANBU METHOD    * * * * *


The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by  7 coordinate points

       Point       x-surf       y-surf
        No.         (ft)         (ft)
```

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```
          1          132.91          57.57
          2          133.48          57.24
          3          135.20          56.22
          4          135.24          56.20
          5          294.26         109.15
          6          295.28         110.87
          7          295.81         111.77

 **   Corrected JANBU FOS =   1.858  **       (Fo factor = 1.006)

Failure surface No. 2 specified by  8 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          244.20          94.60
          2          244.78          94.26
          3          246.50          93.24
          4          247.64          92.60
          5          280.30         104.44
          6          280.33         104.49
          7          281.34         106.22
          8          281.89         107.14

 **   Corrected JANBU FOS =   1.933  **       (Fo factor = 1.034)

Failure surface No. 3 specified by  8 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          260.57         100.05
          2          261.15          99.70
          3          262.88          98.69
          4          263.43          98.38
          5          283.48         105.46
          6          283.53         105.56
          7          284.54         107.28
          8          285.09         108.21

 **   Corrected JANBU FOS =   1.936  **       (Fo factor = 1.042)

Failure surface No. 4 specified by  8 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          258.41          99.33
          2          259.00          98.99
          3          260.72          97.97
          4          261.84          97.34
          5          287.86         106.77
          6          288.03         107.05
          7          289.04         108.78
          8          289.59         109.70

 **   Corrected JANBU FOS =   1.938  **       (Fo factor = 1.039)
```

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PMP
3-Mar-9

```
Failure surface No. 5 specified by  8 coordinate points

      Point        x-surf       y-surf
       No.          (ft)         (ft)

        1          246.20        95.27
        2          246.78        94.92
        3          248.50        93.91
        4          249.53        93.33
        5          286.38       106.43
        6          286.43       106.52
        7          287.44       108.25
        8          287.99       109.17

 **  Corrected JANBU FOS =   1.948  **     (Fo factor = 1.030)

Failure surface No. 6 specified by  7 coordinate points

      Point        x-surf       y-surf
       No.          (ft)         (ft)

        1          258.05        99.21
        2          258.63        98.86
        3          260.35        97.85
        4          260.83        97.58
        5          294.34       109.17
        6          295.35       110.90
        7          295.89       111.80

 **  Corrected JANBU FOS =   1.948  **     (Fo factor = 1.028)

Failure surface No. 7 specified by  7 coordinate points

      Point        x-surf       y-surf
       No.          (ft)         (ft)

        1          252.35        97.31
        2          252.94        96.97
        3          254.66        95.96
        4          254.90        95.82
        5          294.15       109.11
        6          295.17       110.83
        7          295.70       111.74

 **  Corrected JANBU FOS =   1.958  **     (Fo factor = 1.023)

Failure surface No. 8 specified by  8 coordinate points

      Point        x-surf       y-surf
       No.          (ft)         (ft)

        1          250.97        96.86
        2          251.56        96.51
        3          253.28        95.50
        4          253.87        95.17
```

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502-V200
pmp
3-Nov-

```
          5           289.81        107.58
          6           289.85        107.66
          7           290.87        109.39
          8           291.41        110.31

 **   Corrected JANBU FOS =    1.961  **     (Fo factor = 1.027)

Failure surface No. 9 specified by  8 coordinate points

        Point         x-surf        y-surf
         No.           (ft)          (ft)

          1           256.02         98.53
          2           256.60         98.19
          3           258.33         97.18
          4           259.07         96.75
          5           288.08        106.86
          6           288.23        107.12
          7           289.25        108.85
          8           289.79        109.77

 **   Corrected JANBU FOS =    1.961  **     (Fo factor = 1.033)

Failure surface No.10 specified by  8 coordinate points

        Point         x-surf        y-surf
         No.           (ft)          (ft)

          1           241.08         93.56
          2           241.66         93.22
          3           243.38         92.20
          4           244.39         91.63
          5           288.59        107.10
          6           288.69        107.27
          7           289.70        109.00
          8           290.25        109.92

 **   Corrected JANBU FOS =    1.962  **     (Fo factor = 1.026)




The following is a summary of the TEN most critical surfaces

Problem Description : Protective soil with Dozer

       Modified      Correction    Initial     Terminal    Available
      JANBU FOS        Factor      x-coord     x-coord      Strength
                                    (ft)        (ft)         (lb)

 1.      1.858          1.006      132.91      295.81     2.809E+04
 2.      1.933          1.034      244.20      281.89     1.273E+04
 3.      1.936          1.042      260.57      285.09     9.955E+03
 4.      1.938          1.039      258.41      289.59     1.168E+04
 5.      1.948          1.030      246.20      287.99     1.340E+04
 6.      1.948          1.028      258.05      295.89     1.197E+04
 7.      1.958          1.023      252.35      295.70     1.256E+04
```

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GR-VENT

```
   8.     1.961          1.027     250.97      291.41    1.265E+04  PM
   9.     1.961          1.033     256.02      289.79    1.182E+04  3-N
  10.     1.962          1.026     241.08      290.25    1.481E+04

                    * * *  END OF FILE  * * *
```

MONTGOMERY WATSON

Calculation Cover Sheet — Appendix E-3

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Phase 1A Filling Plan Stability

	Name	Date
Prepared By:	Paul Pellicer	11/7/97
Checked By:	John Pellicer	11/13/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

Project Number: 602
Prepared By: P. Pellicer
Checked By: J. Pillinar

Sheet: 1 Of 57
Date: Nov 7 1997
Date: 13-Nov-97

Phase 1a Filling Plan Stability

Objective: Evaluate the stability of the phase 1a filling plan.

Method: Use both SARMA and XSTABL Computer programs to evaluate block mode failures along the liner interface and through the waste.

Assumptions: · The Waste was assigned a typical friction angle for a relatively loose silty Sand (see pg 3) ✓
(Relative density = 25% ⇒ $\phi = 29°$)

Analysis: Two Cross Sections were cut for analysis. (see pg 7) ✓
Cross Section A-A' is Normal to the 3H:1V side slope and has the minimal Base grade (see pg 8) ✓
Cross Section B-B' is oriented to reduce a portion of the base grade even Further (See pg 9) ✓

These Cross Sections were enterd into both SARMA and XSTABL. Liner interface strengths of a = 440 psf and $\delta = 2°$ were used (see pg 4) ✓

SARMA indicates a static F.S. = 1.51 For Section A-A' and F.S = 1.94 for Section B-B'. (see pg 10-11)

XSTABL indicates a Static F.S. = 1.52 for Section A-A' and F.S. = 1.91 for Section B-B' (See pg 12-18, 26-32)

Using a ground acceleration = 0.04g (see pg 5-6) XSTABL indicates a pseudo-static F.S. = 1.01 for Section A-A' and a F.S = 1.19 for Section B-B' (see pg 19-25, 33-39). SARMA indicates ground accelerations = 0.0911 and 0.0615 to a F.S. = 1.0 for both sections Respectively. (see pg 10-11)

In addition to Failure along the entire liner interface XSTABL was used to search For Critical failure planes running along Part of the liner interface and up through the Waste. The Most Critical failure plane found From this Search has a static

F.S. = 1.70 and a pseudo-static F.S. = 1.37. (see pg 40-56)

Sarma was used to check the critical failure surface found by XSTABL for this failure mode. A static F.S. = 1.66, and a ground acceleration = 0.09g is required to reach a pseudo-static F.S. = 1, These values Correspond well w/ XSTABL. (see pg 57)

Conclusions: Staticly The phase 1a filling plan has an adequate Factor of Safety. The pseudo-static factors of safety are a little low but for the short time phase 1a well be at its ultimate capacity it should be O.K.

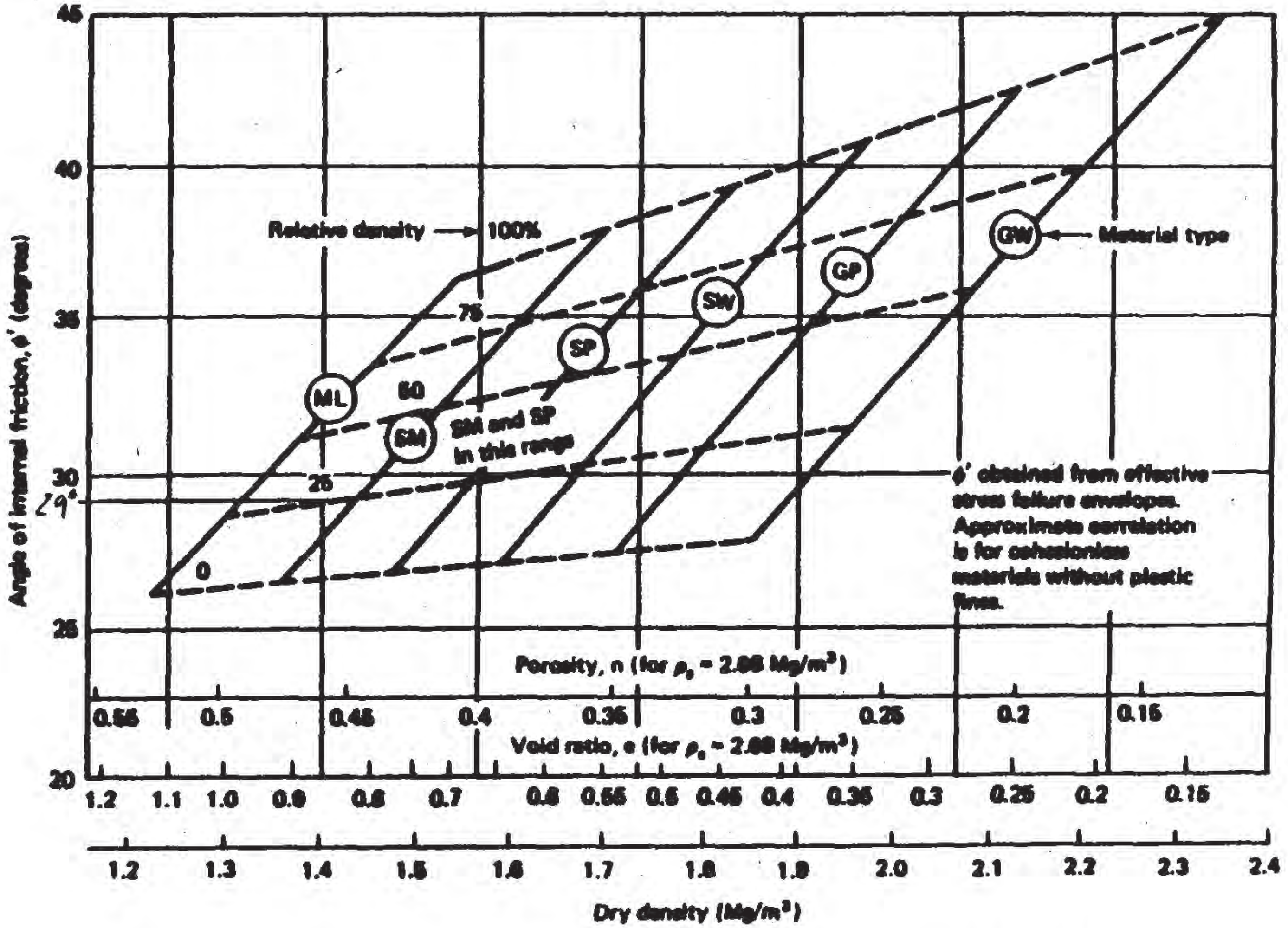

Fig. 11.13 Correlations between the effective friction angle in triaxial compression and the dry density, relative density, and soil classification

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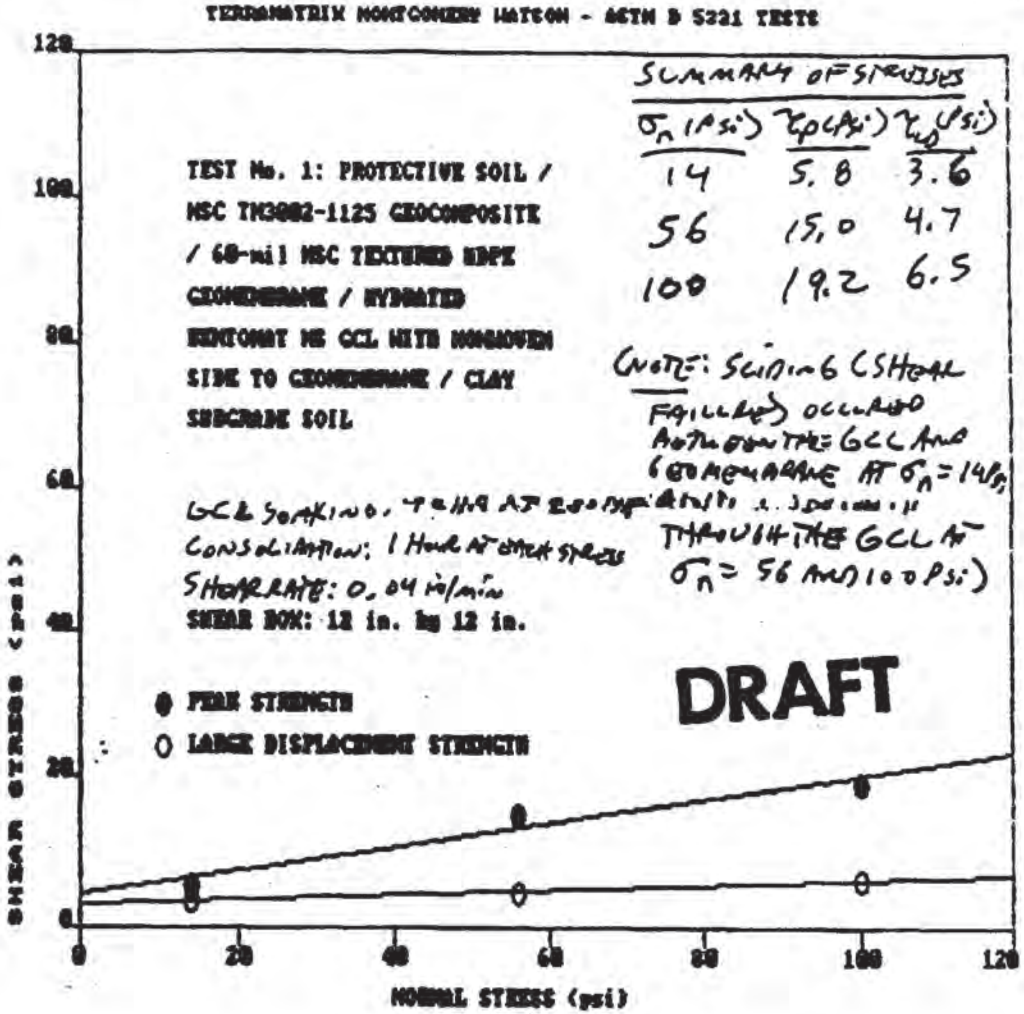
TERRAMATRIX MONTGOMERY WATSON - ASTM D 5321 TESTS



TEST No. 1: PROTECTIVE SOIL / MSC TN3002-1125 GEOCOMPOSITE / 60-mil MSC TEXTURED HDPE GEOMEMBRANE / HYDRATED BENTOMAT MS GCL WITH NONWOVEN SIDE TO GEOMEMBRANE / CLAY SUBGRADE SOIL

GCL SOAKING, 72 HR AT 200 PSF [illegible]
CONSOLIDATION: 1 HOUR AT EACH STRESS
SHEAR RATE: 0.04 in/min
SHEAR BOX: 12 in. by 12 in.

SUMMARY OF STRESSES

σ_n (psi)	τ_p (psi)	τ_{LD} (psi)
14	5.8	3.6
56	15.0	4.7
100	19.2	6.5

(NOTE: SLIDING (SHEAR FAILURE) OCCURRED ALONG THE GCL AND GEOMEMBRANE AT σ_n = 14 psi; [illegible] THROUGH THE GCL AT σ_n = 56 AND 100 psi)

DRAFT

THE REGRESSION POLYNOMIAL OF LINE 9 - PEAK STRENGTH

(4.534E+00) + (1.551E-01)*X
THE VARIANCE - 1.532E+00

a = 650 PSF δ = 9°

THE REGRESSION POLYNOMIAL OF LINE 10 - LARGE DISPLACEMENT STRENGTH

(3.045E+00) + (3.321E-02)*X
THE VARIANCE - 3.240E-02

a = 440 PSF δ = 2°

Reviewed By: Robert H Swan Jr Date: 10-8-97

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602-0200
pmr.
7-Nov-9

United States Department of the Interior

Geological Survey

PROBABILISTIC ESTIMATES OF MAXIMUM ACCELERATION AND VELOCITY IN ROCK IN THE CONTIGUOUS UNITED STATES

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S. T. Algermissen, D. M. Perkins, P. C. Thenhaus,
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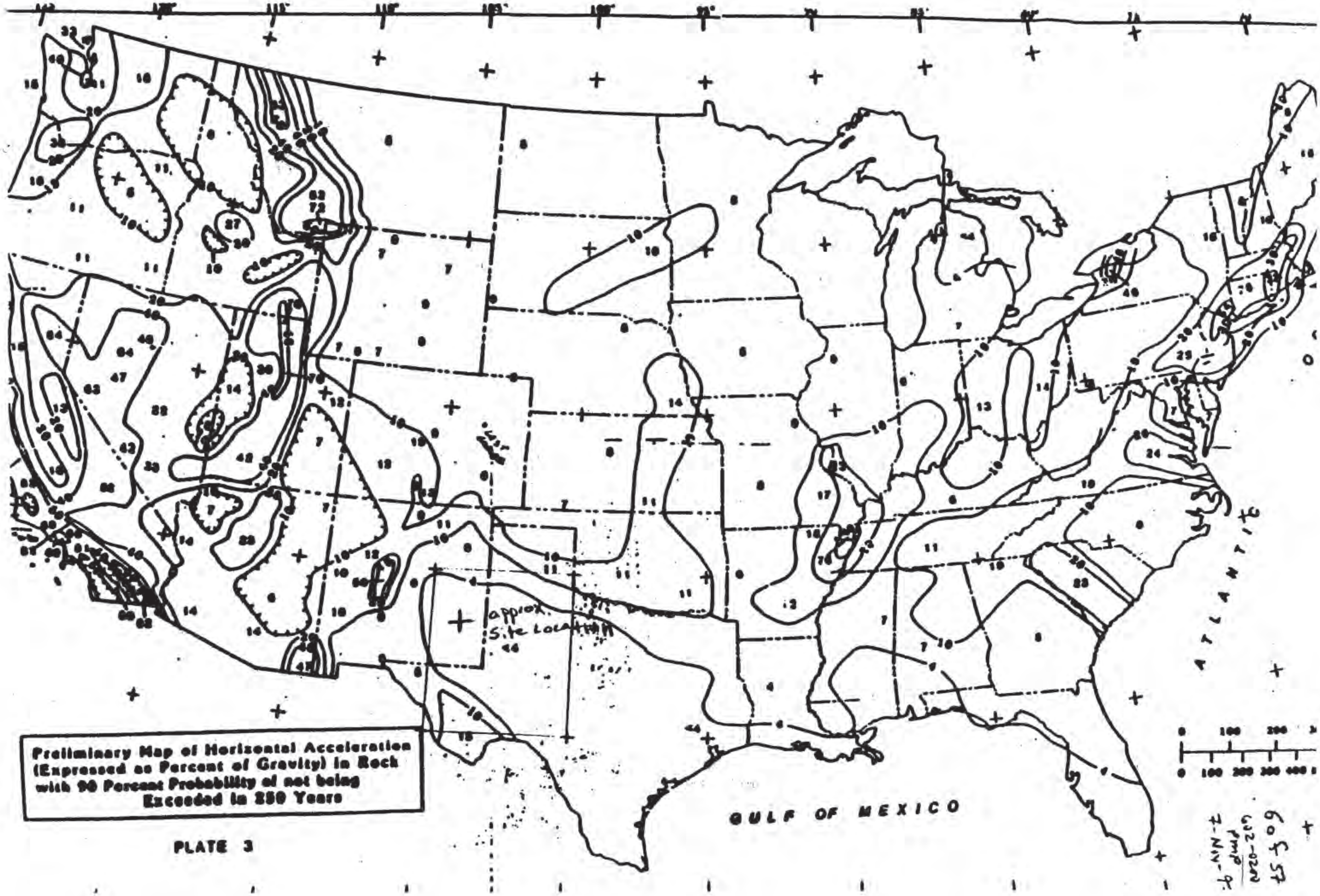
Open-File Report 82-1033

1982

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards.



Preliminary Map of Horizontal Acceleration (Expressed as Percent of Gravity) in Rock with 90 Percent Probability of not being Exceeded in 250 Years

PLATE 3

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602-0200
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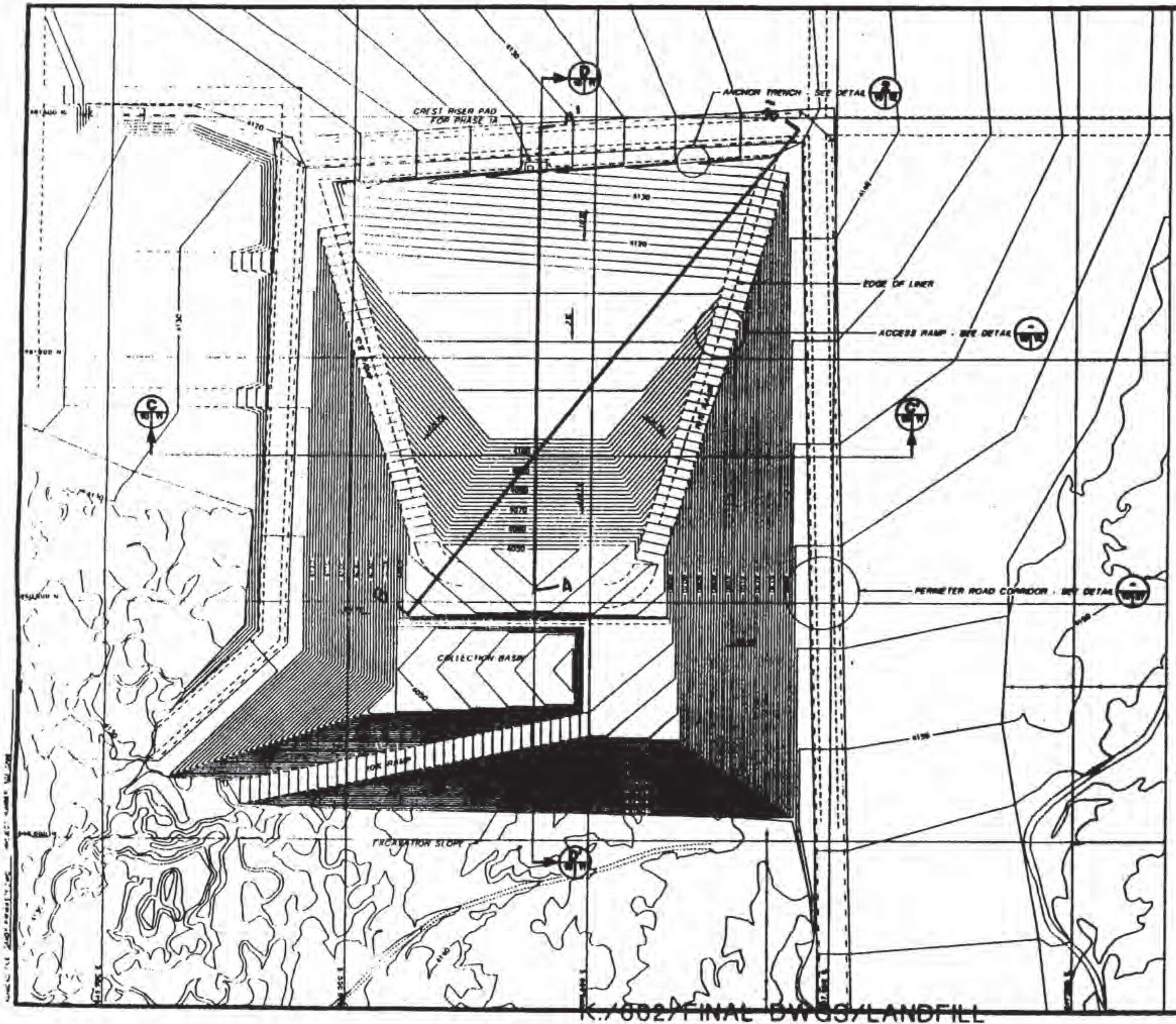
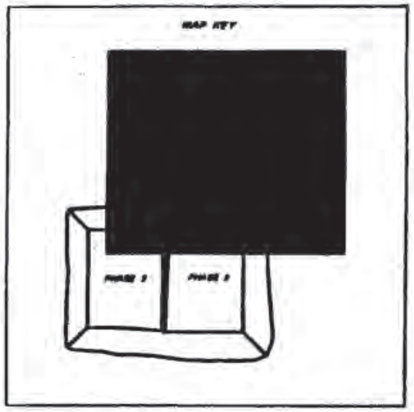
7-NOV-97
II-3





NOTES
1. FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".
2. TOPOGRAPHY FROM AERIAL SURVEYS PERFORMED AUGUST 1997 BY KOOGLE AND POULS ENGINEERING
3. WASTE FILL VOLUME FOR PHASE 1A: 953,200 CY

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date ______ Patrick G. Corser, NM P.E. [illegible]

SCALE
100' 0 100' 200'
CONTOUR INTERVAL 2 FT.

Not For Construction

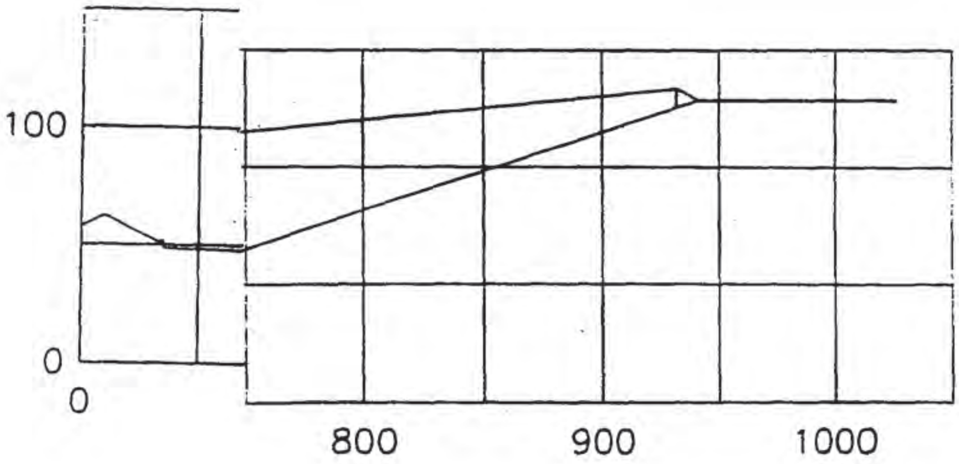
TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE:
FILLING PLAN - PHASE 1A

TerraMatrix

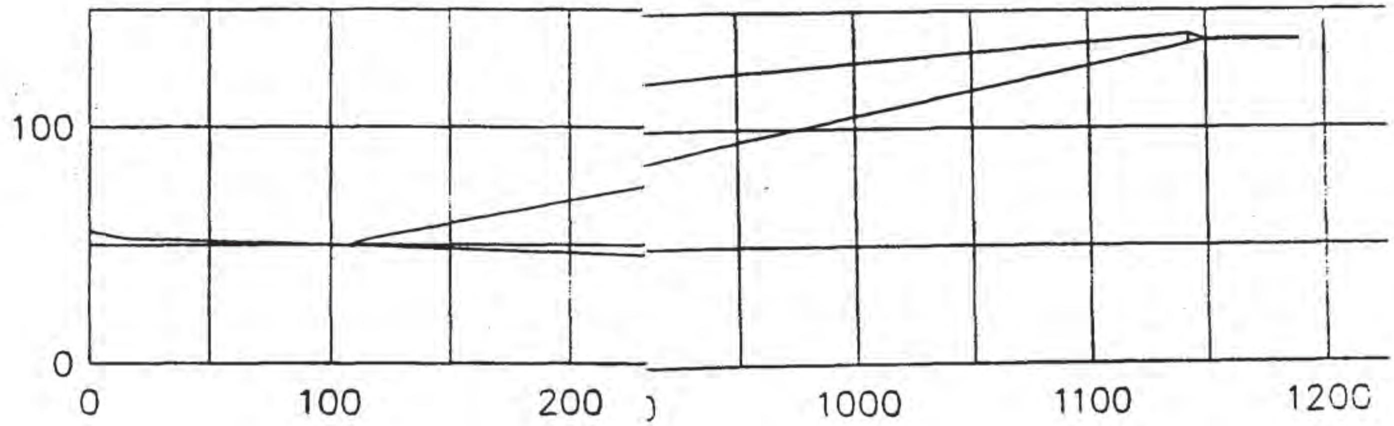
K:/602/FINAL DWGS/LANDFILL
GANDY-P WASTE.dwg
2, ,081
12/09/ 12:06p

[illegible]
602-0200
pmf
7-Nov



[redacted]

[illegible]


100
0
0
100
200
)
1000
1100
1200

602-0200
PMP
7-May-9

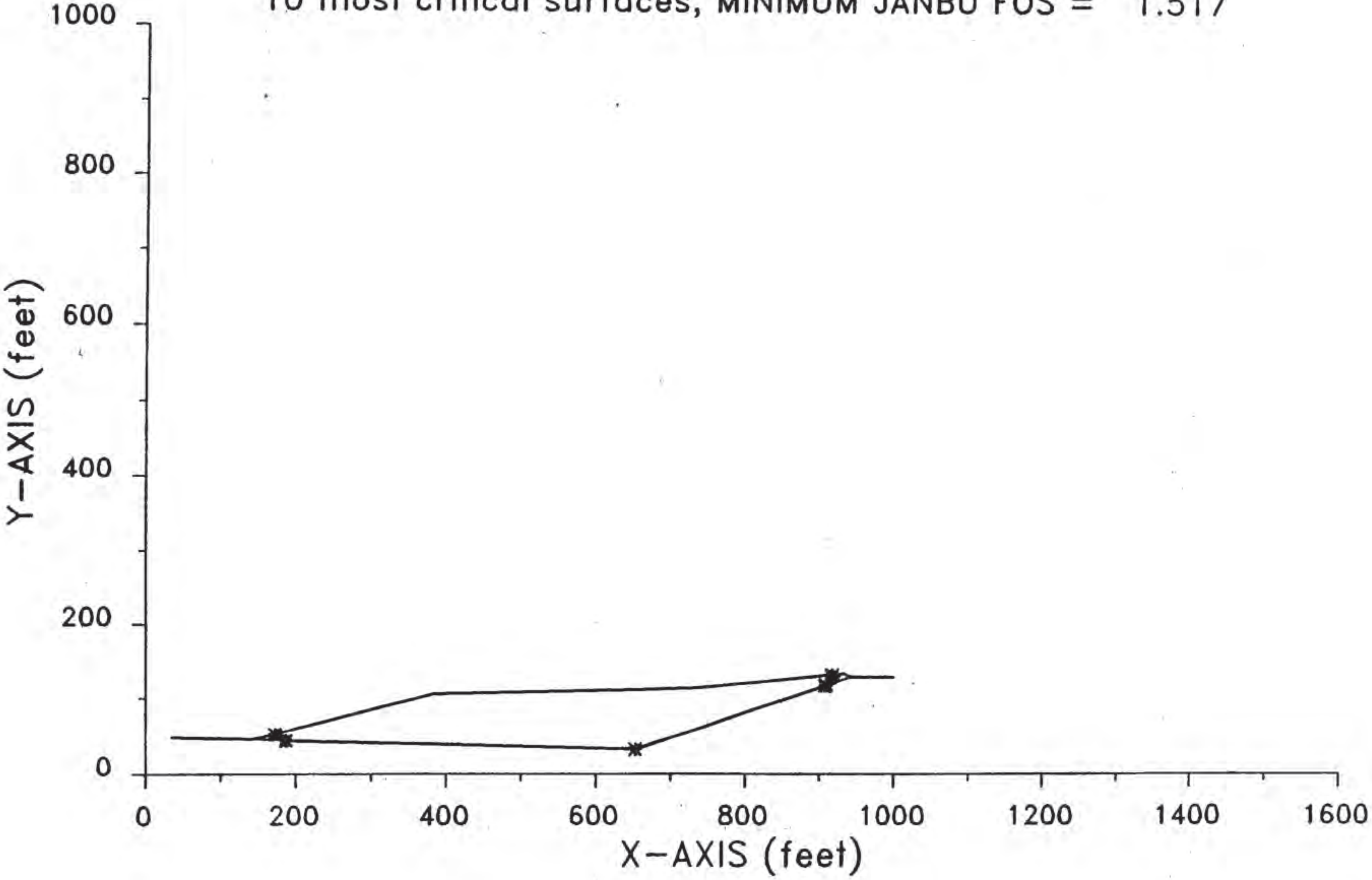
```
                   SARMA NON-VERTICAL SLICE ANALYSIS

Analysis no. gp1a3

Unit weight of water = 62.4

Side number         1         2         3         4         5         6
Coordinate xt    143.33    383.61    654.57    741.12    931.94    941.00
Coordinate yt     45.93    106.00    111.42    114.00    133.58    128.66
Coordinate xw    143.33    383.61    654.57    741.12    931.94    941.00
Coordinate yw     45.93     39.94     38.18     62.03    125.64    128.66
Coordinate xb    143.33    383.61    654.57    741.12    931.94    941.00
Coordinate yb     45.93     39.94     38.18     62.03    125.64    128.66
Friction angle     0.00      0.00      0.00      0.00      0.00      0.00
Cohesion           0.00      0.00      0.00      0.00      0.00      0.00

Slice number             1         2         3         4         5
Rock unit weight      110.00    110.00    110.00    110.00    110.00
Friction angle          2.00      2.00      2.00      2.00      2.00
Cohesion              440.00    440.00    440.00    440.00    440.00
Force T                 0.00      0.00      0.00      0.00      0.00
Angle theta             0.00      0.00      0.00      0.00      0.00

Effective normal stresses
F  e                 3642.68   7664.55   6763.00   3173.30    336.85
   e               0.00   1698.72   3453.25   2509.96   -213.70

      Acceleration Kc =     0.0411             Factor of Safety =  1.51
      Negative effective normal stresses     -    solution unacceptable
```

602-[illegible]
PMP
7-Nov-9

```
                    SARMA NON-VERTICAL SLICE ANALYSIS

Analysis no. gp1b3

Unit weight of water = 62.4

Side number          1          2          3          4          5          6
Coordinate xt     106.80     393.05     420.55     683.00     781.70    1143.00
Coordinate yt      49.76     106.00     106.42     110.48     112.00     139.79
Coordinate xw     106.80     393.05     420.55     683.00     781.70    1143.00
Coordinate yw      49.76      40.32      39.41      38.04      58.95     135.83
Coordinate xb     106.80     393.05     420.55     683.00     781.70    1143.00
Coordinate yb      49.76      40.32      39.41      38.04      58.95     135.83
Friction angle      0.00       0.00       0.00       0.00       0.00       0.00
Cohesion            0.00       0.00       0.00       0.00       0.00       0.00

Slice number               1          2          3          4          5          6
Rock unit weight      110.00     110.00     110.00     110.00     110.00     110.0
Friction angle          2.00       2.00       2.00       2.00       2.00       2.0
Cohesion              440.00     440.00     440.00     440.00     440.00     440.0
Force T                 0.00       0.00       0.00       0.00       0.00       0.0
Angle theta             0.00       0.00       0.00       0.00       0.00       0.0

Effective normal stresses
Base                 3622.05    7309.84    7671.66    6827.70    3075.37     158.5
Edge                0.00    1796.93    2008.10    3329.17    2507.60    -295.57




Side number          7
Coordinate xt    1149.18
Coordinate yt     137.42
Coordinate xw    1149.18
Coordinate yw     137.42
Coordinate xb    1149.18
Coordinate yb     137.42
Friction angle      0.00
Cohesion            0.00

Slice number
Rock unit weight
Friction angle
Cohesion
Force T
Angle theta

Effective normal stresses
Base
    e

       Acceleration Kc =     0.0615                 Factor of Safety =  1.94
```

81XA 11-08-97 19:59

Gandy Interem Stability A-A
10 most critical surfaces, MINIMUM JANBU FOS = 1.517



12-5-5
692-020
pmP
7=NL

[illegible]
GB2-[illegible]
PMP
7-Nov-97

```
XSTABL File: GB1XA     11-08-97   19:59

          *****************************************
          *               X S T A B L             *
          *                                       *
          *         Slope Stability Analysis      *
          *                using the              *
          *            Method of Slices           *
          *                                       *
          *         Copyright (C) 1992 á 96       *
          *   Interactive Software Designs, Inc.  *
          *         Moscow, ID 83843, U.S.A.      *
          *                                       *
          *           All Rights Reserved         *
          *                                       *
          *  Ver. 5.200                 96 á 1216 *
          *****************************************

      Problem Description : Gandy Interem Stability A-A



      ----------------------------
      SEGMENT BOUNDARY COORDINATES
      ----------------------------

          7 SURFACE boundary segments

      Segment    x-left     y-left    x-right    y-right     Soil Unit
        No.       (ft)       (ft)       (ft)       (ft)    Below Segment

         1        34.9       48.6      143.3       45.9          2
         2       143.3       45.9      383.6      106.0          1
         3       383.6      106.0      654.6      111.4          1
         4       654.6      111.4      741.1      114.0          1
         5       741.1      114.0      931.9      133.6          1
         6       931.9      133.6      941.0      128.7          1
         7       941.0      128.7     1000.0      128.7          2

          5 SUBSURFACE boundary segments

      Segment    x-left     y-left    x-right    y-right     Soil Unit
        No.       (ft)       (ft)       (ft)       (ft)    Below Segment

         1       143.3       45.9      383.6       39.9          2
         2       383.6       39.9      654.6       33.2          2
         3       654.6       33.2      741.1       62.3          2
         4       741.1       62.3      931.9      125.6          2
         5       931.9      125.6      941.0      128.7          2


      --------------------------
      ISOTROPIC Soil Parameters
      --------------------------

       2 Soil unit(s) specified
```

602-02[illegible]
PMP

```
Soil    Unit Weight   Cohesion  Friction      Pore Pressure        Water
Unit  Moist    Sat.  Intercept    Angle  Parameter  Constant   Surfac
 No.  (pcf)   (pcf)    (psf)      (deg)      Ru       (psf)       No.

  1   110.0   110.0        .0     29.00     .000          .0        0
  2   110.0   110.0     440.0      2.00     .000          .0        0


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.


The active and passive portions of the sliding surfaces
are generated according to the Rankine theory.


  500 trial surfaces will be generated and analyzed.


  3 boxes specified for generation of central block base


Length of line segments for active and passive portions of
sliding block is     15.0 ft


Box          x-left     y-left    x-right    y-right        Width
no.           (ft)       (ft)       (ft)       (ft)          (ft)

 1           183.3       44.4      233.3       43.2           1.0
 2           629.6       33.3      655.6       32.7           1.0
 3           901.0      114.8      921.0      121.5           1.0

*************************************************************************
ERROR # 38
*************************************************************************
The program calculated a point for the PASSIVE wedge that is outside
the defined slope geometry.  The analysis will continue, but the user
should adjust the search box or slope geometry to allow a passive
wedge to be formed from all points within first box.
*************************************************************************



    Factors of safety have been calculated by the :

    * * * * *    SIMPLIFIED JANBU METHOD    * * * * *


    The 10 most critical of all the failure surfaces examined
    are displayed below - the most critical first

    Failure surface No. 1 specified by  9 coordinate points
```

[illegible]
612-0200
pmp
7-Nov-9

```
        Point        x-surf        y-surf
         No.          (ft)          (ft)

          1          172.64         53.24
          2          174.02         52.42
          3          186.94         44.81
          4          187.88         43.90
          5          653.42         32.65
          6          907.06        116.52
          7          908.25        117.75
          8          915.86        130.68
          9          916.66        132.03

  **  Corrected JANBU FOS =   1.517  **     (Fo factor = 1.041)

Failure surface No. 2 specified by  8 coordinate points

        Point        x-surf        y-surf
         No.          (ft)          (ft)

          1          170.78         52.77
          2          171.25         52.49
          3          184.18         44.88
          4          184.80         44.28
          5          653.27         32.68
          6          914.72        119.17
          7          915.76        120.25
          8          923.09        132.70

  **  Corrected JANBU FOS =   1.522  **     (Fo factor = 1.041)

Failure surface No. 3 specified by  9 coordinate points

        Point        x-surf        y-surf
         No.          (ft)          (ft)

          1          171.03         52.83
          2          171.62         52.48
          3          184.55         44.87
          4          184.73         44.69
          5          653.09         32.42
          6          907.80        116.58
          7          909.25        118.09
          8          916.87        131.01
          9          917.52        132.12

  **  Corrected JANBU FOS =   1.525  **     (Fo factor = 1.041)

Failure surface No. 4 specified by  9 coordinate points

        Point        x-surf        y-surf
         No.          (ft)          (ft)

          1          173.73         53.51
          2          175.64         52.38
          3          188.56         44.77
          4          189.16         44.19
```

16 of
602-924
PMP
7-Nov

```
        5          654.16        32.79
        6          901.02       115.16
        7          901.30       115.45
        8          908.91       128.37
        9          910.71       131.42

  **  Corrected JANBU FOS =   1.526  **     (Fo factor = 1.042)

Failure surface No. 5 specified by  8 coordinate points

      Point        x-surf       y-surf
       No.          (ft)         (ft)

        1          178.23        54.64
        2          182.34        52.22
        3          195.26        44.60
        4          196.29        43.61
        5          655.27        32.26
        6          919.87       120.86
        7          920.93       121.96
        8          927.52       133.15

  **  Corrected JANBU FOS =   1.527  **     (Fo factor = 1.041)

Failure surface No. 6 specified by  8 coordinate points

      Point        x-surf       y-surf
       No.          (ft)         (ft)

        1          175.08        53.85
        2          177.66        52.33
        3          190.58        44.72
        4          190.99        44.32
        5          653.67        32.25
        6          912.86       118.52
        7          913.94       119.64
        8          921.54       132.54

  **  Corrected JANBU FOS =   1.528  **     (Fo factor = 1.041)

Failure surface No. 7 specified by  8 coordinate points

      Point        x-surf       y-surf
       No.          (ft)         (ft)

        1          178.53        54.71
        2          182.79        52.20
        3          195.71        44.59
        4          196.60        43.73
        5          655.22        32.88
        6          919.66       120.91
        7          920.56       121.84
        8          927.21       133.12

  **  Corrected JANBU FOS =   1.532  **     (Fo factor = 1.041)
```

1 for [illegible]
642-020
pmr
7-Nov-

```
Failure surface No. 8 specified by  9 coordinate points

        Point      x-surf       y-surf
         No.        (ft)         (ft)

          1        175.03        53.83
          2        177.57        52.33
          3        190.50        44.72
          4        190.62        44.60
          5        652.68        32.35
          6        904.82       116.37
          7        905.17       116.73
          8        912.79       129.66
          9        914.03       131.76

 **  Corrected JANBU FOS =    1.534  **      (Fo factor = 1.042)

Failure surface No. 9 specified by  8 coordinate points

        Point      x-surf       y-surf
         No.        (ft)         (ft)

          1        177.45        54.44
          2        181.18        52.24
          3        194.11        44.63
          4        194.55        44.21
          5        652.41        32.30
          6        916.17       120.03
          7        916.67       120.55
          8        923.88       132.78

 **  Corrected JANBU FOS =    1.535  **      (Fo factor = 1.041)

Failure surface No.10 specified by  8 coordinate points

        Point      x-surf       y-surf
         No.        (ft)         (ft)

          1        175.78        54.02
          2        178.69        52.31
          3        191.62        44.69
          4        191.80        44.51
          5        653.15        32.60
          6        918.41       120.18
          7        919.75       121.57
          8        926.51       133.05

 **  Corrected JANBU FOS =    1.536  **      (Fo factor = 1.041)



The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Interem Stability A-A

      Modified      Correction   Initial     Terminal    Available
```

```
          JANBU FOS          Factor       x-coord       x-coord       Strength
                                            (ft)          (ft)          (lb)

   1.      1.517             1.041        172.64        916.66       4.860E+05
   2.      1.522             1.041        170.78        923.09       4.888E+05
   3.      1.525             1.041        171.03        917.52       4.864E+05
   4.      1.526             1.042        173.73        910.71       4.824E+05
   5.      1.527             1.041        178.23        927.52       4.910E+05
   6.      1.528             1.041        175.08        921.54       4.878E+05
   7.      1.532             1.041        178.53        927.21       4.896E+05
   8.      1.534             1.042        175.03        914.03       4.836E+05
   9.      1.535             1.041        177.45        923.88       4.880E+05
  10.      1.536             1.041        175.78        926.51       4.892E+05

                          * * *  END OF FILE  * * *
```

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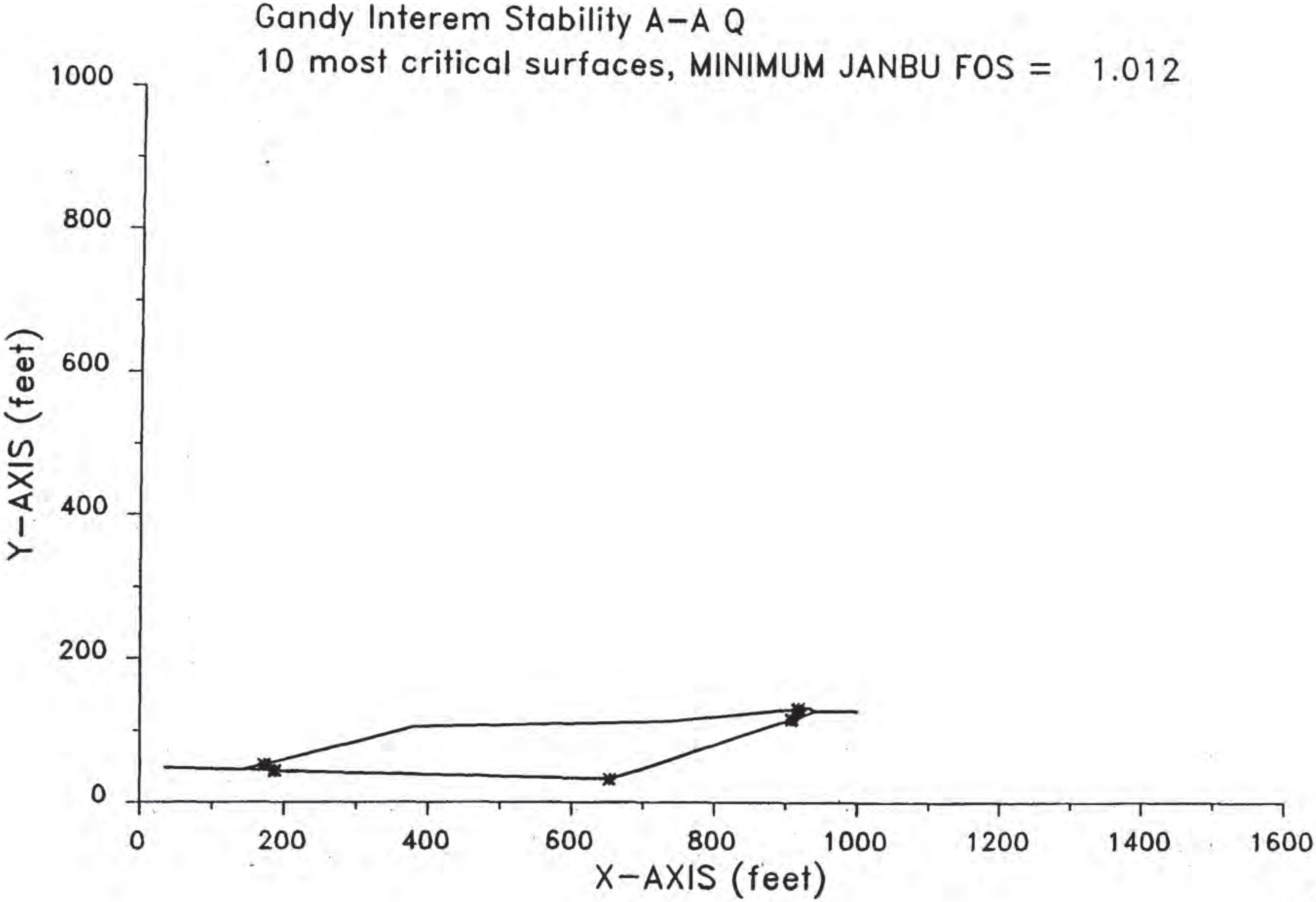
31XAQ 11-08-97 20:00



19 of 5
602-9200
fmp
7-Nov-97

G.2-0200
pmp
7-Nov-97

```
XSTABL File: GB1XAQ     11-08-97   20:00

          ******************************************
          *               X S T A B L              *
          *                                        *
          *       Slope Stability Analysis         *
          *             using the                  *
          *          Method of Slices              *
          *                                        *
          *        Copyright (C) 1992 á 96         *
          *   Interactive Software Designs, Inc.   *
          *       Moscow, ID 83843, U.S.A.         *
          *                                        *
          *          All Rights Reserved           *
          *                                        *
          * Ver. 5.200                 96 á 1216   *
          ******************************************

 Problem Description : Gandy Interem Stability A-A Q



 -----------------------------
 SEGMENT BOUNDARY COORDINATES
 -----------------------------

     7 SURFACE boundary segments

 Segment    x-left     y-left     x-right    y-right      Soil Unit
   No.       (ft)       (ft)        (ft)       (ft)     Below Segment

    1        34.9       48.6       143.3       45.9           2
    2       143.3       45.9       383.6      106.0           1
    3       383.6      106.0       654.6      111.4           1
    4       654.6      111.4       741.1      114.0           1
    5       741.1      114.0       931.9      133.6           1
    6       931.9      133.6       941.0      128.7           1
    7       941.0      128.7      1000.0      128.7           2

     5 SUBSURFACE boundary segments

 Segment    x-left     y-left     x-right    y-right      Soil Unit
   No.       (ft)       (ft)        (ft)       (ft)     Below Segment

    1       143.3       45.9       383.6       39.9           2
    2       383.6       39.9       654.6       33.2           2
    3       654.6       33.2       741.1       62.3           2
    4       741.1       62.3       931.9      125.6           2
    5       931.9      125.6       941.0      128.7           2


 --------------------------
 ISOTROPIC Soil Parameters
 --------------------------

  2 Soil unit(s) specified
```

```
Soil    Unit Weight    Cohesion  Friction     Pore Pressure        Water
Unit  Moist    Sat.   Intercept   Angle  Parameter  Constant  Surface
 No.  (pcf)   (pcf)     (psf)     (deg)      Ru        (psf)     No.

  1   110.0   110.0         .0    29.00      .000          .0      0
  2   110.0   110.0      440.0     2.00      .000          .0      0


A horizontal earthquake loading coefficient
of   .040 has been assigned

A vertical earthquake loading coefficient
of   .000 has been assigned


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.


The active and passive portions of the sliding surfaces
are generated according to the Rankine theory.


  500 trial surfaces will be generated and analyzed.


  3 boxes specified for generation of central block base


Length of line segments for active and passive portions of
sliding block is      15.0 ft


Box          x-left     y-left    x-right    y-right       Width
no.           (ft)       (ft)       (ft)       (ft)         (ft)

 1           183.3       44.4      233.3       43.2          1.0
 2           629.6       33.3      655.6       32.7          1.0
 3           901.0      114.8      921.0      121.5          1.0

**************************************************************************
ERROR # 38
**************************************************************************
The program calculated a point for the PASSIVE wedge that is outside
the defined slope geometry.  The analysis will continue, but the user
should adjust the search box or slope geometry to allow a passive
wedge to be formed from all points within first box.
**************************************************************************


    Factors of safety have been calculated by the :

    * * * * *    SIMPLIFIED JANBU METHOD    * * * * *
```

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7-Nn

```
The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by  9 coordinate points

        Point       x-surf       y-surf
         No.         (ft)         (ft)

          1         172.64        53.24
          2         174.02        52.42
          3         186.94        44.81
          4         187.88        43.90
          5         653.42        32.65
          6         907.06       116.52
          7         908.25       117.75
          8         915.86       130.68
          9         916.66       132.03

  **   Corrected JANBU FOS =    1.012  **      (Fo factor = 1.041)

Failure surface No. 2 specified by  8 coordinate points

        Point       x-surf       y-surf
         No.         (ft)         (ft)

          1         170.78        52.77
          2         171.25        52.49
          3         184.18        44.88
          4         184.80        44.28
          5         653.27        32.68
          6         914.72       119.17
          7         915.76       120.25
          8         923.09       132.70

  **   Corrected JANBU FOS =    1.015  **      (Fo factor = 1.041)

Failure surface No. 3 specified by  9 coordinate points

        Point       x-surf       y-surf
         No.         (ft)         (ft)

          1         171.03        52.83
          2         171.62        52.48
          3         184.55        44.87
          4         184.73        44.69
          5         653.09        32.42
          6         907.80       116.58
          7         909.25       118.09
          8         916.87       131.01
          9         917.52       132.12

  **   Corrected JANBU FOS =    1.015  **      (Fo factor = 1.041)

Failure surface No. 4 specified by  9 coordinate points
```

LS [illegible]
602-[illegible]
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7-Nov-[illegible]

```
        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          173.73          53.51
          2          175.64          52.38
          3          188.56          44.77
          4          189.16          44.19
          5          654.16          32.79
          6          901.02         115.16
          7          901.30         115.45
          8          908.91         128.37
          9          910.71         131.42

 **   Corrected JANBU FOS =    1.016   **     (Fo factor = 1.042)

Failure surface No. 5 specified by  8 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          175.08          53.85
          2          177.66          52.33
          3          190.58          44.72
          4          190.99          44.32
          5          653.67          32.25
          6          912.86         118.52
          7          913.94         119.64
          8          921.54         132.54

 **   Corrected JANBU FOS =    1.018   **     (Fo factor = 1.041)

Failure surface No. 6 specified by  8 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          178.23          54.64
          2          182.34          52.22
          3          195.26          44.60
          4          196.29          43.61
          5          655.27          32.26
          6          919.87         120.86
          7          920.93         121.96
          8          927.52         133.15

 **   Corrected JANBU FOS =    1.019   **     (Fo factor = 1.041)

Failure surface No. 7 specified by  9 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          175.03          53.83
          2          177.57          52.33
          3          190.50          44.72
          4          190.62          44.60
```

612-1200
pmP
7-Nov-

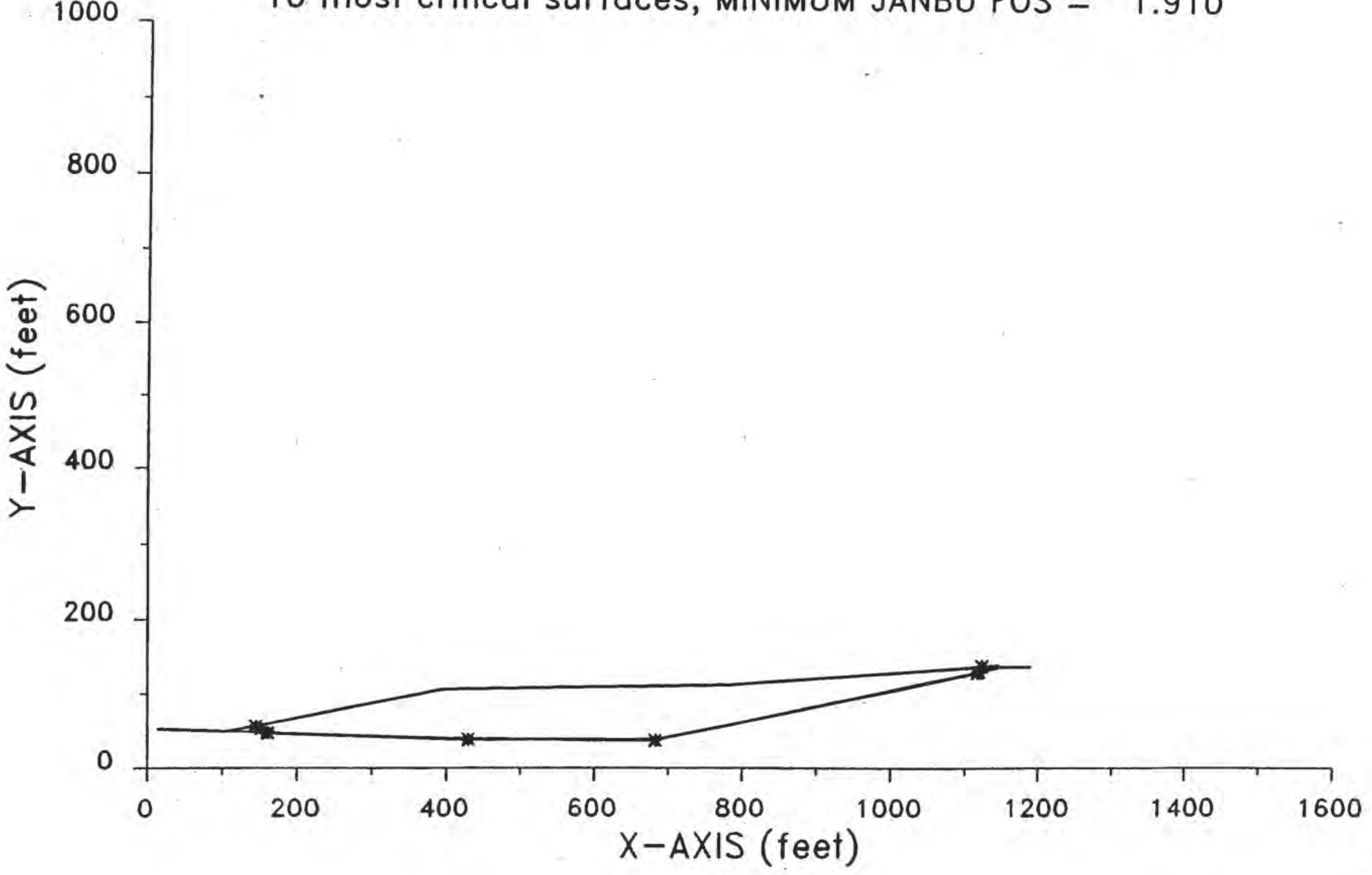
```
          5           652.68        32.35
          6           904.82       116.37
          7           905.17       116.73
          8           912.79       129.66
          9           914.03       131.76

  **  Corrected JANBU FOS =   1.020  **      (Fo factor = 1.042)

 Failure surface No. 8 specified by  8 coordinate points

        Point        x-surf       y-surf
         No.          (ft)         (ft)

          1           178.53        54.71
          2           182.79        52.20
          3           195.71        44.59
          4           196.60        43.73
          5           655.22        32.88
          6           919.66       120.91
          7           920.56       121.84
          8           927.21       133.12

  **  Corrected JANBU FOS =   1.023  **      (Fo factor = 1.041)

 Failure surface No. 9 specified by  8 coordinate points

        Point        x-surf       y-surf
         No.          (ft)         (ft)

          1           177.45        54.44
          2           181.18        52.24
          3           194.11        44.63
          4           194.55        44.21
          5           652.41        32.30
          6           916.17       120.03
          7           916.67       120.55
          8           923.88       132.78

  **  Corrected JANBU FOS =   1.023  **      (Fo factor = 1.041)

 Failure surface No.10 specified by  8 coordinate points

        Point        x-surf       y-surf
         No.          (ft)         (ft)

          1           175.78        54.02
          2           178.69        52.31
          3           191.62        44.69
          4           191.80        44.51
          5           653.15        32.60
          6           918.41       120.18
          7           919.75       121.57
          8           926.51       133.05

  **  Corrected JANBU FOS =   1.023  **      (Fo factor = 1.041)
```

602-020
pmP
7-Nov-

```
The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Interem Stability A-A Q

        Modified      Correction     Initial     Terminal     Available
       JANBU FOS        Factor       x-coord     x-coord       Strength
                                       (ft)        (ft)          (lb)

  1.     1.012          1.041        172.64      916.66      4.861E+05
  2.     1.015          1.041        170.78      923.09      4.889E+05
  3.     1.015          1.041        171.03      917.52      4.863E+05
  4.     1.016          1.042        173.73      910.71      4.824E+05
  5.     1.018          1.041        175.08      921.54      4.883E+05
  6.     1.019          1.041        178.23      927.52      4.919E+05
  7.     1.020          1.042        175.03      914.03      4.839E+05
  8.     1.023          1.041        178.53      927.21      4.905E+05
  9.     1.023          1.041        177.45      923.88      4.888E+05
 10.     1.023          1.041        175.78      926.51      4.898E+05

                      * * *  END OF FILE  * * *
```

31BB 11-08-97 20:15

Gandy Interem Stability BB
10 most critical surfaces, MINIMUM JANBU FOS = 1.910



c...
602-021
pmp
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612-120
PMP
7-Nov-9

```
XSTABL File: GB1BB      11-08-97   20:15

          *****************************************
          *              X S T A B L              *
          *                                       *
          *        Slope Stability Analysis       *
          *              using the                *
          *           Method of Slices            *
          *                                       *
          *        Copyright (C) 1992 á 96        *
          *    Interactive Software Designs, Inc. *
          *        Moscow, ID 83843, U.S.A.       *
          *                                       *
          *          All Rights Reserved          *
          *                                       *
          * Ver. 5.200                 96 á 1216  *
          *****************************************

     Problem Description : Gandy Interem Stability BB



     -----------------------------
     SEGMENT BOUNDARY COORDINATES
     -----------------------------

         6 SURFACE boundary segments

     Segment    x-left     y-left     x-right    y-right     Soil Unit
       No.       (ft)       (ft)        (ft)       (ft)    Below Segment

        1        14.0       52.8       106.8       49.8          2
        2       106.8       49.8       393.0      106.0          1
        3       393.0      106.0       781.7      112.0          1
        4       781.7      112.0      1143.0      139.8          1
        5      1143.0      139.8      1149.2      137.4          1
        6      1149.2      137.4      1189.0      137.4          2

         3 SUBSURFACE boundary segments

     Segment    x-left     y-left     x-right    y-right     Soil Unit
       No.       (ft)       (ft)        (ft)       (ft)    Below Segment

        1       106.8       49.8       420.5       39.4          2
        2       420.5       39.4       683.0       38.0          2
        3       683.0       38.0      1149.2      137.4          2


     --------------------------
     ISOTROPIC Soil Parameters
     --------------------------

      2 Soil unit(s) specified

     Soil   Unit Weight   Cohesion  Friction    Pore Pressure      Water
     Unit  Moist    Sat.  Intercept   Angle   Parameter  Constant  Surface
```

```
No.  (pcf)   (pcf)    (psf)      (deg)       Ru       (psf)     No.

 1   110.0   110.0       .0      29.00      .000         .0      0
 2   110.0   110.0    440.0       2.00      .000         .0      0


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.

The active and passive portions of the sliding surfaces
are generated according to the Rankine theory.

  500 trial surfaces will be generated and analyzed.

  4 boxes specified for generation of central block base

Length of line segments for active and passive portions of
sliding block is      10.0 ft

Box         x-left      y-left     x-right     y-right      Width
no.          (ft)        (ft)        (ft)        (ft)        (ft)

 1           156.8       47.6       176.8        46.8        1.0
 2           410.5       39.2       430.5        38.8        1.0
 3           658.0       37.6       684.0        37.5        1.0
 4          1109.2      127.8      1129.2       132.0        1.0


Factors of safety have been calculated by the :

* * * * *   SIMPLIFIED JANBU METHOD   * * * * *


The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by  9 coordinate points

       Point       x-surf       y-surf
        No.         (ft)         (ft)

         1         145.07        57.31
         2         152.25        53.08
         3         160.87        48.01
         4         161.99        46.92
         5         430.24        38.35
         6         682.53        37.25
         7        1116.21       129.27
         8        1117.54       130.65
         9        1121.98       138.18
```

612-120
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7-Nov-97

```
 **  Corrected JANBU FOS =   1.910  **    (Fo factor = 1.030)

Failure surface No. 2 specified by  9 coordinate points

       Point       x-surf       y-surf
        No.         (ft)         (ft)

         1        141.58        56.63
         2        147.33        53.25
         3        155.94        48.17
         4        156.96        47.19
         5        426.92        38.80
         6        683.31        37.37
         7       1116.29       129.28
         8       1117.63       130.67
         9       1122.06       138.19

 **  Corrected JANBU FOS =   1.911  **    (Fo factor = 1.030)

Failure surface No. 3 specified by  9 coordinate points

       Point       x-surf       y-surf
        No.         (ft)         (ft)

         1        143.53        57.01
         2        150.08        53.15
         3        158.70        48.08
         4        159.65        47.16
         5        427.60        38.77
         6        681.59        37.26
         7       1112.97       128.37
         8       1114.56       130.01
         9       1119.25       137.97

 **  Corrected JANBU FOS =   1.911  **    (Fo factor = 1.030)

Failure surface No. 4 specified by  9 coordinate points

       Point       x-surf       y-surf
        No.         (ft)         (ft)

         1        145.88        57.47
         2        153.40        53.04
         3        162.02        47.97
         4        163.11        46.92
         5        424.25        38.50
         6        682.82        37.91
         7       1115.99       129.21
         8       1117.35       130.61
         9       1121.80       138.17

 **  Corrected JANBU FOS =   1.912  **    (Fo factor = 1.030)

Failure surface No. 5 specified by 10 coordinate points

       Point       x-surf       y-surf
```

602-0209
pmf
7-Nov-97

```
      No.        (ft)         (ft)

       1        149.47        58.18
       2        149.85        57.95
       3        158.47        52.88
       4        167.08        47.80
       5        168.02        46.89
       6        412.94        38.75
       7        681.70        37.14
       8       1112.24       128.16
       9       1113.90       129.87
      10       1118.64       137.93

  **  Corrected JANBU FOS =   1.912  **     (Fo factor = 1.030)

Failure surface No. 6 specified by  9 coordinate points

    Point       x-surf       y-surf
     No.         (ft)         (ft)

      1         145.73        57.44
      2         153.18        53.05
      3         161.80        47.98
      4         162.66        47.14
      5         428.62        38.75
      6         680.32        37.17
      7        1109.99       127.54
      8        1111.81       129.43
      9        1116.73       137.78

  **  Corrected JANBU FOS =   1.912  **     (Fo factor = 1.030)

Failure surface No. 7 specified by  9 coordinate points

    Point       x-surf       y-surf
     No.         (ft)         (ft)

      1         143.27        56.96
      2         149.70        53.17
      3         158.32        48.09
      4         159.27        47.18
      5         423.37        38.54
      6         682.65        37.43
      7        1121.04       130.15
      8        1122.56       131.72
      9.       1126.58       138.54

  **  Corrected JANBU FOS =   1.913  **     (Fo factor = 1.030)

Failure surface No. 8 specified by  9 coordinate points

    Point       x-surf       y-surf
     No.         (ft)         (ft)

      1         142.05        56.72
      2         147.99        53.22
      3         156.60        48.15
```

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7-Nov-97

```
        4          157.59        47.19
        5          423.03        38.57
        6          683.93        37.51
        7         1123.36       130.78
        8         1124.71       132.18
        9         1128.54       138.69

  **   Corrected JANBU FOS =    1.913  **    (Fo factor = 1.029)

Failure surface No. 9 specified by  9 coordinate points

      Point        x-surf        y-surf
       No.          (ft)          (ft)

        1          142.78        56.87
        2          149.02        53.19
        3          157.64        48.11
        4          158.60        47.19
        5          423.37        38.56
        6          683.51        37.47
        7         1122.37       130.51
        8         1123.79       131.98
        9         1127.70       138.62

  **   Corrected JANBU FOS =    1.914  **    (Fo factor = 1.029)

Failure surface No.10 specified by  9 coordinate points

      Point        x-surf        y-surf
       No.          (ft)          (ft)

        1          144.73        57.25
        2          151.77        53.10
        3          160.39        48.02
        4          161.28        47.16
        5          424.05        38.53
        6          681.79        37.36
        7         1119.05       129.60
        8         1120.72       131.33
        9         1124.89       138.41

  **   Corrected JANBU FOS =    1.914  **    (Fo factor = 1.030)



The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Interem Stability BB

       Modified      Correction     Initial      Terminal     Available
      JANBU FOS        Factor       x-coord      x-coord       Strength
                                     (ft)         (ft)          (lb)

 1.      1.910          1.030        145.07      1121.98     6.139E+05
 2.      1.911          1.030        141.58      1122.06     6.144E+05
 3.      1.911          1.030        143.53      1119.25     6.126E+05
```

```
                                                                          [illegible]
  4.     1.912          1.030       145.88       1121.80      6.127E+05  pm
  5.     1.912          1.030       149.47       1118.64      6.114E+05  7-Nov
  6.     1.912          1.030       145.73       1116.73      6.108E+05
  7.     1.913          1.030       143.27       1126.58      6.163E+05  ___
  8.     1.913          1.029       142.05       1128.54      6.176E+05
  9.     1.914          1.029       142.78       1127.70      6.170E+05
 10.     1.914          1.030       144.73       1124.89      6.151E+05

                         * * *  END OF FILE  * * *
```

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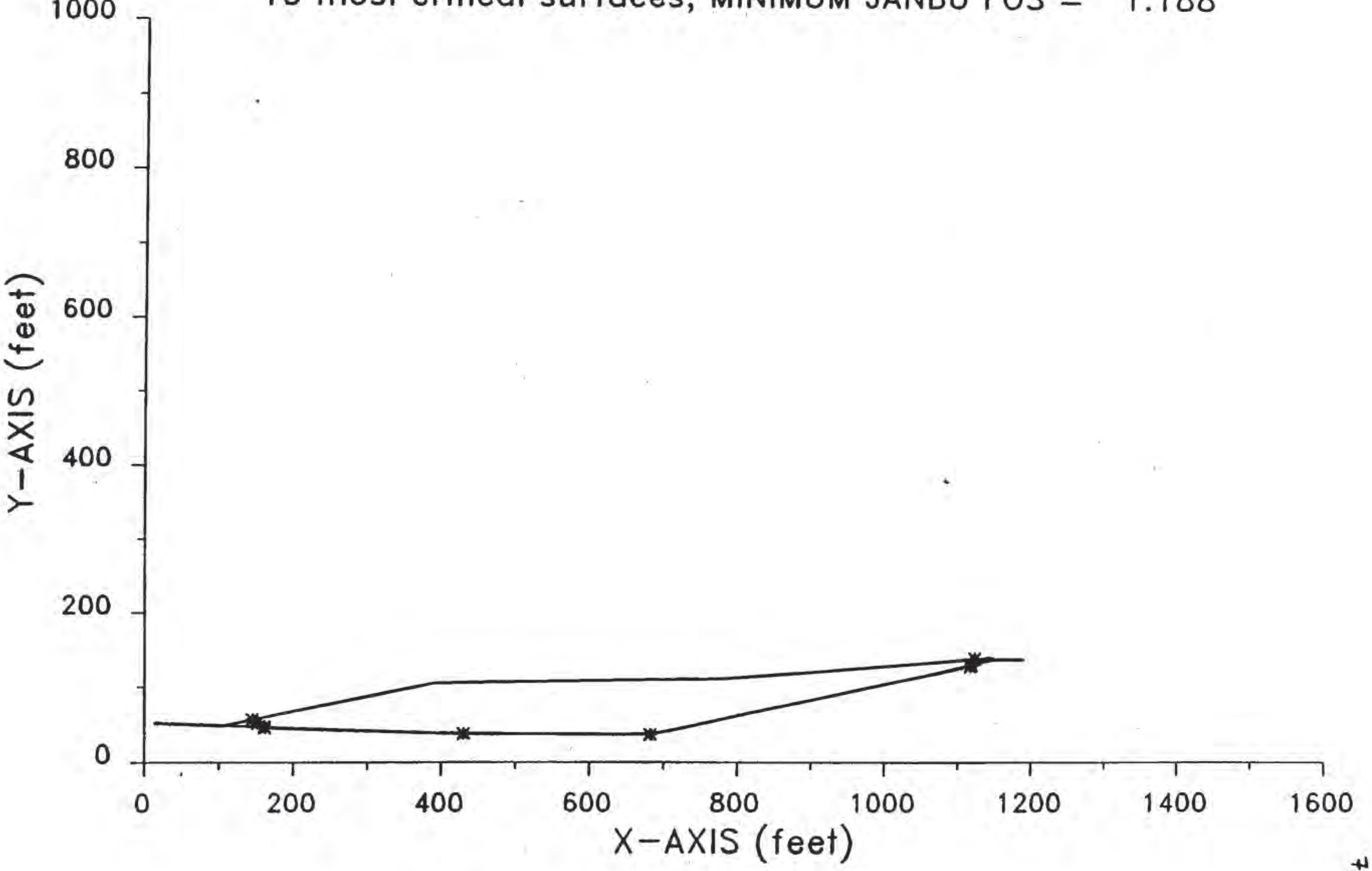
Gandy Interem Stability BB Q
10 most critical surfaces, MINIMUM JANBU FOS = 1.188



602-0200
pmp
7-Nov-9

692-0200
pmp
7-Nov-97

```
XSTABL File: GB1BBQ    11-08-97   20:16

          *****************************************
          *              X S T A B L              *
          *                                       *
          *        Slope Stability Analysis       *
          *               using the               *
          *            Method of Slices           *
          *                                       *
          *         Copyright (C) 1992 á 96       *
          *   Interactive Software Designs, Inc.  *
          *        Moscow, ID 83843, U.S.A.       *
          *                                       *
          *          All Rights Reserved          *
          *                                       *
          *  Ver. 5.200                96 á 1216  *
          *****************************************

    Problem Description : Gandy Interem Stability BB Q


    -----------------------------
    SEGMENT BOUNDARY COORDINATES
    -----------------------------

        6 SURFACE boundary segments

    Segment    x-left    y-left    x-right   y-right    Soil Unit
      No.       (ft)      (ft)      (ft)      (ft)    Below Segment

       1        14.0      52.8     106.8      49.8          2
       2       106.8      49.8     393.0     106.0          1
       3       393.0     106.0     781.7     112.0          1
       4       781.7     112.0    1143.0     139.8          1
       5      1143.0     139.8    1149.2     137.4          1
       6      1149.2     137.4    1189.0     137.4          2

        3 SUBSURFACE boundary segments

    Segment    x-left    y-left    x-right   y-right    Soil Unit
      No.       (ft)      (ft)      (ft)      (ft)    Below Segment

       1       106.8      49.8     420.5      39.4          2
       2       420.5      39.4     683.0      38.0          2
       3       683.0      38.0    1149.2     137.4          2


    --------------------------
    ISOTROPIC Soil Parameters
    --------------------------

     2 Soil unit(s) specified

    Soil   Unit Weight    Cohesion  Friction    Pore Pressure      Water
    Unit  Moist    Sat.  Intercept   Angle   Parameter  Constant  Surface
```

```
 No.  (pcf)  (pcf)    (psf)     (deg)      Ru       (psf)      No. Pr
                                                               7-Nov-
  1   110.0  110.0       .0     29.00     .000         .0        0
  2   110.0  110.0    440.0      2.00     .000         .0        0


A horizontal earthquake loading coefficient
of   .040 has been assigned

A vertical earthquake loading coefficient
of   .000 has been assigned


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.


The active and passive portions of the sliding surfaces
are generated according to the Rankine theory.


  500 trial surfaces will be generated and analyzed.


  4 boxes specified for generation of central block base


Length of line segments for active and passive portions of
sliding block is     10.0 ft


Box         x-left     y-left    x-right    y-right       Width
no.          (ft)       (ft)       (ft)       (ft)         (ft)

 1           156.8       47.6      176.8       46.8          1.0
 2           410.5       39.2      430.5       38.8          1.0
 3           658.0       37.6      684.0       37.5          1.0
 4          1109.2      127.8     1129.2      132.0          1.0


Factors of safety have been calculated by the :

* * * * *     SIMPLIFIED JANBU METHOD     * * * * *


The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by  9 coordinate points

       Point       x-surf      y-surf
        No.         (ft)        (ft)

         1         145.07      57.31
         2         152.25      53.08
```

602-0200
PMP
7-Nov-92

```
        3          160.87          48.01
        4          161.99          46.92
        5          430.24          38.35
        6          682.53          37.25
        7         1116.21         129.27
        8         1117.54         130.65
        9         1121.98         138.18

 **  Corrected JANBU FOS =   1.188  **     (Fo factor = 1.030)

Failure surface No. 2 specified by  9 coordinate points

     Point         x-surf          y-surf
      No.           (ft)            (ft)

        1          143.53          57.01
        2          150.08          53.15
        3          158.70          48.08
        4          159.65          47.16
        5          427.60          38.77
        6          681.59          37.26
        7         1112.97         128.37
        8         1114.56         130.01
        9         1119.25         137.97

 **  Corrected JANBU FOS =   1.189  **     (Fo factor = 1.030)

Failure surface No. 3 specified by  9 coordinate points

     Point         x-surf          y-surf
      No.           (ft)            (ft)

        1          145.73          57.44
        2          153.18          53.05
        3          161.80          47.98
        4          162.66          47.14
        5          428.62          38.75
        6          680.32          37.17
        7         1109.99         127.54
        8         1111.81         129.43
        9         1116.73         137.78

 **  Corrected JANBU FOS =   1.189  **     (Fo factor = 1.030)

Failure surface No. 4 specified by  9 coordinate points

     Point         x-surf          y-surf
      No.           (ft)            (ft)

        1          141.58          56.63
        2          147.33          53.25
        3          155.94          48.17
        4          156.96          47.19
        5          426.92          38.80
        6          683.31          37.37
        7         1116.29         129.28
        8         1117.63         130.67
```

612-7200
pmp
7-Dec-9

```
         9           1122.06        138.19

  **  Corrected JANBU FOS =    1.189   **       (Fo factor = 1.030)

 Failure surface No. 5 specified by 10 coordinate points

       Point          x-surf          y-surf
        No.            (ft)            (ft)

         1            149.47           58.18
         2            149.85           57.95
         3            158.47           52.88
         4            167.08           47.80
         5            168.02           46.89
         6            412.94           38.75
         7            681.70           37.14
         8           1112.24          128.16
         9           1113.90          129.87
        10           1118.64          137.93

  **  Corrected JANBU FOS =    1.189   **       (Fo factor = 1.030)

 Failure surface No. 6 specified by  9 coordinate points

       Point          x-surf          y-surf
        No.            (ft)            (ft)

         1            145.25           57.35
         2            152.51           53.07
         3            161.13           48.00
         4            161.98           47.17
         5            429.27           38.80
         6            682.90           37.29
         7           1113.31          128.44
         8           1114.90          130.09
         9           1119.56          138.00

  **  Corrected JANBU FOS =    1.190   **       (Fo factor = 1.030)

 Failure surface No. 7 specified by  9 coordinate points

       Point          x-surf          y-surf
        No.            (ft)            (ft)

         1            145.88           57.47
         2            153.40           53.04
         3            162.02           47.97
         4            163.11           46.92
         5            424.25           38.50
         6            682.82           37.91
         7           1115.99          129.21
         8           1117.35          130.61
         9           1121.80          138.17

  **  Corrected JANBU FOS =    1.191   **       (Fo factor = 1.030)
```

602-0200
pmp
7-Nov-97

```
Failure surface No. 8 specified by  9 coordinate points

        Point       x-surf       y-surf
         No.         (ft)         (ft)

          1         143.27        56.96
          2         149.70        53.17
          3         158.32        48.09
          4         159.27        47.18
          5         423.37        38.54
          6         682.65        37.43
          7        1121.04       130.15
          8        1122.56       131.72
          9        1126.58       138.54

  **  Corrected JANBU FOS =   1.191  **     (Fo factor = 1.030)

Failure surface No. 9 specified by  9 coordinate points

        Point       x-surf       y-surf
         No.         (ft)         (ft)

          1         144.73        57.25
          2         151.77        53.10
          3         160.39        48.02
          4         161.28        47.16
          5         424.05        38.53
          6         681.79        37.36
          7        1119.05       129.60
          8        1120.72       131.33
          9        1124.89       138.41

  **  Corrected JANBU FOS =   1.191  **     (Fo factor = 1.030)

Failure surface No.10 specified by  9 coordinate points

        Point       x-surf       y-surf
         No.         (ft)         (ft)

          1         145.91        57.48
          2         153.44        53.04
          3         162.05        47.97
          4         162.88        47.17
          5         416.61        39.08
          6         683.48        37.64
          7        1113.54       128.49
          8        1115.12       130.13
          9        1119.76       138.01

  **  Corrected JANBU FOS =   1.191  **     (Fo factor = 1.030)


The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Interem Stability BB Q
```

pmp 7-A

```
        Modified      Correction    Initial       Terminal      Available
        JANBU FOS       Factor      x-coord       x-coord       Strength
                                     (ft)          (ft)           (lb)

  1.      1.188         1.030        145.07       1121.98       6.144E+05
  2.      1.189         1.030        143.53       1119.25       6.129E+05
  3.      1.189         1.030        145.73       1116.73       6.113E+05
  4.      1.189         1.030        141.58       1122.06       6.147E+05
  5.      1.189         1.030        149.47       1118.64       6.122E+05
  6.      1.190         1.030        145.25       1119.56       6.128E+05
  7.      1.191         1.030        145.88       1121.80       6.132E+05
  8.      1.191         1.030        143.27       1126.58       6.167E+05
  9.      1.191         1.030        144.73       1124.89       6.156E+05
 10.      1.191         1.030        145.91       1119.76       6.123E+05

                         * * *  END OF FILE  * * *
```

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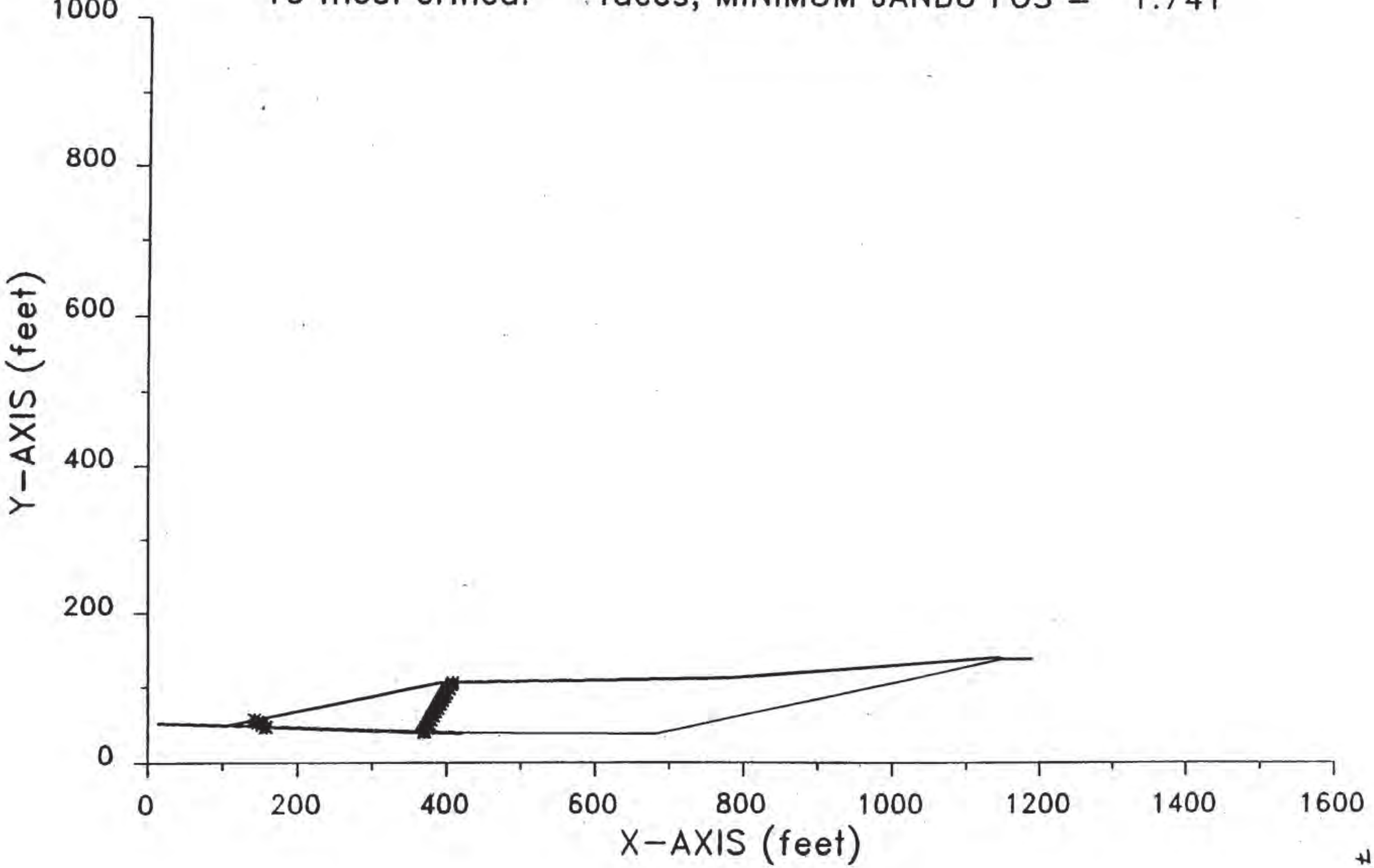
Gandy Interem Stability-~~BB~~AAa
10 most critical faces, MINIMUM JANBU FOS = 1.741



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ymp
7-Nov-97

41 [illegible] T 5
602-0200
pmp
7-Nov-97

```
XSTABL File: GB1BBA     11-08-97   20:25

          ******************************************
          *                X S T A B L             *
          *                                        *
          *        Slope Stability Analysis        *
          *              using the                 *
          *           Method of Slices             *
          *                                        *
          *         Copyright (C) 1992 á 96        *
          *   Interactive Software Designs, Inc.   *
          *        Moscow, ID 83843, U.S.A.        *
          *                                        *
          *          All Rights Reserved           *
          *                                        *
          *  Ver. 5.200                 96 á 1216  *
          ******************************************

                                                   AA
    Problem Description : Gandy Interem Stability [illegible]a



    ----------------------------
    SEGMENT BOUNDARY COORDINATES
    ----------------------------

       6 SURFACE boundary segments

    Segment    x-left    y-left    x-right   y-right     Soil Unit
      No.       (ft)      (ft)      (ft)       (ft)    Below Segment

       1        14.0      52.8     106.8      49.8           2
       2       106.8      49.8     393.0     106.0           1
       3       393.0     106.0     781.7     112.0           1
       4       781.7     112.0    1143.0     139.8           1
       5      1143.0     139.8    1149.2     137.4           1
       6      1149.2     137.4    1189.0     137.4           2

       3 SUBSURFACE boundary segments

    Segment    x-left    y-left    x-right   y-right     Soil Unit
      No.       (ft)      (ft)      (ft)       (ft)    Below Segment

       1       106.8      49.8     420.5      39.4           2
       2       420.5      39.4     683.0      38.0           2
       3       683.0      38.0    1149.2     137.4           2


    -------------------------
    ISOTROPIC Soil Parameters
    -------------------------

     2 Soil unit(s) specified

    Soil   Unit Weight   Cohesion  Friction     Pore Pressure      Water
    Unit  Moist    Sat.  Intercept   Angle  Parameter  Constant  Surface
```

```
 No.  (pcf)   (pcf)    (psf)     (deg)      Ru       (psf)      No.

  1   110.0   110.0       .0     29.00     .000         .0       0
  2   110.0   110.0    440.0      2.00     .000         .0       0


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.


The active and passive portions of the sliding surfaces
are generated according to the Rankine theory.


  500 trial surfaces will be generated and analyzed.


  2 boxes specified for generation of central block base


Length of line segments for active and passive portions of
sliding block is      6.0 ft


Box         x-left     y-left    x-right    y-right      Width
no.          (ft)       (ft)      (ft)       (ft)        (ft)

 1          156.8      47.6      166.8       47.3         1.0
 2          179.0      46.7      420.5       38.9         1.0


Factors of safety have been calculated by the :

* * * * *    SIMPLIFIED JANBU METHOD    * * * * *


The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 20 coordinate points

         Point        x-surf       y-surf
          No.          (ft)         (ft)

           1          143.03       56.91
           2          147.64       54.19
           3          152.81       51.15
           4          157.98       48.10
           5          158.90       47.22
           6          369.64       40.32
           7          370.36       41.06
           8          373.40       46.23
           9          376.45       51.40
          10          379.49       56.57
          11          382.54       61.74
          12          385.58       66.91
```

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```
     13          388.63         72.08
     14          391.67         77.25
     15          394.72         82.42
     16          397.76         87.59
     17          400.81         92.76
     18          403.85         97.93
     19          406.90        103.10
     20          408.75        106.24

 **  Corrected JANBU FOS =    1.741  **     (Fo factor = 1.075)

Failure surface No. 2 specified by 20 coordinate points

   Point         x-surf        y-surf
    No.           (ft)          (ft)

     1           143.71         57.05
     2           148.61         54.16
     3           153.78         51.12
     4           158.95         48.07
     5           160.02         47.04
     6           369.31         40.52
     7           369.85         41.08
     8           372.89         46.25
     9           375.94         51.42
    10           378.98         56.59
    11           382.03         61.76
    12           385.07         66.93
    13           388.12         72.10
    14           391.16         77.27
    15           394.21         82.44
    16           397.25         87.61
    17           400.30         92.78
    18           403.34         97.95
    19           406.39        103.12
    20           408.23        106.24

 **  Corrected JANBU FOS =    1.742  **     (Fo factor = 1.075)

Failure surface No. 3 specified by 20 coordinate points

   Point         x-surf        y-surf
    No.           (ft)          (ft)

     1.          141.64         56.64
     2           145.68         54.26
     3           150.85         51.21
     4           156.02         48.17
     5           156.99         47.24
     6           356.95         40.50
     7           357.90         41.48
     8           360.94         46.65
     9           363.99         51.82
    10           367.03         56.98
    11           370.08         62.15
    12           373.12         67.32
    13           376.17         72.49
    14           379.21         77.66
```

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```
          15          382.26         82.83
          16          385.30         88.00
          17          388.35         93.17
          18          391.39         98.34
          19          394.44        103.51
          20          395.93        106.05

     **  Corrected JANBU FOS =    1.743  **       (Fo factor = 1.076)

   Failure surface No. 4 specified by 20 coordinate points

         Point        x-surf        y-surf
          No.          (ft)          (ft)

           1          143.77         57.06
           2          148.69         54.16
           3          153.86         51.11
           4          159.03         48.07
           5          159.98         47.16
           6          370.19         40.50
           7          370.72         41.05
           8          373.76         46.22
           9          376.81         51.39
          10          379.85         56.56
          11          382.90         61.73
          12          385.94         66.90
          13          388.99         72.07
          14          392.03         77.24
          15          395.08         82.41
          16          398.12         87.58
          17          401.17         92.75
          18          404.22         97.92
          19          407.26        103.09
          20          409.12        106.25

     **  Corrected JANBU FOS =    1.745  **       (Fo factor = 1.075)

   Failure surface No. 5 specified by 20 coordinate points

         Point        x-surf        y-surf
          No.          (ft)          (ft)

           1          141.81         56.67
           2          145.92         54.25
           3          151.09         51.21
           4          156.26         48.16
           5          156.87         47.57
           6          359.59         40.43
           7          360.51         41.39
           8          363.56         46.56
           9          366.60         51.73
          10          369.65         56.90
          11          372.69         62.07
          12          375.74         67.24
          13          378.78         72.41
          14          381.83         77.58
          15          384.87         82.75
          16          387.92         87.92
```

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```
      17          390.96        93.09
      18          394.01        98.26
      19          397.05       103.43
      20          398.62       106.09

  **   Corrected JANBU FOS =   1.745  **      (Fo factor = 1.076)

 Failure surface No. 6 specified by 20 coordinate points

     Point        x-surf       y-surf
      No.          (ft)         (ft)

       1          142.23        56.76
       2          146.52        54.23
       3          151.69        51.19
       4          156.86        48.14
       5          157.79        47.25
       6          367.86        40.92
       7          368.07        41.14
       8          371.12        46.31
       9          374.17        51.48
      10          377.21        56.65
      11          380.26        61.82
      12          383.30        66.99
      13          386.35        72.16
      14          389.39        77.33
      15          392.44        82.50
      16          395.48        87.67
      17          398.53        92.84
      18          401.57        98.01
      19          404.62       103.18
      20          406.40       106.21

  **   Corrected JANBU FOS =   1.748  **      (Fo factor = 1.075)

 Failure surface No. 7 specified by 20 coordinate points

     Point        x-surf       y-surf
      No.          (ft)         (ft)

       1          141.80        56.67
       2          145.91        54.25
       3          151.08        51.21
       4          156.25        48.16
       5          156.94        47.49
       6          359.93        40.67
       7          360.62        41.39
       8          363.67        46.55
       9          366.72        51.72
      10          369.76        56.89
      11          372.81        62.06
      12          375.85        67.23
      13          378.90        72.40
      14          381.94        77.57
      15          384.99        82.74
      16          388.03        87.91
      17          391.08        93.08
      18          394.12        98.25
```

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```
     19          397.17        103.42
     20          398.74        106.09

 **  Corrected JANBU FOS =    1.748  **     (Fo factor = 1.076)

Failure surface No. 8 specified by 20 coordinate points

     Point       x-surf        y-surf
      No.         (ft)          (ft)

      1          143.83         57.07
      2          148.78         54.16
      3          153.95         51.11
      4          159.12         48.07
      5          160.12         47.10
      6          357.02         40.59
      7          357.88         41.48
      8          360.92         46.65
      9          363.97         51.82
     10          367.01         56.99
     11          370.06         62.16
     12          373.10         67.32
     13          376.15         72.49
     14          379.19         77.66
     15          382.24         82.83
     16          385.29         88.00
     17          388.33         93.17
     18          391.38         98.34
     19          394.42        103.51
     20          395.91        106.04

 **  Corrected JANBU FOS =    1.749  **     (Fo factor = 1.076)

Failure surface No. 9 specified by 20 coordinate points

     Point       x-surf        y-surf
      No.         (ft)          (ft)

      1          144.07         57.12
      2          149.12         54.14
      3          154.29         51.10
      4          159.46         48.05
      5          159.97         47.57
      6          368.52         40.29
      7          369.30         41.10
      8          372.34         46.27
      9          375.39         51.44
     10          378.43         56.61
     11          381.48         61.78
     12          384.52         66.95
     13          387.57         72.12
     14          390.61         77.29
     15          393.66         82.46
     16          396.70         87.63
     17          399.75         92.80
     18          402.79         97.97
     19          405.84        103.13
     20          407.66        106.23
```

CI F07
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```
**   Corrected JANBU FOS =   1.749  **     (Fo factor = 1.075)

Failure surface No.10 specified by 21 coordinate points

          Point        x-surf       y-surf
           No.          (ft)         (ft)

            1          145.38        57.38
            2          145.80        57.13
            3          150.97        54.08
            4          156.14        51.04
            5          161.31        47.99
            6          162.30        47.03
            7          367.32        40.96
            8          367.52        41.16
            9          370.56        46.33
           10          373.61        51.50
           11          376.65        56.67
           12          379.70        61.84
           13          382.74        67.01
           14          385.79        72.18
           15          388.83        77.35
           16          391.88        82.51
           17          394.92        87.68
           18          397.97        92.85
           19          401.01        98.02
           20          404.06       103.19
           21          405.83       106.20

**   Corrected JANBU FOS =   1.753  **     (Fo factor = 1.075)




The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Interem Stability BBa

       Modified       Correction     Initial      Terminal      Available
       JANBU FOS        Factor       x-coord       x-coord       Strength
                                      (ft)          (ft)          (lb)

 1.      1.741          1.075        143.03        408.75      2.226E+05
 2.      1.742          1.075        143.71        408.23      2.218E+05
 3.      1.743          1.076        141.64        395.93      2.081E+05
 4.      1.745          1.075        143.77        409.12      2.228E+05
 5.      1.745          1.076        141.81        398.62      2.112E+05
 6.      1.748          1.075        142.23        406.40      2.199E+05
 7.      1.748          1.076        141.80        398.74      2.113E+05
 8.      1.749          1.076        143.83        395.91      2.075E+05
 9.      1.749          1.075        144.07        407.66      2.211E+05
10.      1.753          1.075        145.38        405.83      2.186E+05

                        * * *  END OF FILE  * * *
```

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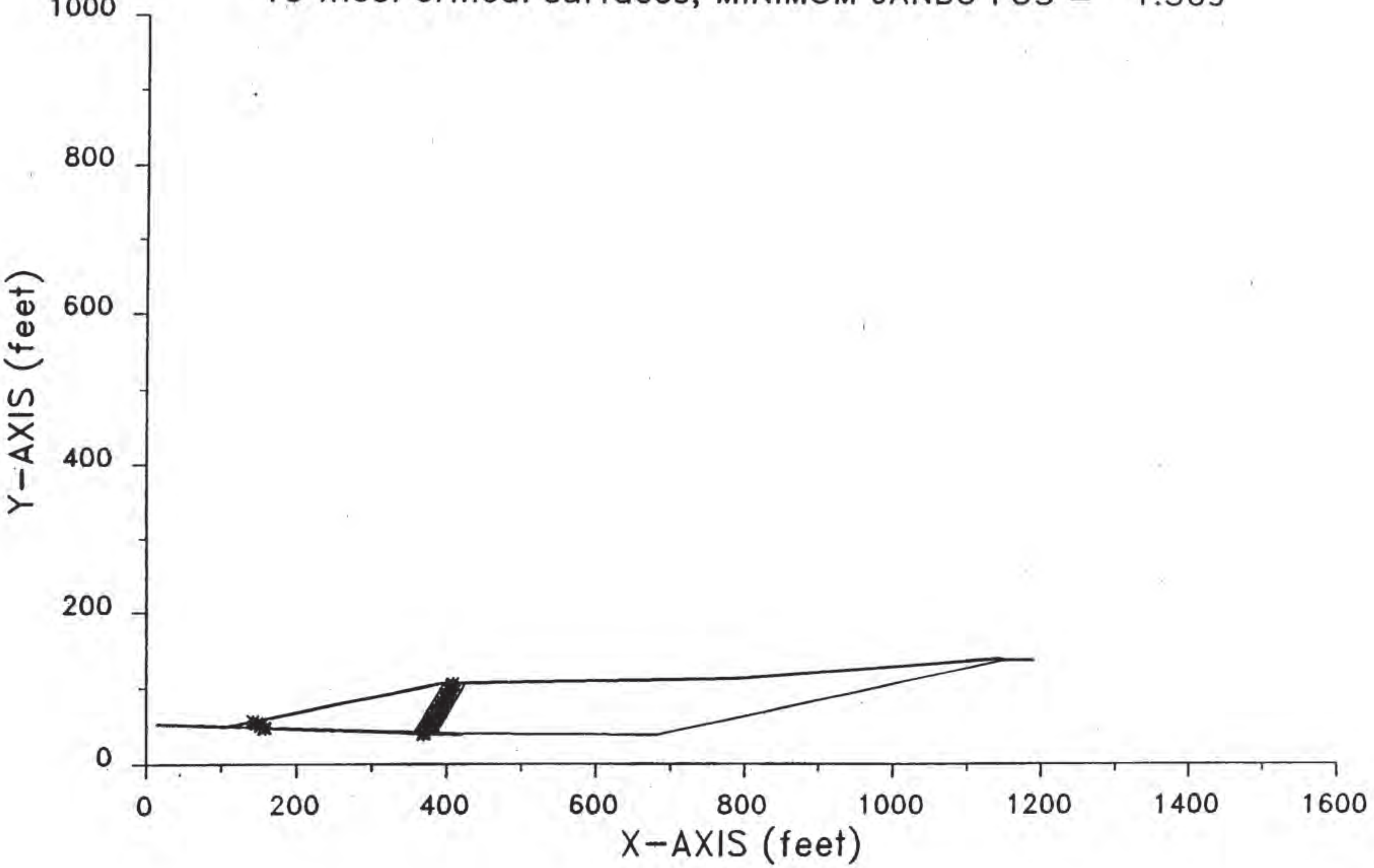
Gandy Interem Stability ~~BB~~AAa Q

10 most critical surfaces, MINIMUM JANBU FOS = 1.369



642-021
pmp
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[illegible]
602-02[illegible]
pmp
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```
XSTABL File: GB1BBAQ   11-08-97   20:26

          *****************************************
          *              X S T A B L              *
          *                                       *
          *       Slope Stability Analysis        *
          *             using the                 *
          *          Method of Slices             *
          *                                       *
          *        Copyright (C) 1992 á 96        *
          *   Interactive Software Designs, Inc.  *
          *        Moscow, ID 83843, U.S.A.       *
          *                                       *
          *         All Rights Reserved           *
          *                                       *
          *  Ver. 5.200               96 á 1216   *
          *****************************************
```

Problem Description : Gandy Interem Stability ~~BB~~AAa Q

```
      ------------------------------
      SEGMENT BOUNDARY COORDINATES
      ------------------------------

        6 SURFACE boundary segments

      Segment    x-left     y-left     x-right    y-right     Soil Unit
        No.       (ft)       (ft)        (ft)       (ft)     Below Segment

         1        14.0       52.8       106.8       49.8          2
         2       106.8       49.8       393.0      106.0          1
         3       393.0      106.0       781.7      112.0          1
         4       781.7      112.0      1143.0      139.8          1
         5      1143.0      139.8      1149.2      137.4          1
         6      1149.2      137.4      1189.0      137.4          2

        3 SUBSURFACE boundary segments

      Segment    x-left     y-left     x-right    y-right     Soil Unit
        No.       (ft)       (ft)        (ft)       (ft)     Below Segment

         1       106.8       49.8       420.5       39.4          2
         2       420.5       39.4       683.0       38.0          2
         3       683.0       38.0      1149.2      137.4          2


      --------------------------
      ISOTROPIC Soil Parameters
      --------------------------

       2 Soil unit(s) specified

      Soil   Unit Weight   Cohesion  Friction     Pore Pressure       Water
      Unit  Moist    Sat.  Intercept   Angle  Parameter  Constant  Surface
```

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602

```
 No.   (pcf)    (pcf)      (psf)       (deg)        Ru        (psf)     No. P

  1    110.0    110.0        .0        29.00       .000          .0       0
  2    110.0    110.0     440.0         2.00       .000          .0       0


A horizontal earthquake loading coefficient
of   .040 has been assigned

A vertical earthquake loading coefficient
of   .000 has been assigned


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.


The active and passive portions of the sliding surfaces
are generated according to the Rankine theory.


  500 trial surfaces will be generated and analyzed.


  2 boxes specified for generation of central block base


Length of line segments for active and passive portions of
sliding block is      6.0 ft


Box           x-left     y-left     x-right     y-right       Width
no.            (ft)       (ft)        (ft)        (ft)         (ft)

 1            156.8       47.6       166.8        47.3          1.0
 2            179.0       46.7       420.5        38.9          1.0


Factors of safety have been calculated by the :

* * * * *     SIMPLIFIED JANBU METHOD     * * * * *


The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 20 coordinate points

          Point        x-surf        y-surf
           No.          (ft)          (ft)

            1          143.03         56.91
            2          147.64         54.19
            3          152.81         51.15
            4          157.98         48.10
```

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```
          5          158.90          47.22
          6          369.64          40.32
          7          370.36          41.06
          8          373.40          46.23
          9          376.45          51.40
         10          379.49          56.57
         11          382.54          61.74
         12          385.58          66.91
         13          388.63          72.08
         14          391.67          77.25
         15          394.72          82.42
         16          397.76          87.59
         17          400.81          92.76
         18          403.85          97.93
         19          406.90         103.10
         20          408.75         106.24

 **  Corrected JANBU FOS =   1.369  **      (Fo factor = 1.075)

Failure surface No. 2 specified by 20 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          143.71          57.05
          2          148.61          54.16
          3          153.78          51.12
          4          158.95          48.07
          5          160.02          47.04
          6          369.31          40.52
          7          369.85          41.08
          8          372.89          46.25
          9          375.94          51.42
         10          378.98          56.59
         11          382.03          61.76
         12          385.07          66.93
         13          388.12          72.10
         14          391.16          77.27
         15          394.21          82.44
         16          397.25          87.61
         17          400.30          92.78
         18          403.34          97.95
         19          406.39         103.12
         20          408.23         106.24

 **  Corrected JANBU FOS =   1.371  **      (Fo factor = 1.075)

Failure surface No. 3 specified by 20 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          143.77          57.06
          2          148.69          54.16
          3          153.86          51.11
          4          159.03          48.07
          5          159.98          47.16
          6          370.19          40.50
```

[illegible]
602-02[illegible]
pmp
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```
       7          370.72         41.05
       8          373.76         46.22
       9          376.81         51.39
      10          379.85         56.56
      11          382.90         61.73
      12          385.94         66.90
      13          388.99         72.07
      14          392.03         77.24
      15          395.08         82.41
      16          398.12         87.58
      17          401.17         92.75
      18          404.22         97.92
      19          407.26        103.09
      20          409.12        106.25

**   Corrected JANBU FOS =    1.373  **     (Fo factor = 1.075)

Failure surface No. 4 specified by 20 coordinate points

     Point        x-surf         y-surf
      No.          (ft)           (ft)

       1          142.72         56.85
       2          147.21         54.21
       3          152.38         51.16
       4          157.54         48.12
       5          158.04         47.64
       6          379.78         39.85
       7          380.62         40.72
       8          383.67         45.89
       9          386.71         51.06
      10          389.76         56.23
      11          392.81         61.40
      12          395.85         66.57
      13          398.90         71.74
      14          401.94         76.91
      15          404.99         82.08
      16          408.03         87.25
      17          411.08         92.42
      18          414.12         97.59
      19          417.17        102.76
      20          419.32        106.41

**   Corrected JANBU FOS =    1.375  **     (Fo factor = 1.074)

Failure surface No. 5 specified by 20 coordinate points

     Point        x-surf         y-surf
      No.          (ft)           (ft)

       1          142.30         56.77
       2          146.62         54.23
       3          151.79         51.18
       4          156.96         48.14
       5          157.82         47.31
       6          385.06         39.72
       7          385.86         40.55
       8          388.90         45.72
```

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```
      9          391.95        50.89
     10          394.99        56.06
     11          398.04        61.23
     12          401.08        66.40
     13          404.13        71.57
     14          407.17        76.74
     15          410.22        81.91
     16          413.26        87.08
     17          416.31        92.25
     18          419.35        97.42
     19          422.40       102.59
     20          424.70       106.49

 **  Corrected JANBU FOS =   1.375  **    (Fo factor = 1.073)

Failure surface No. 6 specified by 20 coordinate points

    Point        x-surf        y-surf
     No.          (ft)          (ft)

      1          142.23        56.76
      2          146.52        54.23
      3          151.69        51.19
      4          156.86        48.14
      5          157.79        47.25
      6          367.86        40.92
      7          368.07        41.14
      8          371.12        46.31
      9          374.17        51.48
     10          377.21        56.65
     11          380.26        61.82
     12          383.30        66.99
     13          386.35        72.16
     14          389.39        77.33
     15          392.44        82.50
     16          395.48        87.67
     17          398.53        92.84
     18          401.57        98.01
     19          404.62       103.18
     20          406.40       106.21

 **  Corrected JANBU FOS =   1.376  **    (Fo factor = 1.075)

Failure surface No. 7 specified by 20 coordinate points

    Point        x-surf        y-surf
     No.          (ft)          (ft)

      1          144.07        57.12
      2          149.12        54.14
      3          154.29        51.10
      4          159.46        48.05
      5          159.97        47.57
      6          368.52        40.29
      7          369.30        41.10
      8          372.34        46.27
      9          375.39        51.44
     10          378.43        56.61
```

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pmp
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```
          11          381.48        61.78
          12          384.52        66.95
          13          387.57        72.12
          14          390.61        77.29
          15          393.66        82.46
          16          396.70        87.63
          17          399.75        92.80
          18          402.79        97.97
          19          405.84       103.13
          20          407.66       106.23

   **  Corrected JANBU FOS =   1.377  **    (Fo factor = 1.075)

 Failure surface No. 8 specified by 20 coordinate points

         Point        x-surf       y-surf
          No.          (ft)         (ft)

           1          142.67        56.84
           2          147.15        54.21
           3          152.32        51.16
           4          157.49        48.12
           5          158.26        47.38
           6          372.84        40.77
           7          373.04        40.97
           8          376.08        46.14
           9          379.13        51.31
          10          382.17        56.48
          11          385.22        61.65
          12          388.26        66.82
          13          391.31        71.99
          14          394.35        77.16
          15          397.40        82.33
          16          400.44        87.50
          17          403.49        92.67
          18          406.53        97.84
          19          409.58       103.01
          20          411.51       106.29

   **  Corrected JANBU FOS =   1.378  **    (Fo factor = 1.074)

 Failure surface No. 9 specified by 20 coordinate points

         Point        x-surf       y-surf
          No.          (ft)         (ft)

           1          143.14        56.94
           2          147.81        54.19
           3          152.98        51.14
           4          158.14        48.10
           5          158.89        47.38
           6          379.73        40.31
           7          380.14        40.74
           8          383.19        45.91
           9          386.23        51.08
          10          389.28        56.25
          11          392.33        61.42
          12          395.37        66.59
```

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```
        13           398.42          71.76
        14           401.46          76.93
        15           404.51          82.10
        16.          407.55          87.27
        17           410.60          92.44
        18           413.64          97.61
        19           416.69         102.78
        20           418.82         106.40

  **   Corrected JANBU FOS =     1.378  **     (Fo factor = 1.074)

Failure surface No.10 specified by 20 coordinate points

      Point          x-surf         y-surf
       No.            (ft)           (ft)

        1            141.64          56.64
        2            145.68          54.26
        3            150.85          51.21
        4            156.02          48.17
        5            156.99          47.24
        6            356.95          40.50
        7            357.90          41.48
        8            360.94          46.65
        9            363.99          51.82
       10            367.03          56.98
       11            370.08          62.15
       12            373.12          67.32
       13            376.17          72.49
       14            379.21          77.66
       15            382.26          82.83
       16            385.30          88.00
       17            388.35          93.17
       18            391.39          98.34
       19            394.44         103.51
       20            395.93         106.05

  **   Corrected JANBU FOS =     1.378  **     (Fo factor = 1.076)



The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Interem Stability BBa Q

      Modified      Correction      Initial      Terminal     Available
     JANBU FOS        Factor        x-coord      x-coord       Strength
                                     (ft)         (ft)          (lb)

 1.     1.369          1.075        143.03       408.75       2.150E+05
 2.     1.371          1.075        143.71       408.23       2.143E+05
 3.     1.373          1.075        143.77       409.12       2.152E+05
 4.     1.375          1.074        142.72       419.32       2.256E+05
 5.     1.375          1.073        142.30       424.70       2.309E+05
 6.     1.376          1.075        142.23       406.40       2.124E+05
 7.     1.377          1.075        144.07       407.66       2.136E+05
 8.     1.378          1.074        142.67       411.51       2.177E+05
```

56 o

```
  9.      1.378         1.074      143.14      418.82    2.250E+05
 10.      1.378         1.076      141.64      395.93    2.012E+05

                  * * *  END OF FILE  * * *
```

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602-0
7-NJ

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?MP
602-0200
Nov 7, 1995

```
                      SARMA NON-VERTICAL SLICE ANALYSIS

Analysis no. gancomb

Unit weight of water = 62.4

Side number          1         2          3         4         5
Coordinate xt     143.02    164.44    369.62    393.00    408.75
Coordinate yt      56.91     61.12    101.41    106.00    106.24
Coordinate xw     143.02    164.44    369.62    393.00    408.91
Coordinate yw      56.91     45.40     40.29     79.50    106.51
Coordinate xb     143.02    164.44    369.62    393.00    408.75
Coordinate yb      56.91     45.40     40.29     79.50    106.24
Friction angle      0.00      0.00      0.00      0.00      0.00
Cohesion            0.00      0.00      0.00      0.00      0.00

Slice number              1          2          3         4
Rock unit weight       110.00     110.00     110.00    110.00
Friction angle          29.00       2.00      29.00     29.00
Cohesion                 0.00     440.00       0.00      0.00
Force T                  0.00       0.00       0.00      0.00
Angle theta              0.00       0.00       0.00      0.00

Effective normal stresses
[illegible]             1054.35    4235.05    3085.83    929.83
[illegible]         0.00    1256.37    1908.49    759.38

      Acceleration Kc =    0.0899               Factor of Safety =  1.66
```

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-4

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Ultimate Filling Plan Waste Stability

	Name	Date
Prepared By:	Paul Pellicer	11/7/97
Checked By:	John Pellicer	11/12/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

TerraMatrix
Engineering & Environmental Services
P.O. Box 774018, 1475 Pine Grove Road
Steamboat Springs, Colorado 80477
Phone 970.879.6260 Fax 970.879.9048

Project Name: Fossil Park
Project Number: 502
Sheet 1 Of 81
Prepared By: [illegible]
Date: [illegible]
Checked By: J. [illegible]
Date: 2-Nov [illegible]

Ultimate Filling Plan Waste Stability

Objective: Evaluate the overall stability of the waste body once the ultimate filling plan has been reached.

Method: Use the XSTABL (version 5.200) computer program to evaluate basal failure evelopes.

Assumptions: The waste was assigned a strength associated with a relatively loose silty sand. (25% relative density ⇒ $\phi = 29°$) (see pg 5) ✓

Calculations: Two Cross Sections were evaluated (see pg 3), Section B-B' running North South and section A-A' running East West. (see fg. 4) ✓

Phase berms were taken out of the crossections or given the same properties as the liner interface so they have no impact on stability (conservative).

Two different failure geometries were checked on both cross sections. Geometry 1 checked failure planes running the entire length of the cross sections through the liner systems weakest interface. This mode of failure was checked both staticly and pseudo-staticly using a maximum ground acceleration = 0.04g.

Analysis of Section B-B' resulted in a static F.S. = 6.4 and a pseudo-static F.S. = 1.6. (see pg 7-24) ✓
Analysis of Section A-A' resulted in a static F.S. = 8.5 and a pseudo-static F.S. = 1.5 (see pg 25-40) ✓

Geometry 2 checked failure planes running through the liner system and up through the waste, daylighting somewhere in the middle of the cell. The entire length of the cross-section was searched to find where the most critical failure plane daylighted.

Project Name: [illegible]
Project Number: 602 Sheet: 2 Of 81
Prepared By: P. Pellicer Date: Nov 7, 1997
Checked By: J. Pellicer Date: 12-Nov-97

With Geometry 2 Section B-B's most critical failure plane has a Static F.S. = 4.8 and a pseudo-static F.S. = 2.0, (see Pg. 41 - 61) Section A-A's most critical failure plane has a Static F.S. = 3.7 and a pseudo-static F.S. = 1.6 (see pg 62 - 81)

Conclusions: This stability analysis used undrained unconsolidated strength from the interface testing program. This is very conservative for this analysis since the filling time to reach the ultimate geometry will allow most of the waste and liner system to drain and consolidate.

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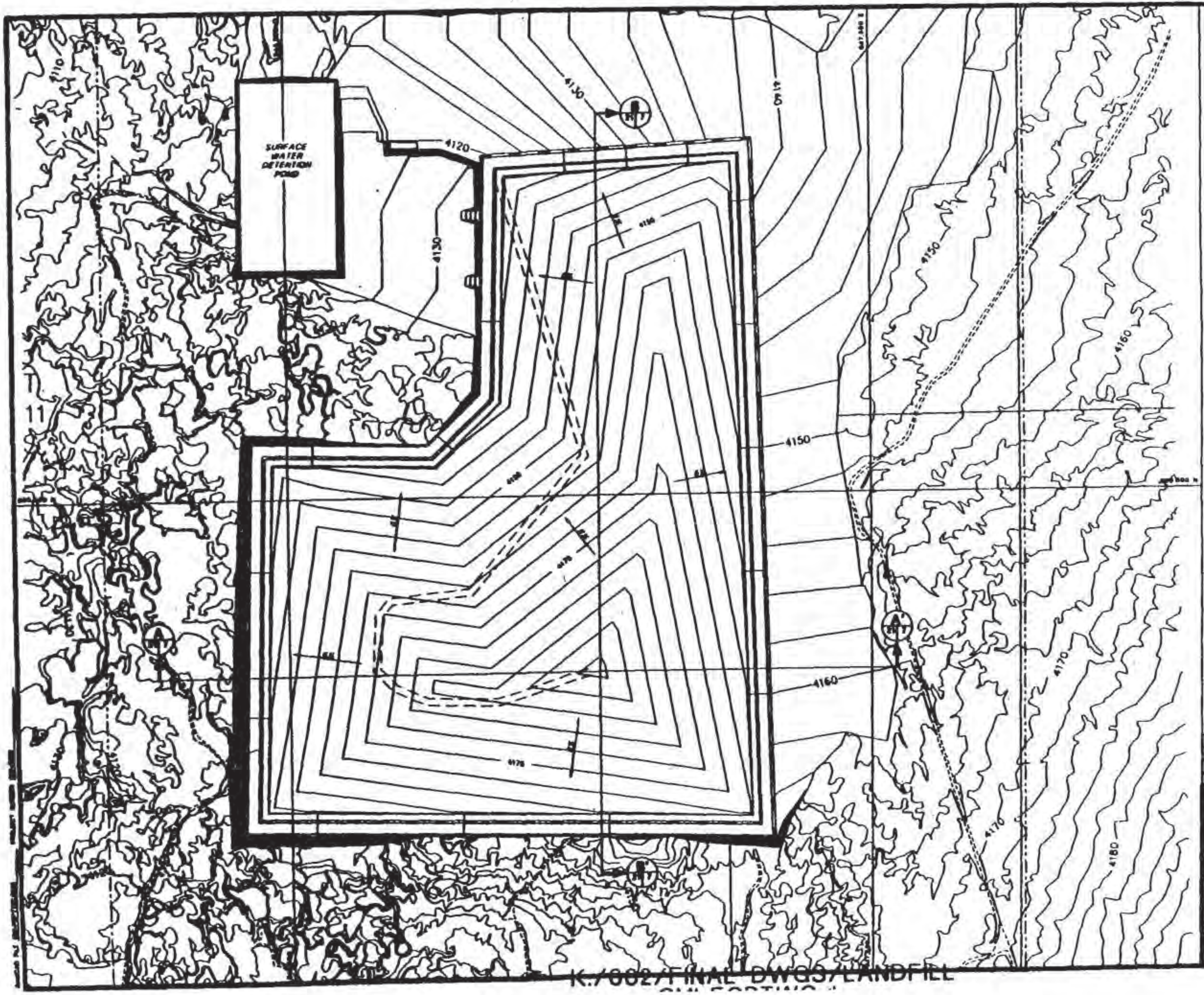
[illegible]

E-4

7-NOV-97

NOTES
1 FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No 2 "INDEX LEGEND AND GENERAL NOTES"
2 TOPOGRAPHY FROM AERIAL SURVEYS PERFORMED AUGUST 1981 BY KOOGLE AND POULS ENGINEERING



PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick E. Corser, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date Patrick E. Corser, NM P.E. [illegible]

SCALE

SURFACE TOPOGRAPHY CONTOUR INTERVAL 2 FT.

Not For Construction

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE
FINAL GRADING PLAN -
TOP OF WASTE CONTOURS

TerraMatrix

DRAWING No. 21

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pwp
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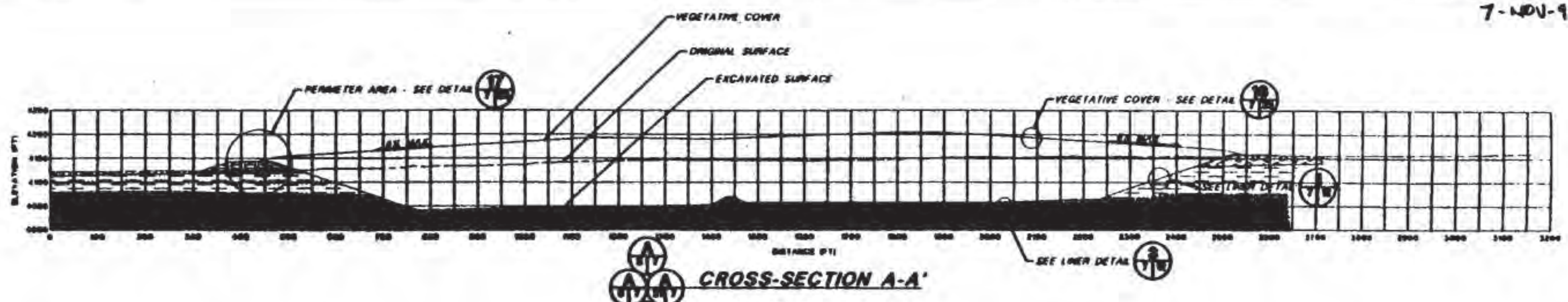
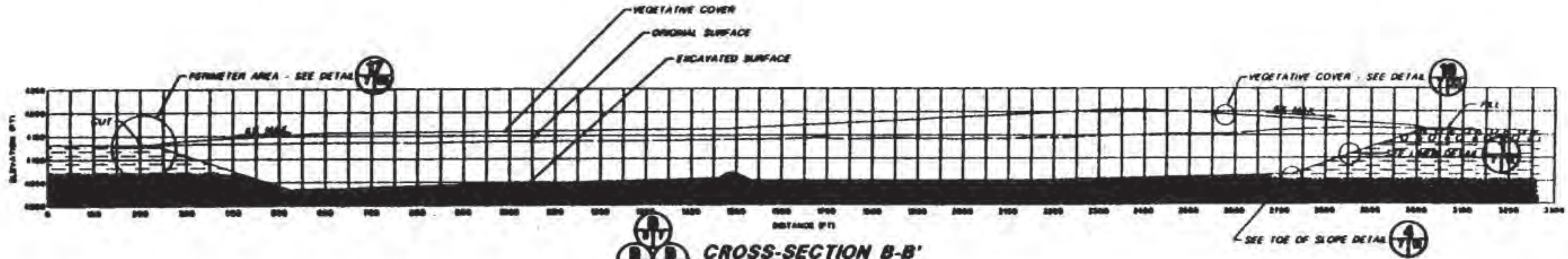
E-9



CROSS-SECTION A-A'

HORIZONTAL SCALE
0 120' 240'

VERTICAL SCALE
0 120' 240'



CROSS-SECTION B-B'

HORIZONTAL SCALE
0 120' 240'

VERTICAL SCALE
0 120' 240'

LEGEND

■	DRAINAGE GRAVEL
▨	ALLUVIAL DEPOSITS
▤	UPPER DOCKUM
■	LOWER DOCKUM
■	WASTE

NOTE:
FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. [illegible]
"[illegible], LEGEND AND GENERAL NOTES".

Not For Construction

PROFESSIONAL ENGINEER'S STATEMENT
I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date ____ Patrick G. Corser, NM P.E. [illegible]

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE:
LANDFILL CROSS-SECTIONS

TerraMatrix
[illegible]

K:/602/FINAL DWGS/LANDFILL
gandy-txsec2.dwg

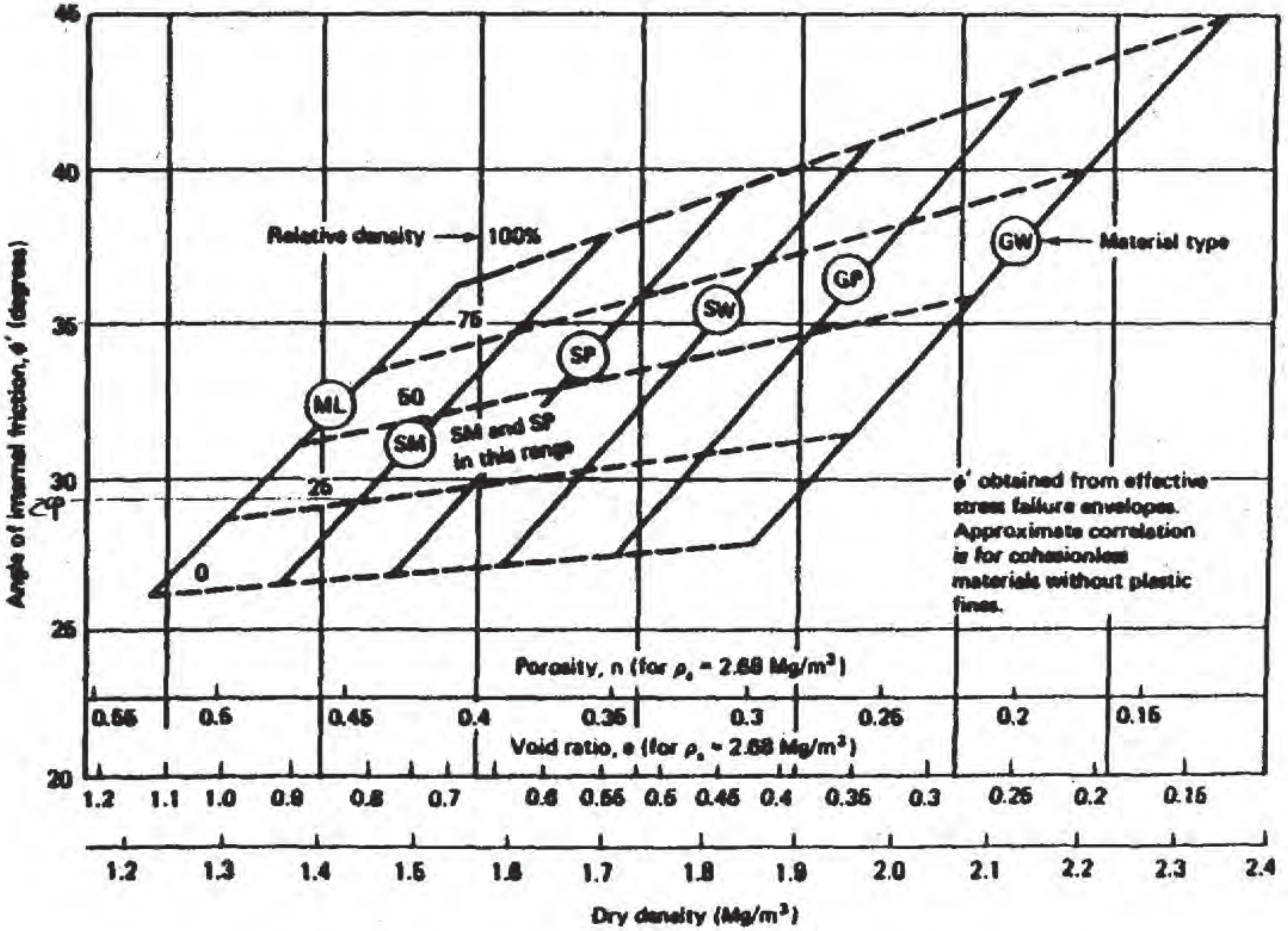


Fig. 11.13 Correlations between the effective friction angle in triaxial compression and the dry density, relative density, and soil classification

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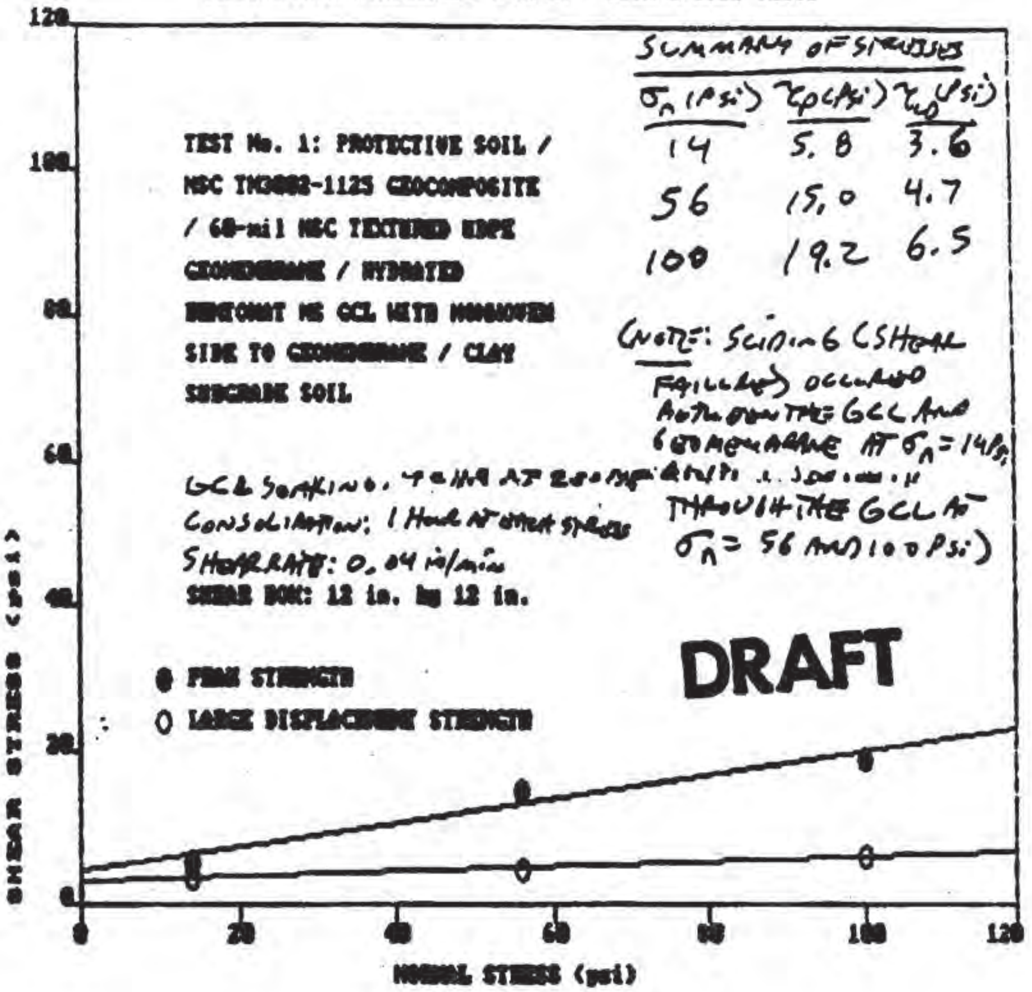


SUMMARY OF STRESSES

σ_n (psi)	τ_p (psi)	τ_{LD} (psi)
14	5.8	3.6
56	15.0	4.7
100	19.2	6.5

(NOTE: SLIDING (SHEAR FAILURE) OCCURRED ALONG THE GCL AND GEOMEMBRANE AT σ_n = 14 psi; AND IN A [illegible] THROUGH THE GCL AT σ_n = 56 AND 100 psi)

THE REGRESSION POLYNOMIAL OF LINE 9 - PEAK STRENGTH

(4.534E+00) + (1.551E-01)*X
THE VARIANCE - 1.532E+00

a = 650 PSF δ = 9°

THE REGRESSION POLYNOMIAL OF LINE 10 - LARGE DISPLACEMENT STRENGTH

(3.045E+00) + (3.321E-02)*X
THE VARIANCE - 3.240E-02

a = 440 PSF δ = 2°

Reviewed By: Robert H Swan Jr Date: 10-8-97

94.08.23
TOTAL P.02

[illegible]

United States Department of the Interior

Geological Survey

PROBABILISTIC ESTIMATES OF MAXIMUM ACCELERATION AND VELOCITY IN ROCK IN THE CONTIGUOUS UNITED STATES

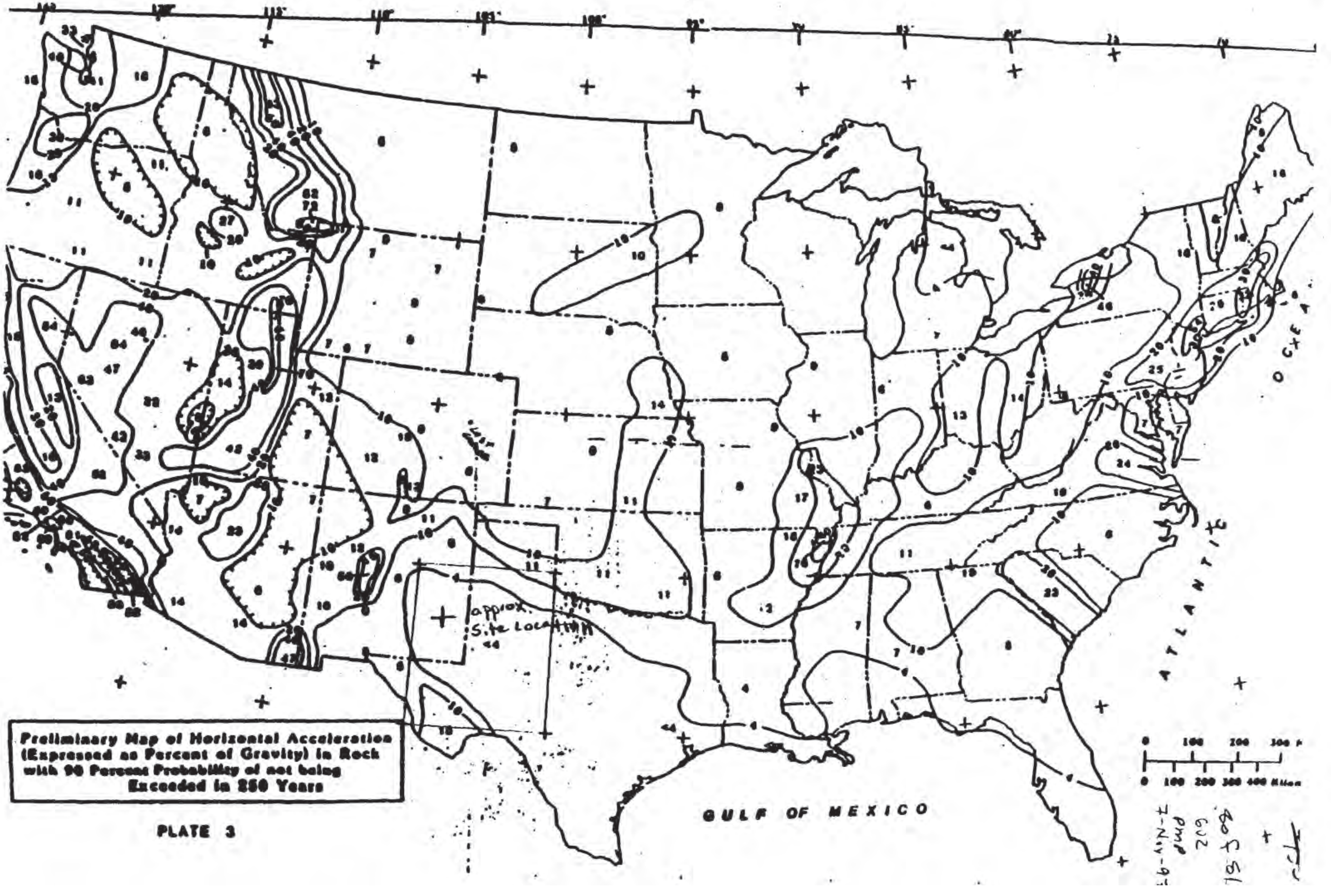
by

S. T. Algermissen, D. M. Perkins, P. C. Thenhaus,
S. L. Hanson and B. L. Bender

Open-File Report 82-1033

1982

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards.



approx. Site Location

Preliminary Map of Horizontal Acceleration (Expressed as Percent of Gravity) in Rock with 90 Percent Probability of not being Exceeded in 250 Years

PLATE 3

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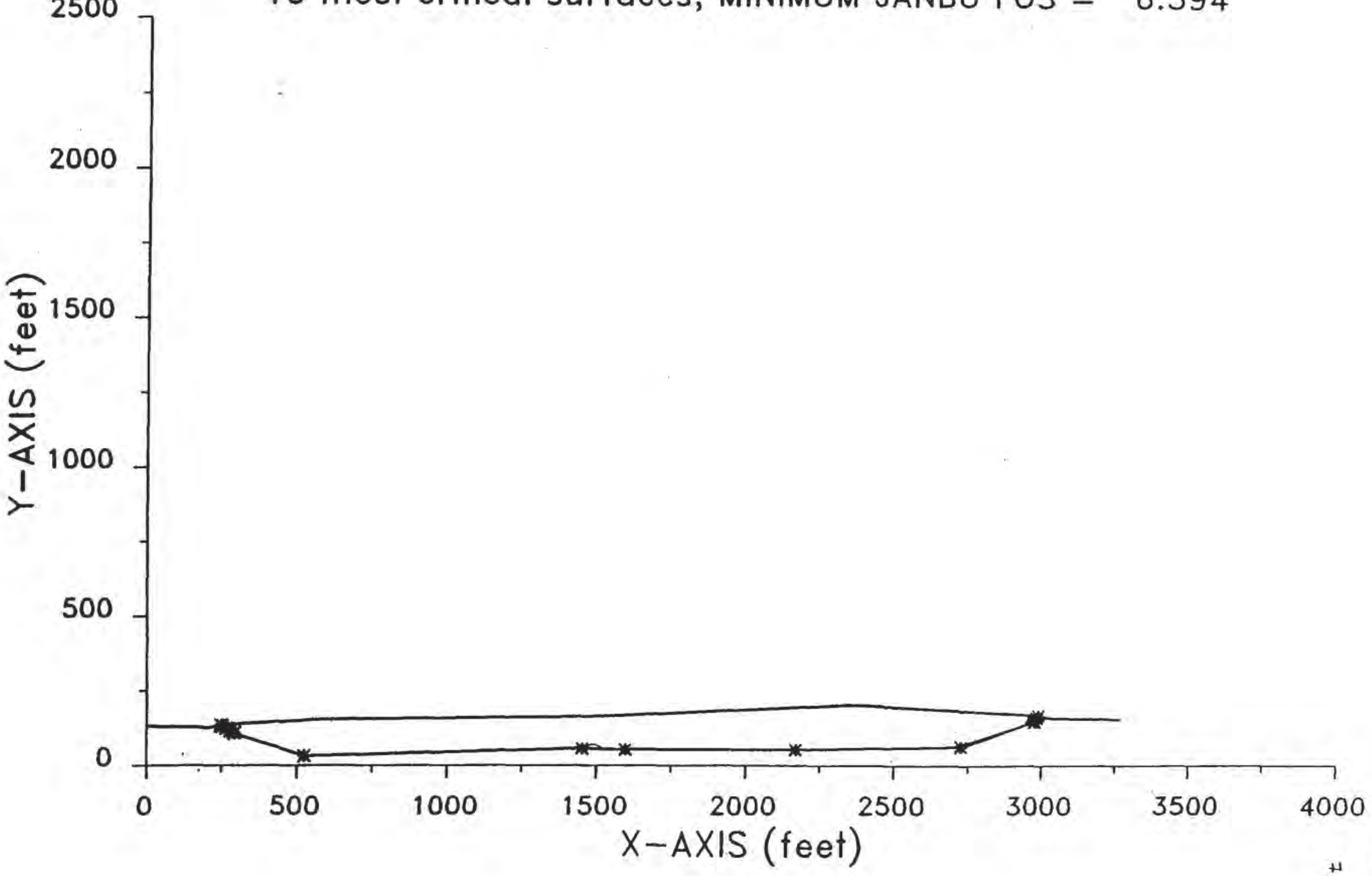
GIB1 11-05-97 19:00

Gandy Total Basal Failue

10 most critical surfaces, MINIMUM JANBU FOS = 6.394



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GUZ-02V

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G02-020
PMP
7-Nov-

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XSTABL File: GTB1       11-05-97   19:00

          *******************************************
          *              X S T A B L                *
          *                                         *
          *        Slope Stability Analysis         *
          *               using the                 *
          *            Method of Slices             *
          *                                         *
          *         Copyright (C) 1992 á 96         *
          *    Interactive Software Designs, Inc.   *
          *        Moscow, ID 83843, U.S.A.         *
          *                                         *
          *           All Rights Reserved           *
          *                                         *
          *  Ver. 5.200                 96 á 1216   *
          *******************************************

    Problem Description : Gandy Total Basal Failue



    -----------------------------
    SEGMENT BOUNDARY COORDINATES
    -----------------------------

       9 SURFACE boundary segments

    Segment     x-left     y-left     x-right     y-right       Soil Unit
      No.        (ft)       (ft)        (ft)        (ft)      Below Segment

       1           .0      131.9       213.0       127.5            2
       2        213.0      127.5       243.3       135.0            1
       3        243.3      135.0       590.6       155.8            1
       4        590.6      155.8      1473.6       163.6            1
       5       1473.6      163.6      2338.5       204.8            1
       6       2338.5      204.8      2394.6       205.0            1
       7       2394.6      205.0      2985.4       170.0            1
       8       2985.4      170.0      3036.6       160.0            1
       9       3036.6      160.0      3266.9       157.0            2


      10 SUBSURFACE boundary segments

    Segment     x-left     y-left     x-right     y-right       Soil Unit
      No.        (ft)       (ft)        (ft)        (ft)      Below Segment

       1        213.0      127.5       241.3       127.4            2
       2        241.3      127.4       525.9        32.6            2
       3        525.9       32.6      1459.4        57.9            2
       4       1459.4       57.9      1483.7        70.0            2
       5       1483.7       70.0      1498.7        70.0            2
       6       1498.7       70.0      1531.4        53.7            2
       7       1531.4       53.7      2159.5        53.7            2
       8       2159.5       53.7      2725.7        65.0            2
       9       2725.7       65.0      3009.3       159.7            2
      10       3009.3      159.7      3036.6       160.0            2
```

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2-Nov-9

```
--------------------------
ISOTROPIC Soil Parameters
--------------------------

 2 Soil unit(s) specified

Soil   Unit Weight   Cohesion  Friction    Pore Pressure      Water
Unit  Moist   Sat.   Intercept   Angle  Parameter Constant  Surfac
 No.  (pcf)   (pcf)    (psf)     (deg)     Ru       (psf)     No.

  1   110.0   110.0       .0     29.00     .000        .0      0
  2   110.0   110.0    440.0      2.00     .000        .0      0


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.


The active and passive portions of the sliding surfaces
are generated according to the Rankine theory.


  500 trial surfaces will be generated and analyzed.


  7 boxes specified for generation of central block base


Length of line segments for active and passive portions of
sliding block is      15.0 ft


Box          x-left      y-left     x-right      y-right       Width
no.           (ft)        (ft)        (ft)         (ft)         (ft)

 1           261.3       120.3       311.3        103.6          1.0
 2           524.9        32.1       575.9         33.4          1.0
 3          1359.4        54.7      1459.4         57.4          1.0
 4          1531.4        53.2      1631.4         53.2          1.0
 5          2134.5        53.2      2184.5         53.7          1.0
 6          2675.7        63.5      2726.7         64.5          1.0
 7          2939.3       135.8      2989.3        152.5          1.0


**************************************************************
**      Factor of safety calculation for surface #    217   **
**      failed to converge within FIFTY iterations          **
**                                                          **
**     The last calculated value of the FOS was  22.9377    **
**     This will be ignored for final summary of results    **
**************************************************************

The trial failure surface in question is
defined by the following 14 coordinate points

       Point       x-surf       y-surf
```

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```
        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          246.32         135.18
          2          257.41         128.65
          3          270.34         121.04
          4          283.26         113.42
          5          284.13         112.58
          6          552.99          33.11
          7         1446.77          56.92
          8         1596.15          53.68
          9         2155.89          53.80
         10         2680.97          63.74
         11         2984.13         150.39
         12         2985.42         151.73
         13         2993.04         164.65
         14         2995.07         168.11


Factors of safety have been calculated by the :

* * * * *    SIMPLIFIED JANBU METHOD    * * * * *


The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 15 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          250.19         135.41
          2          254.30         132.99
          3          267.22         125.38
          4          280.15         117.77
          5          293.07         110.15
          6          294.09         109.17
          7          526.03          32.28
          8         1454.46          57.25
          9         1597.73          53.42
         10         2170.29          53.62
         11         2726.55          64.58
         12         2975.75         148.14
         13         2976.26         148.67
         14         2983.87         161.59
         15         2988.47         169.40

 **  Corrected JANBU FOS =   6.394  **      (Fo factor = 1.018)


Failure surface No. 2 specified by 14 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          243.11         134.95
          2          249.11         131.41
```

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```
         3          262.04       123.80
         4          274.96       116.19
         5          274.97       116.18
         6          525.46        32.32
         7         1368.25        54.51
         8         1570.87        53.32
         9         2142.09        53.00
        10         2722.39        64.03
        11         2968.02       145.74
        12         2968.26       146.00
        13         2975.88       158.92
        14         2982.50       170.17

  **  Corrected JANBU FOS =   6.877  **     (Fo factor = 1.018)


 Failure surface No. 3 specified by 15 coordinate points

       Point        x-surf        y-surf
        No.          (ft)          (ft)

         1          253.72       135.62
         2          263.25       130.01
         3          276.17       122.40
         4          289.10       114.79
         5          302.02       107.17
         6          302.82       106.41
         7          526.62        31.73
         8         1361.54        54.34
         9         1566.29        53.41
        10         2179.75        53.66
        11         2722.22        64.27
        12         2985.59       151.27
        13         2986.33       152.03
        14         2993.94       164.95
        15         2995.73       167.98

  **  Corrected JANBU FOS =   7.087  **     (Fo factor = 1.018)


 Failure surface No. 4 specified by 16 coordinate points

       Point        x-surf        y-surf
        No.          (ft)          (ft)

         1          251.81       135.51
         2.         258.39       131.63
         3          271.31       124.02
         4          284.24       116.41
         5          297.16       108.79
         6          297.38       108.58
         7          525.09        32.07
         8         1388.63        55.37
         9         1579.03        52.84
        10         2173.39        53.71
        11         2714.08        63.81
        12         2953.76       140.14
        13         2955.22       141.64
        14         2962.83       154.57
        15         2970.44       167.49
```

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I-N

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     16          2972.38          170.77

  **  Corrected JANBU FOS =   7.443  **      (Fo factor = 1.019)

 Failure surface No. 5 specified by 15 coordinate points

        Point          x-surf          y-surf
         No.            (ft)            (ft)

          1            245.85          135.15
          2            256.22          129.05
          3            269.14          121.43
          4            282.07          113.82
          5            282.57          113.33
          6            528.40           32.65
          7           1397.91           55.48
          8           1557.75           52.72
          9           2180.81           53.37
         10           2723.06           63.93
         11           2947.29          138.94
         12           2947.37          139.02
         13           2954.98          151.94
         14           2962.60          164.87
         15           2966.28          171.13

  **  Corrected JANBU FOS =   7.549  **      (Fo factor = 1.019)

 Failure surface No. 6 specified by 16 coordinate points

        Point          x-surf          y-surf
         No.            (ft)            (ft)

          1            256.07          135.76
          2            256.28          135.64
          3            269.21          128.03
          4            282.13          120.41
          5            295.06          112.80
          6            307.98          105.19
          7            308.30          104.88
          8            529.57           31.83
          9           1451.03           57.07
         10           1561.70           52.89
         11           2158.20           53.32
         12           2725.93           64.17
         13           2975.52          147.56
         14           2976.74          148.83
         15           2984.35          161.75
         16           2988.82          169.33

  **  Corrected JANBU FOS =   7.603  **      (Fo factor = 1.019)

 Failure surface No. 7 specified by 16 coordinate points

        Point          x-surf          y-surf
         No.            (ft)            (ft)

          1            248.34          135.30
```

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          2          249.61         134.56
          3          262.54         126.94
          4          275.46         119.33
          5          288.39         111.72
          6          289.87         110.28
          7          535.00          32.19
          8         1409.17          56.14
          9         1567.35          53.06
         10         2134.78          53.23
         11         2726.26          64.30
         12         2949.59         139.00
         13         2950.68         140.13
         14         2958.30         153.05
         15         2965.91         165.98
         16         2968.86         170.98

  **  Corrected JANBU FOS =    7.643  **     (Fo factor = 1.019)

Failure surface No. 8 specified by 14 coordinate points

        Point        x-surf        y-surf
         No.          (ft)          (ft)

          1          246.97         135.22
          2          259.05         128.10
          3          271.98         120.49
          4          284.90         112.88
          5          286.39         111.44
          6          526.73          31.77
          7         1428.14          57.02
          8         1532.61          53.45
          9         2179.44          53.19
         10         2704.76          64.30
         11         2968.34         145.03
         12         2969.75         146.49
         13         2977.36         159.42
         14         2983.65         170.10

  **  Corrected JANBU FOS =    7.695  **     (Fo factor = 1.018)

Failure surface No. 9 specified by 17 coordinate points

        Point        x-surf        y-surf
         No.          (ft)          (ft)

          1          256.92         135.82
          2          258.44         134.92
          3          271.36         127.31
          4          284.29         119.70
          5          297.21         112.08
          6          310.14         104.47
          7          311.08         103.55
          8          525.99          32.11
          9         1375.86          54.95
         10         1629.49          52.79
         11         2152.47          53.25
         12         2702.32          63.57
         13         2940.53         136.06
```

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6.2-92
pmf
2-Nov

```
          14          2941.49         137.06
          15          2949.11         149.98
          16          2956.72         162.91
          17          2961.72         171.40

   **  Corrected JANBU FOS =    7.706  **     (Fo factor = 1.019)


 Failure surface No.10 specified by 14 coordinate points

         Point         x-surf         y-surf
          No.           (ft)           (ft)

           1           243.02         134.93
           2           248.83         131.51
           3           261.76         123.89
           4           274.68         116.28
           5           275.19         115.79
           6           525.45          31.94
           7          1389.99          55.55
           8          1569.92          52.82
           9          2174.72          53.44
          10          2698.76          64.18
          11          2966.85         144.67
          12          2968.07         145.93
          13          2975.68         158.86
          14          2982.35         170.18

   **  Corrected JANBU FOS =    7.721  **     (Fo factor = 1.018)


******************************************************************
**                                                              **
**  Out of the    500 surfaces generated and analyzed by XSTABL, **
**        3 surfaces were found to have MISLEADING FOS values.  **
**                                                              **
******************************************************************




The following is a summary of the TEN most critical surfaces

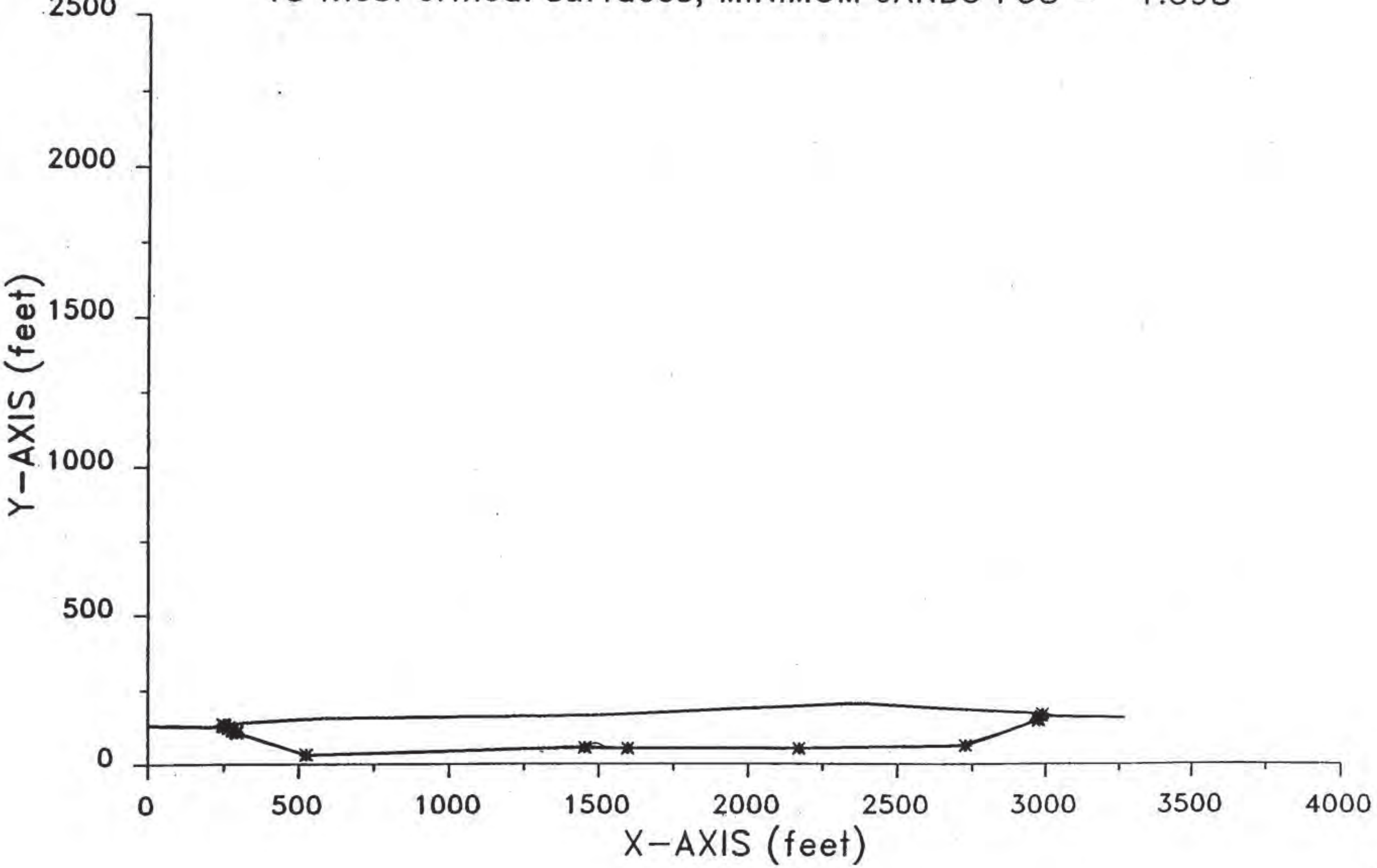
Problem Description : Gandy Total Basal Failue

       Modified     Correction    Initial     Terminal     Available
      JANBU FOS       Factor      x-coord      x-coord      Strength
                                   (ft)         (ft)          (lb)

  1.     6.394        1.018       250.19      2988.47      2.800E+06
  2.     6.877        1.018       243.11      2982.50      3.013E+06
  3.     7.087        1.018       253.72      2995.73      3.074E+06
  4.     7.443        1.019       251.81      2972.38      3.257E+06
  5.     7.549        1.019       245.85      2966.28      3.298E+06
  6.     7.603        1.019       256.07      2988.82      3.286E+06
  7.     7.643        1.019       248.34      2968.86      3.323E+06
  8.     7.695        1.018       246.97      2983.65      3.399E+06
  9.     7.706        1.019       256.92      2961.72      3.396E+06
```

GIB1Q 11-05-97 19:02

Gandy Total Basal Failue Q
10 most critical surfaces, MINIMUM JANBU FOS = 1.598



02 - 2
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602-92
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XSTABL File: GTB1Q     11-05-97   19:02

          ******************************************
          *              X S T A B L               *
          *                                        *
          *       Slope Stability Analysis         *
          *              using the                 *
          *           Method of Slices             *
          *                                        *
          *        Copyright (C) 1992 á 96         *
          *   Interactive Software Designs, Inc.   *
          *       Moscow, ID 83843, U.S.A.         *
          *                                        *
          *          All Rights Reserved           *
          *                                        *
          *   Ver. 5.200                96 á 1216  *
          ******************************************

   Problem Description : Gandy Total Basal Failue Q



   -----------------------------
   SEGMENT BOUNDARY COORDINATES
   -----------------------------

      9 SURFACE boundary segments

   Segment     x-left     y-left     x-right     y-right      Soil Unit
     No.        (ft)       (ft)        (ft)        (ft)     Below Segment

     1            .0      131.9       213.0       127.5           2
     2         213.0      127.5       243.3       135.0           1
     3         243.3      135.0       590.6       155.8           1
     4         590.6      155.8      1473.6       163.6           1
     5        1473.6      163.6      2338.5       204.8           1
     6        2338.5      204.8      2394.6       205.0           1
     7        2394.6      205.0      2985.4       170.0           1
     8        2985.4      170.0      3036.6       160.0           1
     9        3036.6      160.0      3266.9       157.0           2

     10 SUBSURFACE boundary segments

   Segment     x-left     y-left     x-right     y-right      Soil Unit
     No.        (ft)       (ft)        (ft)        (ft)     Below Segment

     1         213.0      127.5       241.3       127.4           2
     2         241.3      127.4       525.9        32.6           2
     3         525.9       32.6      1459.4        57.9           2
     4        1459.4       57.9      1483.7        70.0           2
     5        1483.7       70.0      1498.7        70.0           2
     6        1498.7       70.0      1531.4        53.7           2
     7        1531.4       53.7      2159.5        53.7           2
     8        2159.5       53.7      2725.7        65.0           2
     9        2725.7       65.0      3009.3       159.7           2
    10        3009.3      159.7      3036.6       160.0           2
```

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--------------------------
ISOTROPIC Soil Parameters
--------------------------

 2 Soil unit(s) specified

Soil   Unit Weight   Cohesion  Friction    Pore Pressure      Wate
Unit  Moist    Sat.  Intercept   Angle  Parameter  Constant  Surfac
 No.  (pcf)   (pcf)    (psf)     (deg)      Ru       (psf)     No.

  1   110.0   110.0       .0     29.00     .000         .0      0
  2   110.0   110.0    440.0      2.00     .000         .0      0


A horizontal earthquake loading coefficient
of   .040 has been assigned

A vertical earthquake loading coefficient
of   .000 has been assigned


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.


The active and passive portions of the sliding surfaces
are generated according to the Rankine theory.


  500 trial surfaces will be generated and analyzed.


  7 boxes specified for generation of central block base


Length of line segments for active and passive portions of
sliding block is      15.0 ft


Box          x-left     y-left    x-right    y-right      Width
no.           (ft)       (ft)       (ft)       (ft)        (ft)

1            261.3      120.3      311.3      103.6         1.0
2            524.9       32.1      575.9       33.4         1.0
3           1359.4       54.7     1459.4       57.4         1.0
4           1531.4       53.2     1631.4       53.2         1.0
5           2134.5       53.2     2184.5       53.7         1.0
6           2675.7       63.5     2726.7       64.5         1.0
7           2939.3      135.8     2989.3      152.5         1.0


Factors of safety have been calculated by the :

* * * * *   SIMPLIFIED JANBU METHOD    * * * * *
```

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```
The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 15 coordinate points

       Point        x-surf        y-surf
        No.          (ft)          (ft)

         1          250.19        135.41
         2          254.30        132.99
         3          267.22        125.38
         4          280.15        117.77
         5          293.07        110.15
         6          294.09        109.17
         7          526.03         32.28
         8         1454.46         57.25
         9         1597.73         53.42
        10         2170.29         53.62
        11         2726.55         64.58
        12         2975.75        148.14
        13         2976.26        148.67
        14         2983.87        161.59
        15         2988.47        169.40

 **  Corrected JANBU FOS =   1.598  **     (Fo factor = 1.018)

Failure surface No. 2 specified by 14 coordinate points

       Point        x-surf        y-surf
        No.          (ft)          (ft)

         1          243.11        134.95
         2          249.11        131.41
         3          262.04        123.80
         4          274.96        116.19
         5          274.97        116.18
         6          525.46         32.32
         7         1368.25         54.51
         8         1570.87         53.32
         9         2142.09         53.00
        10         2722.39         64.03
        11         2968.02        145.74
        12         2968.26        146.00
        13         2975.88        158.92
        14         2982.50        170.17

 **  Corrected JANBU FOS =   1.693  **     (Fo factor = 1.018)

Failure surface No. 3 specified by 15 coordinate points

       Point        x-surf        y-surf
        No.          (ft)          (ft)

         1          253.72        135.62
         2          263.25        130.01
```

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```
        3          276.17         122.40
        4          289.10         114.79
        5          302.02         107.17
        6          302.82         106.41
        7          526.62          31.73
        8         1361.54          54.34
        9         1566.29          53.41
       10         2179.75          53.66
       11         2722.22          64.27
       12         2985.59         151.27
       13         2986.33         152.03
       14         2993.94         164.95
       15         2995.73         167.98

  **   Corrected JANBU FOS =    1.736   **      (Fo factor = 1.018)

 Failure surface No. 4 specified by 16 coordinate points

      Point        x-surf         y-surf
       No.          (ft)           (ft)

        1          251.81         135.51
        2          258.39         131.63
        3          271.31         124.02
        4          284.24         116.41
        5          297.16         108.79
        6          297.38         108.58
        7          525.09          32.07
        8         1388.63          55.37
        9         1579.03          52.84
       10         2173.39          53.71
       11         2714.08          63.81
       12         2953.76         140.14
       13         2955.22         141.64
       14         2962.83         154.57
       15         2970.44         167.49
       16         2972.38         170.77

  **   Corrected JANBU FOS =    1.836   **      (Fo factor = 1.019)

 Failure surface No. 5 specified by 14 coordinate points

      Point        x-surf         y-surf
       No.          (ft)           (ft)

        1          246.97         135.22
        2          259.05         128.10
        3          271.98         120.49
        4          284.90         112.88
        5          286.39         111.44
        6          526.73          31.77
        7         1428.14          57.02
        8         1532.61          53.45
        9         2179.44          53.19
       10         2704.76          64.30
       11         2968.34         145.03
       12         2969.75         146.49
       13         2977.36         159.42
```

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```
        14          2983.65        170.10

  **  Corrected JANBU FOS =     1.907  **      (Fo factor = 1.018)


Failure surface No. 6 specified by 16 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          255.78         135.75
          2          268.47         128.27
          3          281.39         120.66
          4          294.32         113.05
          5          307.24         105.43
          6          308.04         104.67
          7          525.86          31.76
          8         1381.43          55.31
          9         1540.90          53.55
         10         2161.09          53.66
         11         2714.09          64.69
         12         2954.98         141.33
         13         2955.31         141.67
         14         2962.93         154.60
         15         2970.54         167.52
         16         2972.45         170.77

  **  Corrected JANBU FOS =     1.915  **      (Fo factor = 1.019)


Failure surface No. 7 specified by 17 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          256.92         135.82
          2          258.44         134.92
          3          271.36         127.31
          4          284.29         119.70
          5          297.21         112.08
          6          310.14         104.47
          7          311.08         103.55
          8          525.99          32.11
          9         1375.86          54.95
         10         1629.49          52.79
         11         2152.47          53.25
         12         2702.32          63.57
         13         2940.53         136.06
         14         2941.49         137.06
         15         2949.11         149.98
         16         2956.72         162.91
         17         2961.72         171.40

  **  Corrected JANBU FOS =     1.917  **      (Fo factor = 1.019)


Failure surface No. 8 specified by 15 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)
```

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```
           1          241.00        134.43
           2          242.22        133.71
           3          255.15        126.10
           4          268.07        118.48
           5          268.63        117.95
           6          525.65         32.26
           7         1415.01         56.35
           8         1597.36         52.86
           9         2161.86         53.04
          10         2715.21         64.36
          11         2950.85        139.44
          12         2951.91        140.54
          13         2959.52        153.46
          14         2967.13        166.38
          15         2969.81        170.92

   **  Corrected JANBU FOS =    1.921  **     (Fo factor = 1.019)


 Failure surface No. 9 specified by 14 coordinate points

         Point        x-surf        y-surf
          No.          (ft)          (ft)

           1          243.02        134.93
           2          248.83        131.51
           3          261.76        123.89
           4          274.68        116.28
           5          275.19        115.79
           6          525.45         31.94
           7         1389.99         55.55
           8         1569.92         52.82
           9         2174.72         53.44
          10         2698.76         64.18
          11         2966.85        144.67
          12         2968.07        145.93
          13         2975.68        158.86
          14         2982.35        170.18

   **  Corrected JANBU FOS =    1.921  **     (Fo factor = 1.018)


 Failure surface No.10 specified by 15 coordinate points

         Point        x-surf        y-surf
          No.          (ft)          (ft)

           1          244.27        135.06
           2          252.22        130.38
           3          265.14        122.77
           4          278.07        115.15
           5          278.17        115.05
           6          525.85         31.93
           7         1374.48         55.40
           8         1560.34         53.26
           9         2150.67         53.02
          10         2699.92         63.97
          11         2954.28        141.09
          12         2954.62        141.44
```

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```
         13          2962.24          154.37
         14          2969.85          167.29
         15          2971.92          170.80

  **   Corrected JANBU FOS =     1.925   **       (Fo factor = 1.019)



The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Total Basal Failue Q

        Modified        Correction      Initial       Terminal       Available
        JANBU FOS         Factor        x-coord        x-coord        Strength
                                          (ft)           (ft)           (lb)

  1.      1.598           1.018         250.19         2988.47       2.807E+06
  2.      1.693           1.018         243.11         2982.50       2.962E+06
  3.      1.736           1.018         253.72         2995.73       3.029E+06
  4.      1.836           1.019         251.81         2972.38       3.195E+06
  5.      1.907           1.018         246.97         2983.65       3.329E+06
  6.      1.915           1.019         255.78         2972.45       3.323E+06
  7.      1.917           1.019         256.92         2961.72       3.330E+06
  8.      1.921           1.019         241.00         2969.81       3.353E+06
  9.      1.921           1.018         243.02         2982.35       3.362E+06
 10.      1.925           1.019         244.27         2971.92       3.360E+06

                         * * *  END OF FILE  * * *
```

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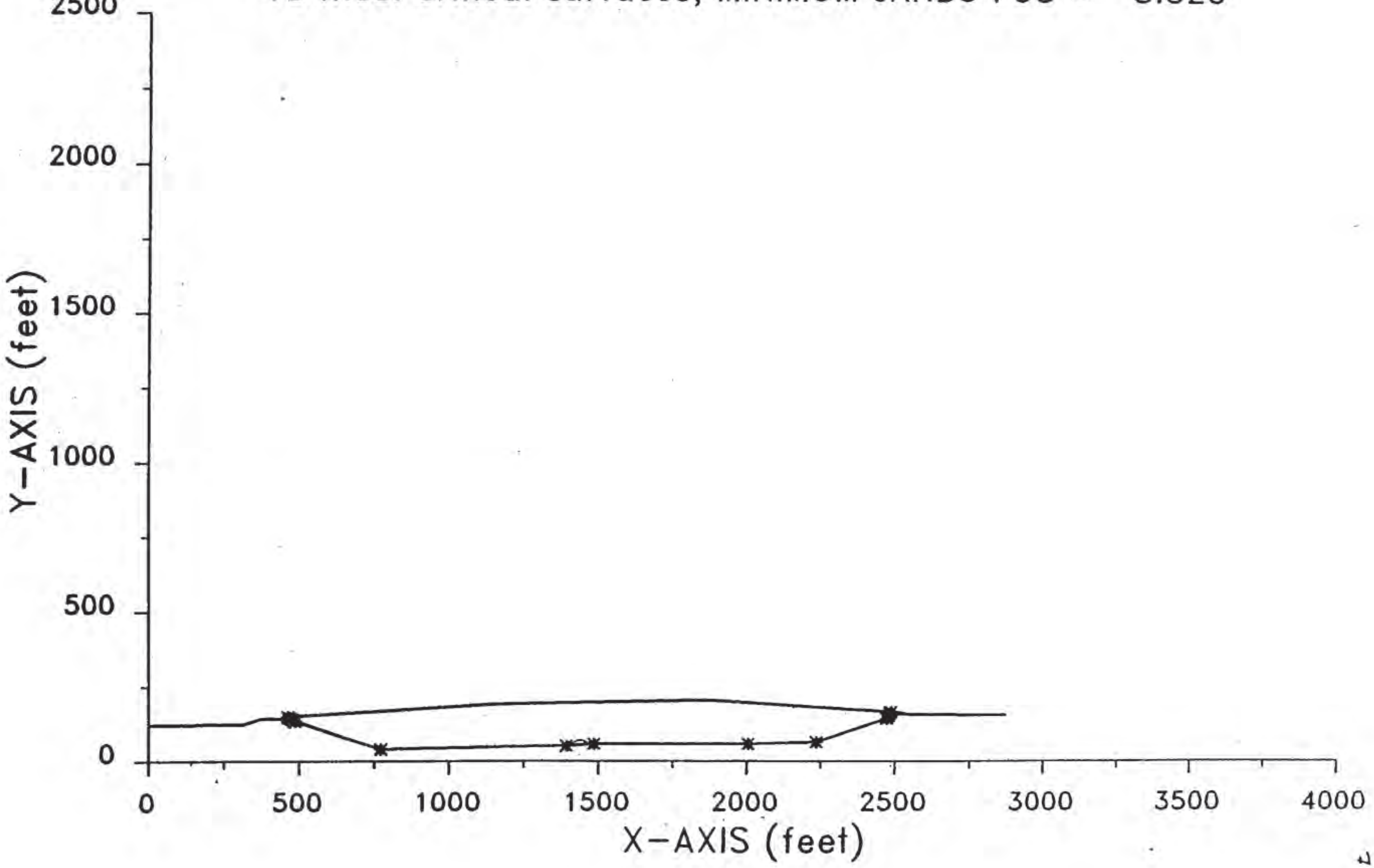
Gandy Basal Failure aa
10 most critical surfaces, MINIMUM JANBU FOS = 8.520



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602-0200
pmp
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```
XSTABL File: GTBA1     11-06-97     8:45

          ******************************************
          *               X S T A B L              *
          *                                        *
          *         Slope Stability Analysis       *
          *               using the                *
          *            Method of Slices            *
          *                                        *
          *          Copyright (C) 1992 á 96       *
          *    Interactive Software Designs, Inc.  *
          *         Moscow, ID 83843, U.S.A.       *
          *                                        *
          *           All Rights Reserved          *
          *                                        *
          *  Ver. 5.200                96 á 1216   *
          ******************************************

   Problem Description : Gandy Basal Failure aa



   -----------------------------
   SEGMENT BOUNDARY COORDINATES
   -----------------------------

      10 SURFACE boundary segments

   Segment     x-left      y-left     x-right     y-right      Soil Unit
     No.        (ft)        (ft)        (ft)        (ft)     Below Segment

      1          5.0       122.0       315.6       123.8            2
      2        315.6       123.8       375.2       143.6            2
      3        375.2       143.6       436.8       143.6            2
      4        436.8       143.6       474.5       153.0            1
      5        474.5       153.0      1146.0       192.8            1
      6       1146.0       192.8      1813.7       204.9            1
      7       1813.7       204.9      1884.7       205.0            1
      8       1884.7       205.0      2519.5       165.0            1
      9       2519.5       165.0      2543.7       159.0            1
     10       2543.7       159.0      2872.9       156.7            2

      10 SUBSURFACE boundary segments

   Segment     x-left      y-left     x-right     y-right      Soil Unit
     No.        (ft)        (ft)        (ft)        (ft)     Below Segment

      1        436.8       143.6       465.1       143.6            2
      2        465.1       143.6       772.5        41.1            2
      3        772.5        41.1      1399.3        52.9            2
      4       1399.3        52.9      1433.2        69.8            2
      5       1433.2        69.8      1448.8        69.9            2
      6       1448.8        69.9      1472.6        58.0            2
      7       1472.6        58.0      2008.1        58.3            2
      8       2008.1        58.3      2233.9        65.1            2
      9       2233.9        65.1      2515.4       159.0            2
```

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```
   10       2515.4     159.0     2543.7     159.0           2

 --------------------------
 ISOTROPIC Soil Parameters
 --------------------------

  2 Soil unit(s) specified

 Soil   Unit Weight   Cohesion  Friction    Pore Pressure       Water
 Unit  Moist    Sat.  Intercept   Angle  Parameter  Constant  Surface
  No.  (pcf)   (pcf)    (psf)     (deg)     Ru        (psf)      No.

   1   110.0   110.0        .0    29.00     .000          .0       0
   2   110.0   110.0     440.0     2.00     .000          .0       0


 A critical failure surface searching method, using a random
 technique for generating sliding BLOCK surfaces, has been
 specified.


 The active and passive portions of the sliding surfaces
 are generated according to the Rankine theory.


   500 trial surfaces will be generated and analyzed.


   7 boxes specified for generation of central block base


 Length of line segments for active and passive portions of
 sliding block is     10.0 ft


 Box          x-left     y-left     x-right    y-right        Width
 no.           (ft)       (ft)       (ft)       (ft)           (ft)

  1           485.1      136.5      535.1      119.8            1.0
  2           771.5       40.6      772.5       40.6            1.0
  3          1374.3       51.9     1399.3       52.4            1.0
  4          1472.6       57.5     1497.6       57.5            1.0
  5          1998.1       57.8     2018.1       58.1            1.0
  6          2233.9       64.6     2234.9       64.6            1.0
  7          2470.4      143.5     2495.4      151.8            1.0


 **************************************************************
 **      Factor of safety calculation for surface #    14    **
 **      failed to converge within FIFTY iterations          **
 **                                                          **
 **     The last calculated value of the FOS was  24.1013    **
 **     This will be ignored for final summary of results    **
 **************************************************************

 The trial failure surface in question is
 defined by the following 17 coordinate points
```

24.F
602-0203
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```
     6           518.34         128.05
     7           526.96         122.97
     8           527.27         122.67
     9           772.45          40.43
    10          1389.84          52.11
    11          1474.50          57.87
    12          2015.50          58.52
    13          2234.79          64.33
    14          2479.57         146.59
    15          2480.21         147.26
    16          2485.29         155.88
    17          2490.36         164.49
    18          2491.69         166.75


Factors of safety have been calculated by the :

* * * * *    SIMPLIFIED JANBU METHOD     * * * * *


The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 15 coordinate points

      Point          x-surf         y-surf
       No.            (ft)           (ft)

        1           463.15         150.17
        2           469.09         146.67
        3           477.71         141.60
        4           486.32         136.52
        5           487.29         135.59
        6           772.40          40.13
        7          1393.41          51.80
        8          1485.69          57.85
        9          2006.10          57.83
       10          2234.85          65.02
       11          2471.94         144.45
       12          2472.01         144.53
       13          2477.09         153.14
       14          2482.17         161.76
       15          2485.34         167.15

 **  Corrected JANBU FOS =   8.520  **     (Fo factor = 1.026)


Failure surface No. 2 specified by 15 coordinate points

      Point          x-surf         y-surf
       No.            (ft)           (ft)

        1           462.91         150.11
        2           468.30         146.94
        3           476.92         141.86
        4           485.53         136.79
        5           486.48         135.87
        6           772.31          40.12
```

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7-Nov-9

```
        7         1383.52         51.68
        8         1479.38         57.79
        9         2006.15         58.09
       10         2234.88         64.70
       11         2484.73        148.57
       12         2485.01        148.86
       13         2490.08        157.48
       14         2495.16        166.10
       15         2495.41        166.52

 **  Corrected JANBU FOS =   8.561  **     (Fo factor = 1.026)

Failure surface No. 3 specified by 15 coordinate points

      Point       x-surf          y-surf
       No.         (ft)            (ft)

        1          463.95        150.37
        2          471.72        145.80
        3          480.33        140.72
        4          488.95        135.65
        5          489.83        134.79
        6          771.82         40.61
        7         1382.69         51.61
        8         1489.81         57.19
        9         2003.49         57.89
       10         2234.20         64.99
       11         2478.90        146.38
       12         2479.54        147.04
       13         2484.62        155.65
       14         2489.69        164.27
       15         2491.17        166.78

 **  Corrected JANBU FOS =   8.587  **     (Fo factor = 1.026)

Failure surface No. 4 specified by 15 coordinate points

      Point       x-surf          y-surf
       No.         (ft)            (ft)

        1          462.67        150.05
        2          467.51        147.20
        3          476.13        142.12
        4          484.75        137.05
        5.         485.97        135.87
        6          772.41         40.28
        7         1391.97         51.80
        8         1488.01         57.64
        9         2002.09         57.55
       10         2234.24         64.34
       11         2477.25        145.96
       12         2477.70        146.42
       13         2482.77        155.04
       14         2487.85        163.66
       15         2489.74        166.87

 **  Corrected JANBU FOS =   8.592  **     (Fo factor = 1.026)
```

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602-0205
pmp
7 Nov-9

```
Failure surface No. 5 specified by 15 coordinate points

       Point       x-surf       y-surf
        No.         (ft)         (ft)

         1         462.48       150.00
         2         466.87       147.42
         3         475.48       142.34
         4         484.10       137.26
         5         485.50       135.91
         6         772.37        40.47
         7        1381.45        51.74
         8        1484.86        57.41
         9        1998.79        57.56
        10        2234.71        64.37
        11        2471.18       143.60
        12        2472.11       144.56
        13        2477.18       153.18
        14        2482.26       161.79
        15        2485.41       167.15

 **  Corrected JANBU FOS =   8.602  **     (Fo factor = 1.026)

Failure surface No. 6 specified by 15 coordinate points

       Point       x-surf       y-surf
        No.         (ft)         (ft)

         1         464.16       150.42
         2         472.40       145.57
         3         481.01       140.50
         4         489.63       135.42
         5         489.76       135.29
         6         771.80        40.46
         7        1392.89        51.81
         8        1488.45        57.78
         9        2008.72        58.26
        10        2234.22        64.77
        11        2476.23       145.20
        12        2477.28       146.28
        13        2482.36       154.90
        14        2487.43       163.52
        15        2489.42       166.90

 **  Corrected JANBU FOS =   8.603  **     (Fo factor = 1.026)

Failure surface No. 7 specified by 15 coordinate points

       Point       x-surf       y-surf
        No.         (ft)         (ft)

         1         464.06       150.40
         2         472.07       145.68
         3         480.69       140.60
         4         489.31       135.53
         5         490.44       134.44
         6         772.11        40.29
```

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PMP
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```
         7          1391.42          52.41
         8          1486.08          57.54
         9          2012.77          57.55
        10          2234.06          64.79
        11          2471.15         143.66
        12          2471.97         144.51
        13          2477.05         153.13
        14          2482.12         161.75
        15          2485.31         167.15

  **   Corrected JANBU FOS =    8.615   **     (Fo factor = 1.026)

 Failure surface No. 8 specified by 15 coordinate points

       Point        x-surf         y-surf
        No.          (ft)           (ft)

         1          463.23         150.19
         2          469.33         146.60
         3          477.94         141.52
         4          486.56         136.45
         5          487.63         135.41
         6          772.44          40.42
         7         1386.64          51.99
         8         1487.94          57.87
         9         2008.46          58.25
        10         2234.66          64.43
        11         2476.27         144.99
        12         2477.63         146.40
        13         2482.71         155.02
        14         2487.79         163.64
        15         2489.70         166.88

  **   Corrected JANBU FOS =    8.621   **     (Fo factor = 1.026)

 Failure surface No. 9 specified by 15 coordinate points

       Point        x-surf         y-surf
        No.          (ft)           (ft)

         1          462.66         150.05
         2          467.49         147.21
         3          476.10         142.13
         4          484.72         137.06
         5          485.90         135.92
         6          772.11          40.95
         7         1382.25          51.80
         8         1490.13          57.59
         9         2011.03          57.93
        10         2234.28          64.79
        11         2481.52         147.24
        12         2482.17         147.92
        13         2487.24         156.53
        14         2492.32         165.15
        15         2493.21         166.66

  **   Corrected JANBU FOS =    8.629   **     (Fo factor = 1.025)
```

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pmp
7-May-9

```
Failure surface No.10 specified by 15 coordinate points

      Point        x-surf       y-surf
       No.          (ft)         (ft)

        1          463.26       150.20
        2          469.44       146.56
        3          478.06       141.48
        4          486.67       136.41
        5          486.99       136.10
        6          771.60        40.80
        7         1397.94        51.94
        8         1475.88        57.05
        9         2009.02        57.66
       10         2234.31        64.52
       11         2477.48       146.27
       12         2477.60       146.39
       13         2482.68       155.01
       14         2487.75       163.62
       15         2489.67       166.88

 **  Corrected JANBU FOS =   8.637  **     (Fo factor = 1.025)


*******************************************************************
**                                                                *
**  Out of the    500 surfaces generated and analyzed by XSTABL,  *
**        6 surfaces were found to have MISLEADING FOS values.    *
**                                                                *
*******************************************************************



The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Basal Failure aa

       Modified      Correction     Initial      Terminal      Available
      JANBU FOS        Factor       x-coord       x-coord       Strength
                                     (ft)          (ft)          (lb)

 1.      8.520         1.026        463.15       2485.34      1.862E+06
 2.      8.561         1.026        462.91       2495.41      1.862E+06
 3.      8.587         1.026        463.95       2491.17      1.863E+06
 4.      8.592         1.026        462.67       2489.74      1.863E+06
 5.      8.602         1.026        462.48       2485.41      1.862E+06
 6.      8.603         1.026        464.16       2489.42      1.862E+06
 7.      8.615         1.026        464.06       2485.31      1.863E+06
 8.      8.621         1.026        463.23       2489.70      1.862E+06
 9.      8.629         1.025        462.66       2493.21      1.861E+06
10.      8.637         1.025        463.26       2489.67      1.862E+06

                    *  *  *   END OF FILE   *  *  *
```

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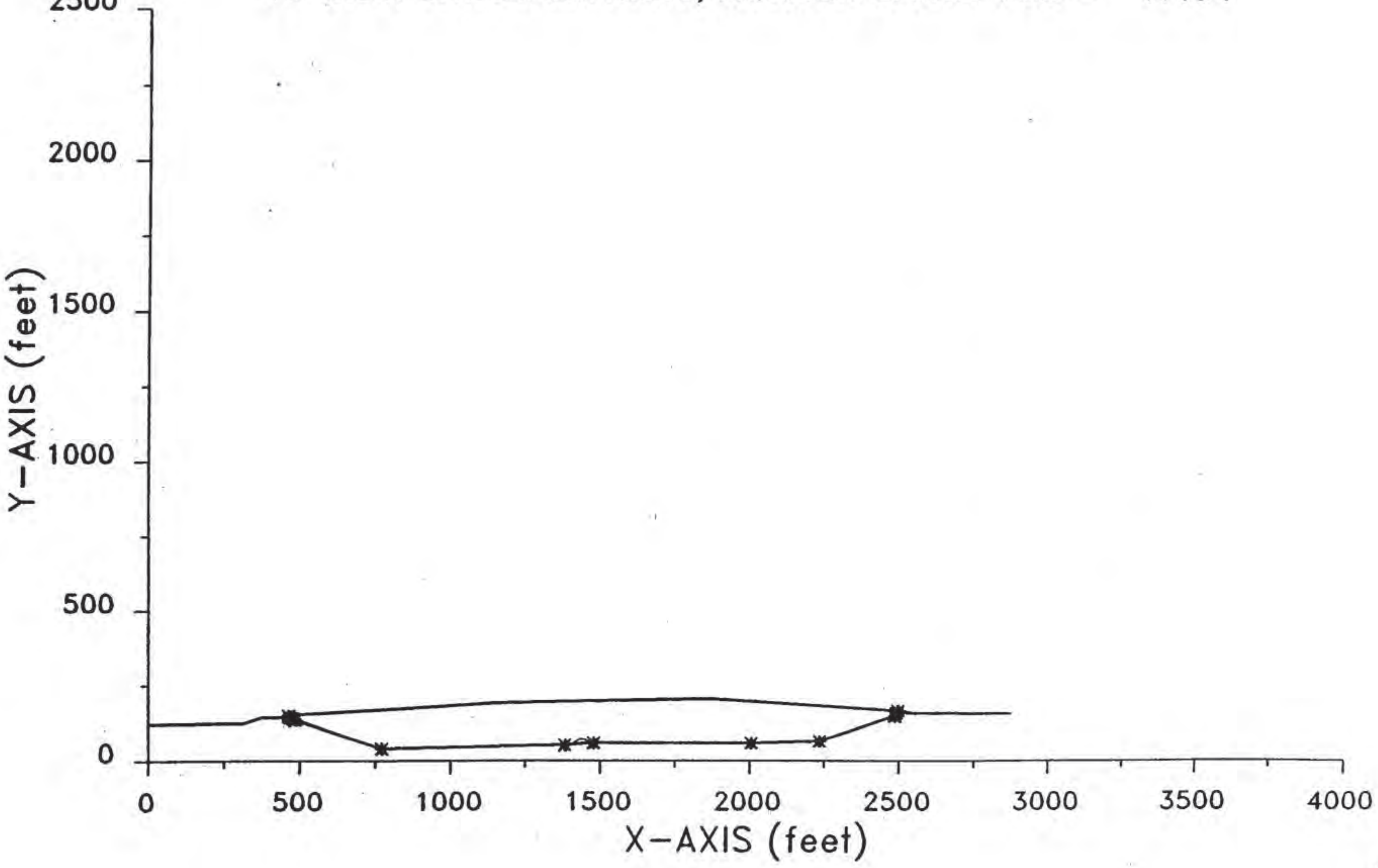
602-12
pmf
7-Nov-

Gandy Basal Failure aa Q
10 most critical surfaces, MINIMUM JANBU FOS = 1.494



602-020
pmp
7-Nov-

```
XSTABL File: GTBA1Q    11-06-97    8:46

          *****************************************
          *              X S T A B L              *
          *                                       *
          *        Slope Stability Analysis       *
          *              using the                *
          *           Method of Slices            *
          *                                       *
          *        Copyright (C) 1992 á 96        *
          *   Interactive Software Designs, Inc.  *
          *       Moscow, ID 83843, U.S.A.        *
          *                                       *
          *          All Rights Reserved          *
          *                                       *
          * Ver. 5.200                 96 á 1216  *
          *****************************************

 Problem Description : Gandy Basal Failure aa Q


 -----------------------------
 SEGMENT BOUNDARY COORDINATES
 -----------------------------

    10 SURFACE boundary segments

 Segment     x-left     y-left     x-right     y-right      Soil Unit
   No.        (ft)       (ft)        (ft)        (ft)     Below Segment

    1          5.0      122.0       315.6       123.8           2
    2        315.6      123.8       375.2       143.6           2
    3        375.2      143.6       436.8       143.6           2
    4        436.8      143.6       474.5       153.0           1
    5        474.5      153.0      1146.0       192.8           1
    6       1146.0      192.8      1813.7       204.9           1
    7       1813.7      204.9      1884.7       205.0           1
    8       1884.7      205.0      2519.5       165.0           1
    9       2519.5      165.0      2543.7       159.0           1
   10       2543.7      159.0      2872.9       156.7           2

    10 SUBSURFACE boundary segments

 Segment     x-left     y-left     x-right     y-right      Soil Unit
   No.        (ft)       (ft)        (ft)        (ft)     Below Segment

    1        436.8      143.6       465.1       143.6           2
    2        465.1      143.6       772.5        41.1           2
    3        772.5       41.1      1399.3        52.9           2
    4       1399.3       52.9      1433.2        69.8           2
    5       1433.2       69.8      1448.8        69.9           2
    6       1448.8       69.9      1472.6        58.0           2
    7       1472.6       58.0      2008.1        58.3           2
    8       2008.1       58.3      2233.9        65.1           2
    9       2233.9       65.1      2515.4       159.0           2
```

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602-024
pmp
7-Nov-

```
    10       2515.4     159.0     2543.7     159.0          2

   ---------------------------
   ISOTROPIC Soil Parameters
   ---------------------------

    2 Soil unit(s) specified

   Soil    Unit Weight   Cohesion  Friction    Pore Pressure       Water
   Unit  Moist    Sat.   Intercept   Angle  Parameter  Constant  Surfac
    No.   (pcf)   (pcf)    (psf)     (deg)       Ru       (psf)     No.

     1   110.0   110.0        .0     29.00      .000          .0      0
     2   110.0   110.0     440.0      2.00      .000          .0      0


   A horizontal earthquake loading coefficient
   of    .040 has been assigned

   A vertical earthquake loading coefficient
   of    .000 has been assigned


   A critical failure surface searching method, using a random
   technique for generating sliding BLOCK surfaces, has been
   specified.


   The active and passive portions of the sliding surfaces
   are generated according to the Rankine theory.


     500 trial surfaces will be generated and analyzed.


     7 boxes specified for generation of central block base


   Length of line segments for active and passive portions of
   sliding block is      10.0 ft


   Box         x-left     y-left    x-right    y-right      Width
   no.          (ft)       (ft)       (ft)       (ft)        (ft)

    1          485.1     136.5      535.1      119.8         1.0
    2          771.5      40.6      772.5       40.6         1.0
    3         1374.3      51.9     1399.3       52.4         1.0
    4         1472.6      57.5     1497.6       57.5         1.0
    5         1998.1      57.8     2018.1       58.1         1.0
    6         2233.9      64.6     2234.9       64.6         1.0
    7         2470.4     143.5     2495.4      151.8         1.0

***********************************************************************
ERROR # 38
***********************************************************************
```

56 -
60
7.

```
The program calculated a point for the PASSIVE wedge that is outside
the defined slope geometry.  The analysis will continue, but the user
should adjust the search box or slope geometry to allow a passive
wedge to be formed from all points within first box.
*************************************************************************


      Factors of safety have been calculated by the :

      * * * * *    SIMPLIFIED JANBU METHOD    * * * * *


      The 10 most critical of all the failure surfaces examined
      are displayed below - the most critical first

      Failure surface No. 1 specified by 15 coordinate points

            Point        x-surf        y-surf
             No.          (ft)          (ft)

              1          462.91        150.11
              2          468.30        146.94
              3          476.92        141.86
              4          485.53        136.79
              5          486.48        135.87
              6          772.31         40.12
              7         1383.52         51.68
              8         1479.38         57.79
              9         2006.15         58.09
             10         2234.88         64.70
             11         2484.73        148.57
             12         2485.01        148.86
             13         2490.08        157.48
             14         2495.16        166.10
             15         2495.41        166.52

       **  Corrected JANBU FOS =   1.494  **     (Fo factor = 1.026)


      Failure surface No. 2 specified by 15 coordinate points

            Point        x-surf        y-surf
             No.          (ft)          (ft)

              1          463.15        150.17
              2          469.09        146.67
              3          477.71        141.60
              4          486.32        136.52
              5          487.29        135.59
              6          772.40         40.13
              7         1393.41         51.80
              8         1485.69         57.85
              9         2006.10         57.83
             10         2234.85         65.02
             11         2471.94        144.45
             12         2472.01        144.53
             13         2477.09        153.14
```

```
         14          2482.17         161.76
         15          2485.34         167.15

  **  Corrected JANBU FOS =    1.495   **      (Fo factor = 1.026)

 Failure surface No. 3 specified by 15 coordinate points

        Point         x-surf          y-surf
         No.           (ft)            (ft)

          1           462.67         150.05
          2           467.51         147.20
          3           476.13         142.12
          4           484.75         137.05
          5           485.97         135.87
          6           772.41          40.28
          7          1391.97          51.80
          8          1488.01          57.64
          9          2002.09          57.55
         10          2234.24          64.34
         11          2477.25         145.96
         12          2477.70         146.42
         13          2482.77         155.04
         14          2487.85         163.66
         15          2489.74         166.87

  **  Corrected JANBU FOS =    1.495   **      (Fo factor = 1.026)

 Failure surface No. 4 specified by 15 coordinate points

        Point         x-surf          y-surf
         No.           (ft)            (ft)

          1           462.48         150.00
          2           466.87         147.42
          3           475.48         142.34
          4           484.10         137.26
          5           485.50         135.91
          6           772.37          40.47
          7          1381.45          51.74
          8          1484.86          57.41
          9          1998.79          57.56
         10          2234.71          64.37
         11          2471.18         143.60
         12          2472.11         144.56
         13          2477.18         153.18
         14          2482.26         161.79
         15          2485.41         167.15

  **  Corrected JANBU FOS =    1.496   **      (Fo factor = 1.026)

 Failure surface No. 5 specified by 14 coordinate points

        Point         x-surf          y-surf
         No.           (ft)            (ft)

          1           462.63         150.04
```

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pmf
7-Nov-0

```
             2        467.37       147.25
             3        475.99       142.17
             4        484.61       137.10
             5        485.32       136.41
             6        771.68        40.44
             7       1375.07        51.57
             8       1483.66        57.47
             9       2010.87        57.67
            10       2234.07        64.61
            11       2493.87       150.81
            12       2495.31       152.30
            13       2500.38       160.91
            14       2503.39       166.02

      **  Corrected JANBU FOS =   1.496  **     (Fo factor = 1.025)

    Failure surface No. 6 specified by 15 coordinate points

          Point       x-surf       y-surf
           No.         (ft)         (ft)

             1        462.66       150.05
             2        467.49       147.21
             3        476.10       142.13
             4        484.72       137.06
             5        485.90       135.92
             6        772.11        40.95
             7       1382.25        51.80
             8       1490.13        57.59
             9       2011.03        57.93
            10       2234.28        64.79
            11       2481.52       147.24
            12       2482.17       147.92
            13       2487.24       156.53
            14       2492.32       165.15
            15       2493.21       166.66

      **  Corrected JANBU FOS =   1.496  **     (Fo factor = 1.025)

    Failure surface No. 7 specified by 15 coordinate points

          Point       x-surf       y-surf
           No.         (ft)         (ft)

             1        463.34       150.22
             2        469.71       146.47
             3        478.33       141.39
             4        486.94       136.32
             5        487.69       135.59
             6        772.14        40.61
             7       1394.22        51.87
             8       1490.96        57.03
             9       1998.34        57.90
            10       2234.42        64.44
            11       2482.28       147.09
            12       2483.50       148.36
            13       2488.58       156.98
            14       2493.65       165.59
```

```
        15          2494.24        166.59

  **   Corrected JANBU FOS =     1.497  **      (Fo factor = 1.025)

 Failure surface No. 8 specified by 15 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          463.95         150.37
          2          471.72         145.80
          3          480.33         140.72
          4          488.95         135.65
          5          489.83         134.79
          6          771.82          40.61
          7         1382.69          51.61
          8         1489.81          57.19
          9         2003.49          57.89
         10         2234.20          64.99
         11         2478.90         146.38
         12         2479.54         147.04
         13         2484.62         155.65
         14         2489.69         164.27
         15         2491.17         166.78

  **   Corrected JANBU FOS =     1.497  **      (Fo factor = 1.026)

 Failure surface No. 9 specified by 15 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          463.17         150.17
          2          469.13         146.66
          3          477.75         141.58
          4          486.37         136.51
          5          486.53         136.35
          6          772.40          40.26
          7         1382.80          51.58
          8         1486.63          57.24
          9         2000.54          57.44
         10         2234.81          64.23
         11         2474.20         144.48
         12         2475.30         145.63
         13         2480.38         154.24
         14         2485.46         162.86
         15         2487.89         166.99

  **   Corrected JANBU FOS =     1.497  **      (Fo factor = 1.026)

 Failure surface No.10 specified by 14 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          462.88         150.10
          2          468.19         146.98
```

602-01
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7-Nov-9

```
         3        476.80       141.90
         4        485.42       136.82
         5        486.10       136.16
         6        771.84        40.55
         7       1388.28        51.92
         8       1494.96        57.76
         9       2016.15        57.80
        10       2234.37        64.30
        11       2491.07       150.44
        12       2491.70       151.10
        13       2496.78       159.71
        14       2500.59       166.19

 **   Corrected JANBU FOS =    1.497  **     (Fo factor = 1.025)




The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Basal Failure aa Q

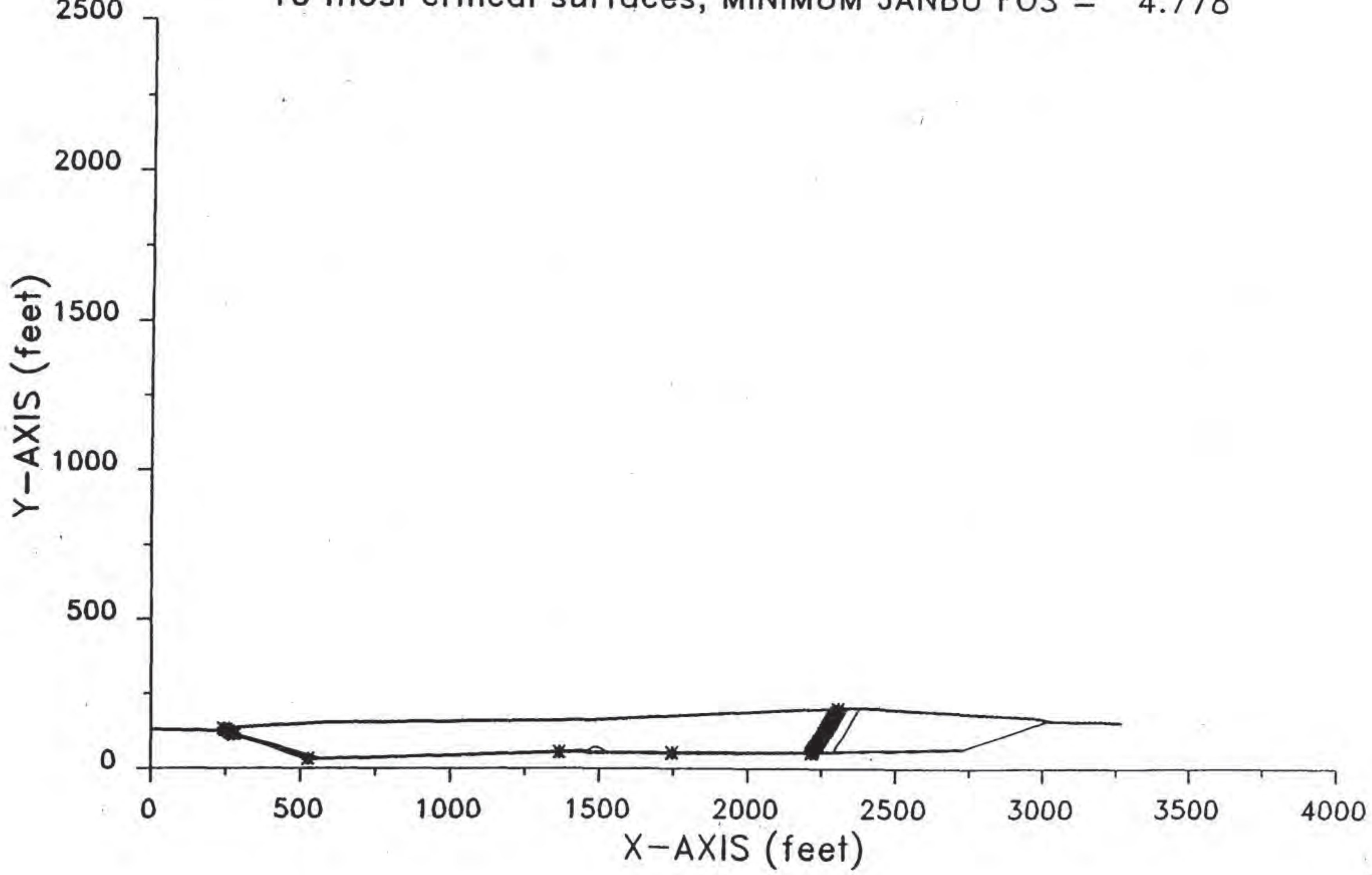
       Modified      Correction     Initial     Terminal     Available
       JANBU FOS       Factor       x-coord     x-coord      Strength
                                     (ft)        (ft)         (lb)

 1.      1.494         1.026        462.91      2495.41     1.862E+06
 2.      1.495         1.026        463.15      2485.34     1.860E+06
 3.      1.495         1.026        462.67      2489.74     1.862E+06
 4.      1.496         1.026        462.48      2485.41     1.860E+06
 5.      1.496         1.025        462.63      2503.39     1.865E+06
 6.      1.496         1.025        462.66      2493.21     1.860E+06
 7.      1.497         1.025        463.34      2494.24     1.863E+06
 8.      1.497         1.026        463.95      2491.17     1.863E+06
 9.      1.497         1.026        463.17      2487.89     1.863E+06
10.      1.497         1.025        462.88      2500.59     1.864E+06

                        * * *  END OF FILE  * * *
```

G1B2 11-06-97 6:34

Gandy Total Basal Failue Q
10 most critical surfaces, MINIMUM JANBU FOS = 4.778



GOE-026
7-Nov-9

[illegible]
602-02[illegible]
7-Nov-
pmo

```
XSTABL File: GTB2        11-06-97    6:34

                 ******************************************
                 *               X S T A B L              *
                 *                                        *
                 *        Slope Stability Analysis        *
                 *               using the                *
                 *            Method of Slices            *
                 *                                        *
                 *         Copyright (C) 1992 á 96        *
                 *    Interactive Software Designs, Inc.  *
                 *         Moscow, ID 83843, U.S.A.       *
                 *                                        *
                 *           All Rights Reserved          *
                 *                                        *
                 *  Ver. 5.200                 96 á 1216  *
                 ******************************************

      Problem Description : Gandy Total Basal Failue Q


      -----------------------------
      SEGMENT BOUNDARY COORDINATES
      -----------------------------

          9 SURFACE boundary segments

      Segment    x-left     y-left     x-right    y-right      Soil Unit
        No.       (ft)       (ft)       (ft)       (ft)      Below Segment

         1          .0       131.9      213.0      127.5          2
         2        213.0      127.5      243.3      135.0          1
         3        243.3      135.0      590.6      155.8          1
         4        590.6      155.8     1473.6      163.6          1
         5       1473.6      163.6     2338.5      204.8          1
         6       2338.5      204.8     2394.6      205.0          1
         7       2394.6      205.0     2985.4      170.0          1
         8       2985.4      170.0     3036.6      160.0          1
         9       3036.6      160.0     3266.9      157.0          2


         10 SUBSURFACE boundary segments

      Segment    x-left     y-left     x-right    y-right      Soil Unit
        No.       (ft)       (ft)       (ft)       (ft)      Below Segment

         1        213.0      127.5      241.3      127.4          2
         2        241.3      127.4      525.9       32.6          2
         3        525.9       32.6     1459.4       57.9          2
         4       1459.4       57.9     1483.7       70.0          2
         5       1483.7       70.0     1498.7       70.0          2
         6       1498.7       70.0     1531.4       53.7          2
         7       1531.4       53.7     2159.5       53.7          2
         8       2159.5       53.7     2725.7       65.0          2
         9       2725.7       65.0     3009.3      159.7          2
        10       3009.3      159.7     3036.6      160.0          2
```

662-9209
pmp
7-Nov

```
--------------------------
ISOTROPIC Soil Parameters
--------------------------

 2 Soil unit(s) specified

Soil   Unit Weight   Cohesion  Friction    Pore Pressure       Wate
Unit  Moist    Sat.  Intercept   Angle  Parameter  Constant  Surfa
 No.  (pcf)   (pcf)    (psf)     (deg)     Ru        (psf)      No.

  1   110.0   110.0        .0    29.00     .000          .0      0
  2   110.0   110.0     440.0     2.00     .000          .0      0


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.


The active and passive portions of the sliding surfaces
are generated according to the Rankine theory.


  500 trial surfaces will be generated and analyzed.


  5 boxes specified for generation of central block base


Length of line segments for active and passive portions of
sliding block is       10.0 ft


Box          x-left      y-left     x-right     y-right        Width
no.            (ft)       (ft)        (ft)        (ft)          (ft)

 1            261.3      120.3      311.3       103.6           1.0
 2            524.9       32.1      575.9        33.4           1.0
 3           1359.4       54.7     1459.4        57.4           1.0
 4           1531.4       53.2     2159.5        52.7           1.0
 5           2184.5       53.7     2726.7        64.5           1.0


**************************************************************
**      Factor of safety calculation for surface #     64    **
**      failed to converge within FIFTY iterations           **
**                                                           **
**     The last calculated value of the FOS was  21.2076     **
**     This will be ignored for final summary of results     **
**************************************************************

The trial failure surface in question is
defined by the following 26 coordinate points

       Point        x-surf       y-surf
        No.          (ft)         (ft)
```

44 [illegible]
612-02[illegible]
pmp
7-Nov

```
The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 29 coordinate points

      Point        x-surf        y-surf
       No.          (ft)          (ft)

        1          243.98        135.04
        2          251.47        130.63
        3          260.09        125.55
        4          268.70        120.48
        5          277.32        115.40
        6          278.63        114.14
        7          527.07         31.99
        8         1367.24         54.58
        9         1746.80         52.70
       10         2216.16         54.07
       11         2216.91         54.85
       12         2221.99         63.46
       13         2227.07         72.08
       14         2232.14         80.69
       15         2237.22         89.31
       16         2242.29         97.93
       17         2247.37        106.54
       18         2252.44        115.16
       19         2257.52        123.78
       20         2262.59        132.39
       21         2267.67        141.01
       22         2272.74        149.63
       23         2277.82        158.24
       24         2282.90        166.86
       25         2287.97        175.47
       26         2293.05        184.09
       27         2298.12        192.71
       28         2303.20        201.32
       29         2304.28        203.17

**   Corrected JANBU FOS =   4.778  **     (Fo factor = 1.032)

Failure surface No. 2 specified by 31 coordinate points

      Point        x-surf        y-surf
       No.          (ft)          (ft)

        1          255.62        135.74
        2          263.75        130.95
        3          272.37        125.87
        4          280.99        120.80
        5          289.60        115.72
        6          298.22        110.65
        7          306.84        105.57
        8          306.89        105.52
        9          560.85         32.94
       10         1376.54         55.51
       11         1656.88         53.39
```

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```
        12         2191.25          53.45
        13         2192.12          54.35
        14         2197.20          62.97
        15         2202.27          71.58
        16         2207.35          80.20
        17         2212.42          88.82
        18         2217.50          97.43
        19         2222.57         106.05
        20         2227.65         114.67
        21         2232.72         123.28
        22         2237.80         131.90
        23         2242.87         140.51
        24         2247.95         149.13
        25         2253.03         157.75
        26         2258.10         166.36
        27         2263.18         174.98
        28         2268.25         183.60
        29         2273.33         192.21
        30         2278.40         200.83
        31         2279.07         201.97

  **  Corrected JANBU FOS =   6.261  **     (Fo factor = 1.032)

Failure surface No. 3 specified by 30 coordinate points

       Point       x-surf          y-surf
        No.         (ft)            (ft)

         1          246.97         135.22
         2          250.43         133.18
         3          259.04         128.11
         4          267.66         123.03
         5          276.28         117.96
         6          284.89         112.88
         7          285.29         112.49
         8          548.51          32.85
         9         1360.20          54.32
        10         1743.27          53.48
        11         2188.01          53.68
        12         2188.59          54.28
        13         2193.66          62.90
        14         2198.74          71.51
        15         2203.81          80.13
        16         2208.89          88.75
        17         2213.96          97.36
        18         2219.04         105.98
        19         2224.11         114.59
        20         2229.19         123.21
        21         2234.26         131.83
        22         2239.34         140.44
        23         2244.42         149.06
        24         2249.49         157.68
        25         2254.57         166.29
        26         2259.64         174.91
        27         2264.72         183.52
        28         2269.79         192.14
        29         2274.87         200.76
        30         2275.48         201.80
```

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```
**  Corrected JANBU FOS =   6.418  **     (Fo factor = 1.032)

Failure surface No. 4 specified by 30 coordinate points

        Point       x-surf       y-surf
         No.         (ft)         (ft)

          1        245.82       135.15
          2        247.53       134.15
          3        256.14       129.07
          4        264.76       124.00
          5        273.38       118.92
          6        281.99       113.85
          7        282.25       113.59
          8        573.03        33.60
          9       1362.45        54.55
         10       2097.66        52.41
         11       2245.43        55.08
         12       2245.76        55.42
         13       2250.84        64.04
         14       2255.91        72.65
         15       2260.99        81.27
         16       2266.06        89.89
         17       2271.14        98.50
         18       2276.21       107.12
         19       2281.29       115.74
         20       2286.36       124.35
         21       2291.44       132.97
         22       2296.51       141.58
         23       2301.59       150.20
         24       2306.67       158.82
         25       2311.74       167.43
         26       2316.82       176.05
         27       2321.89       184.67
         28       2326.97       193.28
         29       2332.04       201.90
         30       2333.61       204.57

**  Corrected JANBU FOS =   6.430  **     (Fo factor = 1.032)

Failure surface No. 5 specified by 28 coordinate points

        Point       x-surf       y-surf
         No.         (ft)         (ft)

          1        240.14       134.22
          2        248.04       129.57
          3        256.66       124.49
          4        265.27       119.41
          5        266.38       118.34
          6        568.42        32.89
          7       1387.20        55.01
          8       1697.66        53.02
          9       2203.86        53.83
         10       2204.61        54.60
         11       2209.68        63.22
         12       2214.76        71.83
         13       2219.84        80.45
```

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```
        14          2224.91          89.07
        15          2229.99          97.68
        16          2235.06         106.30
        17          2240.14         114.91
        18          2245.21         123.53
        19          2250.29         132.15
        20          2255.36         140.76
        21          2260.44         149.38
        22          2265.51         158.00
        23          2270.59         166.61
        24          2275.67         175.23
        25          2280.74         183.84
        26          2285.82         192.46
        27          2290.89         201.08
        28          2291.77         202.57

  **   Corrected JANBU FOS =    6.443   **     (Fo factor = 1.032)

     Failure surface No. 6 specified by 28 coordinate points

       Point         x-surf          y-surf
        No.           (ft)            (ft)

         1           240.36         134.27
         2           248.76         129.33
         3           257.38         124.25
         4           265.99         119.17
         5           267.17         118.03
         6           526.25          31.81
         7          1364.70          55.23
         8          2004.20          52.87
         9          2192.36          54.07
        10          2192.64          54.36
        11          2197.71          62.98
        12          2202.79          71.59
        13          2207.86          80.21
        14          2212.94          88.83
        15          2218.01          97.44
        16          2223.09         106.06
        17          2228.16         114.68
        18          2233.24         123.29
        19          2238.32         131.91
        20          2243.39         140.52
        21          2248.47         149.14
        22          2253.54         157.76
        23          2258.62         166.37
        24          2263.69         174.99
        25          2268.77         183.61
        26          2273.84         192.22
        27          2278.92         200.84
        28          2279.60         201.99

  **   Corrected JANBU FOS =    6.454   **     (Fo factor = 1.032)

     Failure surface No. 7 specified by 28 coordinate points

       Point         x-surf          y-surf
        No.           (ft)            (ft)
```

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```
          1          239.21          133.99
          2          245.00          130.58
          3          253.61          125.50
          4          262.23          120.43
          5          262.91          119.78
          6          527.33           32.54
          7         1366.35           54.92
          8         2151.22           52.22
          9         2196.27           53.67
         10         2197.02           54.45
         11         2202.10           63.07
         12         2207.17           71.68
         13         2212.25           80.30
         14         2217.32           88.91
         15         2222.40           97.53
         16         2227.48          106.15
         17         2232.55          114.76
         18         2237.63          123.38
         19         2242.70          132.00
         20         2247.78          140.61
         21         2252.85          149.23
         22         2257.93          157.84
         23         2263.00          166.46
         24         2268.08          175.08
         25         2273.15          183.69
         26         2278.23          192.31
         27         2283.30          200.93
         28         2284.06          202.21

   **  Corrected JANBU FOS =   6.503  **     (Fo factor = 1.032)

Failure surface No. 8 specified by 29 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          244.55          135.07
          2          252.91          130.15
          3          261.52          125.07
          4          270.14          120.00
          5          278.76          114.92
          6          280.21          113.52
          7          544.74           32.45
          8         1422.26           56.72
          9         1731.78           52.90
         10         2193.15           53.56
         11         2193.95           54.39
         12         2199.03           63.00
         13         2204.11           71.62
         14         2209.18           80.24
         15         2214.26           88.85
         16         2219.33           97.47
         17         2224.41          106.09
         18         2229.48          114.70
         19         2234.56          123.32
         20         2239.63          131.93
         21         2244.71          140.55
         22         2249.78          149.17
```

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```
      23          2254.86        157.78
      24          2259.94        166.40
      25          2265.01        175.02
      26          2270.09        183.63
      27          2275.16        192.25
      28          2280.24        200.86
      29          2280.94        202.06

  **  Corrected JANBU FOS =    6.529   **      (Fo factor = 1.032)

Failure surface No. 9 specified by 30 coordinate points

     Point        x-surf        y-surf
      No.          (ft)          (ft)

       1          249.58        135.38
       2          257.06        130.97
       3          265.67        125.90
       4          274.29        120.82
       5          282.91        115.75
       6          291.52        110.67
       7          291.62        110.57
       8          553.55         32.82
       9         1400.64         56.22
      10         1770.45         52.57
      11         2196.42         53.60
      12         2197.24         54.45
      13         2202.31         63.07
      14         2207.39         71.69
      15         2212.47         80.30
      16         2217.54         88.92
      17         2222.62         97.53
      18         2227.69        106.15
      19         2232.77        114.77
      20         2237.84        123.38
      21         2242.92        132.00
      22         2247.99        140.62
      23         2253.07        149.23
      24         2258.14        157.85
      25         2263.22        166.46
      26         2268.30        175.08
      27         2273.37        183.70
      28         2278.45        192.31
      29         2283.52        200.93
      30         2284.28        202.22

  **  Corrected JANBU FOS =    6.540   **      (Fo factor = 1.032)

Failure surface No.10 specified by 29 coordinate points

     Point        x-surf        y-surf
      No.          (ft)          (ft)

       1          240.47        134.30
       2          240.50        134.28
       3          249.11        129.21
       4          257.73        124.13
       5          266.35        119.06
```

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```
          6         267.68        117.77
          7         528.89         32.33
          8        1374.04         55.47
          9        2089.03         52.34
         10        2288.19         56.06
         11        2288.40         56.27
         12        2293.47         64.89
         13        2298.55         73.51
         14        2303.62         82.12
         15        2308.70         90.74
         16        2313.77         99.35
         17        2318.85        107.97
         18        2323.92        116.59
         19        2329.00        125.20
         20        2334.07        133.82
         21        2339.15        142.44
         22        2344.23        151.05
         23        2349.30        159.67
         24        2354.38        168.28
         25        2359.45        176.90
         26        2364.53        185.52
         27        2369.60        194.13
         28        2374.68        202.75
         29        2375.96        204.93

 **  Corrected JANBU FOS =   6.582  **    (Fo factor = 1.031)


******************************************************************
**                                                               *
**  Out of the    500 surfaces generated and analyzed by XSTABL,  *
**        10 surfaces were found to have MISLEADING FOS values.   *
**                                                               *
******************************************************************




The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Total Basal Failue Q

       Modified       Correction     Initial      Terminal     Available
      JANBU FOS         Factor       x-coord       x-coord      Strength
                                      (ft)          (ft)          (lb)

  1.     4.778          1.032        243.98       2304.28      3.077E+06
  2.     6.261          1.032        255.62       2279.07      3.964E+06
  3.     6.418          1.032        246.97       2275.48      4.090E+06
  4.     6.430          1.032        245.82       2333.61      4.330E+06
  5.     6.443          1.032        240.14       2291.77      4.165E+06
  6.     6.454          1.032        240.36       2279.60      4.233E+06
  7.     6.503          1.032        239.21       2284.06      4.254E+06
  8.     6.529          1.032        244.55       2280.94      4.210E+06
  9.     6.540          1.032        249.58       2284.28      4.211E+06
 10.     6.582          1.031        240.47       2375.96      4.707E+06
```

* * * END OF FILE * * *

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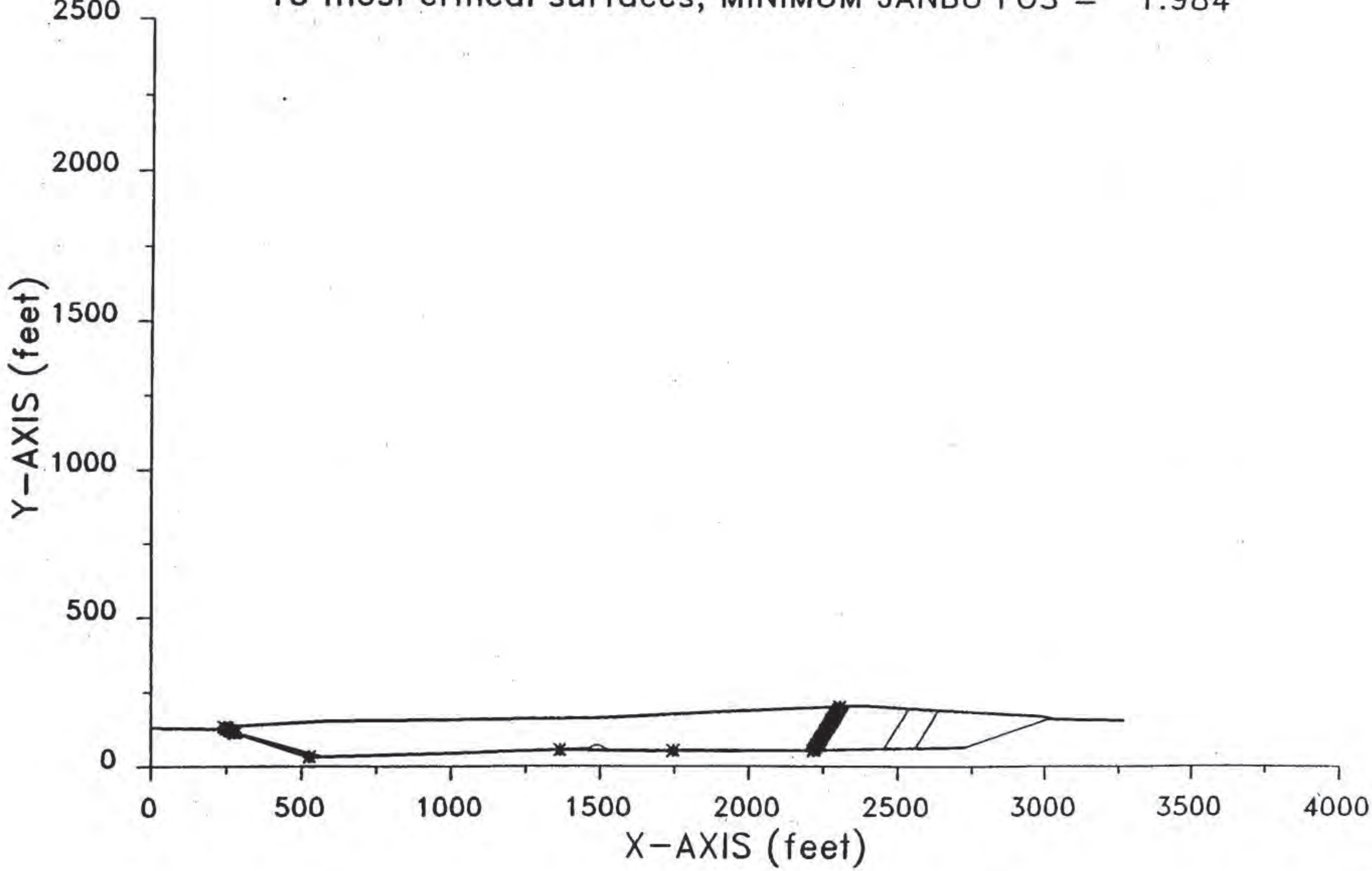
G1B2Q 11-06-97 6:31

Gandy Total Basal Failue Q

10 most critical surfaces, MINIMUM JANBU FOS = 1.984



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[illegible]
602-021
PMP
JNM-9

```
XSTABL File: GTB2Q      11-06-97    6:31

              *******************************************
              *                X S T A B L              *
              *                                         *
              *        Slope Stability Analysis         *
              *               using the                 *
              *           Method of Slices              *
              *                                         *
              *         Copyright (C) 1992 á 96         *
              *   Interactive Software Designs, Inc.    *
              *        Moscow, ID 83843, U.S.A.         *
              *                                         *
              *          All Rights Reserved            *
              *                                         *
              *  Ver. 5.200                  96 á 1216  *
              *******************************************

   Problem Description : Gandy Total Basal Failue Q



   ------------------------------
   SEGMENT BOUNDARY COORDINATES
   ------------------------------

       9 SURFACE boundary segments

   Segment    x-left     y-left     x-right    y-right      Soil Unit
     No.       (ft)       (ft)       (ft)       (ft)     Below Segment

     1           .0      131.9      213.0      127.5           2
     2        213.0      127.5      243.3      135.0           1
     3        243.3      135.0      590.6      155.8           1
     4        590.6      155.8     1473.6      163.6           1
     5       1473.6      163.6     2338.5      204.8           1
     6       2338.5      204.8     2394.6      205.0           1
     7       2394.6      205.0     2985.4      170.0           1
     8       2985.4      170.0     3036.6      160.0           1
     9       3036.6      160.0     3266.9      157.0           2

      10 SUBSURFACE boundary segments

   Segment    x-left     y-left     x-right    y-right      Soil Unit
     No.       (ft)       (ft)       (ft)       (ft)     Below Segment

     1        213.0      127.5      241.3      127.4           2
     2        241.3      127.4      525.9       32.6           2
     3        525.9       32.6     1459.4       57.9           2
     4       1459.4       57.9     1483.7       70.0           2
     5       1483.7       70.0     1498.7       70.0           2
     6       1498.7       70.0     1531.4       53.7           2
     7       1531.4       53.7     2159.5       53.7           2
     8       2159.5       53.7     2725.7       65.0           2
     9       2725.7       65.0     3009.3      159.7           2
    10       3009.3      159.7     3036.6      160.0           2
```

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```
--------------------------
ISOTROPIC Soil Parameters
--------------------------

 2 Soil unit(s) specified

Soil   Unit Weight   Cohesion  Friction     Pore Pressure      Water
Unit  Moist    Sat.  Intercept   Angle  Parameter  Constant  Surfac
 No.  (pcf)   (pcf)    (psf)     (deg)      Ru       (psf)     No.

  1   110.0   110.0       .0     29.00     .000          .0      0
  2   110.0   110.0    440.0      2.00     .000          .0      0


A horizontal earthquake loading coefficient
of   .040 has been assigned

A vertical earthquake loading coefficient
of   .000 has been assigned


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.


The active and passive portions of the sliding surfaces
are generated according to the Rankine theory.


  500 trial surfaces will be generated and analyzed.


  5 boxes specified for generation of central block base


Length of line segments for active and passive portions of
sliding block is      10.0 ft


Box         x-left     y-left    x-right    y-right      Width
no.          (ft)       (ft)       (ft)       (ft)        (ft)

 1          261.3      120.3      311.3      103.6         1.0
 2          524.9       32.1      575.9       33.4         1.0
 3         1359.4       54.7     1459.4       57.4         1.0
 4         1531.4       53.2     2159.5       52.7         1.0
 5         2184.5       53.7     2726.7       64.5         1.0


***************************************************************************
ERROR # 38
***************************************************************************
The program calculated a point for the PASSIVE wedge that is outside
the defined slope geometry.  The analysis will continue, but the user
should adjust the search box or slope geometry to allow a passive
```

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```
wedge to be formed from all points within first box.
************************************************************************


    Factors of safety have been calculated by the :

    * * * * *    SIMPLIFIED JANBU METHOD    * * * * *


    The 10 most critical of all the failure surfaces examined
    are displayed below - the most critical first

    Failure surface No. 1 specified by 29 coordinate points

               Point        x-surf        y-surf
                No.          (ft)          (ft)

                 1          243.98        135.04
                 2          251.47        130.63
                 3          260.09        125.55
                 4          268.70        120.48
                 5          277.32        115.40
                 6          278.63        114.14
                 7          527.07         31.99
                 8         1367.24         54.58
                 9         1746.80         52.70
                10         2216.16         54.07
                11         2216.91         54.85
                12         2221.99         63.46
                13         2227.07         72.08
                14         2232.14         80.69
                15         2237.22         89.31
                16         2242.29         97.93
                17         2247.37        106.54
                18         2252.44        115.16
                19         2257.52        123.78
                20         2262.59        132.39
                21         2267.67        141.01
                22         2272.74        149.63
                23         2277.82        158.24
                24         2282.90        166.86
                25         2287.97        175.47
                26         2293.05        184.09
                27         2298.12        192.71
                28         2303.20        201.32
                29         2304.28        203.17

     **  Corrected JANBU FOS =    1.984  **      (Fo factor = 1.032)


    Failure surface No. 2 specified by 31 coordinate points

               Point        x-surf        y-surf
                No.          (ft)          (ft)

                 1          255.62        135.74
                 2          263.75        130.95
```

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```
        3          272.37        125.87
        4          280.99        120.80
        5          289.60        115.72
        6          298.22        110.65
        7          306.84        105.57
        8          306.89        105.52
        9          560.85         32.94
       10         1376.54         55.51
       11         1656.88         53.39
       12         2191.25         53.45
       13         2192.12         54.35
       14         2197.20         62.97
       15         2202.27         71.58
       16         2207.35         80.20
       17         2212.42         88.82
       18         2217.50         97.43
       19         2222.57        106.05
       20         2227.65        114.67
       21         2232.72        123.28
       22         2237.80        131.90
       23         2242.87        140.51
       24         2247.95        149.13
       25         2253.03        157.75
       26         2258.10        166.36
       27         2263.18        174.98
       28         2268.25        183.60
       29         2273.33        192.21
       30         2278.40        200.83
       31         2279.07        201.97

   **  Corrected JANBU FOS =   2.671  **     (Fo factor = 1.032)

 Failure surface No. 3 specified by 28 coordinate points

      Point        x-surf        y-surf
       No.          (ft)          (ft)

        1          245.44        135.13
        2          246.55        134.47
        3          255.16        129.40
        4          263.78        124.32
        5          272.39        119.25
        6          281.01        114.17
        7          281.87        113.35
        8          539.35         32.88
        9         1364.46         54.59
       10         2118.96         52.56
       11         2452.08         58.87
       12         2452.73         59.55
       13         2457.81         68.17
       14         2462.89         76.78
       15         2467.96         85.40
       16         2473.04         94.02
       17         2478.11        102.63
       18         2483.19        111.25
       19         2488.26        119.87
       20         2493.34        128.48
       21         2498.41        137.10
       22         2503.49        145.72
```

[illegible]
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```
        23            2508.56          154.33
        24            2513.64          162.95
        25            2518.71          171.56
        26            2523.79          180.18
        27            2528.87          188.80
        28            2533.56          196.77

  **   Corrected JANBU FOS =    2.738   **      (Fo factor = 1.027)

    Failure surface No. 4 specified by 28 coordinate points

        Point          x-surf          y-surf
         No.            (ft)            (ft)

         1             240.36          134.27
         2             248.76          129.33
         3             257.38          124.25
         4             265.99          119.17
         5             267.17          118.03
         6             526.25           31.81
         7            1364.70           55.23
         8            2004.20           52.87
         9            2192.36           54.07
        10            2192.64           54.36
        11            2197.71           62.98
        12            2202.79           71.59
        13            2207.86           80.21
        14            2212.94           88.83
        15            2218.01           97.44
        16            2223.09          106.06
        17            2228.16          114.68
        18            2233.24          123.29
        19            2238.32          131.91
        20            2243.39          140.52
        21            2248.47          149.14
        22            2253.54          157.76
        23            2258.62          166.37
        24            2263.69          174.99
        25            2268.77          183.61
        26            2273.84          192.22
        27            2278.92          200.84
        28            2279.60          201.99

  **   Corrected JANBU FOS =    2.739   **      (Fo factor = 1.032)

    Failure surface No. 5 specified by 30 coordinate points

        Point          x-surf          y-surf
         No.            (ft)            (ft)

         1             246.97          135.22
         2             250.43          133.18
         3             259.04          128.11
         4             267.66          123.03
         5             276.28          117.96
         6             284.89          112.88
         7             285.29          112.49
         8             548.51           32.85
```

SB = [illegible]
602-9200
PMP
7-Nov-

```
         9          1360.20         54.32
        10          1743.27         53.48
        11          2188.01         53.68
        12          2188.59         54.28
        13          2193.66         62.90
        14          2198.74         71.51
        15          2203.81         80.13
        16          2208.89         88.75
        17          2213.96         97.36
        18          2219.04        105.98
        19          2224.11        114.59
        20          2229.19        123.21
        21          2234.26        131.83
        22          2239.34        140.44
        23          2244.42        149.06
        24          2249.49        157.68
        25          2254.57        166.29
        26          2259.64        174.91
        27          2264.72        183.52
        28          2269.79        192.14
        29          2274.87        200.76
        30          2275.48        201.80

 **  Corrected JANBU FOS =   2.741  **    (Fo factor = 1.032)

Failure surface No. 6 specified by 28 coordinate points

       Point        x-surf          y-surf
        No.          (ft)            (ft)

         1           240.14         134.22
         2           248.04         129.57
         3           256.66         124.49
         4           265.27         119.41
         5           266.38         118.34
         6           568.42          32.89
         7          1387.20          55.01
         8          1697.66          53.02
         9          2203.86          53.83
        10          2204.61          54.60
        11          2209.68          63.22
        12          2214.76          71.83
        13          2219.84          80.45
        14          2224.91          89.07
        15          2229.99          97.68
        16          2235.06         106.30
        17          2240.14         114.91
        18          2245.21         123.53
        19          2250.29         132.15
        20          2255.36         140.76
        21          2260.44         149.38
        22          2265.51         158.00
        23          2270.59         166.61
        24          2275.67         175.23
        25          2280.74         183.84
        26          2285.82         192.46
        27          2290.89         201.08
        28          2291.77         202.57
```

```
**  Corrected JANBU FOS =   2.756  **     (Fo factor = 1.032)

Failure surface No. 7 specified by 30 coordinate points

          Point        x-surf        y-surf
           No.          (ft)          (ft)

            1          245.82        135.15
            2          247.53        134.15
            3          256.14        129.07
            4          264.76        124.00
            5          273.38        118.92
            6          281.99        113.85
            7          282.25        113.59
            8          573.03         33.60
            9         1362.45         54.55
           10         2097.66         52.41
           11         2245.43         55.08
           12         2245.76         55.42
           13         2250.84         64.04
           14         2255.91         72.65
           15         2260.99         81.27
           16         2266.06         89.89
           17         2271.14         98.50
           18         2276.21        107.12
           19         2281.29        115.74
           20         2286.36        124.35
           21         2291.44        132.97
           22         2296.51        141.58
           23         2301.59        150.20
           24         2306.67        158.82
           25         2311.74        167.43
           26         2316.82        176.05
           27         2321.89        184.67
           28         2326.97        193.28
           29         2332.04        201.90
           30         2333.61        204.57

**  Corrected JANBU FOS =   2.772  **     (Fo factor = 1.032)

Failure surface No. 8 specified by 28 coordinate points

          Point        x-surf        y-surf
           No.          (ft)          (ft)

            1          251.53        135.49
            2          253.39        134.40
            3          262.01        129.32
            4          270.63        124.25
            5          279.24        119.17
            6          287.86        114.10
            7          296.48        109.02
            8          297.97        107.58
            9          532.87         32.49
           10         1362.40         54.69
           11         2103.14         52.67
           12         2556.40         60.88
           13         2557.13         61.64
```

602-0204
pmp
7-Nov-0

```
         14          2562.21         70.25
         15          2567.28         78.87
         16          2572.36         87.48
         17          2577.43         96.10
         18          2582.51        104.72
         19          2587.58        113.33
         20          2592.66        121.95
         21          2597.73        130.57
         22          2602.81        139.18
         23          2607.88        147.80
         24          2612.96        156.41
         25          2618.04        165.03
         26          2623.11        173.65
         27          2628.19        182.26
         28          2633.25        190.86

  **  Corrected JANBU FOS =   2.785  **    (Fo factor = 1.025)

Failure surface No. 9 specified by 28 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)

          1          239.21         133.99
          2          245.00         130.58
          3          253.61         125.50
          4          262.23         120.43
          5          262.91         119.78
          6          527.33          32.54
          7         1366.35          54.92
          8         2151.22          52.22
          9         2196.27          53.67
         10         2197.02          54.45
         11         2202.10          63.07
         12         2207.17          71.68
         13         2212.25          80.30
         14         2217.32          88.91
         15         2222.40          97.53
         16         2227.48         106.15
         17         2232.55         114.76
         18         2237.63         123.38
         19         2242.70         132.00
         20         2247.78         140.61
         21         2252.85         149.23
         22         2257.93         157.84
         23         2263.00         166.46
         24         2268.08         175.08
         25         2273.15         183.69
         26         2278.23         192.31
         27         2283.30         200.93
         28         2284.06         202.21

  **  Corrected JANBU FOS =   2.786  **    (Fo factor = 1.032)

Failure surface No.10 specified by 29 coordinate points

        Point        x-surf         y-surf
         No.          (ft)           (ft)
```

[illegible]
692-02[illegible]
PMP
7-Nov-9[illegible]

```
            1         244.55       135.07
            2         252.91       130.15
            3         261.52       125.07
            4         270.14       120.00
            5         278.76       114.92
            6         280.21       113.52
            7         544.74        32.45
            8        1422.26        56.72
            9        1731.78        52.90
           10        2193.15        53.56
           11        2193.95        54.39
           12        2199.03        63.00
           13        2204.11        71.62
           14        2209.18        80.24
           15        2214.26        88.85
           16        2219.33        97.47
           17        2224.41       106.09
           18        2229.48       114.70
           19        2234.56       123.32
           20        2239.63       131.93
           21        2244.71       140.55
           22        2249.78       149.17
           23        2254.86       157.78
           24        2259.94       166.40
           25        2265.01       175.02
           26        2270.09       183.63
           27        2275.16       192.25
           28        2280.24       200.86
           29        2280.94       202.06

      **   Corrected JANBU FOS =    2.797   **      (Fo factor = 1.032)




The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Total Basal Failue Q

      Modified       Correction    Initial     Terminal     Available
      JANBU FOS        Factor      x-coord     x-coord       Strength
                                    (ft)        (ft)          (lb)

 1.     1.984          1.032       243.98      2304.28     2.959E+06
 2.     2.671          1.032       255.62      2279.07     3.918E+06
 3.     2.738          1.027       245.44      2533.56     4.544E+06
 4.     2.739          1.032       240.36      2279.60     4.137E+06
 5.     2.741          1.032       246.97      2275.48     4.043E+06
 6.     2.756          1.032       240.14      2291.77     4.116E+06
 7.     2.772          1.032       245.82      2333.61     4.281E+06
 8.     2.785          1.025       251.53      2633.25     4.625E+06
 9.     2.786          1.032       239.21      2284.06     4.193E+06
10.     2.797          1.032       244.55      2280.94     4.162E+06

                      * * *  END OF FILE  * * *
```

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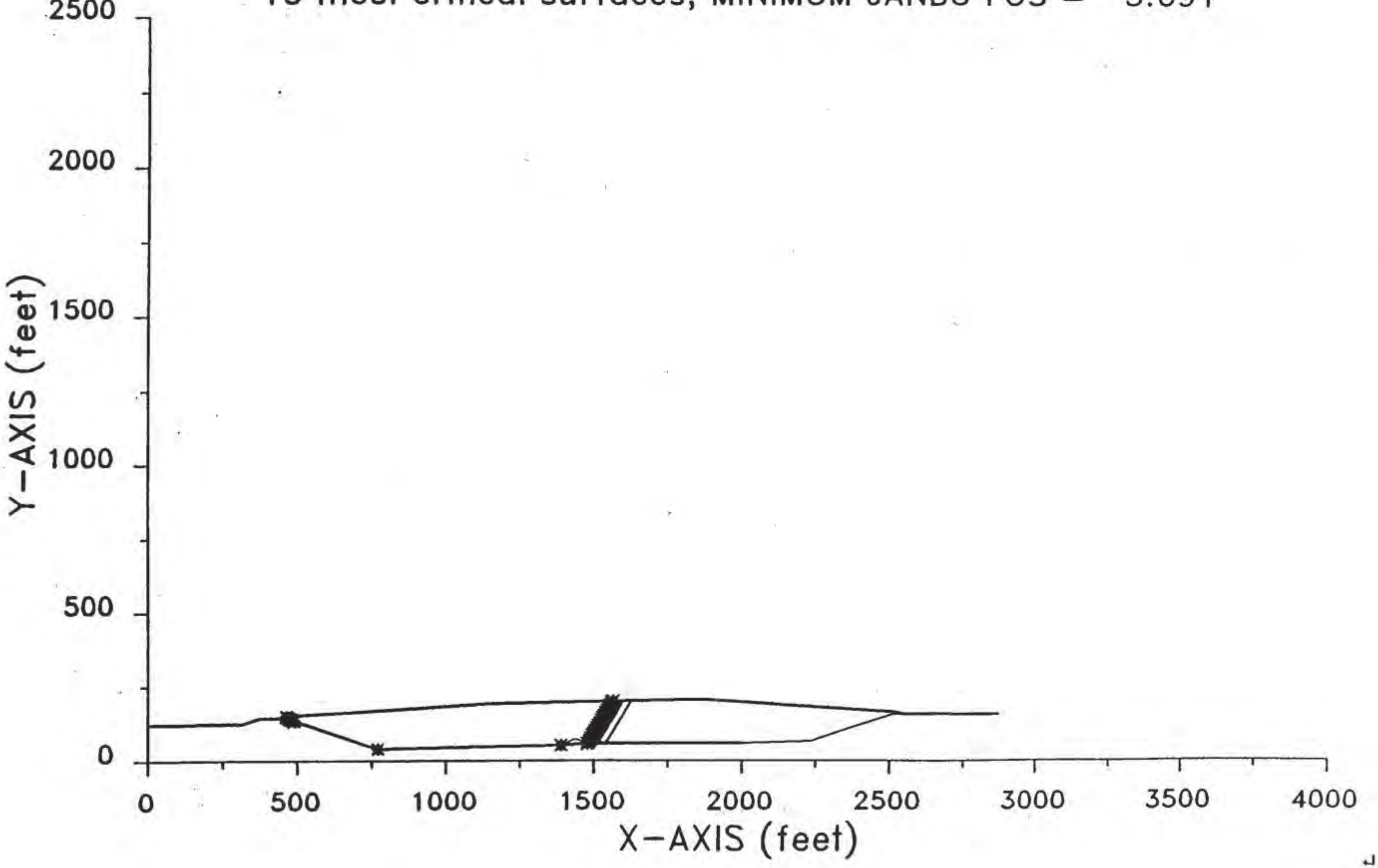
Gandy Basal Failure aa 2

10 most critical surfaces, MINIMUM JANBU FOS = 3.691



8 of 79
9020-204
pmp
7-Nov-[illegible]

[illegible]
602-0200
PMP
7-Nov-9

```
XSTABL File: GTBA3     11-06-97    8:51

          ******************************************
          *              X S T A B L               *
          *                                        *
          *       Slope Stability Analysis         *
          *               using the                *
          *           Method of Slices             *
          *                                        *
          *         Copyright (C) 1992 á 96        *
          *    Interactive Software Designs, Inc.  *
          *       Moscow, ID 83843, U.S.A.         *
          *                                        *
          *          All Rights Reserved           *
          *                                        *
          *   Ver. 5.200                96 á 1216  *
          ******************************************


Problem Description : Gandy Basal Failure aa 2



-----------------------------
SEGMENT BOUNDARY COORDINATES
-----------------------------

   10 SURFACE boundary segments

Segment     x-left     y-left     x-right    y-right      Soil Unit
  No.        (ft)       (ft)       (ft)       (ft)     Below Segment

   1          5.0      122.0      315.6      123.8           2
   2        315.6      123.8      375.2      143.6           2
   3        375.2      143.6      436.8      143.6           2
   4        436.8      143.6      474.5      153.0           1
   5        474.5      153.0     1146.0      192.8           1
   6       1146.0      192.8     1813.7      204.9           1
   7       1813.7      204.9     1884.7      205.0           1
   8       1884.7      205.0     2519.5      165.0           1
   9       2519.5      165.0     2543.7      159.0           1
  10       2543.7      159.0     2872.9      156.7           2

   10 SUBSURFACE boundary segments

Segment     x-left     y-left     x-right    y-right      Soil Unit
  No.        (ft)       (ft)       (ft)       (ft)     Below Segment

   1        436.8      143.6      465.1      143.6           2
   2        465.1      143.6      772.5       41.1           2
   3        772.5       41.1     1399.3       52.9           2
   4       1399.3       52.9     1433.2       69.8           2
   5       1433.2       69.8     1448.8       69.9           2
   6       1448.8       69.9     1472.6       58.0           2
   7       1472.6       58.0     2008.1       58.3           2
   8       2008.1       58.3     2233.9       65.1           2
   9       2233.9       65.1     2515.4      159.0           2
```

602-920
PMP
1-Nov-9

```
  10       2515.4     159.0      2543.7     159.0          2

--------------------------
ISOTROPIC Soil Parameters
--------------------------

 2 Soil unit(s) specified

Soil   Unit Weight    Cohesion  Friction      Pore Pressure        Water
Unit  Moist     Sat.  Intercept   Angle   Parameter  Constant   Surfac
 No.  (pcf)    (pcf)    (psf)     (deg)       Ru        (psf)      No.

  1   110.0    110.0        .0    29.00       .000            .0      0
  2   110.0    110.0     440.0     2.00       .000            .0      0


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.


The active and passive portions of the sliding surfaces
are generated according to the Rankine theory.


  500 trial surfaces will be generated and analyzed.


  4 boxes specified for generation of central block base


Length of line segments for active and passive portions of
sliding block is      10.0 ft

Box          x-left      y-left     x-right     y-right        Width
no.           (ft)        (ft)        (ft)        (ft)          (ft)

 1           485.1       136.5       535.1       119.8          1.0
 2           771.5        40.6       772.5        40.6          1.0
 3          1374.3        51.9      1399.3        52.4          1.0
 4          1472.6        57.5      2008.1        57.5          1.0


Factors of safety have been calculated by the :

* * * * *   SIMPLIFIED JANBU METHOD   * * * * *


The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 26 coordinate points

       Point       x-surf       y-surf
        No.         (ft)         (ft)
```

55 [illegible]
502-020V
pmp
7-Nov-[illegible]

```
      1           463.87        150.35
      2           471.45        145.89
      3           480.06        140.81
      4           488.68        135.74
      5           489.64        134.81
      6           771.93         40.40
      7          1390.88         51.83
      8          1480.58         57.64
      9          1480.94         58.00
     10          1486.01         66.62
     11          1491.09         75.24
     12          1496.16         83.85
     13          1501.24         92.47
     14          1506.31        101.09
     15          1511.39        109.70
     16          1516.46        118.32
     17          1521.54        126.94
     18          1526.61        135.55
     19          1531.69        144.17
     20          1536.77        152.78
     21          1541.84        161.40
     22          1546.92        170.02
     23          1551.99        178.63
     24          1557.07        187.25
     25          1562.14        195.87
     26          1564.81        200.39

 **  Corrected JANBU FOS =   3.691  **     (Fo factor = 1.052)


Failure surface No. 2 specified by 26 coordinate points

    Point        x-surf        y-surf
     No.          (ft)          (ft)

      1           463.04        150.14
      2           468.71        146.80
      3           477.33        141.72
      4           485.95        136.65
      5           486.71        135.91
      6           771.56         40.87
      7          1382.20         51.82
      8          1484.94         57.82
      9          1485.12         58.01
     10          1490.20         66.62
     11          1495.27         75.24
     12          1500.35         83.86
     13          1505.42         92.47
     14          1510.50        101.09
     15          1515.57        109.70
     16          1520.65        118.32
     17          1525.72        126.94
     18          1530.80        135.55
     19          1535.88        144.17
     20          1540.95        152.79
     21          1546.03        161.40
     22          1551.10        170.02
     23          1556.18        178.64
     24          1561.25        187.25
```

[illegible]

GoZ-021
pmf
7-Nov

```
       25          1566.33        195.87
       26          1569.04        200.47

  **  Corrected JANBU FOS =    3.695  **     (Fo factor = 1.052)

 Failure surface No. 3 specified by 26 coordinate points

      Point         x-surf         y-surf
       No.           (ft)           (ft)

        1           462.90         150.11
        2           468.25         146.95
        3           476.87         141.88
        4           485.49         136.80
        5           485.82         136.48
        6           771.56          40.38
        7          1385.46          52.08
        8          1505.19          57.81
        9          1505.39          58.02
       10          1510.46          66.63
       11          1515.54          75.25
       12          1520.61          83.87
       13          1525.69          92.48
       14          1530.76         101.10
       15          1535.84         109.72
       16          1540.92         118.33
       17          1545.99         126.95
       18          1551.07         135.57
       19          1556.14         144.18
       20          1561.22         152.80
       21          1566.29         161.41
       22          1571.37         170.03
       23          1576.44         178.65
       24          1581.52         187.26
       25          1586.59         195.88
       26          1589.51         200.84

  **  Corrected JANBU FOS =    3.697  **     (Fo factor = 1.051)

 Failure surface No. 4 specified by 26 coordinate points

      Point         x-surf         y-surf
       No.           (ft)           (ft)

        1.          463.64         150.29
        2           470.70         146.14
        3           479.31         141.06
        4           487.93         135.99
        5           488.48         135.46
        6           772.25          40.88
        7          1393.45          52.38
        8          1480.05          57.58
        9          1480.46          58.00
       10          1485.53          66.62
       11          1490.61          75.24
       12          1495.68          83.85
       13          1500.76          92.47
       14          1505.83         101.09
```

```
                15          1510.91          109.70
                16          1515.99          118.32
                17          1521.06          126.93
                18          1526.14          135.55
                19          1531.21          144.17
                20          1536.29          152.78
                21          1541.36          161.40
                22          1546.44          170.02
                23          1551.51          178.63
                24          1556.59          187.25
                25          1561.66          195.87
                26          1564.32          200.38

   **  Corrected JANBU FOS =     3.701  **      (Fo factor = 1.052)

  Failure surface No. 5 specified by 26 coordinate points

              Point         x-surf          y-surf
               No.           (ft)            (ft)

                1           463.22          150.19
                2           469.32          146.60
                3           477.94          141.52
                4           486.55          136.45
                5           487.63          135.40
                6           771.92           40.90
                7          1385.81           51.93
                8          1506.73           57.31
                9          1507.41           58.02
               10          1512.49           66.64
               11          1517.56           75.25
               12          1522.64           83.87
               13          1527.71           92.48
               14          1532.79          101.10
               15          1537.86          109.72
               16          1542.94          118.33
               17          1548.01          126.95
               18          1553.09          135.57
               19          1558.17          144.18
               20          1563.24          152.80
               21          1568.32          161.42
               22          1573.39          170.03
               23          1578.47          178.65
               24          1583.54          187.26
               25          1588.62          195.88
               26          1591.56          200.87

   **  Corrected JANBU FOS =     3.705  **      (Fo factor = 1.051)

  Failure surface No. 6 specified by 26 coordinate points

              Point         x-surf          y-surf
               No.           (ft)            (ft)

                1           462.74          150.07
                2           467.73          147.13
                3           476.35          142.05
                4           484.97          136.98
```

[illegible]
[illegible]
pmp
[illegible]

```
      5          485.82        136.16
      6          772.25         40.41
      7         1378.23         51.66
      8         1540.79         57.56
      9         1541.25         58.04
     10         1546.33         66.65
     11         1551.41         75.27
     12         1556.48         83.89
     13         1561.56         92.50
     14         1566.63        101.12
     15         1571.71        109.74
     16         1576.78        118.35
     17         1581.86        126.97
     18         1586.93        135.59
     19         1592.01        144.20
     20         1597.08        152.82
     21         1602.16        161.43
     22         1607.23        170.05
     23         1612.31        178.67
     24         1617.39        187.28
     25         1622.46        195.90
     26         1625.76        201.49

 **  Corrected JANBU FOS =   3.708  **    (Fo factor = 1.050)

Failure surface No. 7 specified by 27 coordinate points

    Point        x-surf        y-surf
     No.          (ft)          (ft)

      1          465.80        150.83
      2          469.15        148.86
      3          477.76        143.78
      4          486.38        138.71
      5          495.00        133.63
      6          496.13        132.53
      7          771.69         40.47
      8         1395.06         52.29
      9         1490.66         57.08
     10         1491.56         58.01
     11         1496.63         66.63
     12         1501.71         75.24
     13         1506.79         83.86
     14         1511.86         92.48
     15         1516.94        101.09
     16         1522.01        109.71
     17         1527.09        118.32
     18         1532.16        126.94
     19         1537.24        135.56
     20         1542.31        144.17
     21         1547.39        152.79
     22         1552.46        161.41
     23         1557.54        170.02
     24         1562.62        178.64
     25         1567.69        187.25
     26         1572.77        195.87
     27         1575.54        200.58

 **  Corrected JANBU FOS =   3.710  **    (Fo factor = 1.052)
```

```
Failure surface No. 8 specified by 27 coordinate points

          Point        x-surf        y-surf
           No.          (ft)          (ft)

            1          464.73        150.56
            2          465.64        150.03
            3          474.25        144.95
            4          482.87        139.88
            5          491.49        134.80
            6          491.67        134.62
            7          771.64         40.45
            8         1386.72         52.14
            9         1514.26         57.82
           10         1514.47         58.02
           11         1519.54         66.64
           12         1524.62         75.26
           13         1529.69         83.87
           14         1534.77         92.49
           15         1539.84        101.10
           16         1544.92        109.72
           17         1549.99        118.34
           18         1555.07        126.95
           19         1560.14        135.57
           20         1565.22        144.19
           21         1570.30        152.80
           22         1575.37        161.42
           23         1580.45        170.04
           24         1585.52        178.65
           25         1590.60        187.27
           26         1595.67        195.88
           27         1598.69        201.00

  **  Corrected JANBU FOS =   3.712  **      (Fo factor = 1.051)

Failure surface No. 9 specified by 26 coordinate points

          Point        x-surf        y-surf
           No.          (ft)          (ft)

            1          464.31        150.46
            2          472.88        145.41
            3          481.49        140.34
            4          490.11        135.26
            5          490.83        134.56
            6          772.32         40.46
            7         1379.07         51.70
            8         1540.94         57.54
            9         1541.42         58.04
           10         1546.49         66.65
           11         1551.57         75.27
           12         1556.65         83.89
           13         1561.72         92.50
           14         1566.80        101.12
           15         1571.87        109.74
           16         1576.95        118.35
           17         1582.02        126.97
```

[illegible]

```
          18          1587.10          135.59
          19          1592.17          144.20
          20          1597.25          152.82
          21          1602.32          161.43
          22          1607.40          170.05
          23          1612.48          178.67
          24          1617.55          187.28
          25          1622.63          195.90
          26          1625.92          201.50

   **   Corrected JANBU FOS =     3.718   **     (Fo factor = 1.050)

      Failure surface No.10 specified by 27 coordinate points

         Point          x-surf          y-surf
          No.            (ft)            (ft)

           1            466.93          151.11
           2            472.86          147.62
           3            481.48          142.54
           4            490.09          137.47
           5            498.71          132.39
           6            499.76          131.38
           7            772.41           40.51
           8           1395.76           51.99
           9           1493.74           57.08
          10           1494.64           58.01
          11           1499.72           66.63
          12           1504.79           75.24
          13           1509.87           83.86
          14           1514.94           92.48
          15           1520.02          101.09
          16           1525.09          109.71
          17           1530.17          118.33
          18           1535.24          126.94
          19           1540.32          135.56
          20           1545.39          144.18
          21           1550.47          152.79
          22           1555.55          161.41
          23           1560.62          170.02
          24           1565.70          178.64
          25           1570.77          187.26
          26           1575.85          195.87
          27           1578.66          200.64

   **   Corrected JANBU FOS =     3.719   **     (Fo factor = 1.052)



      The following is a summary of the TEN most critical surfaces

      Problem Description : Gandy Basal Failure aa 2

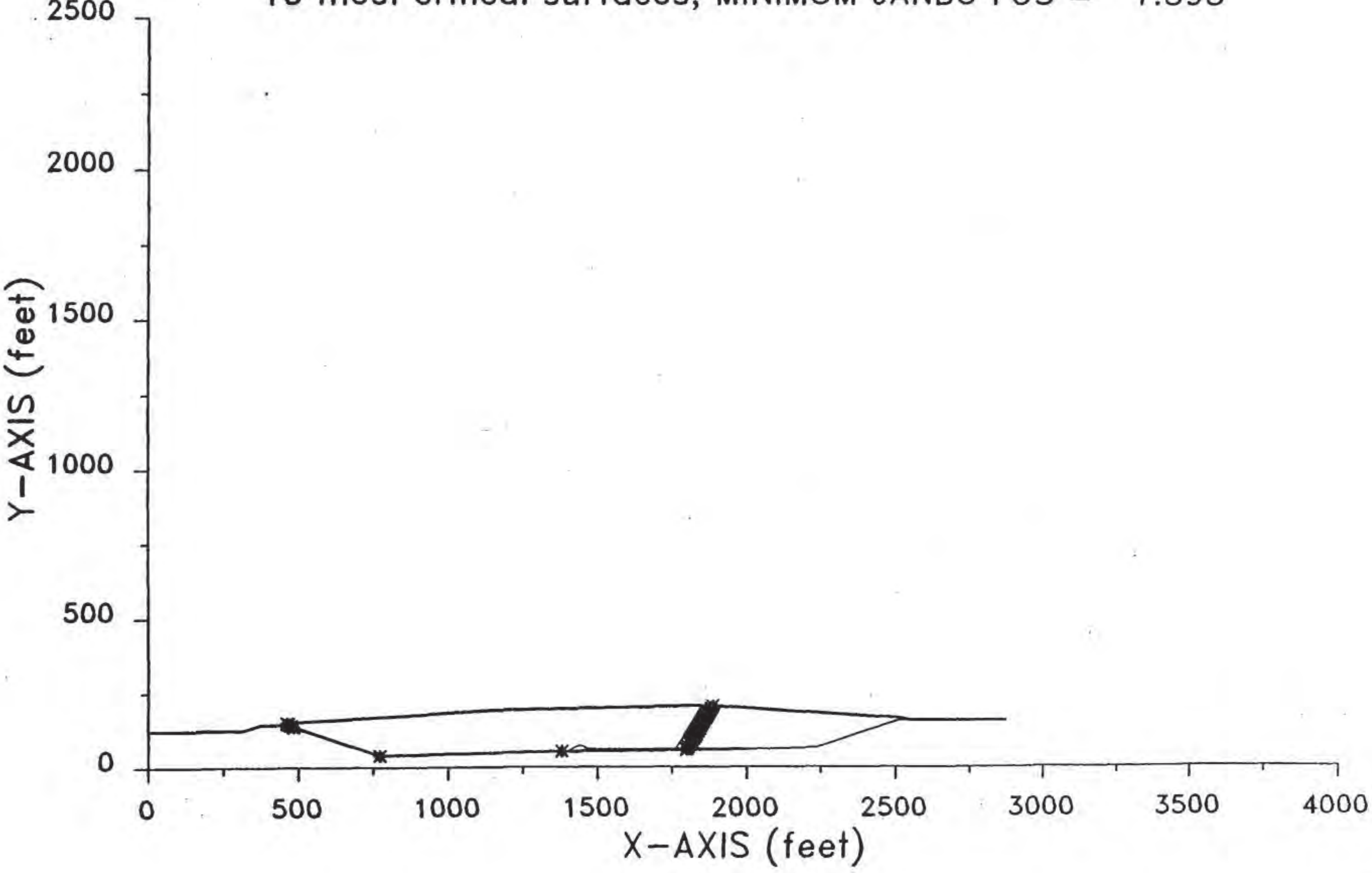
           Modified      Correction    Initial     Terminal     Available
          JANBU FOS        Factor      x-coord     x-coord      Strength
                                        (ft)         (ft)         (lb)
```

```
                                                                          6oz=
  1.     3.691          1.052       463.87      1564.81     1.493E+06  pm
  2.     3.695          1.052       463.04      1569.04     1.495E+06  2-n
  3.     3.697          1.051       462.90      1589.51     1.519E+06 ____
  4.     3.701          1.052       463.64      1564.32     1.490E+06
  5.     3.705          1.051       463.22      1591.56     1.521E+06
  6.     3.708          1.050       462.74      1625.76     1.560E+06
  7.     3.710          1.052       465.80      1575.54     1.508E+06
  8.     3.712          1.051       464.73      1598.69     1.532E+06
  9.     3.718          1.050       464.31      1625.92     1.563E+06
 10.     3.719          1.052       466.93      1578.66     1.514E+06

                    * * *  END OF FILE  * * *
```

BA3Q 11-06-97 8:52

Gandy Basal Failure aa 2 Q
10 most critical surfaces, MINIMUM JANBU FOS = 1.595



6-2-02
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3-N1

```
XSTABL File: GTBA3Q    11-06-97    8:52

          ******************************************
          *              X S T A B L               *
          *                                        *
          *        Slope Stability Analysis        *
          *               using the                *
          *            Method of Slices            *
          *                                        *
          *         Copyright (C) 1992 á 96        *
          *    Interactive Software Designs, Inc.  *
          *        Moscow, ID 83843, U.S.A.        *
          *                                        *
          *          All Rights Reserved           *
          *                                        *
          *  Ver. 5.200                96 á 1216   *
          ******************************************

   Problem Description : Gandy Basal Failure aa 2 Q



   -----------------------------
   SEGMENT BOUNDARY COORDINATES
   -----------------------------

      10 SURFACE boundary segments

   Segment    x-left     y-left     x-right    y-right     Soil Unit
     No.       (ft)       (ft)        (ft)       (ft)     Below Segment

      1         5.0      122.0       315.6      123.8          2
      2       315.6      123.8       375.2      143.6          2
      3       375.2      143.6       436.8      143.6          2
      4       436.8      143.6       474.5      153.0          1
      5       474.5      153.0      1146.0      192.8          1
      6      1146.0      192.8      1813.7      204.9          1
      7      1813.7      204.9      1884.7      205.0          1
      8      1884.7      205.0      2519.5      165.0          1
      9      2519.5      165.0      2543.7      159.0          1
     10      2543.7      159.0      2872.9      156.7          2

      10 SUBSURFACE boundary segments

   Segment    x-left     y-left     x-right    y-right     Soil Unit
     No.       (ft)       (ft)        (ft)       (ft)     Below Segment

      1       436.8      143.6       465.1      143.6          2
      2       465.1      143.6       772.5       41.1          2
      3       772.5       41.1      1399.3       52.9          2
      4      1399.3       52.9      1433.2       69.8          2
      5      1433.2       69.8      1448.8       69.9          2
      6      1448.8       69.9      1472.6       58.0          2
      7      1472.6       58.0      2008.1       58.3          2
      8      2008.1       58.3      2233.9       65.1          2
      9      2233.9       65.1      2515.4      159.0          2
```

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```
    10       2515.4     159.0     2543.7     159.0              2

  --------------------------
  ISOTROPIC Soil Parameters
  --------------------------

   2 Soil unit(s) specified

  Soil   Unit Weight   Cohesion  Friction     Pore Pressure       Water
  Unit  Moist    Sat.  Intercept   Angle  Parameter  Constant   Surfac
   No.  (pcf)   (pcf)    (psf)     (deg)      Ru        (psf)      No.

    1   110.0   110.0         .0    29.00     .000          .0       0
    2   110.0   110.0      440.0     2.00     .000          .0       0


  A horizontal earthquake loading coefficient
  of    .040 has been assigned

  A vertical earthquake loading coefficient
  of    .000 has been assigned


  A critical failure surface searching method, using a random
  technique for generating sliding BLOCK surfaces, has been
  specified.


  The active and passive portions of the sliding surfaces
  are generated according to the Rankine theory.


    500 trial surfaces will be generated and analyzed.


    4 boxes specified for generation of central block base


  Length of line segments for active and passive portions of
  sliding block is      10.0 ft


  Box          x-left     y-left    x-right    y-right        Width
  no.           (ft)       (ft)       (ft)       (ft)          (ft)

   1           485.1      136.5      535.1      119.8           1.0
   2           771.5       40.6      772.5       40.6           1.0
   3          1374.3       51.9     1399.3       52.4           1.0
   4          1472.6       57.5     2008.1       57.5           1.0


  Factors of safety have been calculated by the :

  * * * * *    SIMPLIFIED JANBU METHOD    * * * * *
```

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```
The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 27 coordinate points

  Point       x-surf       y-surf
   No.         (ft)         (ft)

    1         462.63       150.04
    2         467.37       147.25
    3         475.99       142.17
    4         484.60       137.10
    5         485.42       136.30
    6         772.40        40.15
    7        1380.63        52.28
    8        1798.39        57.73
    9        1798.83        58.18
   10        1803.90        66.80
   11        1808.98        75.42
   12        1814.05        84.03
   13        1819.13        92.65
   14        1824.21       101.26
   15        1829.28       109.88
   16        1834.36       118.50
   17        1839.43       127.11
   18        1844.51       135.73
   19        1849.58       144.35
   20        1854.66       152.96
   21        1859.73       161.58
   22        1864.81       170.19
   23        1869.88       178.81
   24        1874.96       187.43
   25        1880.03       196.04
   26        1885.11       204.66
   27        1885.29       204.96

 **  Corrected JANBU FOS =   1.595  **    (Fo factor = 1.043)

Failure surface No. 2 specified by 26 coordinate points

  Point       x-surf       y-surf
   No.         (ft)         (ft)

    1         463.22       150.19
    2.        469.32       146.60
    3         477.93       141.52
    4         486.55       136.45
    5         486.62       136.38
    6         772.10        40.19
    7        1376.04        51.56
    8        1823.15        57.89
    9        1823.44        58.20
   10        1828.52        66.81
   11        1833.60        75.43
   12        1838.67        84.05
   13        1843.75        92.66
   14        1848.82       101.28
   15        1853.90       109.89
```

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        16         1858.97        118.51
        17         1864.05        127.13
        18         1869.12        135.74
        19         1874.20        144.36
        20         1879.27        152.98
        21         1884.35        161.59
        22         1889.43        170.21
        23         1894.50        178.82
        24         1899.58        187.44
        25         1904.65        196.06
        26         1909.02        203.47

 **   Corrected JANBU FOS =   1.595  **     (Fo factor = 1.042)

Failure surface No. 3 specified by 26 coordinate points

      Point        x-surf         y-surf
       No.          (ft)           (ft)

        1          463.78         150.33
        2          471.13         145.99
        3          479.75         140.92
        4          488.37         135.84
        5          489.59         134.66
        6          772.14          40.22
        7         1398.82          52.36
        8         1825.22          57.44
        9         1825.95          58.20
       10         1831.02          66.81
       11         1836.10          75.43
       12         1841.17          84.05
       13         1846.25          92.66
       14         1851.32         101.28
       15         1856.40         109.90
       16         1861.47         118.51
       17         1866.55         127.13
       18         1871.63         135.74
       19         1876.70         144.36
       20         1881.78         152.98
       21         1886.85         161.59
       22         1891.93         170.21
       23         1897.00         178.83
       24         1902.08         187.44
       25         1907.15         196.06
       26         1911.43         203.32

 **   Corrected JANBU FOS =   1.597  **     (Fo factor = 1.042)

Failure surface No. 4 specified by 27 coordinate points

      Point        x-surf         y-surf
       No.          (ft)           (ft)

        1          462.88         150.10
        2          468.18         146.98
        3          476.80         141.90
        4          485.41         136.83
        5          485.71         136.54
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        6          772.40        40.14
        7         1388.55        52.41
        8         1783.57        57.03
        9         1784.67        58.17
       10         1789.75        66.79
       11         1794.82        75.41
       12         1799.90        84.02
       13         1804.97        92.64
       14         1810.05       101.26
       15         1815.12       109.87
       16         1820.20       118.49
       17         1825.27       127.11
       18         1830.35       135.72
       19         1835.43       144.34
       20         1840.50       152.95
       21         1845.58       161.57
       22         1850.65       170.19
       23         1855.73       178.80
       24         1860.80       187.42
       25         1865.88       196.04
       26         1870.95       204.65
       27         1871.15       204.98

  **  Corrected JANBU FOS =    1.598  **     (Fo factor = 1.044)

Failure surface No. 5 specified by 27 coordinate points

      Point        x-surf        y-surf
       No.          (ft)          (ft)

        1          462.60       150.03
        2          467.28       147.28
        3          475.89       142.20
        4          484.51       137.13
        5          485.94       135.75
        6          772.07        40.64
        7         1391.26        52.30
        8         1780.11        57.97
        9         1780.31        58.17
       10         1785.39        66.79
       11         1790.46        75.40
       12         1795.54        84.02
       13         1800.61        92.64
       14         1805.69       101.25
       15         1810.76       109.87
       16         1815.84       118.49
       17         1820.91       127.10
       18         1825.99       135.72
       19         1831.06       144.34
       20         1836.14       152.95
       21         1841.22       161.57
       22         1846.29       170.18
       23         1851.37       178.80
       24         1856.44       187.42
       25         1861.52       196.03
       26         1866.59       204.65
       27         1866.78       204.97

  **  Corrected JANBU FOS =    1.598  **     (Fo factor = 1.044)
```

```
Failure surface No. 6 specified by 27 coordinate points

          Point       x-surf       y-surf
           No.         (ft)         (ft)

            1         463.77       150.32
            2         471.10       146.00
            3         479.71       140.93
            4         488.33       135.85
            5         489.23       134.98
            6         772.12        40.18
            7        1394.94        52.56
            8        1791.58        57.93
            9        1791.83        58.18
           10        1796.90        66.80
           11        1801.98        75.41
           12        1807.05        84.03
           13        1812.13        92.64
           14        1817.20       101.26
           15        1822.28       109.88
           16        1827.35       118.49
           17        1832.43       127.11
           18        1837.51       135.73
           19        1842.58       144.34
           20        1847.66       152.96
           21        1852.73       161.57
           22        1857.81       170.19
           23        1862.88       178.81
           24        1867.96       187.42
           25        1873.03       196.04
           26        1878.11       204.66
           27        1878.31       204.99

 **  Corrected JANBU FOS =   1.598  **     (Fo factor = 1.044)

Failure surface No. 7 specified by 26 coordinate points

          Point       x-surf       y-surf
           No.         (ft)         (ft)

            1         464.04       150.39
            2         472.01       145.70
            3         480.62       140.63
            4         489.24       135.55
            5         490.62       134.22
            6         772.16        40.23
            7        1387.85        52.48
            8        1824.26        57.66
            9        1824.78        58.20
           10        1829.85        66.81
           11        1834.93        75.43
           12        1840.00        84.05
           13        1845.08        92.66
           14        1850.15       101.28
           15        1855.23       109.90
           16        1860.31       118.51
           17        1865.38       127.13
```

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        18          1870.46        135.74
        19          1875.53        144.36
        20          1880.61        152.98
        21          1885.68        161.59
        22          1890.76        170.21
        23          1895.83        178.83
        24          1900.91        187.44
        25          1905.98        196.06
        26          1910.30        203.39

  **  Corrected JANBU FOS =   1.599  **     (Fo factor = 1.042)

Failure surface No. 8 specified by 27 coordinate points

      Point         x-surf         y-surf
       No.           (ft)           (ft)

        1           464.30         150.46
        2           472.84         145.42
        3           481.46         140.35
        4           490.07         135.27
        5           491.28         134.11
        6           772.14          40.20
        7          1398.00          52.30
        8          1789.67          57.36
        9          1790.46          58.18
       10          1795.53          66.79
       11          1800.61          75.41
       12          1805.68          84.03
       13          1810.76          92.64
       14          1815.83         101.26
       15          1820.91         109.88
       16          1825.98         118.49
       17          1831.06         127.11
       18          1836.13         135.72
       19          1841.21         144.34
       20          1846.29         152.96
       21          1851.36         161.57
       22          1856.44         170.19
       23          1861.51         178.81
       24          1866.59         187.42
       25          1871.66         196.04
       26          1876.74         204.66
       27          1876.93         204.99

  **  Corrected JANBU FOS =   1.599  **     (Fo factor = 1.044)

Failure surface No. 9 specified by 27 coordinate points

      Point         x-surf         y-surf
       No.           (ft)           (ft)

        1           462.96         150.12
        2           468.45         146.89
        3           477.06         141.81
        4           485.68         136.74
        5           485.80         136.62
        6           772.05          40.12
```

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     7          1398.97         51.92
     8          1760.83         57.76
     9          1761.21         58.16
    10          1766.29         66.78
    11          1771.36         75.39
    12          1776.44         84.01
    13          1781.51         92.63
    14          1786.59        101.24
    15          1791.67        109.86
    16          1796.74        118.48
    17          1801.82        127.09
    18          1806.89        135.71
    19          1811.97        144.32
    20          1817.04        152.94
    21          1822.12        161.56
    22          1827.19        170.17
    23          1832.27        178.79
    24          1837.34        187.41
    25          1842.42        196.02
    26          1847.50        204.64
    27          1847.68        204.95

**   Corrected JANBU FOS =    1.599  **      (Fo factor = 1.044)

Failure surface No.10 specified by 26 coordinate points

    Point         x-surf          y-surf
     No.           (ft)            (ft)

     1            463.99         150.38
     2            471.82         145.76
     3            480.44         140.69
     4            489.06         135.61
     5            490.02         134.69
     6            771.81          40.71
     7           1390.15          52.34
     8           1811.88          57.58
     9           1812.47          58.19
    10           1817.54          66.81
    11           1822.62          75.42
    12           1827.70          84.04
    13           1832.77          92.66
    14           1837.85         101.27
    15           1842.92         109.89
    16           1848.00         118.50
    17           1853.07         127.12
    18           1858.15         135.74
    19           1863.22         144.35
    20           1868.30         152.97
    21           1873.37         161.59
    22           1878.45         170.20
    23           1883.53         178.82
    24           1888.60         187.43
    25           1893.68         196.05
    26           1898.44         204.13

**   Corrected JANBU FOS =    1.599  **      (Fo factor = 1.043)
```

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```
The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Basal Failure aa 2 Q

         Modified       Correction    Initial      Terminal     Available
         JANBU FOS        Factor      x-coord      x-coord      Strength
                                       (ft)         (ft)          (lb)

  1.       1.595          1.043       462.63       1885.29      1.725E+06
  2.       1.595          1.042       463.22       1909.02      1.750E+06
  3.       1.597          1.042       463.78       1911.43      1.754E+06
  4.       1.598          1.044       462.88       1871.15      1.711E+06
  5.       1.598          1.044       462.60       1866.78      1.705E+06
  6.       1.598          1.044       463.77       1878.31      1.719E+06
  7.       1.599          1.042       464.04       1910.30      1.753E+06
  8.       1.599          1.044       464.30       1876.93      1.720E+06
  9.       1.599          1.044       462.96       1847.68      1.687E+06
 10.       1.599          1.043       463.99       1898.44      1.740E+06

                        * * *  END OF FILE  * * *
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MONTGOMERY WATSON

Calculation Cover Sheet — Appendix E-5

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Cover Stability

	Name	Date
Prepared By:	Paul Pellicer	11/4/97
Checked By:	John Pellicer	11/12/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

Project Number: 602
Prepared By: P. Pellicer
Checked By: J. Pellicer

Sheet: 1 Of 48
Date: Nov 4, 1997
Date: 12-Nov-97

Cover Stability

Objective: Analyze the stability of The Cover system

Method: The Stability of The Cover slopes + Cover System were analyzed Three ways. First The Cover system was analyzed using infinite slope failure methods. Next The cover slope stability was analyzed using XSTABL (ver 5.200) to check both Circular and Block Modes of Failure.

Assumptions:
- Waste strength was assumed to be associated with a loose (25% relative density) Silty Sand (SM), The onsite Silty Sand will be used as daily cover. This should also be a conservative estimate of most soil, solidified waste, and debris placed in the Cell. $\phi = 29°$ (see pg 6)
- Underlaying foundation soil were assigned a medial undrained strength. $C = 1100$ psf. (conservative)

Calculations: Cross-section C (see pg 3+4) was cut through The longest Cover slope The cover slope is 6%.

Infinite slope stability methods were used to assess a failure of The cover system with the failure plane running through the liner system. Using an interface shear strength: $a = 15$ psf + $\delta = 31$ (see pg 8) the cover system has a static F.S. = 10.9 and a pseudo-static F.S = 5.5 using a ground acceleration = 0.04g (see pg 10-12)

XSTABL (ver 5.200) was used to assess Circular failure modes associated w/ the cover Slope. The static F.S for circular failures = 3.0. However the critical failure surfaces were failing Through the foundation Soil. This is very unlikely, and is probably due to The very conservative foundation Soil Strength
(See pg 13) assumed. (see pg 13-22)

Therefore a more likely failure mode was analyzed. A Block type failure running through the waste and along the liner system was analyzed. A waste strength of 29°, and liner interface strength of a = 400 psf, δ = 2° (see pg 7) were used. The casal grade was adjusted to remove a prasing berm and create a worst case sengrio (conservative) (see pg 4). The Block failure analysis resulted in a static F.S. = 2.8 (see pg 22-38) and a psuedo-static F.S. = 1.5 (see pg 39-48) useing a ground acceleration = 0.04g (see pg 10).

Conclusions: Both the cover system and the Cover waste slopes have adequate factors of safety both staticly + pseudo-staticly.

Addendum: Infinite slope analysis was completed for static and pseudostatic conditions assuming a fully saturated cover. This is to model periods after intense rainstorms.

Static SF = 5.25

Pseudostatic SF = 3.13

Cover system is stable under saturated conditions

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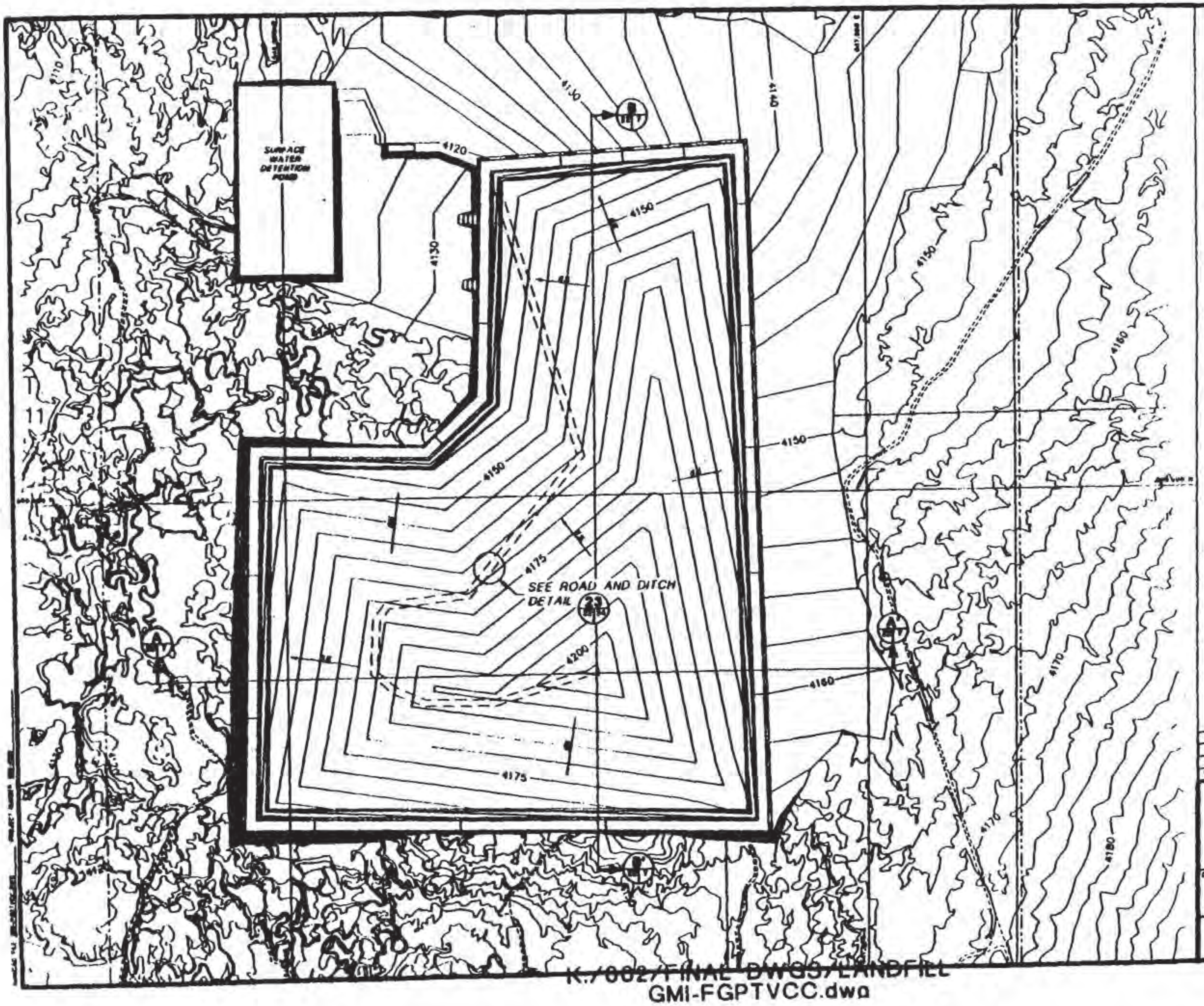

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NOTES
1 FOR GENERAL NOTES AND LEGEND INFORMATION S
DRAWING No 2 "INDEX, LEGEND AND GENERAL NO

2 TOPOGRAPHY FROM AERIAL SURVEYS PERFORMED
AUGUST 1997 BY KOOGLE AND POULS ENGINEERING

PROFESSIONAL ENGINEER'S STATEMENT
I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date ___ Patrick G. Corser, NM PE [illegible]

SCALE

[illegible] INTERVAL, 5 FT.
SURFACE TOPOGRAPHY CONTOUR INTERVAL 1 FT

Not For Construction

TRIASSIC PARK
WASTE DISPOSAL FACILIT

DRAWING TITLE
FINAL GRADING PLAN - TOP OF VEGETATIVE COVER CONTOURS

TerraMatrix

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602-0200
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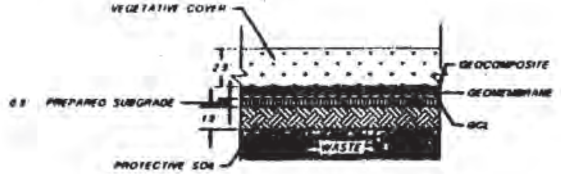
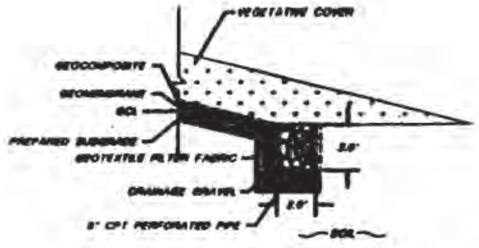
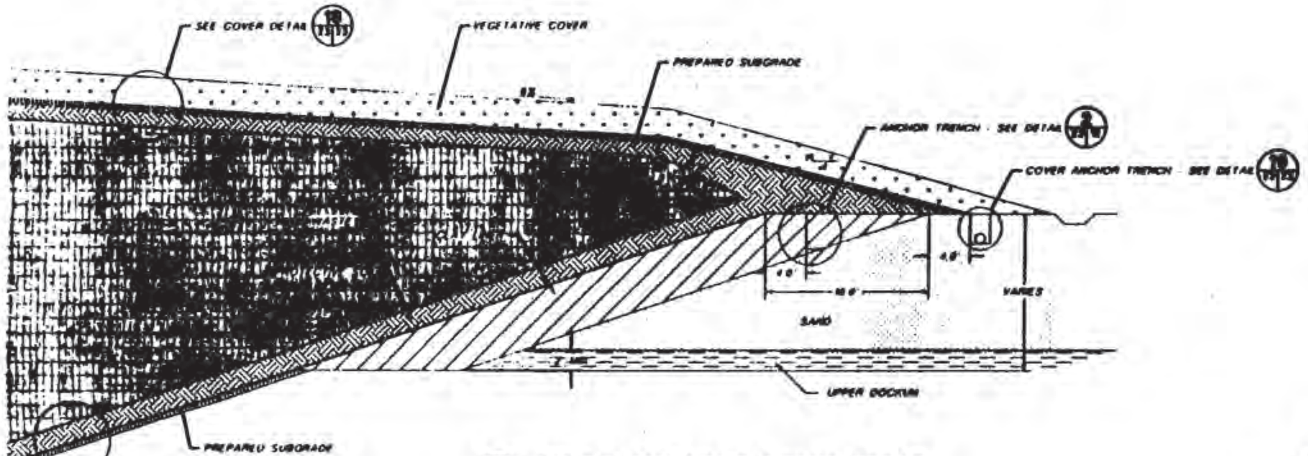
4-Nov-97



18 COVER DETAIL
NOT TO SCALE



COVER ANCHOR TRENCH DETAIL
NOT TO SCALE



17 COVER AND LINER CREST DETAIL
NOT TO SCALE

NOTE:
FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2,
"INDEX, LEGEND AND GENERAL NOTES".

Not For Construction

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE:
FINAL COVER DETAILS

TerraMatrix

K:/602/FINAL DWGS/LANDFILL
GANDY-COVERDETAIL.dwg
10,. .076
12/10/9 12:01p

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602-0209

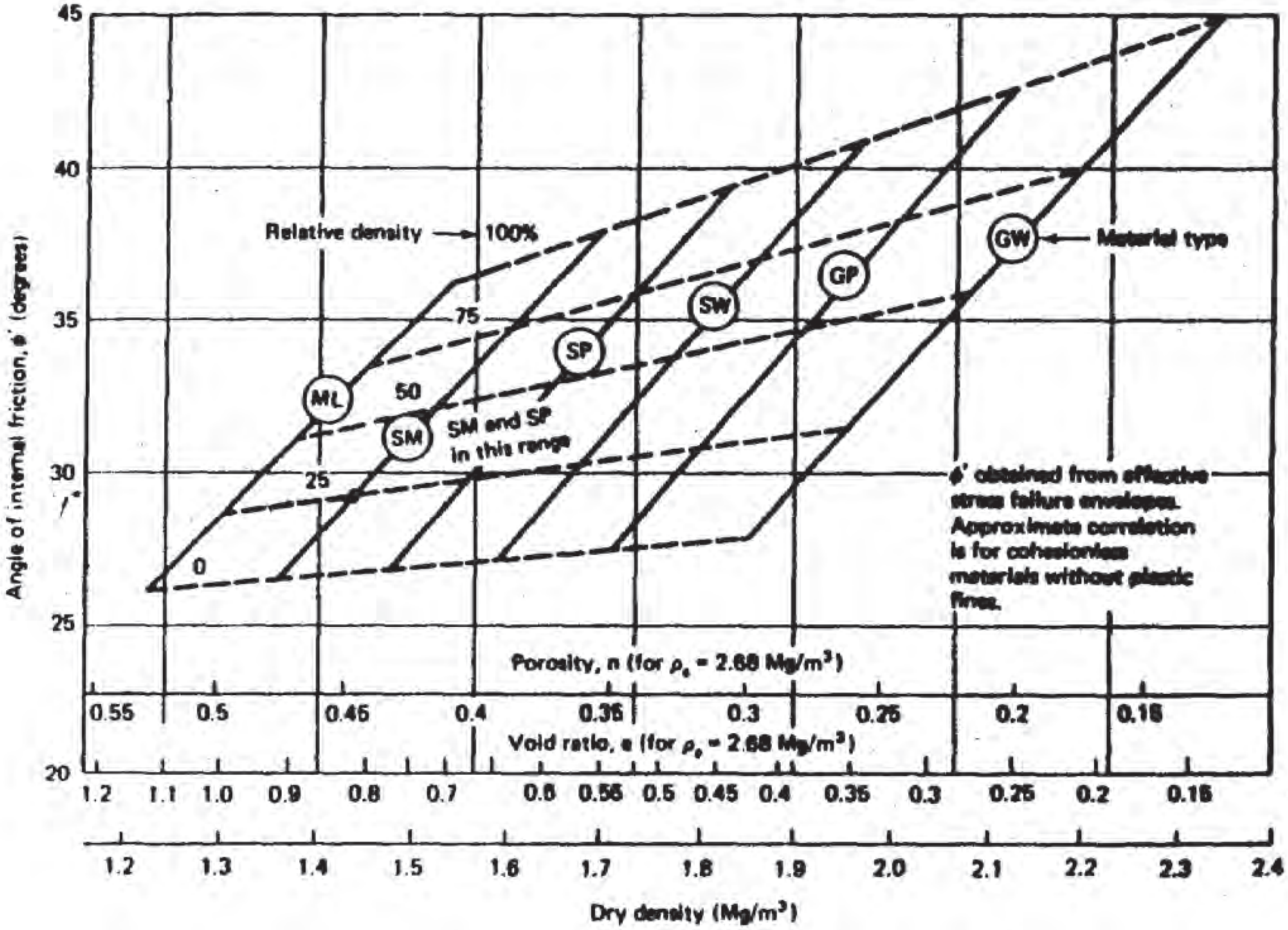

Fig. 11.13 Correlations between the effective friction angle in triaxial compression and the dry density, relative density, and soil classification (after U.S. Navy, 1971).

GEOSYNTEC CONSULTANTS

SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

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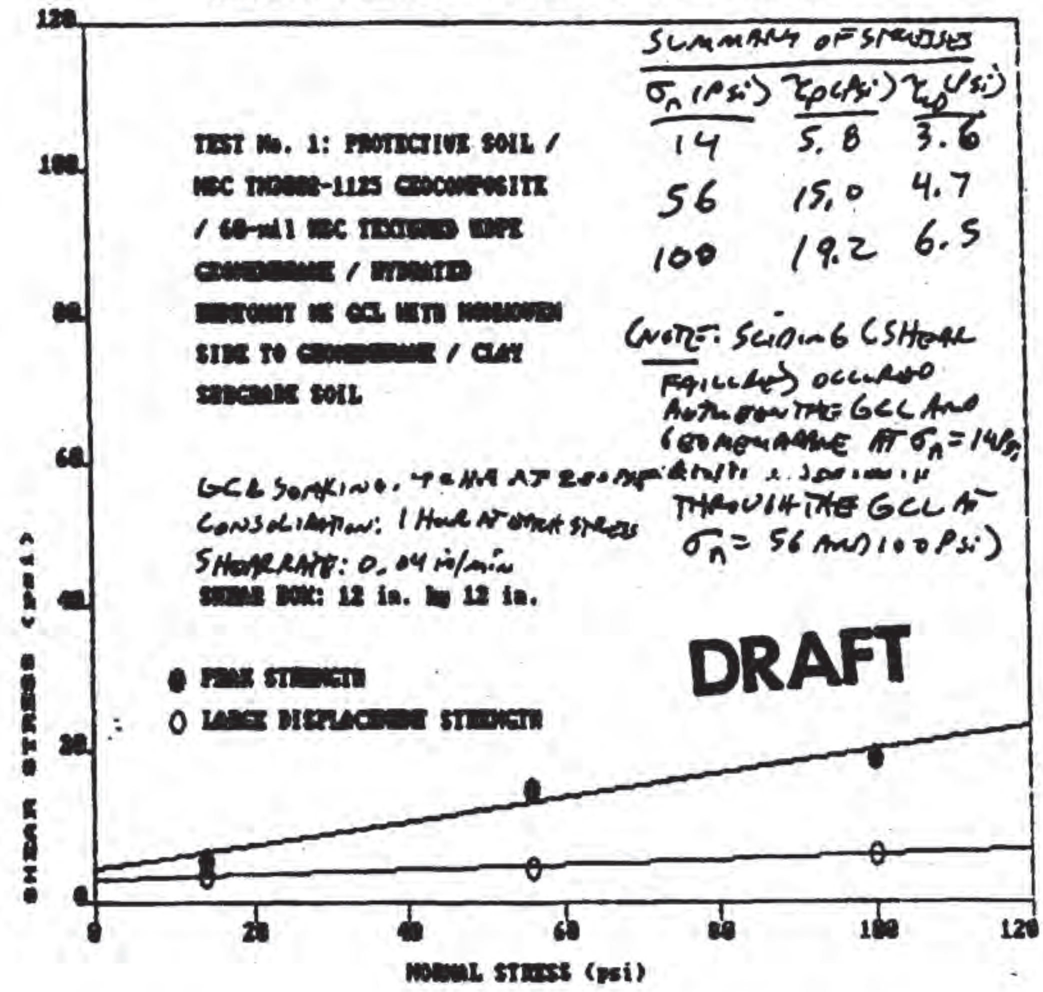
TERRAMATRIX MONTGOMERY WATSON - ASTM D 5321 TESTS



SUMMARY OF STRENGTHS

σ_n (psi)	τ_p (psi)	τ_{LD} (psi)
14	5.8	3.6
56	15.0	4.7
100	19.2	6.5

TEST No. 1: PROTECTIVE SOIL / NDC TN3000-1125 GEOCOMPOSITE / 60-mil NDC TEXTURED HDPE GEOMEMBRANE / HYDRATED BENTOMAT ST GCL WITH NONWOVEN SIDE TO GEOMEMBRANE / CLAY SUBGRADE SOIL

GCL SOAKING: 48 HR AT 200 PSF
CONSOLIDATION: 1 HOUR AT EACH STRESS
SHEAR RATE: 0.04 in/min
SHEAR BOX: 12 in. by 12 in.

(NOTE: SLIDING (SHEAR FAILURE) OCCURRED ALONG THE GCL AND GEOMEMBRANE AT σ_n=14 psi; AND IT IS [illegible] THROUGH THE GCL AT σ_n= 56 AND 100 psi)

THE REGRESSION POLYNOMIAL OF LINE 9 - PEAK STRENGTH

(4.534E+00) + (1.551E-01)*X a= 650 PSF δ= 9°
THE VARIANCE - 1.532E+00

THE REGRESSION POLYNOMIAL OF LINE 10 - LARGE DISPLACEMENT STRENGTH

(3.045E+00) + (3.321E-02)*X a= 440 PSF δ= 2°
THE VARIANCE - 3.240E-02

Reviewed By: Robert H. Swan Jr. Date: 10-8-97

GEOSYNTEC CONSULTANTS

SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

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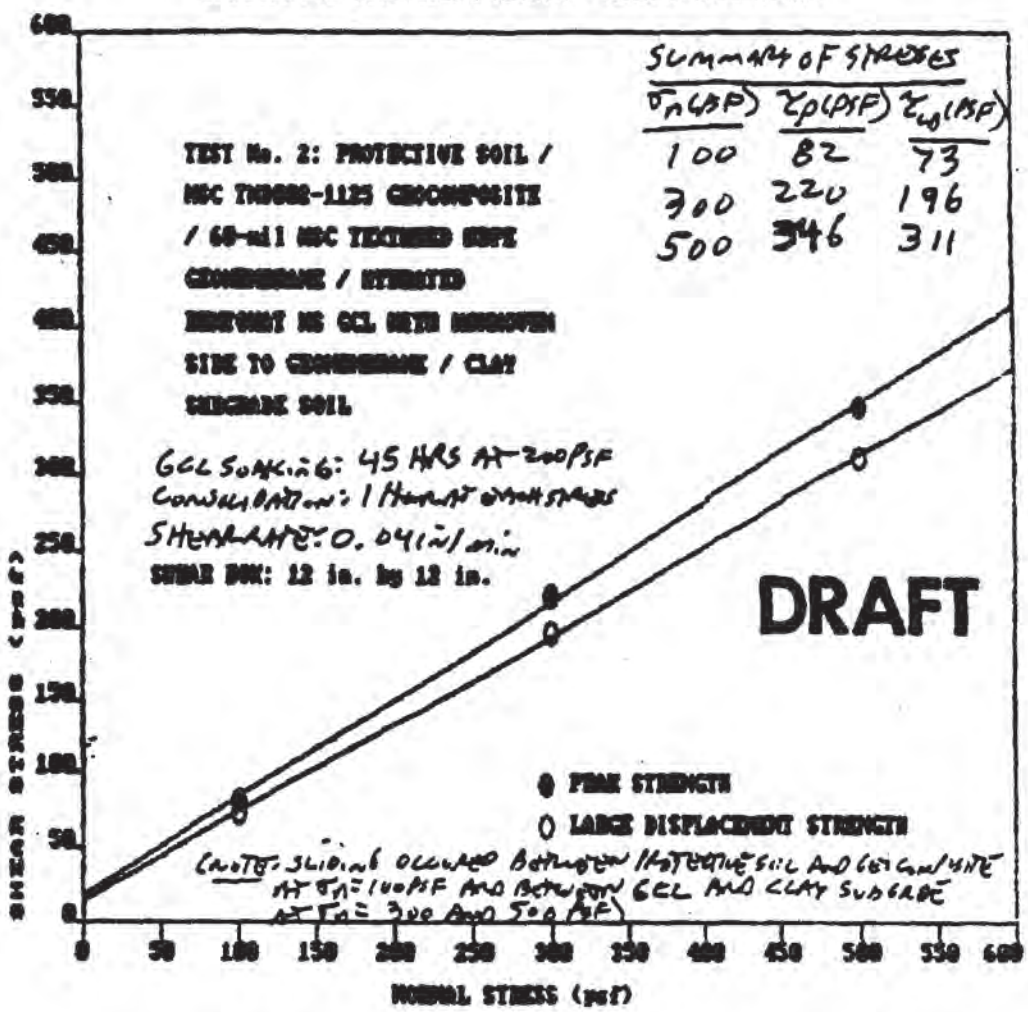
TERRAMATRIX MONTGOMERY WATSON - ASTM D 5321 TESTS



SUMMARY OF STRESSES

σ_n(PSF)	τ_p(PSF)	τ_{LD}(PSF)
100	82	73
300	220	196
500	346	311

TEST No. 2: PROTECTIVE SOIL / MSC TN3002-1125 GEOCOMPOSITE / 60-mil MSC TEXTURED HDPE GEOMEMBRANE / HYDRATED BENTOMAT DS GCL WITH NONWOVEN SIDE TO GEOMEMBRANE / CLAY SUBGRADE SOIL

GCL SOAKING: 45 HRS AT 200PSF
CONSOLIDATION: 1 HOUR AT EACH STRESS
SHEAR RATE: 0.04 in/min
SHEAR BOX: 12 in. by 12 in.

● PEAK STRENGTH
○ LARGE DISPLACEMENT STRENGTH

(NOTE: SLIDING OCCURRED BETWEEN PROTECTIVE SOIL AND GEOCOMPOSITE AT σ_n=100PSF AND BETWEEN GCL AND CLAY SUBGRADE AT σ_n= 300 AND 500 PSF)

THE REGRESSION POLYNOMIAL OF LINE 9 - PEAK STRENGTH

(1.800E+01) + (6.600E-01)*X
THE VARIANCE - 8.000E+00

a = 18 PSF δ = 33°

THE REGRESSION POLYNOMIAL OF LINE 10 - LARGE DISPLACEMENT STRENGTH

(1.483E+01) + (5.950E-01)*X
THE VARIANCE - 3.556E+00

a = 15 PSF δ = 31°

Reviewed By: Robert H Swan Jr Date: 10-10-97

[illegible]

602-1200
pmp
1-Nov-97

United States Department of the Interior

Geological Survey

PROBABILISTIC ESTIMATES OF MAXIMUM ACCELERATION AND VELOCITY IN ROCK IN THE CONTIGUOUS UNITED STATES

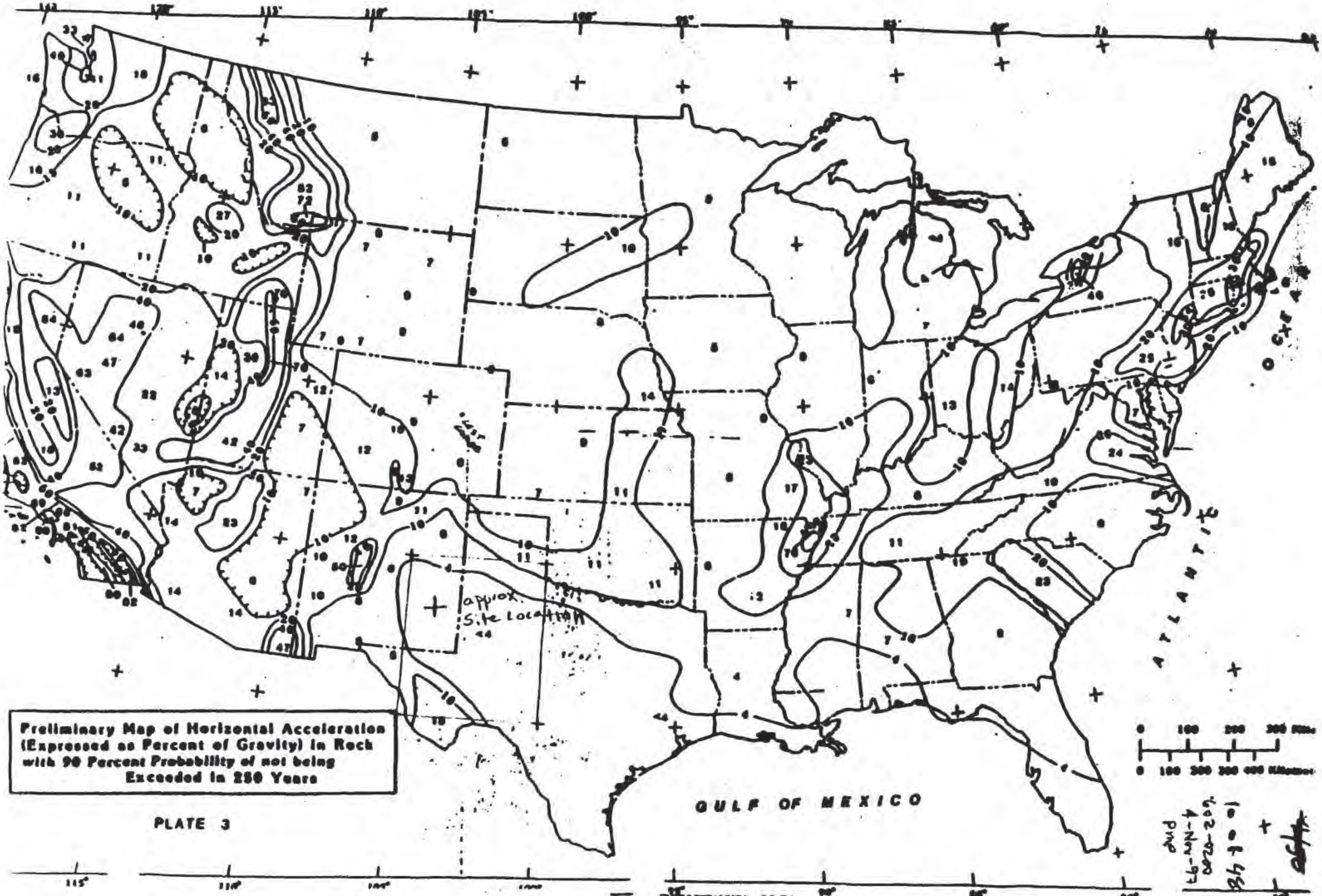
by

S. T. Algermissen, D. M. Perkins, P. C. Thenhaus,
S. L. Hanson and B. L. Bender

Open-File Report 82-1033

1982

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards.



Preliminary Map of Horizontal Acceleration (Expressed as Percent of Gravity) in Rock with 90 Percent Probability of not being Exceeded in 250 Years

PLATE 3

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602-0270
PMP
4-Nov-97

Infinite slope analysis spreadsheet
Date: 04-Nov-97
By: Paul Pellicer
Filename: Cover system stability .wq1

Soil Parameters

Cohesion:	15 psf		0.054643341
Friction Angle:	31 degrees	tangent	0.600860619
Gamma Moist:	110 pcf		

Slope Geometry:

Slope Angle:	3.43 degrees	cosine	0.998208638 sine
Failure Plane Depth:	2.5 ft		

Groundwater Parameters

Height of water in failure mass:	0 ft
Pore Pressure Ratio:	0 no units

Seismic Parameters

Ground Acceleration: 0 g's

Safety Factor: 10.9383 ✓

12.F 48
612-1210
PMP
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Infinite slope analysis spreadsheet
Date: 04-Nov-97
By: Paul Pellicer
Filename: Cover system stability Q.wq1

Soil Parameters

Cohesion:	15 psf		0.054643341
Friction Angle:	31 degrees	tangent	0.600860619
Gamma Moist:	110 pcf		

Slope Geometry:

Slope Angle:	3.43 degrees	cosine	0.998208638 sine
Failure Plane Depth:	2.5 ft		

Groundwater Parameters

Height of water in failure mass:	0 ft
Pore Pressure Ratio:	0 no units

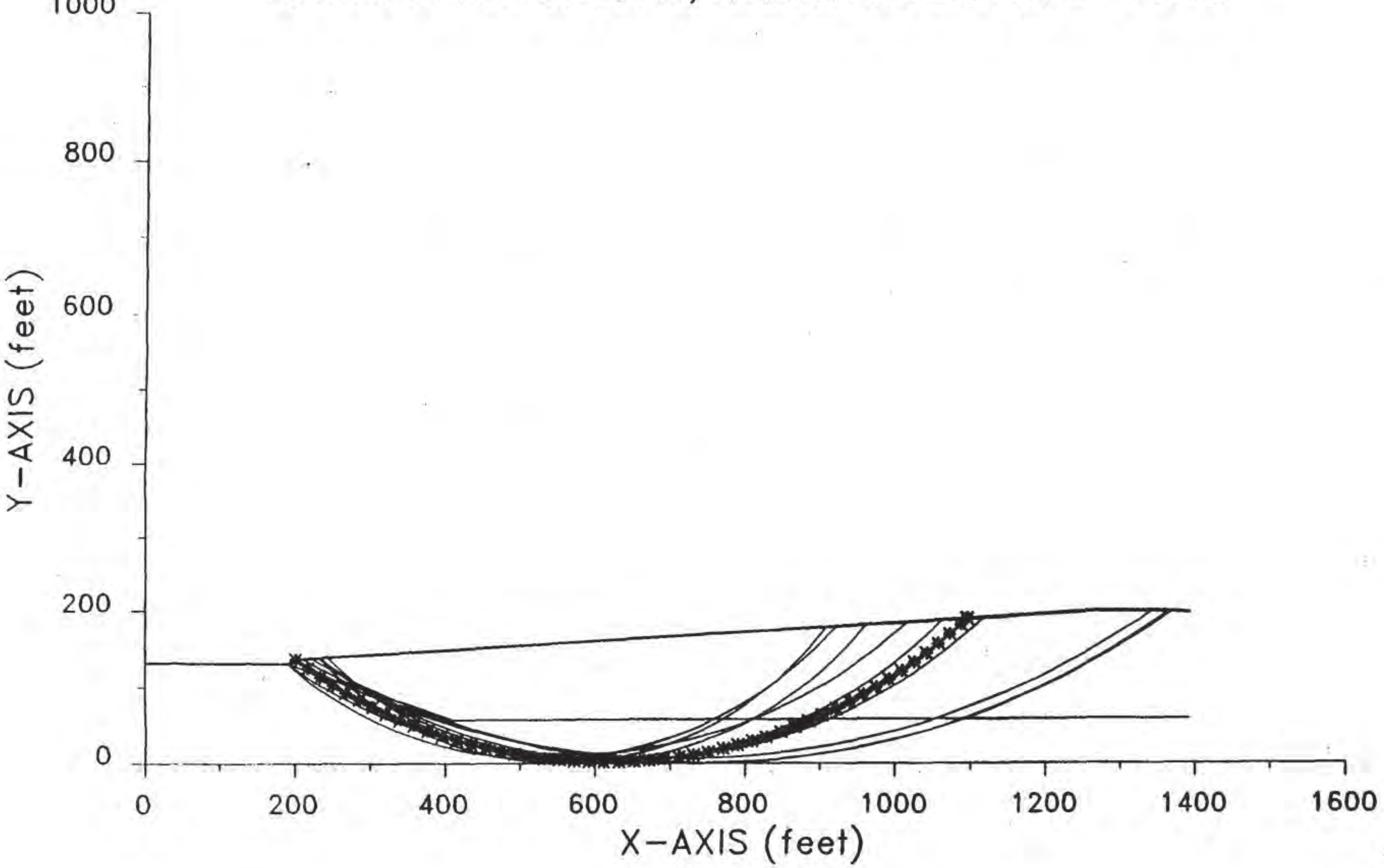
Seismic Parameters

Ground Acceleration:	0.04 g's

Safety Factor: 6.54578 ✓

ANC1 11-04-97 20:38

Gandy Cover Circular Failure
10 most critical surfaces, MINIMUM JANBU FOS = 3.040



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```
XSTABL File: GANC1    11-04-97   20:38

          ******************************************
          *                X S T A B L             *
          *                                        *
          *        Slope Stability Analysis        *
          *               using the                *
          *           Method of Slices             *
          *                                        *
          *        Copyright (C) 1992 á 96         *
          *   Interactive Software Designs, Inc.   *
          *        Moscow, ID 83843, U.S.A.        *
          *                                        *
          *           All Rights Reserved          *
          *                                        *
          * Ver. 5.200                  96 á 1216  *
          ******************************************


     Problem Description : Gandy Cover Circular Failure



     -----------------------------
     SEGMENT BOUNDARY COORDINATES
     -----------------------------

         5 SURFACE boundary segments

     Segment    x-left     y-left    x-right    y-right      Soil Unit
       No.       (ft)       (ft)       (ft)       (ft)     Below Segment

        1          .0      131.7      190.1      130.5           2
        2       190.1      130.5      200.1      135.9           1
        3       200.1      135.9     1270.7      200.0           1
        4      1270.7      200.0     1355.5      200.0           1
        5      1355.5      200.0     1393.4      198.4           1

         2 SUBSURFACE boundary segments

     Segment    x-left     y-left    x-right    y-right      Soil Unit
       No.       (ft)       (ft)       (ft)       (ft)     Below Segment

        1       190.1      130.5      411.8       57.5           2
        2       411.8       57.5     1393.4       59.4           2


     --------------------------
     ISOTROPIC Soil Parameters
     --------------------------

      2 Soil unit(s) specified

     Soil   Unit Weight   Cohesion  Friction     Pore Pressure      Wate
     Unit  Moist    Sat.  Intercept   Angle   Parameter  Constant  Surfac
      No.  (pcf)   (pcf)    (psf)     (deg)       Ru       (psf)     No.
```

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```
 1   110.0   110.0      .0    29.00      .000          .0     0
 2   110.0   110.0   1100.0     .00      .000          .0     0
```

```
A critical failure surface searching method, using a random
technique for generating CIRCULAR surfaces has been specified.

  900 trial surfaces will be generated and analyzed.

  30 Surfaces initiate from each of  30 points equally spaced
along the ground surface between  x =     190.0 ft
                              and  x =     500.0 ft

Each surface terminates between   x =     600.0 ft
                             and  x =    1370.0 ft

Unless further limitations were imposed, the minimum elevation
at which a surface extends is  y =        .0 ft

   20.0 ft line segments define each trial failure surface.


---------------------
ANGULAR RESTRICTIONS
---------------------

  The first segment of each failure surface will be inclined
  within the angular range defined by :

          Lower angular limit :=   -45.0 degrees
          Upper angular limit :=  (slope angle - 5.0) degrees



************************************************************
**      Factor of safety calculation for surface #   858    **
**      failed to converge within FIFTY iterations          **
**                                                          **
**     The last calculated value of the FOS was  11.7258    **
**     This will be ignored for final summary of results    **
************************************************************

The trial failure surface in question is
defined by the following  9 coordinate points

         Point         x-surf        y-surf
          No.           (ft)          (ft)

           1           489.31        153.22
           2           503.74        139.36
           3           521.26        129.72
           4           540.68        124.95
```

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```
         5          560.68       125.38
         6          579.88       130.98
         7          596.97       141.37
         8          610.79       155.83
         9          613.42       160.65


************************************************************
**      Factor of safety calculation for surface #   874      **
**      failed to converge within FIFTY iterations            **
**                                                            **
**     The last calculated value of the FOS was  11.7428      **
**     This will be ignored for final summary of results      **
************************************************************

The trial failure surface in question is
defined by the following  8 coordinate points

       Point        x-surf       y-surf
        No.          (ft)         (ft)

         1          500.00       153.86
         2          514.82       140.43
         3          532.99       132.06
         4          552.83       129.52
         5          572.51       133.04
         6          590.24       142.31
         7          604.38       156.46
         8          606.34       160.22


Factors of safety have been calculated by the :

* * * * *      SIMPLIFIED JANBU METHOD      * * * * *


The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 50 coordinate points

       Point        x-surf       y-surf
        No.          (ft)         (ft)

         1          200.69       135.94
         2          217.07       124.45
         3          233.76       113.44
         4          250.76       102.90
         5          268.04        92.84
         6          285.61        83.28
         7          303.44        74.21
         8          321.51        65.65
         9          339.82        57.61
        10          358.35        50.09
        11          377.09        43.09
        12          396.02        36.62
        13          415.12        30.69
        14          434.38        25.30
```

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```
      15          453.78        20.46
      16          473.32        16.17
      17          492.96        12.43
      18          512.71         9.25
      19          532.54         6.62
      20          552.43         4.56
      21          572.37         3.05
      22          592.35         2.11
      23          612.35         1.74
      24          632.35         1.93
      25          652.33         2.69
      26          672.29         4.00
      27          692.20         5.89
      28          712.05         8.33
      29          731.82        11.33
      30          751.50        14.89
      31          771.08        19.00
      32          790.52        23.67
      33          809.83        28.88
      34          828.99        34.63
      35          847.97        40.92
      36          866.77        47.75
      37          885.37        55.10
      38          903.76        62.98
      39          921.91        71.37
      40          939.82        80.27
      41          957.47        89.67
      42          974.85        99.57
      43          991.95       109.95
      44         1008.74       120.81
      45         1025.22       132.14
      46         1041.37       143.93
      47         1057.19       156.18
      48         1072.65       168.86
      49         1087.75       181.98
      50         1095.97       189.54

 **   Corrected JANBU FOS =   3.040  **    (Fo factor = 1.067)


Failure surface No. 2 specified by 63 coordinate points

    Point         x-surf        y-surf
     No.           (ft)          (ft)

      1           211.38       136.58
      2           228.99       127.09
      3           246.76       117.93
      4           264.71       109.09
      5           282.81       100.58
      6           301.06        92.41
      7           319.46        84.57
      8           338.00        77.07
      9           356.67        69.90
     10           375.47        63.08
     11           394.39        56.60
     12           413.43        50.47
     13           432.58        44.69
     14           451.83        39.26
     15           471.17        34.18
```

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```
          16            490.61          29.46
          17            510.12          25.09
          18            529.72          21.08
          19            549.38          17.42
          20            569.11          14.13
          21            588.89          11.20
          22            608.72           8.62
          23            628.60           6.41
          24            648.52           4.57
          25            668.46           3.09
          26            688.43           1.97
          27            708.42           1.22
          28            728.41            .83
          29            748.41            .81
          30            768.41           1.15
          31            788.40           1.86
          32            808.37           2.93
          33            828.32           4.37
          34            848.23           6.17
          35            868.12           8.33
          36            887.96          10.86
          37            907.75          13.75
          38            927.48          17.00
          39            947.15          20.61
          40            966.75          24.58
          41            986.28          28.90
          42           1005.73          33.58
          43           1025.08          38.62
          44           1044.34          44.01
          45           1063.50          49.75
          46           1082.55          55.84
          47           1101.49          62.27
          48           1120.30          69.05
          49           1138.99          76.17
          50           1157.55          83.63
          51           1175.97          91.43
          52           1194.24          99.57
          53           1212.36         108.03
          54           1230.32         116.83
          55           1248.12         125.95
          56           1265.75         135.40
          57           1283.20         145.16
          58           1300.47         155.25
          59           1317.56         165.64
          60           1334.45         176.35
          61           1351.14         187.36
          62           1367.63         198.68
          63           1368.70         199.44

  **  Corrected JANBU FOS =   3.076  **    (Fo factor = 1.057)

Failure surface No. 3 specified by 62 coordinate points

        Point          x-surf          y-surf
         No.            (ft)            (ft)

           1            200.69          135.94
           2            218.43          126.71
           3            236.34          117.81
```

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4	254.41	109.23
5	272.63	100.98
6	291.00	93.06
7	309.50	85.48
8	328.14	78.23
9	346.91	71.33
10	365.81	64.76
11	384.81	58.54
12	403.93	52.66
13	423.15	47.13
14	442.47	41.95
15	461.87	37.11
16	481.37	32.64
17	500.94	28.51
18	520.58	24.74
19	540.28	21.33
20	560.05	18.27
21	579.87	15.58
22	599.73	13.24
23	619.63	11.26
24	639.57	9.64
25	659.53	8.39
26	679.51	7.49
27	699.50	6.96
28	719.50	6.79
29	739.50	6.99
30	759.49	7.54
31	779.47	8.46
32	799.43	9.74
33	819.36	11.38
34	839.26	13.38
35	859.12	15.74
36	878.93	18.46
37	898.70	21.54
38	918.40	24.98
39	938.04	28.77
40	957.60	32.92
41	977.09	37.42
42	996.49	42.28
43	1015.80	47.48
44	1035.01	53.03
45	1054.12	58.93
46	1073.12	65.18
47	1092.01	71.77
48	1110.77	78.70
49	1129.40	85.97
50	1147.90	93.57
51	1166.25	101.51
52	1184.46	109.78
53	1202.52	118.38
54	1220.42	127.31
55	1238.15	136.55
56	1255.72	146.12
57	1273.10	156.00
58	1290.31	166.20
59	1307.33	176.71
60	1324.15	187.52
61	1340.78	198.64
62	1342.74	200.00

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```
  **  Corrected JANBU FOS =   3.158  **       (Fo factor = 1.056)

Failure surface No. 4 specified by 62 coordinate points

        Point        x-surf        y-surf
         No.          (ft)          (ft)

          1          222.07        137.22
          2          239.61        127.60
          3          257.32        118.31
          4          275.20        109.36
          5          293.25        100.74
          6          311.46         92.47
          7          329.82         84.54
          8          348.32         76.95
          9          366.97         69.71
         10          385.74         62.82
         11          404.64         56.28
         12          423.66         50.10
         13          442.80         44.27
         14          462.04         38.81
         15          481.38         33.71
         16          500.81         28.97
         17          520.32         24.59
         18          539.91         20.58
         19          559.58         16.94
         20          579.31         13.67
         21          599.10         10.77
         22          618.94          8.24
         23          638.82          6.08
         24          658.74          4.29
         25          678.69          2.88
         26          698.67          1.84
         27          718.65          1.18
         28          738.65           .89
         29          758.65           .98
         30          778.65          1.44
         31          798.63          2.27
         32          818.59          3.48
         33          838.53          5.06
         34          858.43          7.02
         35          878.30          9.35
         36          898.11         12.05
         37          917.88         15.12
         38          937.58         18.56
         39          957.21         22.37
         40          976.77         26.55
         41          996.25         31.09
         42         1015.64         35.99
         43         1034.93         41.26
         44         1054.12         46.89
         45         1073.21         52.88
         46         1092.17         59.22
         47         1111.02         65.92
         48         1129.73         72.97
         49         1148.32         80.37
         50         1166.75         88.12
         51         1185.05         96.21
         52         1203.18        104.64
```

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```
       53         1221.16       113.41
       54         1238.96       122.52
       55         1256.60       131.95
       56         1274.05       141.72
       57         1291.32       151.81
       58         1308.39       162.22
       59         1325.27       172.95
       60         1341.94       184.00
       61         1358.41       195.36
       62         1364.36       199.63

 **  Corrected JANBU FOS =   3.194  **     (Fo factor = 1.058)

Failure surface No. 5 specified by 47 coordinate points

      Point        x-surf        y-surf
       No.          (ft)          (ft)

        1          232.76       137.86
        2          248.62       125.67
        3          264.86       114.00
        4          281.47       102.87
        5          298.43        92.27
        6          315.73        82.22
        7          333.33        72.73
        8          351.23        63.81
        9          369.41        55.47
       10          387.85        47.72
       11          406.52        40.56
       12          425.42        34.01
       13          444.52        28.07
       14          463.80        22.75
       15          483.24        18.05
       16          502.82        13.97
       17          522.52        10.53
       18          542.32         7.72
       19          562.20         5.55
       20          582.14         4.01
       21          602.12         3.12
       22          622.12         2.87
       23          642.12         3.27
       24          662.09         4.31
       25          682.02         5.98
       26          701.89         8.30
       27          721.67        11.25
       28          741.34        14.84
       29          760.89        19.06
       30          780.30        23.90
       31          799.54        29.37
       32          818.59        35.45
       33          837.44        42.14
       34          856.06        49.43
       35          874.44        57.31
       36          892.56        65.78
       37          910.39        74.83
       38          927.93        84.45
       39          945.15        94.63
       40          962.03       105.35
       41          978.56       116.61
```

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fmr
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```
      42          994.72         128.40
      43         1010.49         140.70
      44         1025.86         153.49
      45         1040.81         166.78
      46         1055.32         180.54
      47         1062.22         187.52

 **   Corrected JANBU FOS =    3.210  **      (Fo factor = 1.070)

Failure surface No. 6 specified by 50 coordinate points

     Point          x-surf          y-surf
      No.            (ft)            (ft)

       1           232.76          137.86
       2           249.08          126.30
       3           265.73          115.22
       4           282.70          104.62
       5           299.95           94.52
       6           317.50           84.91
       7           335.31           75.82
       8           353.37           67.23
       9           371.68           59.17
      10           390.21           51.64
      11           408.94           44.65
      12           427.87           38.20
      13           446.98           32.29
      14           466.25           26.93
      15           485.67           22.13
      16           505.21           17.89
      17           524.87           14.22
      18           544.63           11.11
      19           564.47            8.57
      20           584.37            6.60
      21           604.32            5.20
      22           624.30            4.38
      23           644.30            4.13
      24           664.30            4.45
      25           684.28            5.35
      26           704.22            6.83
      27           724.12            8.87
      28           743.95           11.49
      29           763.69           14.68
      30           783.34           18.43
      31           802.87           22.74
      32           822.26           27.62
      33           841.51           33.05
      34           860.60           39.03
      35           879.50           45.55
      36           898.21           52.62
      37           916.71           60.22
      38           934.98           68.35
      39           953.02           77.00
      40           970.79           86.17
      41           988.30           95.84
      42          1005.52          106.01
      43          1022.44          116.68
      44          1039.05          127.82
      45          1055.33          139.44
```

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```
        46          1071.27        151.52
        47          1086.85        164.05
        48          1102.07        177.03
        49          1116.91        190.43
        50          1117.31        190.82

 **   Corrected JANBU FOS =    3.234   **     (Fo factor = 1.067)

Failure surface No. 7 specified by 42 coordinate points

      Point          x-surf         y-surf
       No.            (ft)           (ft)

        1           190.00         130.50
        2           205.52         117.88
        3           221.50         105.86
        4           237.92          94.45
        5           254.77          83.67
        6           272.01          73.54
        7           289.63          64.06
        8           307.59          55.27
        9           325.87          47.16
       10           344.45          39.74
       11           363.29          33.04
       12           382.38          27.06
       13           401.67          21.80
       14           421.15          17.28
       15           440.79          13.50
       16           460.56          10.47
       17           480.43           8.18
       18           500.37           6.66
       19           520.36           5.89
       20           540.36           5.87
       21           560.34           6.62
       22           580.29           8.12
       23           600.16          10.38
       24           619.93          13.38
       25           639.58          17.14
       26           659.07          21.64
       27           678.37          26.87
       28           697.46          32.83
       29           716.31          39.51
       30           734.90          46.89
       31           753.19          54.98
       32           771.16          63.75
       33           788.79          73.20
       34           806.05          83.31
       35           822.91          94.07
       36           839.35         105.46
       37           855.35         117.46
       38           870.88         130.06
       39           885.92         143.24
       40           900.45         156.98
       41           914.45         171.26
       42           921.57         179.10

 **   Corrected JANBU FOS =    3.235   **     (Fo factor = 1.072)
```

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```
Failure surface No. 8 specified by 40 coordinate points

         Point       x-surf       y-surf
          No.         (ft)         (ft)

           1         232.76       137.86
           2         246.92       123.73
           3         261.70       110.26
           4         277.08        97.47
           5         293.01        85.38
           6         309.47        74.03
           7         326.43        63.42
           8         343.85        53.60
           9         361.70        44.56
          10         379.93        36.34
          11         398.51        28.95
          12         417.41        22.41
          13         436.59        16.72
          14         456.00        11.90
          15         475.61         7.97
          16         495.37         4.91
          17         515.25         2.76
          18         535.22         1.50
          19         555.21         1.14
          20         575.20         1.68
          21         595.15         3.12
          22         615.02         5.47
          23         634.75         8.70
          24         654.32        12.82
          25         673.69        17.81
          26         692.81        23.68
          27         711.65        30.39
          28         730.16        37.96
          29         748.32        46.34
          30         766.08        55.54
          31         783.41        65.53
          32         800.27        76.29
          33         816.63        87.79
          34         832.45       100.03
          35         847.71       112.96
          36         862.36       126.56
          37         876.39       140.82
          38         889.77       155.69
          39         902.46       171.15
          40         907.79       178.27

 **  Corrected JANBU FOS =   3.302  **     (Fo factor = 1.078)


Failure surface No. 9 specified by 42 coordinate points

         Point       x-surf       y-surf
          No.         (ft)         (ft)

           1         243.45       138.50
           2         258.14       124.93
           3         273.38       111.97
           4         289.13        99.65
           5         305.37        87.98
           6         322.08        76.99
```

```
      7         339.22       66.68
      8         356.77       57.09
      9         374.70       48.22
     10         392.97       40.09
     11         411.56       32.72
     12         430.44       26.11
     13         449.57       20.28
     14         468.92       15.23
     15         488.47       10.98
     16         508.17        7.53
     17         527.99        4.89
     18         547.91        3.06
     19         567.88        2.05
     20         587.88        1.86
     21         607.87        2.48
     22         627.82        3.92
     23         647.69        6.17
     24         667.46        9.23
     25         687.08       13.10
     26         706.53       17.77
     27         725.77       23.23
     28         744.77       29.47
     29         763.50       36.48
     30         781.93       44.25
     31         800.02       52.77
     32         817.76       62.02
     33         835.10       71.98
     34         852.01       82.65
     35         868.48       94.00
     36         884.47      106.01
     37         899.96      118.67
     38         914.91      131.95
     39         929.31      145.83
     40         943.14      160.28
     41         956.35      175.29
     42         961.37      181.48

 **  Corrected JANBU FOS =   3.327  **     (Fo factor = 1.076)

Failure surface No.10 specified by 46 coordinate points

    Point        x-surf      y-surf
     No.          (ft)        (ft)

      1         190.00      130.50
      2         206.63      119.39
      3         223.58      108.78
      4         240.85       98.69
      5         258.41       89.11
      6         276.25       80.07
      7         294.35       71.57
      8         312.70       63.61
      9         331.28       56.21
     10         350.08       49.37
     11         369.07       43.10
     12         388.24       37.39
     13         407.57       32.27
     14         427.04       27.73
     15         446.65       23.77
```

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```
          16          466.36          20.40
          17          486.17          17.63
          18          506.05          15.45
          19          525.99          13.87
          20          545.96          12.88
          21          565.96          12.50
          22          585.96          12.71
          23          605.94          13.53
          24          625.89          14.94
          25          645.79          16.95
          26          665.62          19.56
          27          685.36          22.76
          28          705.00          26.55
          29          724.52          30.93
          30          743.89          35.89
          31          763.11          41.44
          32          782.15          47.55
          33          801.00          54.23
          34          819.64          61.48
          35          838.06          69.28
          36          856.23          77.63
          37          874.15          86.52
          38          891.79          95.94
          39          909.14         105.89
          40          926.18         116.36
          41          942.90         127.33
          42          959.29         138.79
          43          975.32         150.75
          44          990.99         163.18
          45         1006.28         176.07
          46         1015.97         184.75

 **  Corrected JANBU FOS =   3.344  **    (Fo factor = 1.066)


*******************************************************************
**                                                               **
**  Out of the    900 surfaces generated and analyzed by XSTABL, **
**        2 surfaces were found to have MISLEADING FOS values.   **
**                                                               **
*******************************************************************



The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Cover Circular Failure

       Modified      Correction    Initial     Terminal    Available
      JANBU FOS        Factor      x-coord      x-coord     Strength
                                    (ft)         (ft)         (lb)

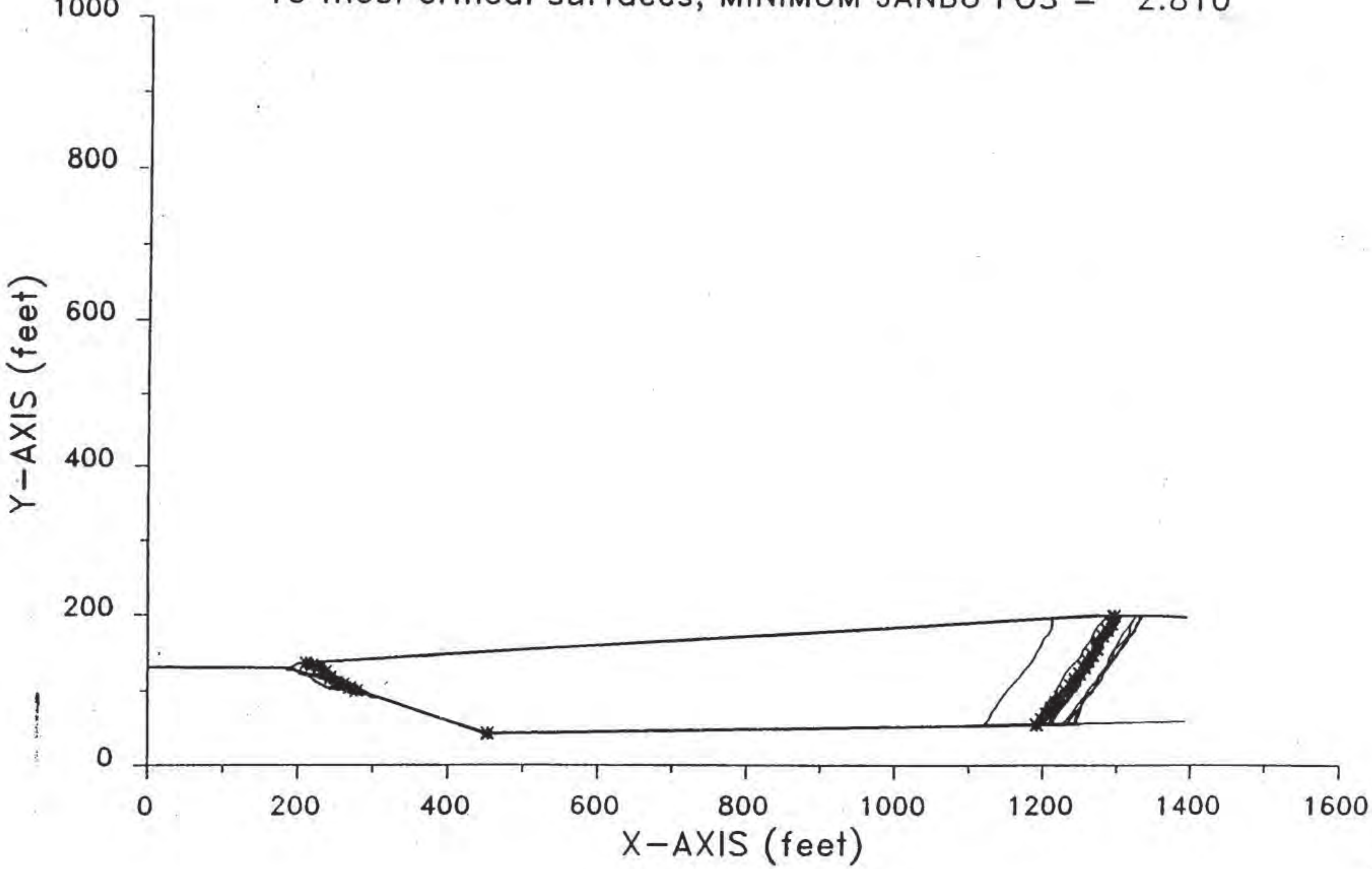
 1.     3.040          1.067       200.69      1095.97     1.660E+06
 2.     3.076          1.057       211.38      1368.70     2.329E+06
 3.     3.158          1.056       200.69      1342.74     2.291E+06
 4.     3.194          1.058       222.07      1364.36     2.385E+06
 5.     3.210          1.070       232.76      1062.22     1.589E+06
```

```
   6.     3.234        1.067     232.76     1117.31    1.731E+06  Prod
   7.     3.235        1.072     190.00      921.57    1.343E+06  602-
   8.     3.302        1.078     232.76      907.79    1.252E+06
   9.     3.327        1.076     243.45      961.37    1.369E+06
  10.     3.344        1.066     190.00     1015.97    1.571E+06

                      * * *  END OF FILE  * * *
```

ANC4 11-04-97 20:26

Gandy Cover Block Failure
10 most critical surfaces, MINIMUM JANBU FOS = 2.810



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602-9209
pmr
4-Nov-9

```
XSTABL File: GANC4     11-04-97   20:26

          *****************************************
          *              X S T A B L              *
          *                                       *
          *        Slope Stability Analysis       *
          *              using the                *
          *           Method of Slices            *
          *                                       *
          *         Copyright (C) 1992 á 96       *
          *    Interactive Software Designs, Inc. *
          *        Moscow, ID 83843, U.S.A.       *
          *                                       *
          *          All Rights Reserved          *
          *                                       *
          *  Ver. 5.200               96 á 1216   *
          *****************************************

    Problem Description : Gandy Cover Block    Failure



    -----------------------------
    SEGMENT BOUNDARY COORDINATES
    -----------------------------

        5 SURFACE boundary segments

    Segment    x-left     y-left    x-right    y-right     Soil Unit
      No.       (ft)       (ft)       (ft)       (ft)    Below Segment

       1           .0     131.7      190.1      130.5          2
       2        190.1     130.5      200.1      135.9          1
       3        200.1     135.9     1270.7      200.0          1
       4       1270.7     200.0     1355.5      200.0          1
       5       1355.5     200.0     1393.4      198.4          1

        2 SUBSURFACE boundary segments

    Segment    x-left     y-left    x-right    y-right     Soil Unit
      No.       (ft)       (ft)       (ft)       (ft)    Below Segment

       1        190.1     130.5      453.1       43.8          2
       2        453.1      43.8     1393.4       59.4          2


    --------------------------
    ISOTROPIC Soil Parameters
    --------------------------

     2 Soil unit(s) specified

    Soil   Unit Weight   Cohesion  Friction     Pore Pressure      Water
    Unit  Moist    Sat.  Intercept   Angle  Parameter  Constant  Surface
     No.  (pcf)   (pcf)    (psf)     (deg)      Ru       (psf)      No.
```

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```
  1   110.0   110.0        .0    29.00      .000        .0    0
  2   110.0   110.0     440.0     2.00      .000        .0    0


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.


  500 trial surfaces will be generated and analyzed.


  3 boxes specified for generation of central block base


Length of line segments for active and passive portions of
sliding block is      10.0 ft


Box         x-left     y-left    x-right    y-right      Width
no.          (ft)       (ft)       (ft)       (ft)        (ft)

 1          269.1      103.6      344.9       78.6         1.0
 2          450.0       42.8      470.0       43.1         1.0
 3         1100.0       53.6     1250.0       56.1         1.0


*************************************************************
**     Factor of safety calculation for surface #   387    **
**     failed to converge within FIFTY iterations          **
**                                                         **
**    The last calculated value of the FOS was   9.6297    **
**    This will be ignored for final summary of results    **
*************************************************************

The trial failure surface in question is
defined by the following 29 coordinate points

       Point      x-surf      y-surf
        No.        (ft)        (ft)

         1        216.72      136.90
         2        219.36      134.26
         3        227.03      127.84
         4        234.10      120.77
         5        244.09      120.30
         6        254.08      120.15
         7        263.14      115.92
         8        271.15      109.92
         9        279.62      104.60
        10        286.73       97.58
        11        467.65       43.47
        12       1114.11       53.36
        13       1114.33       63.35
        14       1115.17       73.32
        15       1120.88       81.53
        16       1121.19       91.52
        17       1125.15      100.71
        18       1129.17      109.87
```

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```
      19          1131.14        119.67
      20          1131.79        129.65
      21          1137.07        138.14
      22          1144.14        145.21
      23          1148.86        154.03
      24          1154.95        161.95
      25          1161.51        169.51
      26          1168.57        176.59
      27          1175.49        183.80
      28          1182.51        190.93
      29          1186.48        194.96


Factors of safety have been calculated by the :

* * * * *    SIMPLIFIED JANBU METHOD    * * * * *


The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 30 coordinate points

     Point        x-surf         y-surf
      No.          (ft)           (ft)

       1          210.78         136.54
       2          219.25         134.15
       3          228.70         130.88
       4          236.86         125.10
       5          244.12         118.22
       6          251.19         111.15
       7          261.06         109.57
       8          269.72         104.56
       9          278.77         100.32
      10          453.41          43.18
      11         1191.28          55.21
      12         1198.18          62.45
      13         1204.84          69.90
      14         1211.33          77.51
      15         1217.47          85.41
      16         1223.53          93.36
      17         1230.55         100.48
      18         1237.62         107.55
      19         1242.65         116.19
      20         1249.72         123.26
      21         1255.89         131.14
      22         1260.50         140.01
      23         1266.42         148.07
      24         1272.49         156.02
      25         1273.41         165.98
      26         1280.09         173.41
      27         1285.99         181.49
      28         1292.14         189.37
      29         1294.37         199.12
      30         1295.08         200.00

 **  Corrected JANBU FOS =   2.810  **     (Fo factor = 1.052)
```

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```
Failure surface No. 2 specified by 30 coordinate points

          Point      x-surf       y-surf
           No.        (ft)         (ft)

            1        218.35       136.99
            2        222.80       133.29
            3        230.53       126.94
            4        238.53       120.94
            5        245.73       113.99
            6        255.71       113.38
            7        262.86       106.39
            8        272.17       102.74
            9        281.40        98.90
           10        291.10        96.46
           11        453.34        42.53
           12       1207.47        55.58
           13       1212.13        64.43
           14       1218.81        71.87
           15       1225.71        79.10
           16       1232.75        86.21
           17       1237.89        94.79
           18       1244.96       101.86
           19       1249.07       110.98
           20       1253.70       119.84
           21       1257.09       129.25
           22       1259.97       138.83
           23       1266.43       146.46
           24       1269.84       155.86
           25       1276.41       163.40
           26       1283.47       170.48
           27       1285.16       180.33
           28       1290.27       188.93
           29       1294.68       197.91
           30       1295.99       200.00

 **  Corrected JANBU FOS =   2.848  **    (Fo factor = 1.053)

Failure surface No. 3 specified by 28 coordinate points

          Point      x-surf       y-surf
           No.        (ft)         (ft)

            1        218.48       137.00
            2        224.02       134.07
            3        232.86       129.40
            4        240.00       122.39
            5        248.38       116.93
            6        255.51       109.92
            7        265.50       109.51
            8        272.58       102.45
            9        454.90        42.73
           10       1209.31        55.03
           11       1214.83        63.37
           12       1220.24        71.77
           13       1223.80        81.12
           14       1230.86        88.20
```

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```
        15          1237.73         95.47
        16          1241.21        104.84
        17          1248.23        111.96
        18          1253.81        120.27
        19          1260.88        127.34
        20          1266.17        135.82
        21          1268.73        145.49
        22          1274.75        153.47
        23          1278.17        162.87
        24          1285.24        169.95
        25          1291.62        177.65
        26          1296.50        186.37
        27          1302.01        194.72
        28          1304.52        200.00

  **   Corrected JANBU FOS =    2.859   **     (Fo factor = 1.053)

 Failure surface No. 4 specified by 31 coordinate points

       Point          x-surf        y-surf
        No.            (ft)          (ft)

         1           192.53        131.81
         2           199.08        125.82
         3           208.87        123.76
         4           218.65        121.68
         5           228.65        121.60
         6           238.47        119.73
         7           248.39        118.48
         8           256.27        112.32
         9           264.17        106.19
        10           273.98        104.25
        11           282.55         99.10
        12           450.02         42.41
        13          1224.73         55.25
        14          1231.78         62.34
        15          1238.54         69.71
        16          1244.15         77.98
        17          1250.26         85.90
        18          1256.51         93.70
        19          1261.02        102.63
        20          1267.70        110.07
        21          1274.64        117.28
        22          1281.69        124.36
        23          1287.18        132.72
        24          1287.98        142.69
        25          1292.84        151.43
        26          1298.24        159.84
        27          1302.79        168.75
        28          1307.08        177.78
        29          1313.98        185.02
        30          1318.96        193.69
        31          1325.14        200.00

  **   Corrected JANBU FOS =    2.871   **     (Fo factor = 1.051)

 Failure surface No. 5 specified by 33 coordinate points
```

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```
         Point        x-surf         y-surf
          No.          (ft)           (ft)

           1          206.98         136.31
           2          211.40         134.77
           3          219.80         129.36
           4          229.80         129.05
           5          236.90         122.00
           6          245.40         116.74
           7          252.47         109.67
           8          262.33         108.03
           9          270.45         102.19
          10          280.05          99.37
          11          289.81          97.23
          12          297.64          91.00
          13          307.63          90.67
          14          453.91          43.03
          15         1241.72          55.54
          16         1246.59          64.27
          17         1249.81          73.74
          18         1252.11          83.47
          19         1258.91          90.81
          20         1265.86          98.00
          21         1269.91         107.14
          22         1273.41         116.51
          23         1280.47         123.59
          24         1287.38         130.82
          25         1292.80         139.22
          26         1299.24         146.87
          27         1303.44         155.95
          28         1309.35         164.02
          29         1315.57         171.85
          30         1322.62         178.94
          31         1324.41         188.78
          32         1331.45         195.88
          33         1333.13         200.00

   **  Corrected JANBU FOS =   2.926  **     (Fo factor = 1.051)

 Failure surface No. 6 specified by 34 coordinate points

         Point        x-surf         y-surf
          No.          (ft)           (ft)

           1          182.53         130.55
           2          186.08         127.21
           3          196.06         126.60
           4          204.83         121.78
           5          214.67         120.03
           6          222.57         113.90
           7          231.27         108.97
           8          240.50         105.11
           9          250.27         102.99
          10          260.25         102.39
          11          269.83          99.51
          12          279.79          98.68
          13          289.56          96.53
          14          299.05          93.39
          15          451.02          43.08
```

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```
     16          1231.97        56.10
     17          1238.20        63.93
     18          1244.27        71.87
     19          1251.34        78.95
     20          1254.15        88.54
     21          1261.13        95.70
     22          1267.86       103.10
     23          1274.63       110.46
     24          1274.92       120.46
     25          1281.69       127.82
     26          1286.87       136.38
     27          1293.23       144.10
     28          1295.31       153.88
     29          1302.27       161.06
     30          1309.27       168.20
     31          1314.86       176.49
     32          1316.78       186.30
     33          1321.31       195.21
     34          1326.09       200.00

  **  Corrected JANBU FOS =   2.934  **     (Fo factor = 1.050)

Failure surface No. 7 specified by 32 coordinate points

    Point        x-surf         y-surf
     No.          (ft)           (ft)

      1          205.47        136.22
      2          206.47        135.25
      3          213.68        128.33
      4          223.65        127.54
      5          233.07        124.20
      6          242.14        119.99
      7          251.03        115.40
      8          258.91        109.25
      9          267.52        104.16
     10          276.15         99.11
     11          285.26         94.98
     12          295.25         94.63
     13          455.06         42.90
     14         1208.48         55.31
     15         1214.56         63.25
     16         1220.60         71.22
     17         1226.80         79.07
     18         1233.01         86.91
     19         1239.51         94.50
     20         1240.82        104.42
     21         1244.21        113.83
     22         1250.99        121.17
     23         1255.99        129.84
     24         1257.78        139.67
     25         1264.85        146.75
     26         1268.12        156.20
     27         1272.54        165.17
     28         1279.57        172.29
     29         1286.01        179.93
     30         1291.99        187.95
     31         1298.56        195.49
     32         1300.68        200.00
```

[illegible]
pmf
4-Nov-97

```
**  Corrected JANBU FOS =   2.958  **    (Fo factor = 1.052)

Failure surface No. 8 specified by 30 coordinate points

         Point      x-surf      y-surf
          No.        (ft)        (ft)

           1        229.86      137.68
           2        233.15      135.14
           3        240.91      128.83
           4        248.09      121.87
           5        255.32      114.96
           6        264.59      111.21
           7        274.41      109.34
           8        283.06      104.31
           9        291.74       99.35
          10        300.03       93.76
          11        456.02       42.52
          12       1188.34       55.31
          13       1192.52       64.40
          14       1198.66       72.29
          15       1203.00       81.30
          16       1209.39       89.00
          17       1216.23       96.29
          18       1219.09      105.87
          19       1224.45      114.31
          20       1228.92      123.26
          21       1235.77      130.54
          22       1242.78      137.67
          23       1249.80      144.80
          24       1253.26      154.18
          25       1259.15      162.26
          26       1265.06      170.32
          27       1267.85      179.93
          28       1273.85      187.92
          29       1280.91      195.01
          30       1285.44      200.00

**  Corrected JANBU FOS =   2.964  **    (Fo factor = 1.054)

Failure surface No. 9 specified by 31 coordinate points

         Point      x-surf      y-surf
          No.        (ft)        (ft)

           1        228.11      137.58
           2        233.60      132.73
           3        240.92      125.92
           4        248.05      118.90
           5        257.82      116.77
           6        265.22      110.05
           7        275.08      108.35
           8        282.34      101.48
           9        290.33       95.47
          10        299.49       91.45
          11        309.41       90.15
          12        453.79       42.51
```

602-020[illegible]
pmp
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```
      13          1119.67        54.29
      14          1126.53        61.57
      15          1130.47        70.76
      16          1136.83        78.48
      17          1141.95        87.07
      18          1147.04        95.68
      19          1153.00       103.71
      20          1160.04       110.80
      21          1166.89       118.09
      22          1172.99       126.02
      23          1180.02       133.13
      24          1185.73       141.34
      25          1190.17       150.30
      26          1195.77       158.59
      27          1198.98       168.06
      28          1206.05       175.13
      29          1210.26       184.20
      30          1211.15       194.16
      31          1211.45       196.45

  **  Corrected JANBU FOS =   2.979  **     (Fo factor = 1.056)

Failure surface No.10 specified by 28 coordinate points

     Point        x-surf       y-surf
      No.          (ft)         (ft)

       1          228.82       137.62
       2          232.86       133.59
       3          239.96       126.54
       4          248.22       120.90
       5          257.60       117.45
       6          264.72       110.43
       7          273.71       106.04
       8          281.34        99.58
       9          451.60        43.25
      10         1242.47        56.37
      11         1244.78        66.10
      12         1248.94        75.19
      13         1253.60        84.04
      14         1258.56        92.72
      15         1265.13       100.26
      16         1271.58       107.91
      17         1278.60       115.02
      18         1281.31       124.65
      19         1286.49       133.21
      20         1293.24       140.58
      21         1298.20       149.26
      22         1305.11       156.49
      23         1311.26       164.38
      24         1316.82       172.69
      25         1322.04       181.21
      26         1327.92       189.30
      27         1328.99       199.24
      28         1329.44       200.00

  **  Corrected JANBU FOS =   2.980  **     (Fo factor = 1.052)
```

```
*********************************************************************
**                                                                 *
**  Out of the    500 surfaces generated and analyzed by XSTABL,   *
**        1 surfaces were found to have MISLEADING FOS values.     *
**                                                                 *
*********************************************************************



The following is a summary of the TEN most critical surfaces

Problem Description : Gandy Cover Block    Failure

        Modified      Correction    Initial     Terminal     Available
        JANBU FOS       Factor      x-coord     x-coord       Strength
                                     (ft)        (ft)           (lb)

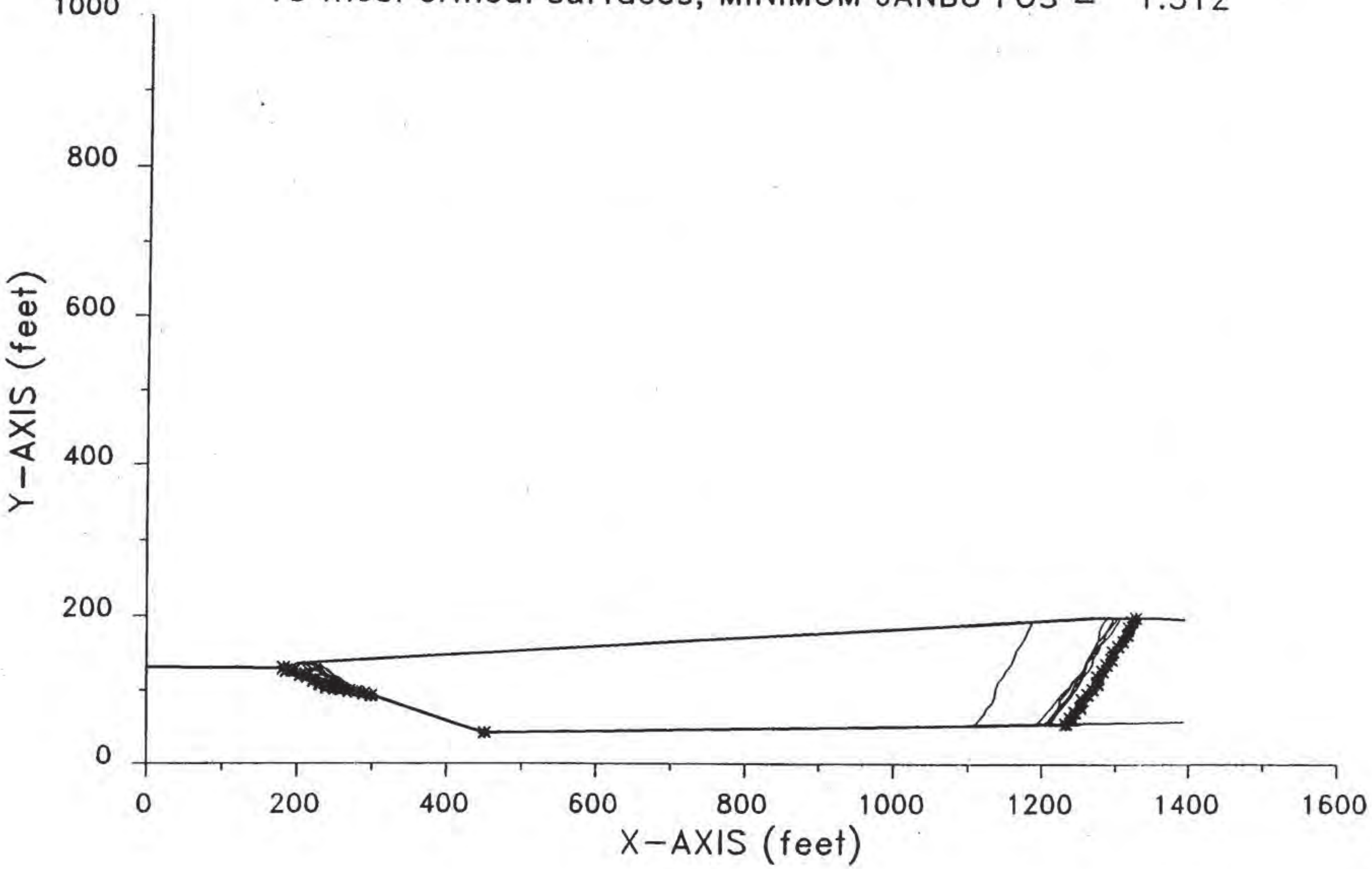
 1.       2.810         1.052       210.78      1295.08      1.526E+06
 2.       2.848         1.053       218.35      1295.99      1.472E+06
 3.       2.859         1.053       218.48      1304.52      1.489E+06
 4.       2.871         1.051       192.53      1325.14      1.566E+06
 5.       2.926         1.051       206.98      1333.13      1.488E+06
 6.       2.934         1.050       182.53      1326.09      1.471E+06
 7.       2.958         1.052       205.47      1300.68      1.459E+06
 8.       2.964         1.054       229.86      1285.44      1.497E+06
 9.       2.979         1.056       228.11      1211.45      1.416E+06
10.       2.980         1.052       228.82      1329.44      1.492E+06

                         * * *  END OF FILE  * * *
```

.ANC4Q 11-04-97 20:28

Gandy Cover Block Failure Q

10 most critical surfaces, MINIMUM JANBU FOS = 1.512



0020-209
pmp
4-Nov-97

602-1204
pmf
4-Nov-9

```
XSTABL File: GANC4Q    11-04-97   20:28

          *******************************************
          *               X S T A B L               *
          *                                         *
          *        Slope Stability Analysis         *
          *               using the                 *
          *           Method of Slices              *
          *                                         *
          *         Copyright (C) 1992 á 96         *
          *    Interactive Software Designs, Inc.   *
          *        Moscow, ID 83843, U.S.A.         *
          *                                         *
          *          All Rights Reserved            *
          *                                         *
          *  Ver. 5.200                 96 á 1216   *
          *******************************************

    Problem Description : Gandy Cover Block    Failure Q



    -----------------------------
    SEGMENT BOUNDARY COORDINATES
    -----------------------------

        5 SURFACE boundary segments

    Segment     x-left      y-left     x-right     y-right       Soil Unit
      No.        (ft)        (ft)        (ft)        (ft)      Below Segment

       1           .0        131.7       190.1       130.5           2
       2        190.1        130.5       200.1       135.9           1
       3        200.1        135.9      1270.7       200.0           1
       4       1270.7        200.0      1355.5       200.0           1
       5       1355.5        200.0      1393.4       198.4           1

        2 SUBSURFACE boundary segments

    Segment     x-left      y-left     x-right     y-right       Soil Unit
      No.        (ft)        (ft)        (ft)        (ft)      Below Segment

       1        190.1        130.5       453.1        43.8           2
       2      . 453.1         43.8      1393.4        59.4           2


    --------------------------
    ISOTROPIC Soil Parameters
    --------------------------

     2 Soil unit(s) specified

    Soil   Unit Weight    Cohesion  Friction    Pore Pressure        Water
    Unit  Moist     Sat.  Intercept   Angle  Parameter  Constant   Surfac
     No.  (pcf)    (pcf)    (psf)     (deg)      Ru       (psf)      No.
```

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pmp
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```
  1   110.0   110.0        .0    29.00       .000            .0   0
  2   110.0   110.0     440.0     2.00       .000            .0   0


A horizontal earthquake loading coefficient
of   .040 has been assigned

A vertical earthquake loading coefficient
of   .000 has been assigned


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.

  500 trial surfaces will be generated and analyzed.

  3 boxes specified for generation of central block base

Length of line segments for active and passive portions of
sliding block is      10.0 ft

Box          x-left     y-left    x-right    y-right      Width
no.           (ft)       (ft)       (ft)       (ft)        (ft)

 1           269.1      103.6      344.9       78.6         1.0
 2           450.0       42.8      470.0       43.1         1.0
 3          1100.0       53.6     1250.0       56.1         1.0


Factors of safety have been calculated by the :

* * * * *    SIMPLIFIED JANBU METHOD    * * * * *


The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 34 coordinate points

           Point      x-surf      y-surf
            No.        (ft)        (ft)

             1        182.53      130.55
             2        186.08      127.21
             3        196.06      126.60
             4        204.83      121.78
             5        214.67      120.03
             6        222.57      113.90
             7        231.27      108.97
             8        240.50      105.11
             9        250.27      102.99
```

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```
       10          260.25         102.39
       11          269.83          99.51
       12          279.79          98.68
       13          289.56          96.53
       14          299.05          93.39
       15          451.02          43.08
       16         1231.97          56.10
       17         1238.20          63.93
       18         1244.27          71.87
       19         1251.34          78.95
       20         1254.15          88.54
       21         1261.13          95.70
       22         1267.86         103.10
       23         1274.63         110.46
       24         1274.92         120.46
       25         1281.69         127.82
       26         1286.87         136.38
       27         1293.23         144.10
       28         1295.31         153.88
       29         1302.27         161.06
       30         1309.27         168.20
       31         1314.86         176.49
       32         1316.78         186.30
       33         1321.31         195.21
       34         1326.09         200.00

  **  Corrected JANBU FOS =   1.512  **     (Fo factor = 1.050)

Failure surface No. 2 specified by 30 coordinate points

      Point         x-surf          y-surf
       No.           (ft)            (ft)

        1          218.35         136.99
        2          222.80         133.29
        3          230.53         126.94
        4          238.53         120.94
        5          245.73         113.99
        6          255.71         113.38
        7          262.86         106.39
        8          272.17         102.74
        9          281.40          98.90
       10          291.10          96.46
       11          453.34          42.53
       12         1207.47          55.58
       13         1212.13          64.43
       14         1213.81          71.87
       15         1225.71          79.10
       16         1232.75          86.21
       17         1237.89          94.79
       18         1244.96         101.86
       19         1249.07         110.98
       20         1253.70         119.84
       21         1257.09         129.25
       22         1259.97         138.83
       23         1266.43         146.46
       24         1269.84         155.86
       25         1276.41         163.40
       26         1283.47         170.48
```

602-02[illegible]
PMP
4-Nov-[illegible]

```
          27         1285.16       180.33
          28         1290.27       188.93
          29         1294.68       197.91
          30         1295.99       200.00

  **  Corrected JANBU FOS =    1.552  **     (Fo factor = 1.053)


Failure surface No. 3 specified by 30 coordinate points

        Point         x-surf        y-surf
         No.           (ft)          (ft)

          1           210.78       136.54
          2           219.25       134.15
          3           228.70       130.88
          4           236.86       125.10
          5           244.12       118.22
          6           251.19       111.15
          7           261.06       109.57
          8           269.72       104.56
          9           278.77       100.32
         10           453.41        43.18
         11          1191.28        55.21
         12          1198.18        62.45
         13          1204.84        69.90
         14          1211.33        77.51
         15          1217.47        85.41
         16          1223.53        93.36
         17          1230.55       100.48
         18          1237.62       107.55
         19          1242.65       116.19
         20          1249.72       123.26
         21          1255.89       131.14
         22          1260.50       140.01
         23          1266.42       148.07
         24          1272.49       156.02
         25          1273.41       165.98
         26          1280.09       173.41
         27          1285.99       181.49
         28          1292.14       189.37
         29          1294.37       199.12
         30          1295.08       200.00

  **  Corrected JANBU FOS =    1.553  **     (Fc factor = 1.052)


Failure surface No. 4 specified by 31 coordinate points

        Point         x-surf        y-surf
         No.           (ft)          (ft)

          1           192.53       131.81
          2           199.08       125.82
          3           208.87       123.76
          4           218.65       121.68
          5           228.65       121.60
          6           238.47       119.73
          7           248.39       118.48
          8           256.27       112.32
```

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Pmp
4-Nov-97

```
          9          264.17         106.19
         10          273.98         104.25
         11          282.55          99.10
         12          450.02          42.41
         13         1224.73          55.25
         14         1231.78          62.34
         15         1238.54          69.71
         16         1244.15          77.98
         17         1250.26          85.90
         18         1256.51          93.70
         19         1261.02         102.63
         20         1267.70         110.07
         21         1274.64         117.28
         22         1281.69         124.36
         23         1287.18         132.72
         24         1287.98         142.69
         25         1292.84         151.43
         26         1298.24         159.84
         27         1302.79         168.75
         28         1307.08         177.78
         29         1313.98         185.02
         30         1318.96         193.69
         31         1325.14         200.00

  **  Corrected JANBU FOS =   1.558  **    (Fo factor = 1.051)

Failure surface No. 5 specified by 33 coordinate points

       Point         x-surf         y-surf
        No.           (ft)           (ft)

          1          206.98         136.31
          2          211.40         134.77
          3          219.80         129.36
          4          229.80         129.05
          5          236.90         122.00
          6          245.40         116.74
          7          252.47         109.67
          8          262.33         108.03
          9          270.45         102.19
         10          280.05          99.37
         11          289.81          97.23
         12          297.64          91.00
         13          307.63          90.67
         14          453.91          43.03
         15         1241.72          55.54
         16         1246.59          64.27
         17         1249.81          73.74
         18         1252.11          83.47
         19         1258.91          90.81
         20         1265.86          98.00
         21         1269.91         107.14
         22         1273.41         116.51
         23         1280.47         123.59
         24         1287.38         130.82
         25         1292.80         139.22
         26         1299.24         146.87
         27         1303.44         155.95
         28         1309.35         164.02
```

602-0209
PMP
1-Nov-9

```
          29          1315.57        171.85
          30          1322.62        178.94
          31          1324.41        188.78
          32          1331.45        195.88
          33          1333.13        200.00

  **   Corrected JANBU FOS =    1.560  **      (Fo factor = 1.051)

    Failure surface No. 6 specified by 28 coordinate points

          Point        x-surf         y-surf
           No.          (ft)           (ft)

           1           218.48        137.00
           2           224.02        134.07
           3           232.86        129.40
           4           240.00        122.39
           5           248.38        116.93
           6           255.51        109.92
           7           265.50        109.51
           8           272.58        102.45
           9           454.90         42.73
          10          1209.31         55.03
          11          1214.83         63.37
          12          1220.24         71.77
          13          1223.80         81.12
          14          1230.86         88.20
          15          1237.73         95.47
          16          1241.21        104.84
          17          1248.23        111.96
          18          1253.81        120.27
          19          1260.88        127.34
          20          1266.17        135.82
          21          1268.73        145.49
          22          1274.75        153.47
          23          1278.17        162.87
          24          1285.24        169.95
          25          1291.62        177.65
          26          1296.50        186.37
          27          1302.01        194.72
          28          1304.52        200.00

  **   Corrected JANBU FOS =    1.566  **      (Fo factor = 1.053)

    Failure surface No. 7 specified by 32 coordinate points

          Point        x-surf         y-surf
           No.          (ft)           (ft)

           1           205.47        136.22
           2           206.47        135.25
           3           213.68        128.33
           4           223.65        127.54
           5           233.07        124.20
           6           242.14        119.99
           7           251.03        115.40
           8           258.91        109.25
           9           267.52        104.16
```

[illegible]
602-0200
PmP
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```
        10           276.15          99.11
        11           285.26          94.98
        12           295.25          94.63
        13           455.06          42.90
        14          1208.48          55.31
        15          1214.56          63.25
        16          1220.60          71.22
        17          1226.80          79.07
        18          1233.01          86.91
        19          1239.51          94.50
        20          1240.82         104.42
        21          1244.21         113.83
        22          1250.99         121.17
        23          1255.99         129.84
        24          1257.78         139.67
        25          1264.85         146.75
        26          1268.12         156.20
        27          1272.54         165.17
        28          1279.57         172.29
        29          1286.01         179.93
        30          1291.99         187.95
        31          1298.56         195.49
        32          1300.68         200.00

  **   Corrected JANBU FOS =    1.574  **     (Fo factor = 1.052)


Failure surface No. 8 specified by 28 coordinate points

       Point         x-surf          y-surf
        No.           (ft)            (ft)

         1           228.82         137.62
         2           232.86         133.59
         3           239.96         126.54
         4           248.22         120.90
         5           257.60         117.45
         6           264.72         110.43
         7           273.71         106.04
         8           281.34          99.58
         9           451.60          43.25
        10          1242.47          56.37
        11          1244.78          66.10
        12          1248.94          75.19
        13          1253.60          84.04
        14          1258.56          92.72
        15          1265.13         100.26
        16          1271.58         107.91
        17          1278.60         115.02
        18          1281.31         124.65
        19          1286.49         133.21
        20          1293.24         140.58
        21          1298.20         149.26
        22          1305.11         156.49
        23          1311.26         164.38
        24          1316.82         172.69
        25          1322.04         181.21
        26          1327.92         189.30
        27          1328.99         199.24
        28          1329.44         200.00
```

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612-R20
pmf
4-Nov-'

```
**  Corrected JANBU FOS =   1.590  **    (Fo factor = 1.052)

Failure surface No. 9 specified by 30 coordinate points

        Point        x-surf        y-surf
         No.          (ft)          (ft)

          1          186.85        130.52
          2          192.21        127.57
          3          201.72        124.49
          4          210.38        119.50
          5          219.88        116.36
          6          229.86        115.63
          7          238.40        110.43
          8          248.11        108.04
          9          257.98        106.45
         10          267.03        102.20
         11          276.93        100.82
         12          451.38         42.94
         13         1106.11         53.43
         14         1113.10         60.58
         15         1119.85         67.96
         16         1123.83         77.13
         17         1130.88         84.22
         18         1134.62         93.49
         19         1135.75        103.43
         20         1139.15        112.83
         21         1146.19        119.94
         22         1150.36        129.03
         23         1157.39        136.14
         24         1161.14        145.41
         25         1163.82        155.04
         26         1169.78        163.07
         27         1175.42        171.33
         28         1179.22        180.58
         29         1183.40        189.66
         30         1185.10        194.88

**  Corrected JANBU FOS =   1.608  **    (Fo factor = 1.055)

Failure surface No.10 specified by 31 coordinate points

        Point        x-surf        y-surf
         No.          (ft)          (ft)

          1          214.74        136.78
          2          215.63        136.39
          3          225.43        134.41
          4          235.02        131.57
          5          243.74        126.68
          6          250.99        119.79
          7          258.63        113.33
          8          267.51        108.74
          9          275.87        103.26
         10          283.27         96.53
         11          293.21         95.40
         12          454.35         42.48
```

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PMP
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```
              13        1201.92        55.28
              14        1208.99        62.36
              15        1214.93        70.40
              16        1221.43        78.00
              17        1222.85        87.90
              18        1229.49        95.38
              19        1235.95       103.01
              20        1238.82       112.59
              21        1245.54       120.00
              22        1252.55       127.12
              23        1257.59       135.76
              24        1261.05       145.14
              25        1266.53       153.51
              26        1271.22       162.34
              27        1275.85       171.20
              28        1276.78       181.16
              29        1279.60       190.76
              30        1286.25       198.22
              31        1287.86       200.00

    **  Corrected JANBU FOS =   1.610  **     (Fo factor = 1.053)




 The following is a summary of the TEN most critical surfaces

 Problem Description : Gandy Cover Block     Failure Q

       Modified      Correction    Initial     Terminal    Available
       JANBU FOS       Factor      x-coord     x-coord      Strength
                                     (ft)        (ft)         (lb)

  1.     1.512         1.050       182.53      1326.09     1.376E+06
  2.     1.552         1.053       218.35      1295.99     1.392E+06
  3.     1.553         1.052       210.78      1295.08     1.451E+06
  4.     1.558         1.051       192.53      1325.14     1.486E+06
  5.     1.560         1.051       206.98      1333.13     1.403E+06
  6.     1.566         1.053       218.48      1304.52     1.412E+06
  7.     1.574         1.052       205.47      1300.68     1.375E+06
  8.     1.590         1.052       228.82      1329.44     1.412E+06
  9.     1.608         1.055       186.85      1185.10     1.194E+06
 10.     1.610         1.053       214.74      1287.86     1.388E+06

                     * * *  END OF FILE  * * *
```

612-0210
pmp
12-Nov-97

Infinite slope analysis spreadsheet
Date: 12-Nov-97
By: Paul Pellicer
Filename: Cover system stability .wq1

Soil Parameters

Cohesion:	15 psf		0.054643341
Friction Angle:	31 degrees	tangent	0.600860619
Gamma Moist:	110 pcf		

Slope Geometry:

Slope Angle:	3.43 degrees	cosine	0.998208638 sine
Failure Plane Depth:	2.5 ft		

Groundwater Parameters

Height of water in failure mass:	2.5 ft
Pore Pressure Ratio:	0.567272727 no units

Seismic Parameters

Ground Acceleration:	0 g's

Safety Factor: 5.2514

[illegible]
612-020V
pmp
12-Nov-97

Infinite slope analysis spreadsheet
Date: 12-Nov-97
By: Paul Pellicer
Filename: Cover system stability .wq1

Soil Parameters

Cohesion:	15 psf		0.054643341
Friction Angle:	31 degrees	tangent	0.600860619
Gamma Moist:	110 pcf		

Slope Geometry:

Slope Angle:	3.43 degrees	cosine	0.998208638 sine
Failure Plane Depth:	2.5 ft		

Groundwater Parameters

Height of water in failure mass:	2.5 ft
Pore Pressure Ratio:	0.567272727 no units

Seismic Parameters

Ground Acceleration:	0.04 g's

Safety Factor: 3.13509

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-6

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Ramp Stability

	Name	Date
Prepared By:	Paul Pellicer	11/14/97
Checked By:	John Pellicer	11/14/97
Reviewed By:	Pat Corser	11/15/97

Revisions	Date	By	Checked By	Reviewed By

TerraMatrix
Engineering & Environmental Services
P.O. Box 774018, 1475 Pine Grove Road
Steamboat Springs, Colorado 80477
Phone 970.879.6260 Fax 970.879.9048

Project Name [illegible]
Project Number 602-0200 Sheet 1 Of 10
Prepared By: P. Pellizer Date: 14-Nov-97
Checked By: J. Pellizer Date: 14-Nov-97

Ramp Stability

Objective: Evaluate Stability of Ramp Select Subbase and Road Base on the Ramp, Statically, Pseudo-statically, and w/ a loaded Scraper.

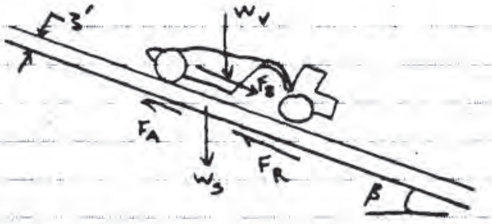
Assumptions: - Use a fully loaded 631 scraper applying brakes for scraper load.

Calculations:

Evaluate static + pseudo-static using Infinite Slope Spread sheet.

γ for select subbase and Road Base = 125pcf
assume failur plane runs through liner system
Liner system strength: $a = 18$ psf (see pg 3) ✓
$\delta = 31°$
Road grade = 10% ✓ (RESIDUAL STRENGTHS FROM SIERRA PACIFIC TESTING)
Infinite slope analysis indicate a static F.S. = 6.4 and a pseudo-static F.S. = 4.6 - using a ground acceleration of 0.04g (see pg 4 - 7)

Evaluate static stability of ramp with a loaded 631 Scraper breaking on the Ramp.



Length of Scraper ≈ 50' (see pg 10) ✓
width of access Ramp ≈ 47 ft (subgrade) (see pg 9) ✓

Weakest interface ⇒ $\delta_{min} = 31°$, $a_{min} = 15$ psf (see pg 3) ✓

Evaluate stability of ramp w/ scraper just for one length of the scraper (conservative)

Define Resisting Forces:
F_R = Frictional Force @ Base of Roadway.

Project Name: Jurassic Park
Project Number: 602-0200 Sheet 2 Of 10
Prepared By: P. Pellizer Date 14-Nov-97
Checked By: J. Pellicer Date: 14-Nov-97

$F_R = (W_v + W_s) * \cos\beta * \tan\delta_{min}$

W_v = wt of Scraper
= GVW + Rated load
= 93410 lb + 75000 lb (from Cat Handbook see pg 10)
= 168410 lbs ✓

W_s = wt of Soil
$= (w \times L \times T)\gamma_s$ w = 47 ft, L = 50 ft, T = 3 ft (see pg 9)
$= (47ft \times 50ft \times 3ft)\, 125pcf$, γ_s = 125 pcf (assumed)
= 881250 lbs ✓

β = 10% ⇒ 5.71° (see pg 8) ✓

$F_R = (168410\ lbs + 881250\ lbs) * \cos 5.71 * \tan 31°$
= 627570 lbs ✓

F_A = Adhesion Force
$= WL * a_{min}$
$= (47ft * 50ft) * 15psf$
= 35250 lbs ✓

$F_{R_{total}} = F_R + F_A$
= <u>662820</u> lbs ✓

Define Diving Forces:

F_{SD} = Soil and vehicle driving Force
$= (W_s + W_v)\sin\beta$
$= (168410 + 881250)\sin 5.71$
= 104,434 lbs ✓

F_b = Braking Force from Scraper
$= 0.3\, W_v$
$= 0.3\,(168410\ lbs) =$
= 50523 lbs ✓

$F_{D_{total}} = F_{SD} + F_b = 154957$ ✓

$$F.S. = \frac{F_{R total}}{F_{D total}} = \frac{662820}{154957} = \underline{4.3} \text{ o.k.}$$ ✓

Conclusion: The Ramp is stable for the conditions analyzed.

GEOSYNTEC CONSULTANTS

SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

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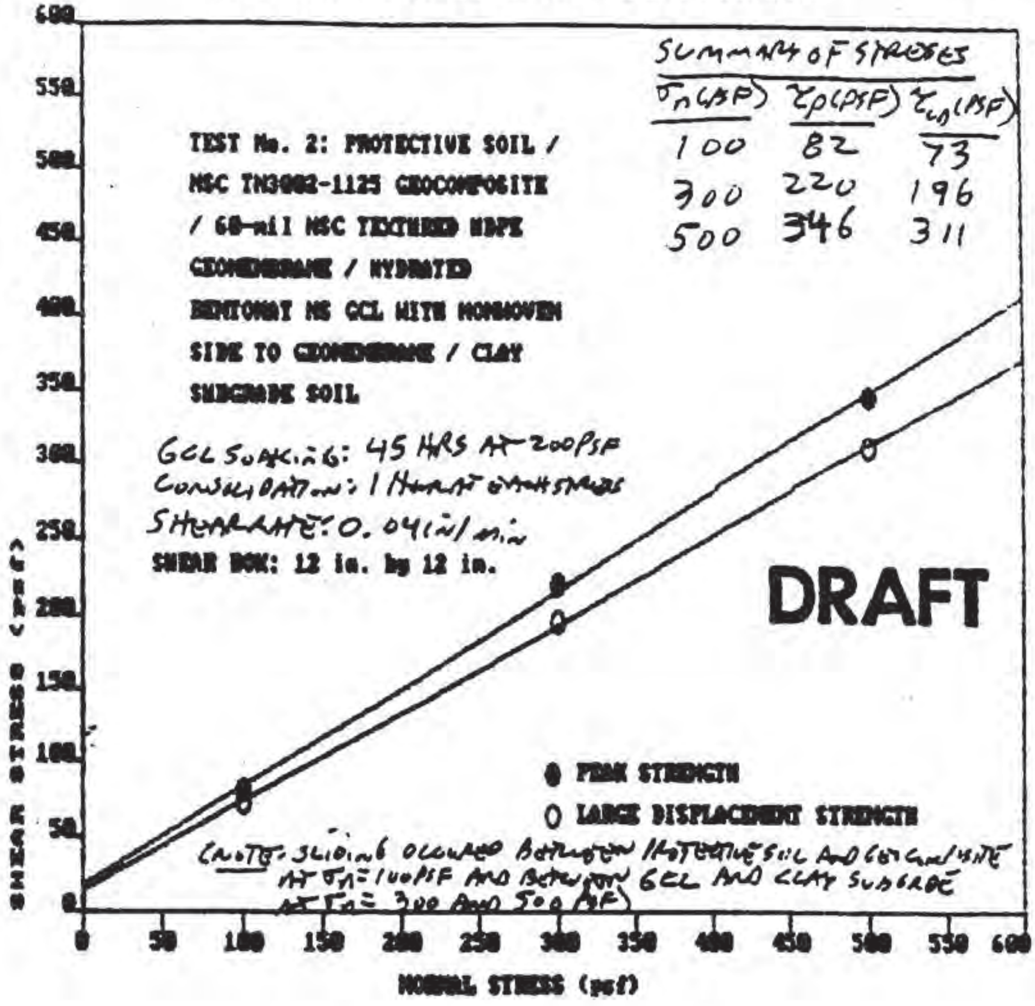
14-Nov-97
PMP

TERRAMATRIX MONTGOMERY WATSON - ASTM D 5321 TESTS



SUMMARY OF STRESSES

σ_n (PSF)	τ_p (PSF)	τ_{LD} (PSF)
100	82	73
300	220	196
500	346	311

TEST No. 2: PROTECTIVE SOIL /
MSC TN3002-1125 GEOCOMPOSITE
/ 60-mil MSC TEXTURED HDPE
GEOMEMBRANE / HYDRATED
BENTOMAT MS GCL WITH NONWOVEN
SIDE TO GEOMEMBRANE / CLAY
SUBGRADE SOIL

GCL SOAKING: 45 HRS AT 200PSF
CONSOLIDATION: 1 HOUR AT EACH STRESS
SHEAR RATE: 0.04 in/min
SHEAR BOX: 12 in. by 12 in.

(NOTE: SLIDING OCCURRED BETWEEN PROTECTIVE SOIL AND GEOCOMPOSITE AT σ_n=100PSF AND BETWEEN GCL AND CLAY SUBGRADE AT σ_n= 300 AND 500 PSF)

THE REGRESSION POLYNOMIAL OF LINE 9 - PEAK STRENGTH

(1.800E+01) + (6.600E-01)*X
THE VARIANCE - 8.000E+00

a= 18 PSF δ= 33°

THE REGRESSION POLYNOMIAL OF LINE 10 - LARGE DISPLACEMENT STRGH

(1.483E+01) + (5.950E-01)*X
THE VARIANCE - 3.556E+00

a= 15 PSF δ= 31°

Reviewed By: Robert H Swan Jr Date: 10-10-97

SGI FORM-14/GEL94351

94.08.2
TOTAL P.02

[illegible]

United States Department of the Interior

Geological Survey

PROBABILISTIC ESTIMATES OF MAXIMUM ACCELERATION AND VELOCITY IN ROCK IN THE CONTIGUOUS UNITED STATES

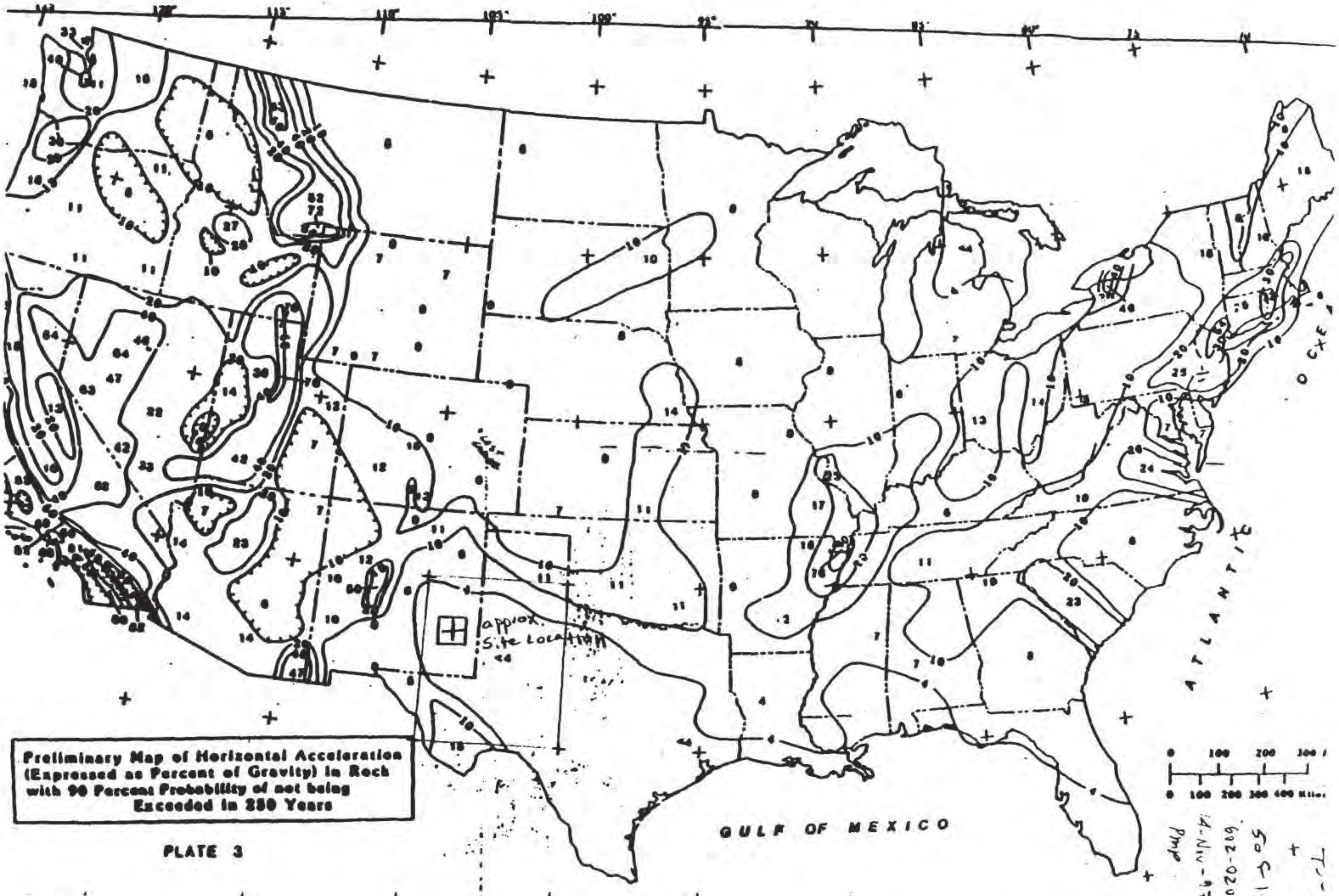
by

S. T. Algermissen, D. M. Perkins, P. C. Thenhaus,
S. L. Hanson and B. L. Bender

Open-File Report 82-1033

1982

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards.



Preliminary Map of Horizontal Acceleration (Expressed as Percent of Gravity) in Rock with 90 Percent Probability of not being Exceeded in 250 Years

PLATE 3

T-
50-10
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14-Nov-97
PMP

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602-0200
14-Nov-97
PMP

Infinite slope analysis spreadsheet
Date: 13-Nov-97
By: Paul Pellicer
Filename: ~~Protective cover stabilit~~y.wq1
Ramp Stability

Soil Parameters

Cohesion: 15 psf 0.040199461
Friction Angle: 31 degrees tangent 0.600860619
Gamma Moist: 125 pcf

Slope Geometry:

Slope Angle: 5.71 degrees cosine 0.99503822 sine
Failure Plane Depth: 3 ft

Groundwater Parameters

Height of water in failure mass: 0 ft
Pore Pressure Ratio: 0 no units

Seismic Parameters

Ground Acceleration: 0 g's

Safety Factor: 6.41328

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14-Nov-97
602-0200
PMP

Infinite slope analysis spreadsheet
Date: 13-Nov-97
By: Paul Pellicer
Filename: Protective cover stability.wq1

Soil Parameters

Cohesion:	15 psf		0.040199461
Friction Angle:	31 degrees	tangent	0.600860619
Gamma Moist:	125 pcf		

Slope Geometry:

Slope Angle:	5.71 degrees	cosine	0.99503822 sine
Failure Plane Depth:	3 ft		

Groundwater Parameters

Height of water in failure mass:	0 ft
Pore Pressure Ratio:	0 no units

Seismic Parameters

Ground Acceleration:	0.04 g's

Safety Factor: 4.56361

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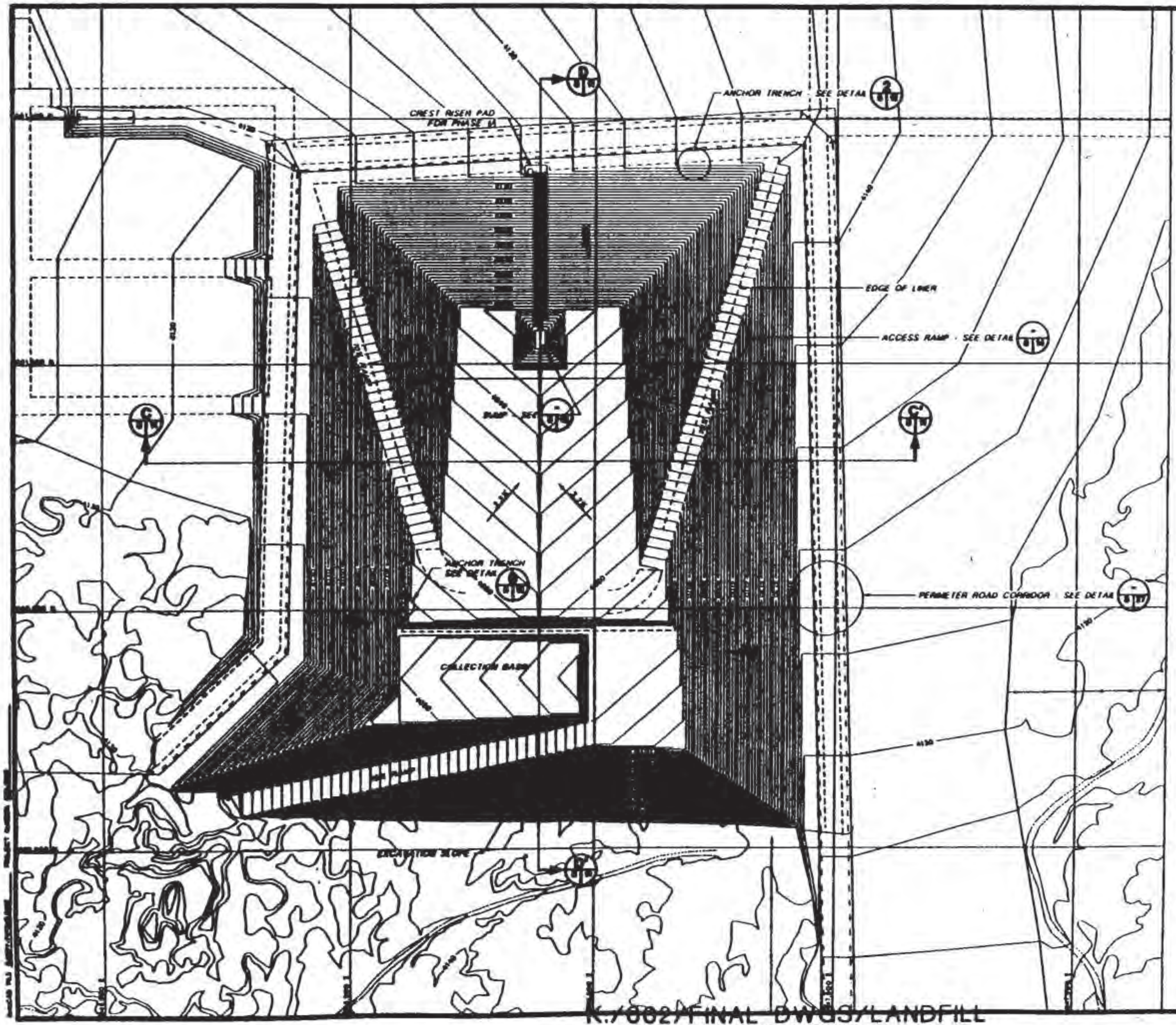
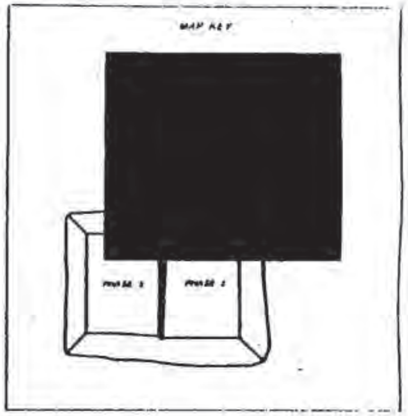
602-0200
14-NOV-97
PMP

E-6





NOTES
1 FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No 1 "INDEX LEGEND AND GENERAL NOTES"
2 TOPOGRAPHY FROM AERIAL SURVEYS PERFORMED AUGUST 1997 BY KOOGLE AND POULS ENGINEERING

PATRICK G. CORSER
NEW MEXICO
10200

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information

Date *Patrick G. Corser, NM P.E. 10236*

SCALE

CONTOUR INTERVAL 2 FT.

Not For Construction

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE
DETAILED EXCAVATION PLAN - PHASE 1A

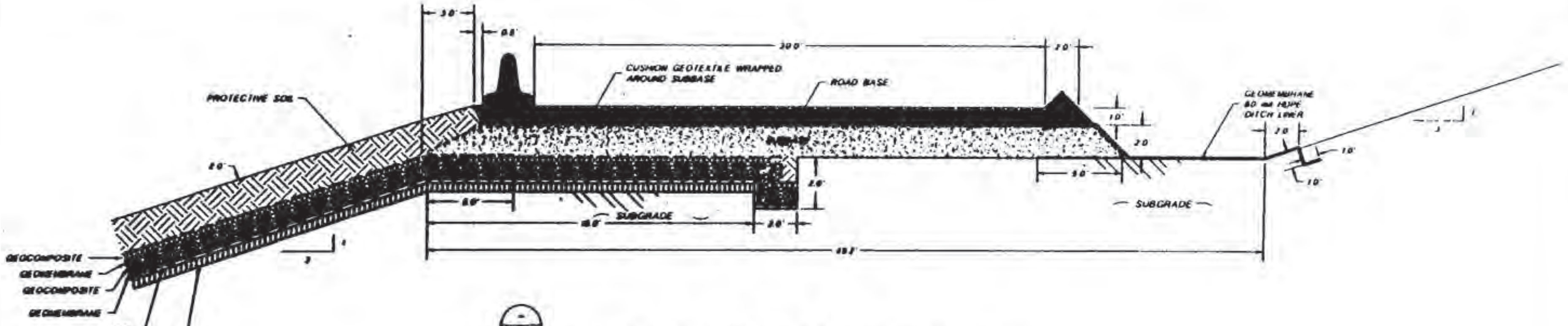
TerraMatrix

Sheet 1 of 1 Sheets
SCALE
DRAWING No
8

K:/602/FINAL DWGS/LANDFILL
GANDY B1RSUB.dwg

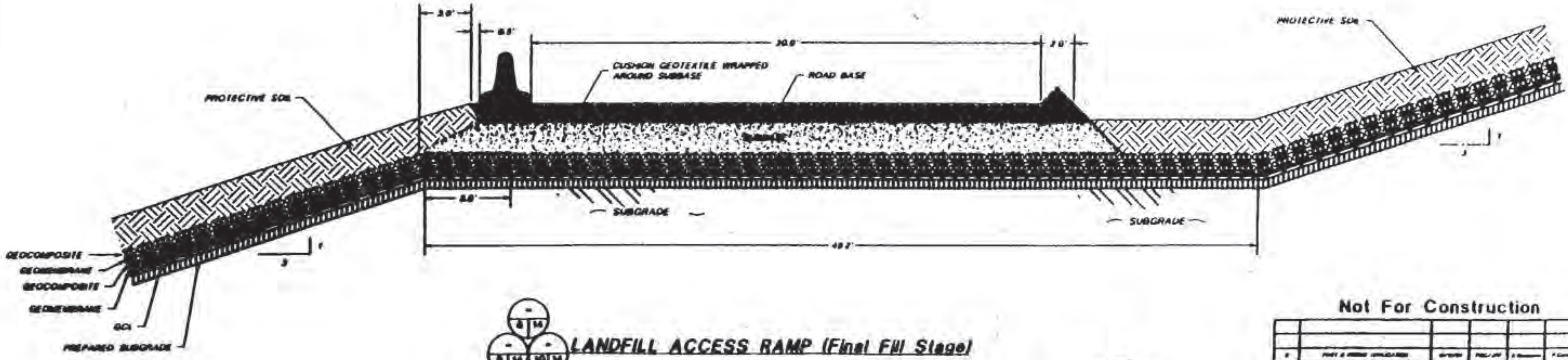
6.6

9 of 10
602-0200
14-NOV-97
pmp



LANDFILL ACCESS RAMP (Interim Fill Stage)

SCALE
0 3 6
Feet



LANDFILL ACCESS RAMP (Final Fill Stage)

SCALE
0 3 6
Feet

Not For Construction

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE
TYPICAL LANDFILL ACCESS RAMP

PROFESSIONAL ENGINEER'S STATEMENT
I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented hereon is true [illegible]

Specifications
• Standard Scrapers

[illegible]-10 of 10
602-0200
pmp
14-Niv-97



	621B		631D		651
Flywheel power	246 kW	330 HP	336 kW	450 HP	410 kW
Operating weight (empty)◄	30 205 kg	66,590 lb	42 370 kg	93,410 lb	59 420 kg
Scraper capacity —					
Struck	10.7 m³	14 yd³	16 m³	21 yd³	24.5 m³
Heaped	15.3 m³	20 yd³	23.7 m³	31 yd³	33.6 m³
Rated load	21 770 kg	48,000 lb	34 000 kg	75,000 lb	47 170 kg
Weight distribution — Empty					
Drive	70%		69%		69%
Rear	30%		31%		31%
Weight distribution — Loaded					
Drive	55%		54%		54%
Rear	45%		46%		46%
Engine model	3406		3408		3412
Rated engine RPM	1900		2000		1900
Displacement	14.6 L	893 in³	18.0 L	1098 in³	27.0 L
Top speed (loaded)	48 km/h	30 mph	50 km/h	31 mph	50 km/h
Non-stop turning circle	11.1 m	36'6"	12.2 m	40'1"	13.6 m
With ROPS restriction	—		—		14.5 m
Tires — Tractor drive	29.5-29, 28 PR (E-3)		33.25-35, 38 PR (E-3)		37.5R39 Radial
Scraper	29.5-29, 28 PR (E-3)		33.25-35, 38 PR (E-3)		37.5R39 Radial
Width of cut	3.02 m	9'11"	3.50 m	11'6"	3.68 m
Maximum depth of cut	340 mm	13.4"	483 mm	19"	440 mm
Maximum depth of spread	460 mm	18"	425 mm	16.7"	660 mm
Fuel tank refill capacity	511 L	135 gal	760 L	200 gal	1063 L
GENERAL DIMENSIONS:					
Height to top of scraper	3.63 m	11'11"	4.17 m	13'8"	4.70 m
Wheelbase	7.72 m	25'4"	8.74 m	28'8"	9.96 m
Overall length	12.7 m	41'7"	14.25 m	46'9"	16.13 m
Overall width	3.45 m	11'4"	3.96 m	13'	4.34 m
Shipping width					
(draft arm on inside of bowl)	—		3.66 m	12'0"	3.91 m
Scraper tread	2.18 m	7'2"	2.46 m	8'1"	2.82 m
Tractor tread	2.21 m	7'3"	2.46 m	8'1"	2.84 m

◄Operating weight includes coolant, lubricants, full fuel tank, ROPS canopy and operator.

MONTGOMERY WATSON

Calculation Cover Sheet **Appendix E-8**

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Prepared Subgrade Settlement

	Name	Date
Prepared By:	Paul Pellicer	11/12/97
Checked By:	John Pellicer	11/13/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

Project Number: 602-0200
Prepared By: P Pellicer
Checked By: J Pellicer
Sheet: 1 Of 6
Date: Nov 12, 1997
Date: 13-Nov-97

Prepared Subgrade Settlement.

Objective: Determine the amount of settlement of the 6 in prepared subgrade.

Assumptions:
- $\gamma_{waste} = 110 pcf$
- Waste Thickness$_{max}$ = 140 ft.
- C = 1100 psf for recompacted prepared subgrade (conservative
- σ_p' for prepared subgrade is due to compactive effort during placement and is greater than the actual overburden load from the protective soil.
- $\gamma_{protective\ soil} = 90 pcf$

Calculations:

Primary Consolidation:

$$S_c = C_{r\epsilon} H_o \log \frac{\sigma_p'}{\sigma_{vo}} + C_{c\epsilon} H_o \log \frac{\sigma_{vo}' + \Delta\sigma_v}{\sigma_p'}$$

$$C_{r\epsilon} = \frac{C_r}{1+e_o}$$

$$C_{c\epsilon} = \frac{C_c}{1+e_o}$$

H_o = Thickness of Prepared subgrade = 6"

σ_{v_o} = initial overburden pressure = $\underbrace{(2 ft)(90 pcf)}_{\text{protective soil}} = 180 psf$

$\Delta\sigma_v$ = change in overburden Pressure = $\underbrace{(140 ft)(110 pcf)}_{\text{waste}} = 15,400 p$

σ_p' = Maximum past pressure.

estimate σ_p' using c/p ratios (from figure 18.4 p117 Terzaghi and peck 1967) (see pg. 4)

using the Avg PI = 28 (see pg 3) enter the c/p vs PI plot (pg 4) ⇒ $c/p = 0.22$ using c = 1100 psf (conservative) ⇒ $p = 5000 psf = \sigma_p'$

e_o = initial void ratio. = $\frac{G_s \gamma_w}{\gamma_d} - 1$

assume $G_s = 2.7$
$\gamma_w = 62.4 pcf$
Soil is to be placed at 90% of Modified proctor.

Project Number: 602-0200
Sheet: 2 of 6
Prepared By: P. Pellicer
Date: Nov 12, 1997
Checked By: J. Pellicer
Date: 13-Nov-97

Modified proctor Max. Dry density = 127 pcf (see pg 6)

$\gamma_d = (0.9)(127 pcf) = 114.3 pcf$ say 114

$e_o = \frac{(2.7)(62.4)}{114} - 1 = 0.478$ ✓

$C_c = 0.007(LL-7)$ (Empirical eq. p 341 Holz + Kovacs)
(see pg 5)

$LL_{avg} = 42$ (see pg 3)

$C_c = 0.007(42-7) = 0.245$ ✓

Assume $C_r = 0.05\, C_c = 0.0123$ ✓ (see pg 5)

$C_{r\epsilon} = \frac{0.0123}{1+0.478} = 0.0083$ ✓

$C_{c\epsilon} = \frac{0.245}{1+0.478} = 0.1658$ ✓

$S_c = (0.0083)(6 in) \log \frac{5000 psf}{180 psf} + (0.1658)(6 in) \log \frac{180 psf + 15,400 psf}{5000 psf}$

$S_c = 0.072 in + .491 in = \underline{\underline{0.56 in}}$ ✓

Since primary consolidation is so small secondary consolidation should be considered negligible. ✓

SUMMARY OF LABORATORY TEST RESULTS

Sample Location		Natural Moisture Content (%)	Natural Dry Density (%)	Atterberg Limits		Gradation			Unconfined Compressive Strength (psf)	Soil/Bedrock Description	Unified Soil Classification (USCS)
Test Pit Hole No.	Depth (Feet)			Liquid Limit (%)	Plasticity Index (%)	Gravel (%)	Sand (%)	Fines (%)			
1	17	9.9		37	19		5	95			CL
2	17	12.1		54	40		27	73			CH
3	7.5	9.7		36	20		2	98			CL
4	14	8.6		39	27		13	87			CL
4	~~20~~	~~7.0~~					~~1~~	~~99~~	Caliche not applicable		
5	18	12.3		46	32		35	65			CL
			Avg =	42.4	27.6			83			

Project Name: Gandy - Triassic Park Waste Disposal Facility
Project Location: New Mexico
Project No.: 790-12101 **Technician:** DCP **Date:** 9-10-97

TerraMatrix
Engineering & Materials Testing Services
[illegible] Avenue
[illegible] Springs, Colorado [illegible]

SUMMARY OF LABORATORY TEST RESULTS

12-Nov-97

G02-0200
PMP

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602-0200
PMP
12-Nov 97

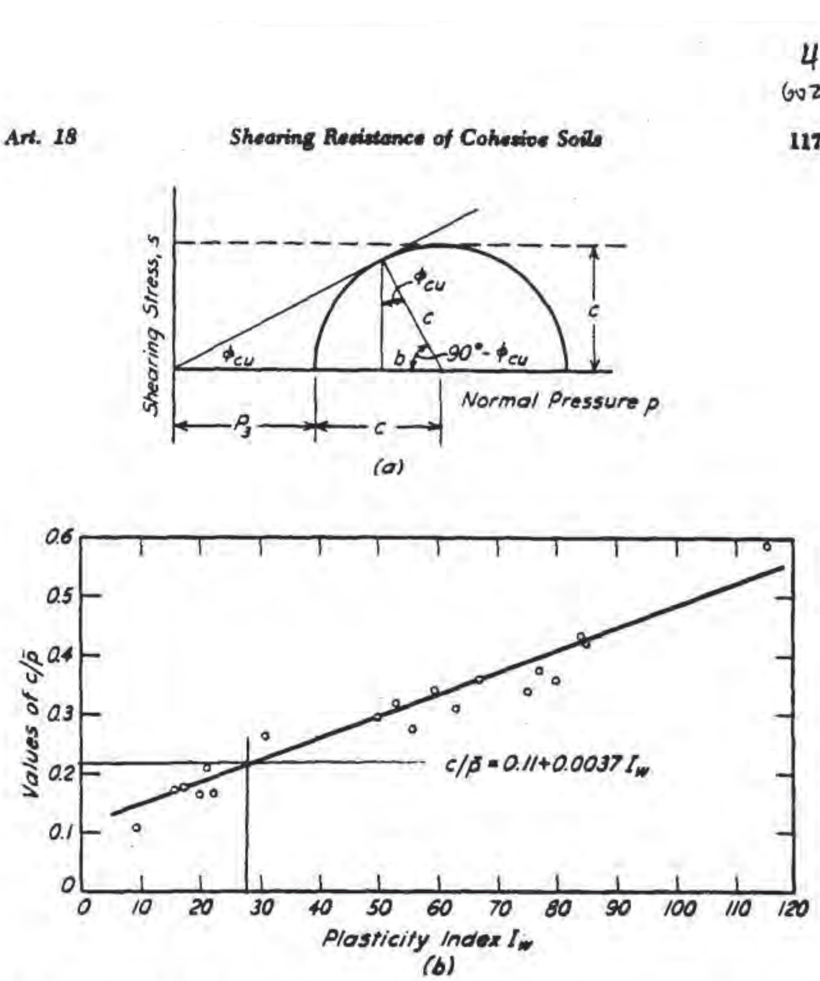

Fig. 18.4. (*a*) Mohr rupture diagram for calculating relation between c and $\bar{p}_3$ for consolidated-undrained test. (*b*) Statistical relation between $c/\bar{p}$ ratio and plasticity index (after Skempton 1957).

tivity. Some natural clay deposits, moreover, consist of a mixture of particles of fairly uniform fine sand and clay. While sedimentation proceeds, the simultaneous deposition of the flaky constituents of the finest fraction and of the equidimensional sand grains interferes with the rolling of the sand grains into stable arrangements. Therefore, if the sand grains touch each other, their configuration may be as metastable as that of true quicksands. However, the interstices between the sand grains are occupied by the clay-size materials which acquire, as a result of such physico-chemical processes as thixotropy and syneresis, appreciable strength as sedimentation proceeds. As a consequence, although the clay is sensitive, it does not exhibit the properties of true quicksands. In many respects, the states of transition from loose sand

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602-0200
pmp
12-Nov-97

8.11 APPROXIMATE METHODS AND TYPICAL VALUES OF COMPRESSION INDICES

Because of the time and expense involved in consolidation testing, it is sometimes desirable to be able to relate the compression indices to the simple classification properties of soils. These relationships are also commonly used for preliminary designs and estimates and for checking the validity of test results.

Table 8-2 is a list of some published equations for the prediction of compression indices (Azzouz, Krizek, and Corotis, 1976).

TABLE 8-2 Some Empirical Equations for C_c and C_{ce}*

Equation	Regions of Applicability
→ $C_c = 0.007\,(LL - 7)$	Remolded clays
$C_{ce} = 0.208e_o + 0.0083$	Chicago clays
$C_c = 17.66 \times 10^{-5} w_n^2 + 5.93 \times 10^{-3} w_n - 1.35 \times 10^{-1}$	Chicago clays
$C_c = 1.15(e_o - 0.35)$	All clays
$C_c = 0.30(e_o - 0.27)$	Inorganic, cohesive soil; silt, some clay; silty clay; clay
$C_c = 1.15 \times 10^{-2} w_n$	Organic soils–meadow mats, peats, and organic silt and clay
$C_c = 0.75(e_o - 0.50)$	Soils of very low plasticity
$C_{ce} = 0.156e_o + 0.0107$	All clays
$C_c = 0.01w_n$	Chicago clays

*As summarized by Azzouz, Krizek, and Corotis (1976).
Note: w_n = natural water content.

Terzaghi and Peck (1967) proposed the following equation, based on research on undisturbed clays of low to medium sensitivity:

$$C_c = 0.009\,(LL - 10) \qquad (8\text{-}21)$$

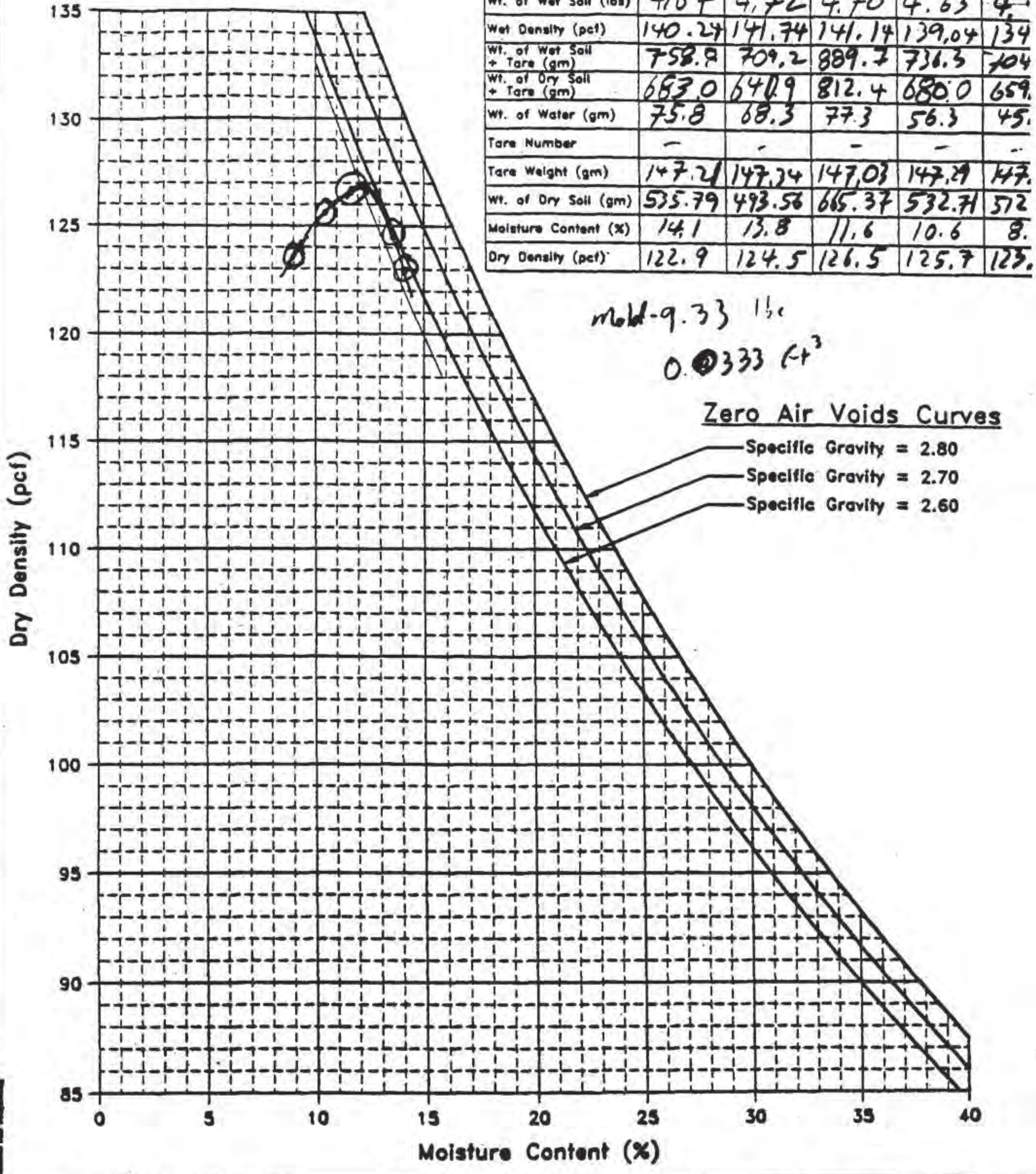
which has a reliability range of about ±30%. This equation is widely used, despite its wide reliability range, to make initial consolidation settlement estimates. The equation should not be used where the sensitivity of the clay is greater than 4, if the LL is greater than 100, or if the clay contains a high percentage of organic matter. Some typical values of the compression index, based on our experience and the geotechnical literature, are listed in Table 8-3.

Often, C_r is assumed to be 5% to 10% of C_c. Typical values of C_r range from 0.015 to 0.035 (Leonards, 1976). The lower values are for clays of lower plasticity and low OCR. Values of C_r outside the range of 0.005 to 0.05 should be considered questionable.

~~Water (ml)~~ #	1	2	3	4	5
Wt. of Wet Soil + Mold (lbs)	14.00	14.05	14.03	13.96	13.
Wt. of Wet Soil (lbs)	4.67	4.72	4.70	4.63	4.
Wet Density (pcf)	140.24	141.74	141.14	139.04	134
Wt. of Wet Soil + Tare (gm)	758.9	709.2	889.7	736.3	704
Wt. of Dry Soil + Tare (gm)	683.0	640.9	812.4	680.0	659.
Wt. of Water (gm)	75.8	68.3	77.3	56.3	45.
Tare Number	–	–	–	–	–
Tare Weight (gm)	147.21	147.34	147.03	147.29	147.
Wt. of Dry Soil (gm)	535.79	493.56	665.37	532.71	512
Moisture Content (%)	14.1	13.8	11.6	10.6	8.
Dry Density (pcf)	122.9	124.5	126.5	125.7	125.

Mold-9.33 lbs

0.0333 ft^3



Project Name: Gandy			**TerraMatri** **MONTGOMERY WATSON** Mining Group **MOISTURE-DENSITY** **RELATIONSHIP OF SO**
Sample Location:		**Sample No.:** Composite	
Sample Source:		**Technician:** DCP	
Sample Description: Red Clay			
Max. Dry Density (pcf): 127	**Opt. Moisture (%):** 12.2	**Procedure:** D1557	
Liquid Limit (%):	**Plasticity Index (%):** [illegible]	**Natural Moisture (%):**	**Project No.:**
% + 3/4 in.:	**% – No. 4:**	**% – No. 200:**	**Date:** 9-16-97

MONTGOMERY WATSON

Calculation Cover Sheet **Appendix E-9**

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Subgrade Settlement

	Name	**Date**
Prepared By:	Paul Pellicer	11/12/97
Checked By:	John Pellicer	11/12/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

Project Number: 602-0200
Prepared By: P. Pellicer
Checked By: J. Pellicer

Sheet: 1 Of 2
Date: Nov 12, 1997
Date: 12-Nov-97

Subgrade Settlement.

Objective. Determine the Maximum amount of Potential Settlement for the Subgrade. To be used for determining Induced Stresses in the liner geomembrane.

Assumptions:
- Simplified Geometry, No side slopes, uniform waste Thickness (associated w/ deepest part of land fill 140 ft)
- Unit weight of waste : 110 pcf
- Waste behaves as a flexible mat.
- Foundation Soil is of a finite depth (conservative).

Calculations: Divide cell foot print into rectangles with a Common Corner "O" at the deepest section of the land fill. (see pg 3) ✓

Use Elastic Settlement Theory. (pp. 169-172 - Fang 1991) (see pg 4-7) $S_i = C_s\, q\, B \left(\frac{1-\nu^2}{E_u}\right)$ ✓

Estimate physical Parameters of foundation soil Lower Dockum ⇒ $\nu = 0.3$, $E_u = 72{,}000$ ksf (see pg 7-9 (conservative estimates.)

$$q = (110\,\text{pcf})(140\,\text{ft}) = 15400\,\text{psf.}$$ ✓

$$\frac{1-\nu^2}{E_u} = \frac{1-(.3)^2}{72{,}000{,}000\,\text{psf}} = 1.264 \times 10^{-8}\,\frac{\text{ft}^2}{\text{lb}}$$ ✓

$$q \times \frac{1-\nu^2}{E_u} = 1.946 \times 10^{-4}$$ ✓

Area	L(ft)	B(ft)	$\frac{L}{B}$	C_s*	S_i (ft)
A	2143	610	3.5 ✓	.9	.107 ✓
B	2143	422	5.1 ✓	1.05	.086
C	999	906	1.1	.56	.099
D	1421	626	2.5 ✓	.79	.096
E	626	610	1.0 ✓	.56	.066
- F	906	422	2.1	.76	-.062

* interpolated from table 5.3 (see pg 6)

Project Number: 502-0200
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Date: 12-Nov-97

$\Sigma S_i = 0.39$ ft $\Rightarrow$ Say 5"

Conclusions: The assumptions used in this calculation are extremely conservative and were used to achieve a worst case settlement for induced stress in the geomembrane. Actual subgrade settlement will not be this large for two reasons

- The waste thickness is less than what was assumed exspecially on the side slopes.
- The base of the cell has already been loaded by overburden that will be excavated out and therefore will not behave in a fully elastic manner, and the net change of effective stress on the foundation soils is minimal.

NOTE: A specific calculation was not completed for the evaporation pond. The estimated settlement for the landfill is not considered harmful. The evaporation is smaller than the landfill; therefore, the subgrade will settle less. Therefore subgrade settlement in the evaporation pond will not be a problem.

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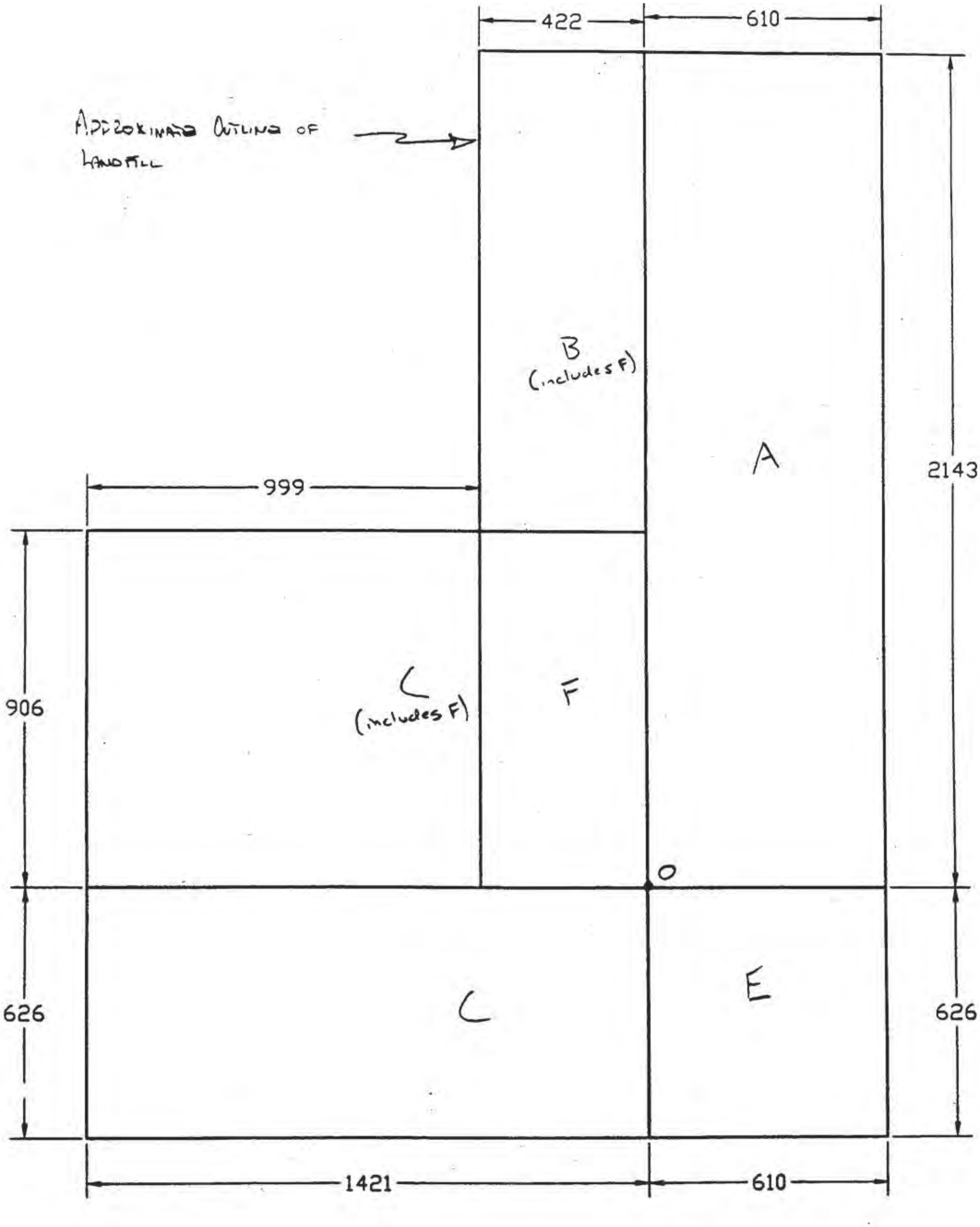

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FOUNDATION ENGINEERING HANDBOOK

Second Edition

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and less than at the edges (Fig. 5.2b). Contact stress distributions are important for the design of foundations and footings ·Bowles, 1975a). For the structural design of footings, a linear ntact stress distribution is often assumed although this is iously incorrect from a soil mechanics point of view.

5.4.2 Immediate Settlement of Cohesive Foundations

For soils that are predominately cohesive, linear theory of elasticity is used to estimate the magnitude of initial settlements. Soil profiles are typically simplified, although some solutions involving multiple layer theory are available. Homogeneity and isotropy are implicitly assumed so that only two elastic parameters, the modulus of elasticity E and Poisson's ratio ν are needed. This approach works reasonably well on clay soils if the applied stress level is low; that is, if the factor of safety is large and we do not have plastic yielding in the foundation. If foundation yielding is likely to occur, another approach is recommended, which will be described below.

In many foundations on cohesive soils, the immediate or distortion settlement is a relatively small part of the total vertical movement and, thus, rough estimates are acceptable. A discussion of relative importance of immediate and consolidation settlement will be given later in this section.

A Distributed Load at or Near the Surface of a Deep Layer When the foundation problem can be approximated as one or more uniformly distributed loads acting on circular or rectangular areas near the surface of a relatively deep stratum, the vertical settlement can be estimated by

$$s_i = C_s q B\left(\frac{1-\nu^2}{E_u}\right) \tag{5.2}$$

where

s_i = settlement of a point on the surface
C_s = shape and rigidity factor
q = magnitude of the uniformly distributed load
B = characteristic dimension of the loaded area as shown in Figure 5.3
E_u = Young's modulus (undrained)
ν = Poisson's ratio

The coefficient C_s accounts for the shape and rigidity of the loaded area and for the position of the point for which the settlement is being calculated. Values of C_s are given in Table 5.3.

EXAMPLE 5.1

A structure is to be supported on a stiff reinforced concrete mat foundation whose dimensions are 20 m by 50 m. The load on the mat is to be uniformly distributed; its magnitude is 65 kPa. The mat rests on a deep saturated deposit of saturated clay for which the average undrained Young's modulus is approximately 40 MPa. Estimate the immediate settlement at the center and corner of the mat.

5

Solution [redacted]

Since the mat is stiff, use the rigid factors from Table 5.3a. With $L/B = 50/20 = 2.5$, the shape factors for both the center and corner are determined by interpolation to be $C_s = 1.20$. Thus from Equation 5.2 the immediate surface settlement at both the center and corner of the mat is $s_i = 1.20(65)(20)\ [(1 - 0.5^2)]$ divided by $[(40 \times 10^3)] = 0.029$ m = 29 mm.

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For comparison, the shape factors for a flexible mat would be determined by interpolation to be

At the center $C_s = 1.63$
At the corner $C_s = 0.81$

Thus, the immediate surface settlements are

At the center $s_i = 40$ mm
At the corner $s_i = 20$ mm

A mat foundation is usually neither completely flexible nor completely rigid, depending on its size and thickness and how heavily reinforced it is. If it is large, the distribution of contact pressure may be nearly uniform over its center portion. At the corners and edges, however, the rigidity of the mat may be significant (owing to its thickness and the amount of reinforcing), and settlements are likely to be less than predicted. In a saturated clay, because of settlement in the middle portion of the foundation, some heave may occur in the outer portions because of undrained (constant volume) loading and shear.

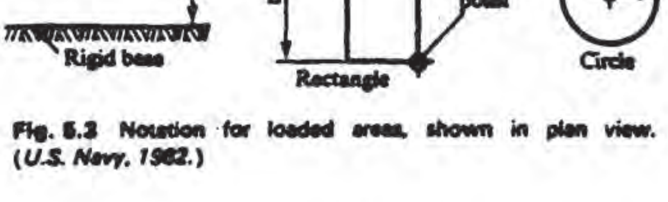

Fig. 5.3 Notation for loaded areas, shown in plan view. (*U.S. Navy, 1982.*)

Effect of Layered Systems In actuality, most soil profiles are not homogeneous and deep. If the thickness of the top layer is large relative to the dimensions of the loaded area, immediate surface settlement may be calculated as if the soil were a homogeneous layer of infinite depth. However, if the upper stratum is relatively thin, the effect of layering must be taken into consideration. This is likely to be especially important when a soft compressible stratum is underlain by rock or very hard or dense soils. This special case may be approximated by a layer of elastic material of finite thickness underlain by a rigid base. Settlements for this case may be determined by Equation 5.2, but using a shape factor C_s that accounts for the presence of the rigid base. Values for these shape factors C_s are tabulated in Table 5.3b for the settlement under the center of a rigid circular area and under the corner of flexible rectangular areas. These shape factors depend upon both the shape of the loaded area and the thickness of the compressible stratum relative to the width of the loaded area, as illustrated in Figure 5.3.

Examination of Table 5.3 indicates the importance of the presence of a rigid boundary. When $H/B = 0.5$, the reduction in surface displacements of the center of the loaded area relative to that for the halfspace is greater than 50 percent.

EXAMPLE 5.2

Compute the immediate settlement at the center of the uniformly loaded (flexible) area measuring 6 m × 6 m. The applied surface stress is 200 kPa and the depth to firm bottom is 3 m. Assume the undrained elastic modulus is 10 000 kPa and $\nu = 0.5$.

Solution

Use the C_s values for the corners of four equally sided rectangles 3 m × 3 m. In this case, $H/B = 1$, $L/B = 1$, and,

[redacted]

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TABLE 5.3 SHAPE AND RIGIDITY FACTORS, C_s, FOR CALCULATING SETTLEMENTS OF POINTS ON LOADED AREAS AT THE SURFACE OF AN ELASTIC HALFSPACE[a].

a. Infinite Depth

Shape and Rigidity	Center	Corner	Edge/Middle of Long Side	Average
Circle (flexible)	1.00		0.64	0.85
Circle (rigid)	0.79		0.79	0.79
Square (flexible)	1.12	0.56	0.76	0.95
Square (rigid)	0.82	0.82	0.82	0.82
Rectangle: (flexible) length/width				
2	1.53	0.76	1.12	1.30
5	2.10	1.05	1.68	1.82
10	2.56	1.28	2.10	2.24
Rectangle: (rigid) length/width				
2	1.12	1.12	1.12	1.12
5	1.6	1.6	1.6	1.6
10	2.0	2.0	2.0	2.0

b. Limited Depth Over a Rigid Base

H/B	Center of Rigid Circular Area Diameter = B	Corner of Flexible Rectangular Area				
		L/B = 1	L/B = 2	L/B = 5	L/B = 10	L/B = ∞ (strip)
			$\nu = 0.50$			
0	0.00	0.00	0.00	0.00	0.00	0.00
0.5	0.14	0.05	0.04	0.04	0.04	0.04
1.0	0.35	0.15	0.12	0.10	0.10	0.10
1.5	0.48	0.23	0.22	0.18	0.18	0.18
2.0	0.54	0.29	0.29	0.27	0.26	0.26
3.0	0.62	0.36	0.40	0.39	0.38	0.37
5.0	0.69	0.44	0.52	0.55	0.54	0.52
10.0	0.74	0.48	0.64	0.76	0.77	0.73
			$\nu = 0.33$			
0	0.00	0.00	0.00	0.00	0.00	0.00
0.5	0.20	0.09	0.08	0.08	0.08	0.08
1.0	0.40	0.19	0.18	0.16	0.16	0.16
1.5	0.51	0.27	0.28	0.25	0.25	0.25
2.0	0.57	0.32	0.34	0.34	0.34	0.34
3.0	0.64	0.38	0.44	0.46	0.45	0.45
5.0	0.70	0.46	0.56	0.60	0.61	0.61
10.0	0.74	0.49	0.66	0.80	0.82	0.81

[a] After U.S. Navy (1982).

from Table 5.3, $C_s = 0.15$:

$$S_i = 0.15(200)(3)\left(\frac{1 - 0.5^2}{10\,000}\right) \times 4 = 27 \text{ mm}$$

If the soil profile consists of a relatively thin stiffer layer underlain by a less stiff layer of greater depth, then the stresses from the surface load must be distributed to the top of the less compressible layer. Use the stress distribution techniques discussed in Section 5.6.

Analytical and/or numerical methods for the determination of displacements in multilayered systems are available for cases other than those in Table 5.3 (see Poulos and Davis, 1974). A number of multilayer solutions are now available in computer codes. Except for pavements and special foundations, however, the use of multilayered computer analyses is generally not justified, because the material parameters are not accurately determined, the boundary conditions and interface conditions between the strata are not that well known, and, finally, approximations may be required to fit the geometry of the real problem to that for which the solution is available. In many situations an approximate analysis of the intermediate settlement is sufficient, as illustrated in the following two examples.

EXAMPLE 5.3

The mat foundation of Example 5.1, 20 m × 50 m supporting a uniform normal load of 65 kPa, is founded on a soil profile shown in Figure 5.4. The profile indicates a layer of stiff clay over a more compressible layer that is in turn underlain by shale. Assume these conditions are representative of the entire site. Estimate the immediate surface settlement at the center of the mat.

Solution

Assume the shale acts as a rigid base and above it a *single* stratum of thickness $H = 15$ m. Thus,

$$\frac{H}{B} = \frac{15}{10} = 1.5 \quad \frac{L}{B} = \frac{25}{10} = 2.5$$

The shape factor C_s obtained from Table 5.3b by linear

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4-24. Modulus of Elasticity of Rocks

Knowledge about the modulus of elasticity of rocks is an important factor in evaluating rock deformation under various loading conditions. It is also necessary in studies of seismics in rocks. The modulus of elasticity of rock varies from one geologic region to another because of the existence of various types of rock formation. For this reason alone, different values of the modules of elasticity of different rocks can be anticipated. Hence, there exists a need for the determination of the numerical values of the modulus of elasticity of rocks.

Generally, the modulus of elasticity of rock is affected by rock type, porosity, particle size, and water content. The variation in the values of the modulus of elasticity is more pronounced in clayey shales than in sandstone, for example.

The modulus of elasticity is greater perpendicular to stratification and fissure than that determined parallel to the bedding planes and fissures.

The various modes of genesis or formation of rocks also affect the magnitude of the modulus of elasticity.

The reason for high modulus of elasticity values of some rocks probably lies in their structures themselves, as well as in their mineral chemical compounds. The known values of the modulus of elasticity of various rocks may suggest that eruptive igneous rocks of basic nature—like basalts, for example—have a larger modulus value than acidic rocks—such as granite, for example.

Technically, the modulus of elasticity of a rock can be increased considerably by means of rock grouting.

Elasticity constants E and μ of rocks are determined by:

1. static tests
2. longitudinal resonance tests
3. electrical resistance (strain gauge) tests
4. ultrasonic velocity measurements on laboratory rock test specimens, and
5. dynamic tests, in which velocities of propagated energy waves in situ are measured. Measurements of the primary wave (P-wave) and

TABLE 4-13
Elasticity Constants E and μ of Some Rocks

Rock	Young's modulus of elasticity E kg/cm² Multiply by 10^5	Young's modulus of elasticity E N/m² Multiply by 10^{10}	Poisson's ratio μ Average values	References
1	2	3	4	5
Igneous rocks				
Basalt	2.0–10.0	1.96– 9.81	0.14 –0.25	37, 63, 68, 107
		4.85–11.15	0.22 –0.25	18
Diabase	3.0– 9.0	2.94– 8.83	0.125–0.25	42, 63
		–	0.333	68
		2.20–11.40	0.103–0.184	68
		8.00–10.75	–	18
Gabbro	6.0–11.0	5.88–10.78	0.125–0.25	37, 63, 68
		5.84– 8.71	0.154–0.48	18
Granite	2.6– 7.0	2.55– 6.86	0.125–0.25	37, 63
		–	0.155–0.338	18
		–	0.150–0.240	112, 68
		2.13– 7.05	–	18
Syenite	6.0– 8.0	5.88– 7.85	0.25	37
		6.29– 8.63	0.17 –0.319	18
			0.15 –0.34	68
Sedimentary rocks				
Dolomite	2.0– 8.4	1.96– 8.24	0.08 –0.20	37, 63
		7.10– 9.30	0.08 –0.20	68, 107
		–	0.32 –0.37	18
Limestone	1.0– 8.0	0.98– 7.85	0.10 –0.20	63, 107
		–	0.16 –0.23	68
		–	0.33 –	63
		0.80– 2.10	0.14 –0.30	18
Sandstone	0.5– 8.6	0.49– 8.43	0.066–0.125	112
		–	0.230–0.300	56
		–	0.17	63, 68
	163,848,000 psi.	165,970,000	0.07	112
		–	0.62	56
Shale (clay)	0.8– 3.0	0.78– 2.94	0.11 –0.54	37, 68
		0.98– 2.35	0.10	56
		1.20– 4.40	0.23 –0.30	107
		–	0.04 –0.12	18

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TABLE 12-3

Properties of Various Rocks as Foundation Materials

Type	Rock	Typical dry unit weight, p.c.f.	Range of modulus of elasticity, k.s.i.	Range of compressive strength, k.s.i.	Structural characteristics
Igneous:					
Intrusive (coarse grained).	Feldspar predominates, light colored:				
	Granite (abundant quartz)	168	4,000 to 7,000	10 to 25	Generally present as intrusion of great mass. May contain fracture system, closed except where weathering has proceeded downward from the surface. Deep localized weathering may occur at intersection of major fracture systems.
	Diorite (little quartz)	176	5,000 to 8,000		
	Iron, magnesium predominates, dark colored Gabbro.	180	7,000 to 12,000	15 to 30	
Extrusive (fine grained).	Feldspar predominates, light colored:				
	Rhyolite (abundant quartz)	162	5,000 to 8,000	10 to 25	Formed in sheet-like masses characterized by extensive joint system, more open in basalt than rhyolite or andesite. May contain holes, voids, layers of volcanic ash or pumice resulting from vulcanism concurrent with extrusion.
	Andesite (little quartz)	166	6,000 to 9,000		
	Iron, magnesium predominates, dark colored Basalt.	178	7,000 to 13,000	25 to 40	
	Glassy Obsidian	140	1,000 to 4,000	2 to 8	Exhibits flow structures, may be highly vesicular.
	Fragmental Tuff	100	200 to 1,000	0.2 to 1	Light and relatively porous structure formed in volcanic discharge.
Metamorphic:					
Foliated (platy) ...	Medium grained, abundant mica Schist.	167	2,000 to 5,000	5 to 15	Often intricately folded and distorted. Fracturing, softening, weathering or deep erosion occurs in zones of intense movement. Weathering produces clayey, micaceous residue.
	Fine grained, dark colored Slate	160	5,000 to 8,000	10 to 20	
Banded (imperfectly foliated).	Coarse grained, abundant quartz Gneiss.	160	4,000 to 8,000	10 to 20	Less distortion than in the highly foliated rocks. Weathered residue is gritty with resistant silica particles.
Massive	Hard and brittle:				
	Quartzite (mainly quartz)	166	6,000 to 8,000	15 to 35	Quartzite and marble may be extremely hard with only fine fracture system. Some serpentines are soft to great depths.
	Marble (mainly calcite)	168	7,000 to 10,000	12 to 30	
	Relatively soft Serpentine	150	1,000 to 5,000	1 to 10	
Sedimentary:					
Argillaceous (clay minerals predominate).	Fine grained, laminated:		72,000 ksf		
	Shale (clay size)	100 to 140	500 to 2,000	0.1 to 5	Wide variation in engineering properties between materials formed by compaction alone or with cementation. Compaction shales may soften, slake and swell on exposure. Cementation types (argillite) are not sensitive to exposure.
	Siltstone (silt size)	110 to 150	500 to 2,000	0.1 to 5	
Siliceous (silica predominates).	Medium grained Sandstone	147	1,000 to 3,000	4 to 12	Strength and permeability depends on type and degree
	Coarse grained:				

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-10

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Effect of Differential Settlement on Base Grades

	Name	Date
Prepared By:	Paul Pellicer	11/13/97
Checked By:	John Pellicer	11/13/97
Reviewed By:	Pat Corser	11/14/97

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Project Number 602-0200 Sheet: 1 Of 2
Prepared By: P. Pellicer Date: 13-Nov-1997
Checked By: J. Pellicer Date: 13-Nov-97

Effect of Differential Settlement on Base Grades.

Objective: Evaluate the effect of differential settlement on the cell base grades for phase 1

Calculations:

Maximum amount of settlement = 5.56" (from Subgrade Settlement + prepared Subgrade settlement Calculations).

Maximum amount of settlement occurs at pt A. (See pg 2
No Settlement occurs at Pt B (conservative) (see pg 2)

Distance between Pt A + B = 581'

Change in grade = $\left(\frac{-5.56''}{12''/\text{ft}}\right)(581') = -0.0008 \Rightarrow -0.08\%$

Current Minimum grade in phase 1 = 2.5%

Minimum grade in phase 1 after differential settlement
= 2.5% − 0.08% = 2.42% > 2% (Minimum recomended by EPA)

Conclusion: Even w/ extremely conservative assumptions differential settlement has a neglegable effect on the base grades.

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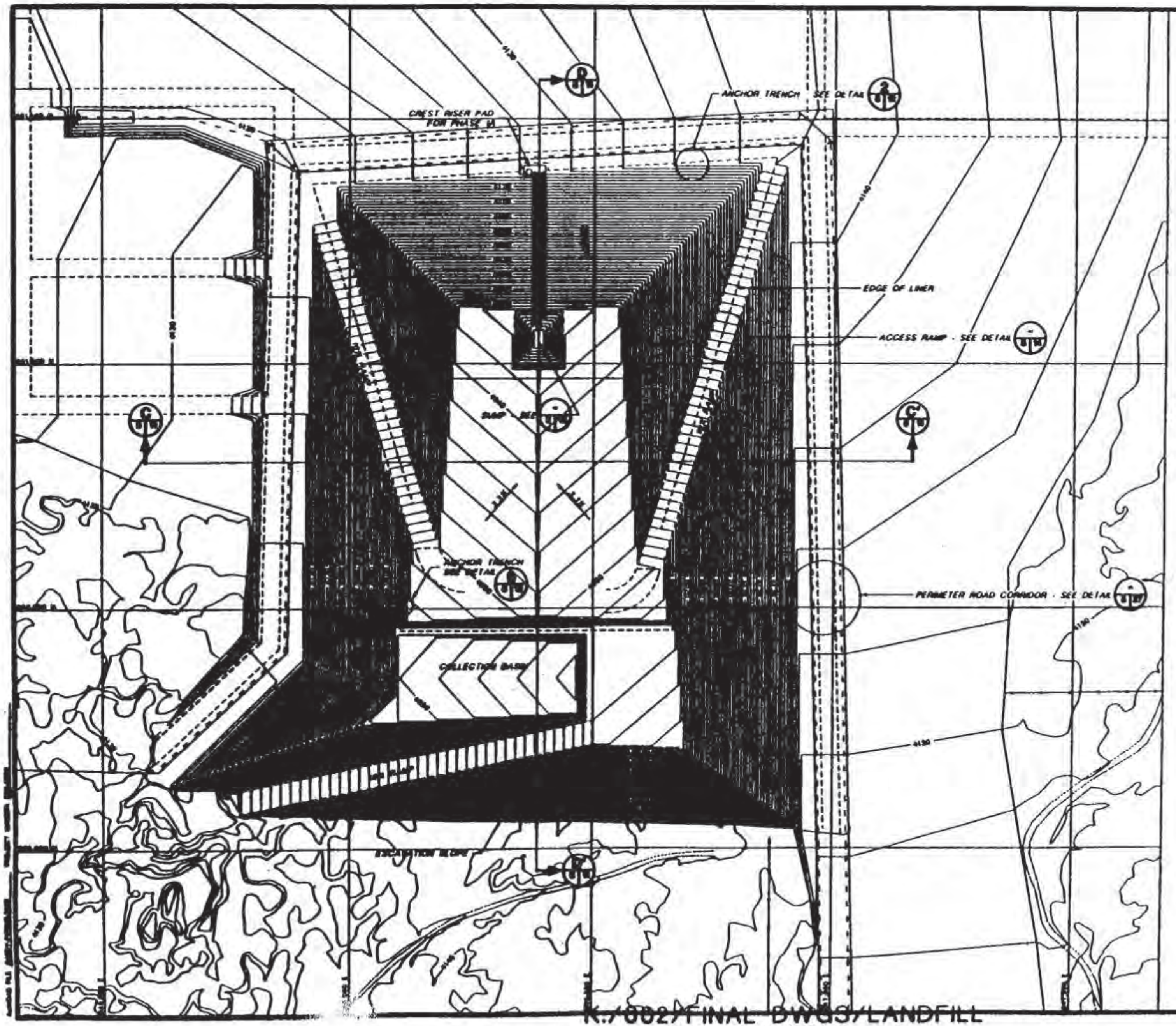
602-0200
13-NOV-97

E-10



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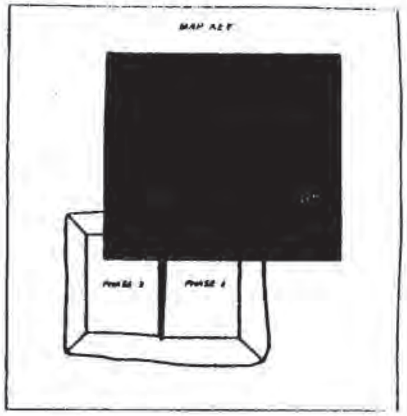

NOTES
1 FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2 "INDEX LEGEND AND GENERAL NOTES"
2 TOPOGRAPHY FROM AERIAL SURVEYS PERFORMED AUGUST 1997 BY KOOGLE AND POULS ENGINEERING

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date — Patrick G. Corser, NM P.E. 12236

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TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE
DETAILED EXCAVATION PLAN - PHASE 1A

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MONTGOMERY WATSON

Calculation Cover Sheet **Appendix E-11**

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Waste Settlement

	Name	**Date**
Prepared By:	Paul Pellicer	11/11/97
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Project Number: 602-0200
Prepared By: P. Pellicer
Checked By: J. Pillicer
Sheet: 1 of 13
Date: Nov 1997
Date: 12-Nov-97

Waste Se[illegible]

Objective: Calculate amount of waste settlement and how this settlement will affect surface grades.

Assumptions:
- Waste settlement [illegible] uniform.
- Primary Settlement has occurred prior to placement of the cover system. Monitoring of the settlement should be conducted.

Calculations:
- take all cross sections perpendicular to cover grades to show true grades. (see pg 2)
- Divide crossections into segments determined by changes in slope of either the cell base or cover. (see pg 3-5)

Results: Total waste settlement up to 7% is acceptable to maintain a minimum cove grade of 5%. (see pg 6-8)

Conclutions: The EPA recomends using 11.5% settlement for design purposes. However this is considered the Maximum amount of settlement possible. Two methods were used to estimate a range of settlements, These two methods were the Power Creep Law and Sowers Method for Secondary Compression. These Two methods resulted in an estimated range of settlement of 2% → 7.8% (see pg 9-11). ∴ the 7% settlement used in this calculation is not unreasonable. During the placement of the cover, waste settlement will be monitored and compared to the estimated 7% settlement used for calculation. If settlement is larger than 7% cover grades will be adjusted to accommodate settlement and maintain minimum 3% grade.

Project Name: Gandy Marley Inc.
Project Number: 602-0200
Prepared By: Paul Pellicer Checked By:
Filename: Gandy waste Settlement xseca.xls

Station	Waste Depth (ft)	Settlement Factor	Maximum Settlement (ft)	Original Elevation (ft)	Post Settlement Elevation (ft)	Slope Segment	Horizontal Distance (ft)	Original Grade (%)	Post Settlement Grade (%)	Minimum Required Slope (%)
A	0	0.07	0	125.81	125.81					
B	7.8	0.07	0.546	131.25	130.70	A-B	10.1	54%	48.5%	3.0%
C	93	0.07	6.51	144.19	137.68	B-C	216.3	6%	3.2%	3.0%
D	112.4	0.07	7.868	159.07	151.20	C-D	248.1	6%	5.5%	3.0%
E	120.1	0.07	8.407	171.66	163.25	D-E	209.9	6%	5.7%	3.0%
F	115.5	0.07	8.085	168.07	159.99	E-F	60	6%	5.4%	3.0%
G	6.3	0.07	0.441	150.00	149.56	F-G	278.2	6%	3.7%	3.0%
H	0	0.07	0	146.10	146.10	G-H	7.2	54%	48.0%	3.0%

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Project Name: Gandy Marley Inc.
Project Number: 602-0200
Prepared By: Paul Pellicer Checked By:
Filename: Gandy waste Settlement xsece.xls
B

Station	Waste Depth (ft)	Settlement Factor	Maximum Settlement (ft)	Original Elevation (ft)	Post Settlement Elevation (ft)	Slope Segment	Horizontal Distance (ft)	Original Grade (%)	Post Settlement Grade (%)	Minimum Required Slope (%)
A	0	0.07	0	158.82	158.82					
B	8.67	0.07	0.6069	164.27	163.66	A-B	10.08	54%	48.0%	3.0%
C	115.76	0.07	8.1032	180.74	172.64	B-C	274.49	6%	3.3%	3.0%
D	144.06	0.07	10.0842	202.07	191.99	C-D	355.65	6%	5.4%	3.0%
E	121.68	0.07	8.5176	165.00	156.48	D-E	NA	NA	NA	NA
F	116.18	0.07	8.1326	151.36	143.23	E-F	227.31	6%	5.8%	3.0%
G	2.47	0.07	0.1729	130.00	129.83	F-G	297.81	7%	4.5%	3.0%
H	0	0.07	0	128.45	128.45	G-H	2.97	52%	46.4%	3.0%

602-0200
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11-Nov-97

Project Name: Gandy Marley Inc.
Project Number: 602-0200
Prepared By: Paul Pellicer Checked By:
Filename: Gandy waste Settlement xsecc.xls

Station	Waste Depth (ft)	Settlement Factor	Maximum Settlement (ft)	Original Elevation (ft)	Post Settlement Elevation (ft)	Slope Segment	Horizontal Distance (ft)	Original Grade (%)	Post Settlement Grade (%)	Minimum Required Slope (%)
A	0	0.07	0	143.15	143.15					
B	8.76	0.07	0.6132	148.60	147.99	A-B	10.08	54%	48.0%	3.0%
C	125.2	0.07	8.764	166.55	157.79	B-C	299.26	6%	3.3%	3.0%
D	140.58	0.07	9.8406	190.00	180.16	C-D	390.9	6%	5.7%	3.0%
E	135.16	0.07	9.4612	190.00	180.54	D-E	248.3	0%	0.2%	NA
F	121.09	0.07	8.4763	191.09	182.61	E-F	30.7	4%	6.8%	NA
G	121.54	0.07	8.5078	191.54	183.03	F-G	15.42	3%	2.7%	NA
H	132.4	0.07	9.268	192.12	182.85	G-H	21.21	3%	0.8%	NA
I	144.1	0.07	10.087	202.11	192.02	H-I	406.6	2%	2.3%	NA
J	137.05	0.07	9.5935	194.58	184.99	I-J	125.49	6%	5.6%	3.0%
K	114.34	0.07	8.0038	179.48	171.48	J-K	251.67	6%	5.4%	3.0%
L	3.56	0.07	0.2492	160	159.75	K-L	278.74	7%	4.2%	3.0%
M	0	0.07	0	157.68	157.68	L-M	3.79	61%	54.6%	3.0%

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Power Creep Law Settlement

Waste Depth (ft)	Slice Thickness (m)	Over Burden Pressure (kPa)	Slice Settlement (m)	Culmative Settlement (ft)	Percent Settlement
0-5	1.524	13.15	0.002	0.007	0.14%
5-10	1.524	39.45	0.007	0.0289	0.29%
10-15	1.524	65.75	0.011	0.0650	0.43%
15-20	1.524	92.05	0.015	0.1156	0.58%
20-25	1.524	118.35	0.020	0.1807	0.72%
25-30	1.524	144.65	0.024	0.2602	0.87%
30-35	1.524	170.95	0.029	0.3541	1.01%
35-40	1.524	197.25	0.033	0.4625	1.16%
40-45	1.524	223.55	0.037	0.5853	1.30%
45-50	1.524	249.85	0.042	0.7226	1.45%
50-55	1.524	276.15	0.046	0.8744	1.59%
55-60	1.524	302.45	0.051	1.0406	1.73%
60-65	1.524	328.75	0.055	1.2213	1.88%
65-70	1.524	355.05	0.059	1.4164	2.02%
70-75	1.524	381.35	0.064	1.6260	2.17%
75-80	1.524	407.65	0.068	1.8500	2.31%
80-85	1.524	433.95	0.073	2.0884	2.46%
85-90	1.524	460.25	0.077	2.3414	2.60%
90-95	1.524	486.55	0.081	2.6088	2.75%
95-100	1.524	512.85	0.086	2.8906	2.89%
100-105	1.524	539.15	0.090	3.1869	3.04%

= Cumulative total settlement

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Sowers Method Secondary Compression

Waste Depth (ft)	Slice Thickness (ft)	Slice Settlement (ft)	Culmative Settlement (ft)	Percent Settlement
0-5	5	0.111	0.111	2.22%
5-10	5	0.111	0.2222	2.22%
10-15	5	0.111	0.3333	2.22%
15-20	5	0.111	0.4444	2.22%
20-25	5	0.111	0.5556	2.22%
25-30	5	0.111	0.6667	2.22%
30-35	5	0.111	0.7778	2.22%
35-40	5	0.111	0.8889	2.22%
40-45	5	0.111	1.0000	2.22%
45-50	5	0.111	1.1111	2.22%
50-55	5	0.111	1.2222	2.22%
55-60	5	0.111	1.3333	2.22%
60-65	5	0.111	1.4444	2.22%
65-70	5	0.111	1.5556	2.22%
70-75	5	0.111	1.6667	2.22%
75-80	5	0.111	1.7778	2.22%
80-85	5	0.111	1.8889	2.22%
85-90	5	0.111	2.0000	2.22%
90-95	5	0.111	2.1111	2.22%
95-100	5	0.111	2.2222	2.22%
100-105	5	0.111	2.3333	2.22% = Cumulative Total Settlement.

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Sowers Method Secondary Compression

Waste Depth (ft)	Slice Thickness (ft)	Slice Settlement (ft)	Culmative Settlement (ft)	Percent Settlement
0-5	5	0.389	0.389	7.78%
5-10	5	0.389	0.7778	7.78%
10-15	5	0.389	1.1667	7.78%
15-20	5	0.389	1.5556	7.78%
20-25	5	0.389	1.9444	7.78%
25-30	5	0.389	2.3333	7.78%
30-35	5	0.389	2.7222	7.78%
35-40	5	0.389	3.1111	7.78%
40-45	5	0.389	3.5000	7.78%
45-50	5	0.389	3.8889	7.78%
50-55	5	0.389	4.2778	7.78%
55-60	5	0.389	4.6667	7.78%
60-65	5	0.389	5.0556	7.78%
65-70	5	0.389	5.4444	7.78%
70-75	5	0.389	5.8333	7.78%
75-80	5	0.389	6.2222	7.78%
80-85	5	0.389	6.6111	7.78%
85-90	5	0.389	7.0000	7.78%
90-95	5	0.389	7.3889	7.78%
95-100	5	0.389	7.7778	7.78%
100-105	5	0.389	8.1667	7.78%

= Cumulative total Settlemen

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SECTION 7

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Conclusions reached as a result of the study are:

a. The dominant mechanisms of settlement of the fill and subsidence of the covers of horizontally layered hazardous waste landfills are expected to be closing of the inherent drum-placement void spaces and compression of cell contents including intermediate cover soils, waste, and waste containers. Cavity related piping and sinkhole phenomena are not expected to play a major role in predicted subsidence. This conclusion is based on review of representative active waste disposal practices in industry and government and analysis of documented and theoretical subsidence mechanisms reported in other, related activities.

b. The maximum postclosure subsidence of the cover (cap) of a simulated hazardous waste landfill operating under interim RCRA guidelines, from compressibility alone, is predicted to be about 11-1/2 percent of the total height of the fill and cover at the center of the landfill. For a 62.5-ft-thick fill and cover the maximum expected subsidence, after deterioration of the waste containers, was 87 in. The final cover slope with that subsidence would be about 2 percent, which is undesirable under current RCRA guidelines. An additional 8 to 9 percent subsidence must be considered if waste drums are assumed to contain the maximum allowable 10 percent void space when placed in the fill.

c. Actual landfill settlement and cover subsidence may be less than the worst-case maximum predicted 11-1/2 percent because more of the voids between containers will probably be filled as a result of less than optimum (tight) stacking of containers during placement. The 11-1/2 percent figure is considered an effective value for design purposes.

RECOMMENDATIONS

Cover subsidence from settlement of compressible fill is expected to occur. Therefore, to minimize the severity of subsidence, managers of hazardous waste landfills should continue at least those operational methods that are being practiced at representative RCRA-guided secure landfills as determined from field observations of this study. Recommended operational methods include:

a. Landfill operators should make an effort to reduce voids when placing wastes and fill within the cell by insuring that intermediate cover soils are allowed to sift between waste containers and debris.

drums or other containers of wastes should be filled to minimize the volume of void within the containers. Much of the potential settlement from compressibility can be eliminated by preventing the inclusion of cavities in the waste placement process in the typical hazardous waste landfill.

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b. Layering of waste and intermediate cover in thin lifts so that some compactive effort is achieved during filling.

c. Control of liquids by installation of efficient leachate collection systems and stabilization of liquid wastes to prevent saturation of the fill and to allow consolidation to occur as rapidly as possible.

d. Installation and monitoring of cover settlement plates so that the subsiding surface can be maintained at the proper slope. Hazardous waste landfills should be documented, instrumented, and monitored after closure. Subsidence of the cover as well as the settlement of internal waste layers should be monitored with time in an effort to gain understanding of postclosure internal changes, how they occur, and how they affect the overall behavior of the landfill. Many of the mechanisms at work within these landfill cells can be understood only by study and experience with representative landfill cells. The data obtained by field monitoring will permit evaluation and improvement of settlement/subsidence prediction models developed in this study. Landfill operators should remember that, when the cover surface can be maintained at a proper runoff slope by the addition of soil or other material, the internal cover liner, whether a clay layer or a flexible membrane liner or both, may have been deformed and stressed by subsidence. Internal cover liner damage or deformation cannot be remedied by simple cover surface cosmetic actions.

e. Placement of a buffer thickness of intermediate cover soils above the uppermost waste layer and beneath the final cover to lessen the potential for collapse of the cover directly above locally compressible zones such as deteriorating drums.

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-12

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Settlement Induced Stresses in Geomembrane

	Name	Date
Prepared By:	Paul Pellicer	11/12/97
Checked By:	John Pellicer	11/13/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

Project Number 602 0200
Prepared By: P. Pellicer
Checked By: J. Pellicer
Sheet 1 Of 5
Date: Nov 12, 1997
Date: 13-Nov-97

Settlement Induced Stress in Geomembrane

Objective: Estimate the stress induced in the Geomembrane liner due to settlement of the subgrade and prepared Subgrade.

Assumptions: Use NSC 60 mil textured liner

Calculations:

Settlement at point "A" is the sum of Subgrade settlement and prepared subgrade settlement.

= 5in + .56in = 5.56in (very Conservative)

From subgrade settlement calc package

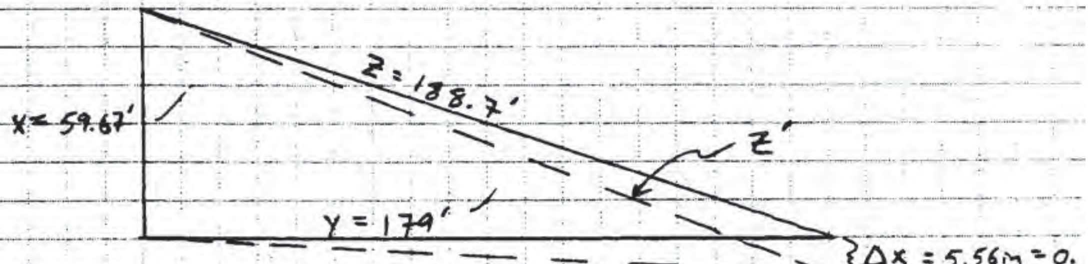
From prepared subgrade Settlement calc. package.

Assume settlement at Point "B" = 0

The shortest slope length will experience the greatest strain and therefore the Maximum induced stress.

The shortest slope length is at C-C′ (see pg 3) = 188.7 ft

W/ 3H:1V Slope This results in the following Geometry.



$$Z' = \left((X+X')^2 + (Y)^2\right)^{1/2}$$
$$= \left((59.67' + 0.463')^2 + (179')^2\right)^{1/2}$$
$$= 188.83'$$

$$\epsilon = \frac{\Delta l}{l_o} = \frac{188.83 - 188.7}{188.7'} = 6.9 \times 10^{-4}$$

$\sigma = E\epsilon$

$E = 94{,}000 \text{ psi}$ (see pg 4)

$\sigma = (94{,}000 \text{ psi})(6.9 \times 10^{-9}) = 64.9 \text{ psi}$

σ_{yield} for 60 mil THDPE = 2200 psi (see pg 5)

$2200 \text{ psi} >> 64.9 \text{ psi}$ F.S. = 34

Conclusions: Based on the calculations, the settlement of the subgrade + prepared subgrade will have No detrimental effect on the liner.

NOTE: No specific calculation was done to estimate stresses induced in the evaporation pond lining system. Since the evaporation pond is substantially smaller than the landfill, it is expected the induced stresses on the liner system will be less. Since the calculated stresses for the landfill are less than the yield strength of the geomembrane, the stresses for the evaporation pond will be less than the geomembrane yield strength also.

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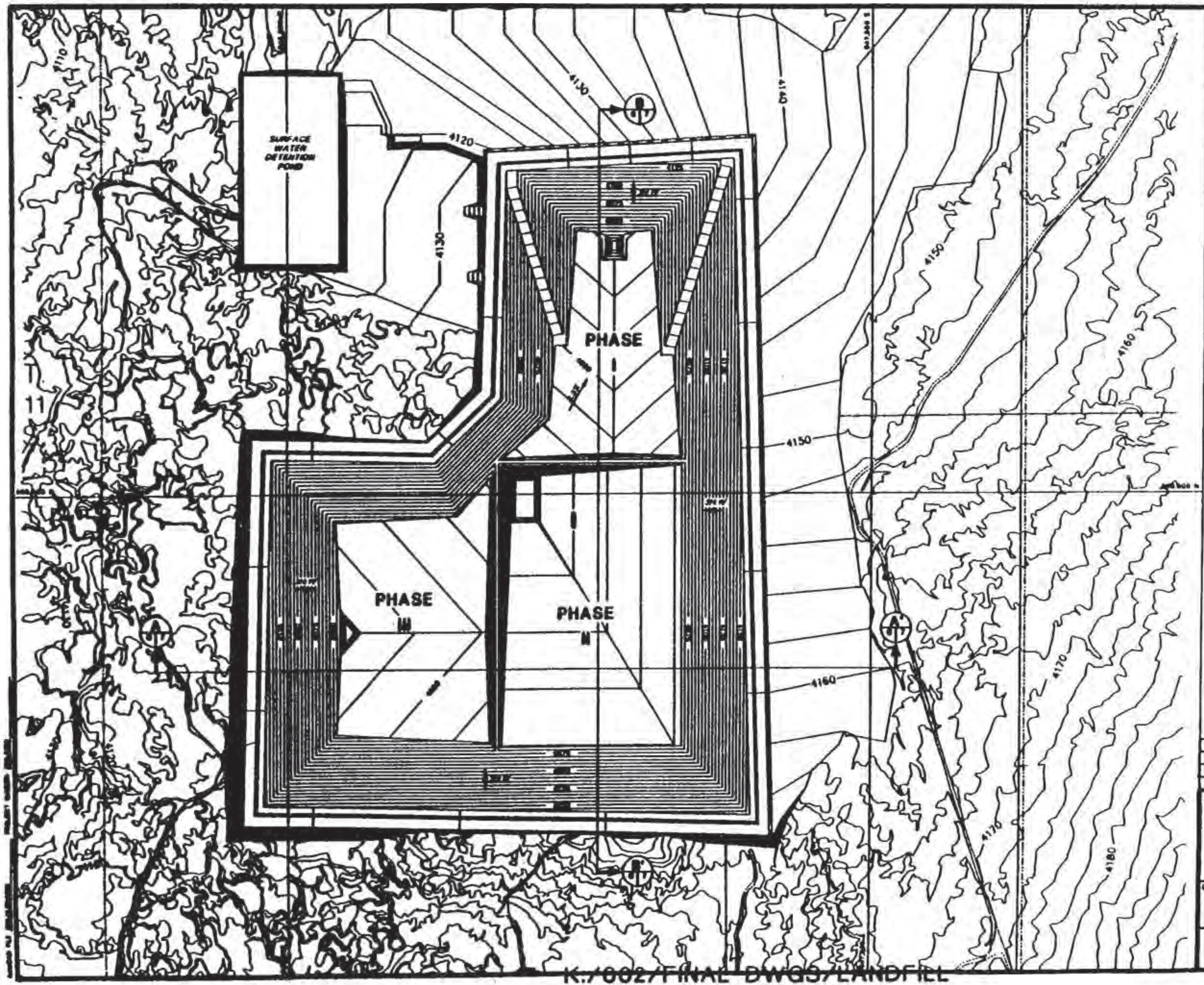

NOTES
1 FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2 "INDEX, LEGEND AND GENERAL NOTES"
2 TOPOGRAPHY FROM AERIAL SURVEYS PERFORMED AUGUST 1997 BY KOOGLE AND POULS ENGINEERING
3 BASE GRADES FOR PHASES [illegible] AND [illegible] TO BE MODIFIED PRIOR TO CONSTRUCTION TO ACHIEVE A MINIMUM OF 2%

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date *Patrick G. Corser, NM P.E. 12236*

SCALE
200' 0 200' 400'
[illegible] INTERVAL 4 FT.
SURFACE TOPOGRAPHY CONTOUR INTERVAL 2 FT.

Not For Construction

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE:
ULTIMATE LANDFILL EXCAVATION PLAN

TerraMatrix
[illegible]

Sheet 1 Of 1 Sheets
SCALE: [illegible]
DRAWING No. 8

K:/002/FINAL DWGS/LANDFILL
GMI-ULEP.dwg

TABLE 6.3 TENSILE BEHAVIOR PROPERTIES OF 30-MIL PVC, 36-MIL CSPE, AND 30-MIL HDPE

Property		Dumbbell shape (Fig. 5.2)			Narrow-width (1.0-in. [25 mm]) shape (Fig. 5.3)			Wide-width (8.0-in. [100-mm]) shape (Fig. 5.3)			Three-dimensional shape (Fig. 5.5)		
		PVC	CSPE-R	HDPE	PVC	CSPE-R	HDPE	PVC	CSPE-R	HDPE	PVC	CSPE-R	HDPE
maximum stress*	(lb./in.^{2})	3400	5700	3200	2900	5100	3000	2800	4300	2800	1200	3300	2300
	(megapascals)	23	39	22	20	35	21	19	30	19	8.3	23	16
maximum strain*	(%)	300	17	11	300	35	13	300	30	15	120+	100	47
modulus	(lb./in.^{2})	9000	33,000	94,000	9000	15,000	40,000	9000	14,000	33,000	4000	5000	25,000
	(megapascals)	62	227	648	62	103	275	62	96	227	28	34	172
ultimate stress	(lb./in.^{2})	3400	1300	≅4000	2700	1200	≅3500	2800	1100	≅3000	d.n.f.	3300	2300
	(megapascals)	23	9.0	28	19	8.3	24	19	7.6	21		23	16
ultimate strain	(%)	300	100	≅700	300	58	≅600	300	51	≅500	d.n.f.	100	47

*Notes:

PVC values are at ultimate

CSPE-R values are at scrim break

HDPE values are at yield

d.n.f. = did not fail

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FRICTION SEAL™ HD GEOMEMBRANE
QUALITY CONTROL SPECIFICATIONS
60 mil

FRICTION SEAL HD, National Seal Company's advanced textured high density polyethylene (HDPE) geomembrane, is manufactured by attaching a friction surface to NSC's high quality HDPE geomembrane. The friction surface is made from high molecular weight polyethylene resin compounded specifically for use in NSC geomembranes. The resin has been formulated to provide stress crack, chemical and ultraviolet resistance for fluid containment. NSC produces FRICTION SEAL HD with a textured surface on one or both sides of the parent sheet.

The following properties are tested as a part of NSC's quality control program. Certified test results for properties on this page are available upon request. Refer to NSC's Quality Control Manual for exact test methods and frequencies.

RESIN PROPERTIES	**METHOD**	**UNITS**	**MINIMUM**[1]	**TYPICAL**
Melt Flow Index[2]	ASTM D 1238	g/10 min	0.50	0.25
Oxidative Induction Time	ASTM D 3895, Al pan, 200°C, 1 atm O_2	minutes	100	120

SHEET PROPERTIES	**METHOD**	**UNITS**	**MINIMUM**[1]	**TYPICAL**
Mass per Unit Area[3]	ASTM D 3776	lb/ft^2	0.31	0.32
Thickness[4]	ASTM D 751, NSF mod.			
Average		mils	60.0	61.5
Individual		mils	57.0	59.7
Density[4]	ASTM D 1505	g/cm^3	0.940	0.948
Carbon Black Content[4]	ASTM D 1603	percent	2.0-3.0	2.35
Carbon Black Dispersion[4]	ASTM D 3015, NSF mod.	rating	A1, A2, B1	A1
Tensile Properties[5]	ASTM D 638			
Stress at Yield		psi	2200	2750
		ppi	132	169
Stress at Break		psi	2200	3240
		ppi	132	199
Strain at Yield	1.3" gage length (NSF)	percent	13.0	17.5
Strain at Break	2.0" gage or extensometer	percent	200	540
	2.5" gage length (NSF)	percent	160	432
Dimensional Stability[2,4]	ASTM D 1204, NSF mod.	percent	1.5.	0.4
Tear Resistance	ASTM D 1004	ppi	750	1000
		lbs	45	62
Puncture Resistance	ASTM D 4833	ppi	1800	2276
		lbs	108	140
Constant Load ESCR, Single Point[4]	GRI, GM-5a	hours	200	>400
Friction Angle, Index	GRI, GS-7	degrees	40	56

[1] This value represents the minimum acceptable test value for a roll as tested according to NSC's Manufacturing Quality Control Manual. Individual test specimen values are not addressed in this specification except thickness.

[2] Indicates Maximum Value

[3] Friction Coating on both sides of base sheet

[4] Testing performed on base sheet

[5] Stress and strength values are normalized to the nominal base sheet thickness. NSC certifies properties based on values calculated usin nominal thickness only. Stress values calculated using actual product thickness is not guaranteed due to the lack of industry accepte thickness test procedures for friction sheet.

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-13

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Geomembrane Stress Induced by Waste Settlement

	Name	Date
Prepared By:	Paul Pellicer	11/14/97
Checked By:	John Pellicer	11/14/97
Reviewed By:	Pat Corser	11/15/97

Revisions	Date	By	Checked By	Reviewed By

Project Number: 602-0200
Prepared By: P. Pellicer
Checked By: J. Pellicer

Sheet: 1 Of
Date: 14-Nov-97
Date: 14-Nov-97

Geomembrane Stress Induced by waste Settlement.

Objective: Assess stresses developed in the slope Geomembrane due to waste settlement.

Method: Any stress induced in the liner system will be transfered to the subgrade until the internal strength of the liner system is over come. Once the internal strength is exceeded the stress will be transfered to the anchor trench system through one or both of the geomembranes. The anchor trench system is designed to let the liner syster pull out before the yield stress of the geomembrane is reached.
∴ Stresses Induced in the liner system due to waste settlement is not critical and will not damage the liner system.

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-16

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Geomembrane Survivability

	Name	Date
Prepared By:	Paul Pellicer	11/14/97
Checked By:	John Pellicer	11/15/97
Reviewed By:	Pat Corser	11/15/97

Revisions	Date	By	Checked By	Reviewed By

TerraMatrix
Engineering & Environmental Services
P.O. Box 774018, 1475 Pine Grove Road
Steamboat Springs, Colorado 80477
Phone 970.879.6260 Fax 970.879.9048

Project Name: Triassic Park
Project Number: 602-0200 Sheet: 1 Of 8
Prepared By: P. Pellicer Date: 14-Nov-97
Checked By: J. Pul[illegible] Date: 15 Nov 97

Geomembrane Survivability

Objective: Assess the survivability of 60 mil THDPE liner.

Method: Utilize guidelines for assessing survivability in "Designing with Geosynthetics" R.M. Koerner 1994. (see pg 2-4)

Minimum Properties	High Survivibility	Very High Survivibility	NSC 60 THDPE	NSC 60 mil smooth HDPE
Thickness (mils)	35	40	60	60
Tensile (lb/in)	60	70	132	132
Tear (lb)	15	20	45	45
Puncture (lb)	35	40	108	108
Impact (ft-lb)	20	25	NV	NV

Conclusions: 60 mil THDPE exceeds all criteria for Very High Survivibility except for the impact value which is not specified by the manufacture.

Note: This calculation is applicable to all the site facilities that use geomembrane.

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[illegible]
[illegible]

If the 196°C reaction took 1000 hours to complete, the comparable 90°C reaction would take

$$\begin{aligned} R_{90^\circ C} &= 6587(1000) \\ &= 6{,}587{,}000 \text{ hours} \\ &= 752 \text{ years} \end{aligned}$$

Thus the predicted values for this particular polymer to reach 50% of its original impact strength at 90°C is approximately 700 years (i.e., its predicted lifetime).

5.1.6 Summary

This relatively long section on properties and test methods has illustrated the wealth of test methods available for use and characterization purposes of geomembranes. Most of the established tests and standardized test methods have come by way of the plastics and rubber industries for non-geotechnical-related uses. This is fortunate, for it gives a base or reference plane to work from. However, many have some variation required for use in below-ground construction. Still other demands require completely new tests and test methods. With ASTM in the United States (as well as standard institutes over the entire world), there is an awareness and vibrant activity to develop such test methods and standards. Until they are available, however, we must act on intuition and develop procedures that model the required design information as closely as possible. Many of the tests and information presented in this section were done in that light. It should be obvious that the complexity of the tests progressed from the simple thickness test to the complex degradation tests. Indeed, a wide range of test methods are available.

Finally, a rather lengthy treatise on durability and aging gave insight into the potential service lifetime of geomembranes. In my experience with geosynthetics over the past 15 years, my original thoughts were that geosynthetics were easy to place but wouldn't last very long. My current thoughts have shifted dramatically, and I argue for extremely long service lifetimes, but I have very real concerns about the proper placement of geosynthetics. Clearly, the geosynthetic must survive its placement if these long predicted lifetimes are to be achieved.

5.2 SURVIVABILITY REQUIREMENTS

For any of the design methods presented in this chapter to function properly, it is necessary that the geomembrane survive the packaging, transportation, handling, and installation demands that are placed on it. This aspect of design cannot be taken lightly or assumed to take care of itself. Yet there is a decided problem in formulating a generalized survivability design for every application, since each

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situation is unique. Some of the major variables affecting a given situation are the following:

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- Storage at the manufacturing facility
- Handling at the manufacturing facility
- Transportation from the factory to the site
- Offloading at the site
- Storage conditions at the site
- Temperature extremes at the site
- Subgrade conditions at the site
- Deployment at the approximate location
- Movement into final seaming location
- Treatment at the site during seaming
- Treatment at the site after seaming
- Placement of the cover material or soil backfill on the completed geomembrane

Note that each of these topics is largely out of the hands of the designer. Only by rigid specifications and a complementary construction quality assurance (CQA) document, competent full-time inspection by CQA personnel, and the cooperation of a knowledgeable manufacturer's manufacturing quality control (MQC) and contractor's construction quality control (CQC) can the geomembrane survive to the point of beginning to function as designed. Although each situation is different, some empirical guidelines are necessary, and the following properties and their minimum values are offered.

While being packaged, transported, handled, and installed, geomembranes are often vulnerable to tear, puncture, and impact. Such events often come about accidentally, by vandalism, or by poor quality of work. Typical situations are the dropping of tools on the liner, the driving of autos or pickup trucks on the unprotected liner, high winds getting beneath the liner during placement, the awkwardness of moving large sheets of the liner into position, and so on. The geomembrane property most involved with resistance or susceptibility to tear, puncture, and impact damage is thickness. At least a linear, and sometimes exponential, increase in resistance to the aforementioned actions is seen as thickness increases. For this reason many agencies require a minimum thickness under any circumstance. For example, the U.S. Bureau of Reclamation requires a minimum thickness of 20 mils (0.50 mm) for canal liners, while the U.S. Environmental Protection Agency requires a minimum thickness for geomembranes for solid waste liners of 30 mils (0.75 mm). For similar applications in Germany, it is necessary to use an 80-mil (2.0-mm)-thick geomembrane. Rather than use a single regulated value for all conditions, however, the minimum thickness and its subsequent properties should be related to site-specific conditions. Using a concept similar to the placement of geotextiles, Table 5.11 is offered at four different required survivability levels. Note

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Table 5.11 Recommended minimum properties for general geomembrane installation survivability

Property and Test Method	*Required Degree of Survivability*			
	Low[a]	*Medium*[b]	*High*[c]	*Very High*[d]
Thickness (D5199) mils (mm)	25 (0.63)	30 (0.75)	35 (0.88)	40 (1.00)
Tensile D882 (1.0 in. [25 mm] strip) lb./in. (kN/m)	40 (7.0)	50 (8.7)	60 (10.5)	70 (12.2)
Tear (D1004 Die C) lb. (N)	7.5 (33)	10 (45)	15 (67)	20 (90)
Puncture (D4833 modified) lb. (N)	25 (110)	30 (130)	35 (160)	40 (180)
Impact (D1424 modified) ft.-lb. (J)	12 (9)	15 (11)	20 (15)	25 (19)

[a] *Low* refers to careful hand placement on very uniform well-graded subgrade with light loads of a static nature—typical of vapor barriers beneath building floor slabs.

[b] *Medium* refers to hand or machine placement on machine-graded subgrade with medium loads—typical of canal liners.

[c] *High* refers to hand or machine placement on machine-graded subgrade of poor texture with high loads—typical of landfill liners and covers.

[d] *Very high* refers to hand or machine placement on machine-graded subgrade of very poor texture with high loads—typical of reservoir covers and liners for heap leach pads.

that these values are not to be used in place of design, but as a check on design to see that installation can be properly assured.

5.3 LIQUID CONTAINMENT (POND) LINERS

The U.S. EPA estimates that there are over 200,000 surface impoundments storing hazardous and nonhazardous liquids, the vast majority of which are unlined. This total does not include potable water and non-EPA-regulated reservoirs and impoundments. Certainly a major use of geomembranes is in the area of liquid containment via a surface impoundment. In fact, the name *geomembrane* is actually one that supersedes the name *pond liner*, reflecting the original use of the polymeric materials to which this section is devoted. Certainly, the agriculture industry has a desperate need to store water, and hence both the U.S. Department of Agriculture and the U.S. Bureau of Reclamation were involved in early research into synthetic pond liners. Staff [36] suggests that thermoset (rubber) liners may have been used prior to the 1930s, and cites the use of polyvinyl chloride sheeting for liners in the 1940s. When covered with a minimum of 12 in. (30 cm) of soil, these PVC liners have performed admirably. Uncovered, however, there was a tendency for progressive brittleness and cracking. This condition was found to be caused by the loss of the plasticizer (used to make it flexible to begin with) from the vinyl due

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FRICTION SEAL™ HD GEOMEMBRANE
QUALITY CONTROL SPECIFICATIONS
60 mil

FRICTION SEAL HD, National Seal Company's advanced textured high density polyethylene (HDPE) geomembrane, is manufactured by attaching a friction surface to NSC's high quality HDPE geomembrane. The friction surface is made from high molecular weight polyethylene resin compounded specifically for use in NSC geomembranes. The resin has been formulated to provide stress crack, chemical and ultraviolet resistance for fluid containment. NSC produces FRICTION SEAL HD with a textured surface on one or both sides of the parent sheet.

The following properties are tested as a part of NSC's quality control program. Certified test results for properties or this page are available upon request. Refer to NSC's Quality Control Manual for exact test methods and frequencies.

RESIN PROPERTIES	METHOD	UNITS	MINIMUM[1]	TYPICAL
Melt Flow Index[2]	ASTM D 1238	g/10 min	0.50	0.25
Oxidative Induction Time	ASTM D 3895, Al pan, 200°C, 1 atm O_2	minutes	100	120
SHEET PROPERTIES	**METHOD**	**UNITS**	**MINIMUM[1]**	**TYPICAL**
Mass per Unit Area[3]	ASTM D 3776	lb/ft^2	0.31	0.32
Thickness[4]	ASTM D 751, NSF mod.			
Average		mils	60.0	61.5
Individual		mils	57.0	59.7
Density[4]	ASTM D 1505	g/cm^3	0.940	0.948
Carbon Black Content[4]	ASTM D 1603	percent	2.0-3.0	2.35
Carbon Black Dispersion[4]	ASTM D 3015, NSF mod.	rating	A1, A2, B1	A1
Tensile Properties[5]	ASTM D 638			
Stress at Yield		psi	2200	2750
		ppi	132	169
Stress at Break		psi	2200	3240
		ppi	132	199
Strain at Yield	1.3" gage length (NSF)	percent	13.0	17.5
Strain at Break	2.0" gage or extensometer	percent	200	540
	2.5" gage length (NSF)	percent	160	432
Dimensional Stability[2,4]	ASTM D 1204, NSF mod.	percent	1.5.	0.4
Tear Resistance	ASTM D 1004	ppi	750	1000
		lbs	45	62
Puncture Resistance	ASTM D 4833	ppi	1800	2276
		lbs	108	140
Constant Load ESCR, Single Point[4]	GRI, GM-5a	hours	200	>400
Friction Angle, Index	GRI, GS-7	degrees	40	56

[1] This value represents the minimum acceptable test value for a roll as tested according to NSC's Manufacturing Quality Control Manua Individual test specimen values are not addressed in this specification except thickness.

[2] Indicates Maximum Value

[3] Friction Coating on both sides of base sheet

[4] Testing performed on base sheet

[5] Stress and strength values are normalized to the nominal base sheet thickness. NSC certifies properties based on values calculated usin nominal thickness only. Stress values calculated using actual product thickness is not guaranteed due to the lack of industry accepte thickness test procedures for friction sheet.

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FRICTION SEAL™ HD GEOMEMBRANE
PHYSICAL PROPERTIES

60 mil

The properties on this page are not part of NSC's Manufacturing Quality Control program and are not included on the material certifications. Seam testing is the responsibility of the installer and/or CQC personnel.

PROPERTIES	METHOD	UNITS	MINIMUM[1]	TYPICAL
Multi-Axial Tensile Elongation	GRI, GM-4	percent	20.0	22.3
Critical Cone Height	GRI, GM-3, NSC mod.	cm	1.0	1.5
Wide Width Tensile	ASTM D 4885			
Stress at Yield		psi	2000	2110
Strain at Yield		%	15.0	20.0
Brittleness Temp. by Impact[2]	ASTM D 746	°C	-75	< -90
Coef. of Linear Thermal Exp.[2]	ASTM D 696	$°C^{-1}$	1.5×10^{-4}	1.2×10^{-4}
ESCR, Bent Strip	ASTM D 1693	hours	1500	>10,000
Hydrostatic Resistance	ASTM D 751	psi	450	550
Modulus of Elasticity	ASTM D 638	psi	80,000	116,000
Ozone Resistance[4]	ASTM D 1149, 168 hrs	P/F	P	P
Permeability[2,4]	ASTM E 96	cm/sec · Pa	2.3×10^{-14}	8.1×10^{-15}
Puncture Resistance	FTMS 101, method 2065	ppi	1300	1570
		lbs	78	97
Soil Burial Resistance[2]	ASTM D 3083, NSF mod.	% change	10	0
Tensile Impact	ASTM D 1822	ft lbs/in^2	130	160
Volatile Loss[2]	ASTM D 1203, A	percent	0.10	0.08
Water Absorption[2,4]	ASTM D 570, 23°C	percent	0.10	0.04
Water Vapor Transmission[2,4]	ASTM E 96	g/day · m^2	0.024	0.009

SEAM PROPERTIES	METHOD	UNITS	MINIMUM[1]	TYPICAL
Shear Strength	ASTM D 4437, NSF mod.	psi	2000	2700
		ppi	120	168
Peel Strength (hot wedge fusion)	ASTM D 4437, NSF mod.	psi	1500	1870
		ppi	90	115
Peel Strength (fillet extrusion)	ASTM D 4437, NSF mod.	psi	1300	1590
		ppi	78	98

STANDARD ROLL DIMENSIONS

Length	850 feet	Area	12,750 ft^2
Width	15 feet	Weight	3,950 lbs

This information contained herein has been compiled by National Seal Company and is, to the best of our knowledge, true and accurate. All suggestions and recommendations are offered without guarantee. Final determination of suitability for use based on any information provided, is the sole responsibility of the user. There is no implied or expressed warranty of merchantability of fitness of the product for the contemplated use.

NSC reserves the right to update the information contained herein in accordance with technological advances in the material properties.

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HDPE GEOMEMBRANE
QUALITY CONTROL SPECIFICATIONS
60 mil

National Seal Company's High Density Polyethylene (HDPE) Geomembranes are produced from virgin, first quality, high molecular weight resins and are manufactured specifically for containment in hydraulic structures. NSC HDPE geomembranes have been formulated to be chemically resistant, free of leachable additives and resistant to ultraviolet degradation.

The following properties are tested as a part of NSC's quality control program. Certified test results for properties on this page are available upon request. Refer to NSC's Quality Control Manual for exact test methods and frequencies.

All properties meet or exceed NSF Standard Number 54.

RESIN PROPERTIES	METHOD	UNITS	MINIMUM[1]	TYPICAL
Melt Flow Index[2]	ASTM D 1238	g/10 min	0.50	0.25
Oxidative Induction Time	ASTM D 3895, Al pan, 200°C, 1 atm O_2	minutes	100	120

SHEET PROPERTIES	METHOD	UNITS	MINIMUM[1]	TYPICAL
Thickness	ASTM D 751, NSF mod.			
Average		mils	60.0	61.5
Individual		mils	57.0	59.7
Density	ASTM D 1505	g/cm^3	0.940	0.948
Carbon Black Content	ASTM D 1603	percent	2.0-3.0	2.35
Carbon Black Dispersion	ASTM D 3015, NSF mod.	rating	A1, A2, B1	A1
Tensile Properties	ASTM D 638			
Stress at Yield		psi	2200	2550
		ppi	132	157
Stress at Break		psi	3800	4850
		ppi	228	298
Strain at Yield	1.3" gage length (NSF)	percent	13.0	16.9
Strain at Break	2.0" gage or extensometer	percent	700	890
	2.5" gage length (NSF)	percent	560	710
Dimensional Stability[2]	ASTM D 1204, NSF mod.	percent	1.5	0.4
Tear Resistance	ASTM D 1004	ppi	750	860
		lbs	45	53
Puncture Resistance	ASTM D 4833	ppi	1800	2130
		lbs	108	131
Constant Load ESCR, Single Point	GRI, GM-5a	hours	200	>400

[1] This value represents the minimum acceptable test value for a roll as tested according to NSC's Manufacturing Quality Control Manual. Individual test specimen values are not addressed in this specification except thickness.

[2] Indicates Maximum Value

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HDPE GEOMEMBRANE
PHYSICAL PROPERTIES

60 mil

The properties on this page are not part of NSC's Manufacturing Quality Control program and are not included on the material certifications. Seam testing is the responsibility of the installer and/or CQA personnel.

PROPERTIES	METHOD	UNITS	MINIMUM[1]	TYPICAL
Multi-Axial Tensile Elongation	GRI, GM-4	percent	20.0	28.0
Critical Cone Height	GRI, GM-3, NSC mod.	cm	1.0	1.5
Wide Width Tensile	ASTM D 4885			
Stress at Yield		psi	2000	2110
Strain at Yield		%	15.0	20.0
Brittleness Temp. by Impact[2]	ASTM D 746	°C	-75	<-90
Coef. of Linear Thermal Exp.[2]	ASTM D 696	$^\circ C^{-1}$	1.5×10^{-4}	1.2×10^{-4}
ESCR, Bent Strip	ASTM D 1693	hours	1500	>10,000
Hydrostatic Resistance	ASTM D 751	psi	450	510
Modulus of Elasticity	ASTM D 638	psi	80,000	135,000
Ozone Resistance	ASTM D 1149, 168 hrs	P/F	P	P
Permeability[2]	ASTM E 96	cm/sec · Pa	2.3×10^{-14}	8.1×10^{-15}
Puncture Resistance	FTMS 101, method 2065	ppi	1300	1700
		lbs	78	105
Soil Burial Resistance[2]	ASTM D 3083, NSF mod.	% change	10	0
Tensile Impact	ASTM D 1822	ft lbs/in^2	250	420
Volatile Loss[2]	ASTM D 1203, A	percent	0.10	0.06
Water Absorption[2]	ASTM D 570, 23°C	percent	0.10	0.04
Water Vapor Transmission[2]	ASTM E 96	g/day · m^2	0.024	0.009

SEAM PROPERTIES	METHOD	UNITS	MINIMUM[1]	TYPICAL
Shear Strength	ASTM D 4437, NSF mod.	psi	2000	2700
		ppi	120	166
Peel Strength (hot wedge fusion)	ASTM D 4437, NSF mod.	psi	1500	1870
		ppi	90	115
Peel Strength (fillet extrusion)	ASTM D 4437, NSF mod.	psi	1300	1590
		ppi	78	98

STANDARD ROLL DIMENSIONS

Length	1110 feet	Area	16,650 ft^2
Width	15 feet	Weight	5,000 lbs

NSC reserves the right to update the information contained herein in accordance with technological advances in the material properties.

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Calculation Cover Sheet Appendix E-17

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Geomembrane Puncture Resistance In Landfill

	Name	Date
Prepared By:	Paul Pellicer	11/14/97
Checked By:	John Pellicer	11/14/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

TerraMatrix
Engineering & Environmental Services
P.O. Box 774018, 1475 Pine Grove Road
Steamboat Springs, Colorado 80477
Phone 970.879.6260 Fax 970.879.9048

Project Number: 602-0200
Prepared By: P. Pellicer
Checked By: J. Pellicer

Sheet: 1 Of 1
Date: 14-Nov-97
Date: 14-Nov-97

Geomembrane Puncture Resistance

Objective: Evaluate Puncture resistance of the Geomembrane liner and cover.

Method: All geomembranes in the landfill liner system and cover system are protected by at least one layer of Geotextile (Geocomposite or GCL) Review of the Puncture resistance of Geotextile/Geocomposit calculation indicate that for worst case scenario the geotextile has a minimum F.S. = 35 (11/200 Geotextile) ∴ the threat of puncture of the geomembrane is Neglegible.

Calculation Cover Sheet Appendix E-19

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Geotextile/Geocomposite Survivability

	Name	Date
Prepared By:	Paul Pellicer	11/14/97
Checked By:	John Pellicer	11/14/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

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Project Number: 602-0200
Prepared By: P. Pellizer
Checked By: J. Pellicer
Sheet: 1 Of 5
Date: 14-Nov-97
Date: 14-Nov-97

Geotextile/Geocomposite Survivability

Objective: Determine Min. Geotextile properties to survive Installation and Operational stresses.

Analysis: Follow Recommendations By R.M. Koerner "Designing with Geosynthetics" 1994

See Attached Recommendations for Medium to High Survivability and compare w/ min Geotextile values

	High - Survivability	Medium Survivability	trevira 011/200	trevira 011/250
grab Strength	180 lb	115 lb.	160	210
Puncture resistance	75 lb	40 lb.	80	95
Trapezoid Tear	75 lb	40 lb	60	75
			ok Medium	o.k. High

Conclusions: Geotextile properties should meet or exceed those listed for 011/200 textile for medium surviveability

Geotetextile properties should meet or exceed those listed for 011/250 textile For High surviveability

THE GEOTEXTILE PROPERTIES SPEC. FOR USE AS FILTER OR CUSHION ~~SEE~~ WILL MEET OR EXCEED HIGH SURVIVABILITY CRITERIA. (SEE ATTACHED SPEC. SHEETS.

Table 2.28 Required degree of survivability as a function of subgrade conditions and construction equipment*

	Construction equipment and 6 to 12 in. of cover material: initial lift thickness		
Subgrade conditions	*Low ground-pressure equipment (≤4 lb./in.)*	*Medium ground-pressure equipment (>4 lb./in.², ≤8 lb./in.²)*	*High ground-pressure equipment (>8 lb./in.²)*
Subgrade has been cleared of all obstacles except grass, weeds, leaves, and fine wood debris. Surface is smooth and level such that any shallow depressions and humps do not exceed 6 in. in depth or height. All larger depressions are filled. Alternatively a smooth working table may be placed.	Low	Moderate	High
Subgrade has been cleared of obstacles larger than small to moderate-sized tree limbs and rocks. Tree trunks and stumps should be removed or covered with a partial working table. Depressions and humps should not exceed 1 in. in depth or height. Larger depressions should be filled.	Moderate	High	Very high
Minimal site preparation is required. Trees may be felled, delimbed, and left in place. Stumps should be cut to project not more than 6 in. ± above subgrade. Fabric may be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels, and large boulders. Items should be removed only if placing the fabric and cover material over them will distort the finished road surface.	High	Very high	Not recommended

*Recommendations are for 6 to 12 in. initial lift thickness. For other initial lift thicknesses:
12 to 18 in.: reduce survivability requirement one level;
18 to 24 in.: reduce survivability requirement two levels;
>24 in.: reduce survivability requirement three levels.
Survivability levels are in increasing order: low, moderate, high, and very high.
For special construction techniques such as prerutting, increase fabric survivability requirement one level.
Placement of excessive initial cover material thickness may cause bearing failure of soft subgrade.

Source: After Christopher and Holtz [146].

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Table 2.21 AASHTO-AGC-ARBTA Joint Committee minimum geotextile properties recommended for survivability (reference 4)

	Physical Property Requirements[a] Geotextiles < 50% Elongation/Geotextiles > 50% Elongation[b,c]		
Survivability Level	*Grab Strength ASTM D4632 (lb.)*	*Puncture Resistance ASTM D4833 (lb.)*	*Trapezoid Tea Strength ASTM D4533 (lb.)*
Medium	180/115	70/40	70/40
High	270/180	100/75	100/75

[a] Values shown are minimum average roll values. Strength values are in the weaker principal direction.

[b] Elongation (strain) at failure as determined by ASTM D4632, Grab Tensile.

[c] The values of geotextile elongation do not imply the allowable consolidation properties of the subgrade soil. These must be determined by a separate investigation.

price indexes, site and climate variations, type and quantity of geotextile, and so on, a few comments are in order.

The cost of the geotextile itself is reasonably related to its mass per unit area. Heavier geotextiles cost proportionately more than lighter ones. Note, however, that the installation cost may not be significantly higher for the heavier geotextiles. The type of manufacture is also a factor, with woven slit film generally being the least expensive, then nonwoven heat bonded and needle-punched nonwoven, and then woven monofilament, which is the most expensive on the basis of an equivalent mass per unit area. These comments, however, should in no way sway a design toward preference of one geotextile over another. They are offered only to give a feeling for the costs involved. As of this writing, these costs ranged from \$0.40 to \$1.50/yd.^{2} for geotextiles in the range 4.0 to 16.0 oz./yd.^{2}, with installation costs being an additional \$0.15 to \$0.60/yd.^{2} depending on the site conditions, quantity involved, and particular application.

Geotextile availability is sometimes very important. In aggressively marketed areas, many geotextiles are available and the free-market system will sort things out. In more remote areas, however, where only one or two geotextiles are available, design must necessarily reflect this situation. It is unrealistic to think that manufacturers will "tailor-make" a geotextile to your design specification if it involves only a small quantity for a remote area.

In a similar vein, union situations have been known to affect costs, as has patent infringement in certain select areas.

2.11.4 Summary

At the heart of any well-designed facility is its proper and careful construction. In my personal investigations of geotextile-related failures, only nine failures were design related (five were clogging problems, two retention problems, and two low-strength problems); all the others (approximately 25) were construction related. Of the latter group, two were loss of strength due to excessive UV exposure, two were from lack of proper overlap on soft soils (sewing would have undoubtedly

Trevira® Spunbond nonwoven engineering products are highly needled fabrics with excellent tensile properties, high filtration potential and outstanding permeability.

Trevira® Spunbond Type 11 products are 100% continuous filament polyester nonwoven needlepunched engineering fabrics. They deliver a combination of advantages unmatched by any other spunbonded geotextiles. They're resistant to freeze-thaw, soil chemicals and ultraviolet light exposure.

Trevira® Spunbond nonwoven engineering fabrics offer excellent performance where the requirement is tensile reinforcement, planar flow, filtration, or separation. They are ideal for roadways, railbeds, drainage systems, lining systems, retaining walls. And much more.

TYPICAL PHYSICAL PROPERTIES OF TREVIRA® TYPE 11 PRODUCTS

[illegible]	Unit	Test Method	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fabric Weight	oz/yd^2	ASTM D-5261	3.5	4.2	6.0	7.5	8.5	10.5	12.4	13.5	16.5
Fabric Thickness, t	mils	ASTM D-5199	60	70	90	110	120	140	165	170	210
Grab Strength (MD/CD)[1]	lbs	ASTM D-4632	120/105	150/125	230/180	300/235	320/260	420/350	475/400	540/450	650/570
Grab Elongation (MD/CD)[1]	%	ASTM D-4632	75/85	75/85	75/85	75/80	75/80	75/80	75/80	80/80	85/85
Trapezoid Tear Strength (MD/CD)[1]	lbs	ASTM D-4533	50/40	55/50	80/75	105/95	110/100	140/125	170/145	180/165	225/200
Puncture Resistance	lbs	ASTM D-4833	55	65	95	115	125	155	170	185	225
Mullen Burst Strength	psi	ASTM D-3786	195	225	330	400	435	560	600	700	855
Water Flow Rate	gpm/ft^2	ASTM D-4491	195	190	170	150	130	120	105	100	80
Permittivity, Ψ	sec^{-1}	ASTM D-4491	2.61	2.54	2.27	2.01	1.76	1.6	1.47	1.34	1.07
Permeability, k = Ψxt	cm/sec	ASTM D-4491	.40	.45	.52	.56	.53	.57	.62	.58	.57
AOS	Sieve Size mm	ASTM D-4751	70-100 .210-.149	70-100 .210-.149	70-100 .210-.149	70-100 .210-.149	70-120 .210-.125	100-120 .149-.125	100-140 .149-.106	120-140 .125-.106	140-170 .106-.088
Standard Roll Widths[2]	ft		12.5 and 15.0								
Standard Roll Lengths[2]	ft		400	400	300	300	300	300	300	300	300

[1] MD = Machine Direction, CD = Cross Machine Direction.

[2] Other width and length rolls are available upon request.

MINIMUM† PHYSICAL PROPERTIES OF TREVIRA® TYPE 11 PRODUCTS

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fabric Weight	oz/yd^2	ASTM D-5261	3.3	4.0	5.7	7.1	8.0	10.0	12.0	13.0	16.0
Fabric Thickness, t	mils	ASTM D-5199	50	55	75	95	105	125	145	150	185
Grab Strength	lbs	ASTM D-4632	90	110	160	210	230	305	350	390	500
Grab Elongation	%	ASTM D-4632	60	60	60	60	60	60	60	65	70
Trapezoid Tear Strength	lbs	ASTM D-4533	30	40	60	75	80	100	120	130	150
Puncture Resistance	lbs	ASTM D-4833	45	50	80	95	100	130	150	155	195
Mullen Burst Strength	psi	ASTM D-3786	170	190	285	360	380	510	550	640	780
Water Flow Rate	gpm/ft^2	ASTM D-4491	155	150	130	110	90	80	65	60	40
Permittivity, Ψ	sec^{-1}	ASTM D-4491	2.07	2.01	1.74	1.47	1.20	1.07	0.87	0.80	0.53
Permeability, k = Ψxt	cm/sec	ASTM D-4491	.26	.28	.33	.35	.32	.34	.32	.31	.25
AOS	Sieve Size mm	ASTM D-4751	50 .300	50 .300	70 .210	70 .210	70 .210	70 .210	70 .210	100 .149	100 .149

† These minimum values represent minimum test values as determined from Quality Control (Q.C.) testing.

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3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all prior work, materials and partially-completed and completed work of these General Specifications.

B. The CQA Engineer will identify any areas requiring repair. The Contractor shall make repairs and replacements as necessary, to the approval of the Owner, and at no additional cost to Owner.

C. The CQA Engineer will issue an approval of geotextile filter, cushion, separator, or sacrificial layer installation in accordance with the CQA Plan prior to placement of material over the geotextile.

TABLE 02714-1
REQUIRED FILTER GEOTEXTILE PROPERTIES

Properties	Units	Specified Values (4)	Test Method
Polymer composition	%	95 [polypropylene, polyester, or polyethylene by weight]	
Mass per unit area	oz/yd^2	8	ASTM D 3776
Apparent opening size	mm	$O_{95} < 0.212$mm	ASTM D 4751
Permitivity	sec^{-1}	0.1	ASTM D 4491
Grab strength	lb	200	ASTM D 4632(1)
Tear strength	lb	85	ASTM D 4533(2)
Puncture strength	lb	100	ASTM D 4833 (3)

Notes:

1. Minimum values for both machine and cross machine direction with 1 inch clamp on constant rate of extension (CRE) machine.
2. Minimum value measured in machine and cross machine direction.
3. Tension testing machine with a 1.75-inch diameter ring clamp, the steel ball being replaced with a 0.31-inch diameter solid steel cylinder with flat tip centered within the ring clamp.
4. Values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table). The specified apparent opening size is a maximum average roll value.

TABLE 02714-2
REQUIRED CUSHION GEOTEXTILE PROPERTIES

Properties	Qualifier	Units	Specified Values (4)	Test Method
Polymer composition	minimum	%	95 [polypropylene, polyester, or polyethylene by weight]	
Mass per unit area	minimum	oz/yd^2	12	ASTM D 3776
Grab strength	minimum	lb	300	ASTM D 4632(1)
Tear strength	minimum	lb	110	ASTM D 4533(2)
Puncture strength	minimum	lb	135	ASTM D 4833 (3)

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-20

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Geotextile/Geocomposite Filtration

	Name	Date
Prepared By:	Paul Pellicer	11/14/97
Checked By:	John Pellicer	11/14/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

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Project Name: Triassic Park
Project Number: 602-0200 Sheet: 1 Of 2
Prepared By: P. Pellicer Date: 14-Nov-97
Checked By: J. Pullian Date: 14-Nov-97

Geotextile / Geocomposite Filtration

Objective: Determine the ability of Geotextile/Geocomposite to filter on site silty sands and Upper dockum.

Analysis: The two critical soils that Geotextiles/Geocomposites will need to Retain are the onsite silty sands (used as protective soil layer and vegetative cover) and the upper dockum (clay liner, in sump area)

According to Task Force 25 the soil retention criteria is as Follows.

1. If Soil has ≤ 50% passing the #200 sieve Then the A.O.S. of Fabric ≥ No 30 sieve (≤ 0.6 mm)
2. If Soil has > 50% Passing the # 200 sieve Then the A.O.S of Fabric ≥ #50 sieve (≤ 0.3 mm)

The onsite silty Sand has < 50% passing the # 200 sieve and the upper doccum has > 50% passing the # 200 sieve

∴ Geotextile Fabric should have
A.O.S. ≥ #50 sieve or ≤ 0.3 mm

Minimum A.O.S. of Trevira products. (see pg 2)

011/120	#50 sieve	0.3 mm	borderline
011/140	#50 sieve	0.3 mm	borderline
011/200	#70 sieve	0.21 mm	o.k.
011/250	#70 sieve	0.21 mm	o.k.
011/280	#70 Sieve	0.21 mm	o.k.

Conclusion: 1) use Trevira 011/200 (equivalent or better) for geotextile and on geocomposites.

2) USE ANY GEOTEXTILE WITH AOS OF 0.21m (#70 SIEVE) OR LESS.

Trevira® Spunbond nonwoven engineering products are highly needled fabrics with excellent tensile properties, high filtration potential and outstanding permeability.

Trevira® Spunbond Type 11 products are 100% continuous filament polyester nonwoven needlepunched engineering fabrics. They deliver a combination of advantages unmatched by any other spunbonded geotextiles. They're resistant to freeze-thaw, soil chemicals and ultraviolet light exposure.

Trevira® Spunbond nonwoven engineering fabrics offer excellent performance where the requirement is tensile reinforcement, planar flow, filtration, or separation. They are ideal for roadways, railbeds, drainage systems, lining systems, retaining walls. And much more.

TYPICAL PHYSICAL PROPERTIES OF TREVIRA® TYPE 11 PRODUCTS

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fabric Weight	oz/yd²	ASTM D-5261	3.5	4.2	6.0	7.5	8.5	10.5	12.4	13.5	16.5
Fabric Thickness, t	mils	ASTM D-5199	60	70	90	110	120	140	165	170	210
Grab Strength (MD/CD)[1]	lbs	ASTM D-4632	120/105	150/125	230/180	300/235	320/260	420/350	475/400	540/450	650/570
Grab Elongation (MD/CD)[1]	%	ASTM D-4632	75/85	75/85	75/85	75/80	75/80	75/80	75/80	80/80	85/85
Trapezoid Tear Strength (MD/CD)[1]	lbs	ASTM D-4533	50/40	55/50	80/75	105/95	110/100	140/125	170/145	180/165	225/200
Puncture Resistance	lbs	ASTM D-4833	55	65	95	115	125	155	170	185	225
Mullen Burst Strength	psi	ASTM D-3786	195	225	330	400	435	560	600	700	855
Water Flow Rate	gpm/ft²	ASTM D-4491	195	190	170	150	130	120	105	100	80
Permittivity, Ψ	sec⁻¹	ASTM D-4491	2.61	2.54	2.27	2.01	1.76	1.6	1.47	1.34	1.07
Permeability, k = Ψxt	cm/sec	ASTM D-4491	.40	.45	.52	.56	.53	.57	.62	.58	.57
AOS	Sieve Size mm	ASTM D-4751	70-100 .210-.149	70-100 .210-.149	70-100 .210-.149	70-100 .210-.149	70-120 .210-.125	100-120 .149-.125	100-140 .149-.106	120-140 .125-.106	140-170 .106-.088
Standard Roll Width[2]	ft		12.5 and 15.0								
Standard Roll Length[2]	ft		400	400	300	300	300	300	300	300	300

[1] MD = Machine Direction, CD = Cross Machine Direction.

[2] Other width and length rolls are available upon request.

MINIMUM† PHYSICAL PROPERTIES OF TREVIRA® TYPE 11 PRODUCTS

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fabric Weight	oz/yd²	ASTM D-5261	3.3	4.0	5.7	7.1	8.0	10.0	12.0	13.0	16.0
Fabric Thickness, t	mils	ASTM D-5199	50	55	75	95	105	125	145	150	185
Grab Strength	lbs	ASTM D-4632	90	110	160	210	230	305	350	390	500
Grab Elongation	%	ASTM D-4632	60	60	60	60	60	60	60	65	70
Trapezoid Tear Strength	lbs	ASTM D-4533	30	40	60	75	80	100	120	130	150
Puncture Resistance	lbs	ASTM D-4833	45	50	80	95	100	130	150	155	195
Mullen Burst Strength	psi	ASTM D-3786	170	190	285	360	380	510	550	640	780
Water Flow Rate	gpm/ft²	ASTM D-4491	155	150	130	110	90	80	65	60	40
Permittivity, Ψ	sec⁻¹	ASTM D-4491	2.07	2.01	1.74	1.47	1.20	1.07	0.87	0.80	0.53
Permeability, k = Ψxt	cm/sec	ASTM D-4491	.26	.28	.33	.35	.32	.34	.32	.31	.25
AOS	Sieve Size mm	ASTM D-4751	50 .300	50 .300	70 .210	70 .210	70 .210	70 .210	70 .210	100 .149	100 .149

†These minimum values represent minimum test values as determined from Quality Control (Q.C.) testing.

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MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-21

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Puncture Resistance of Geotextile/Geocomposite

	Name	Date
Prepared By:	Paul Pellicer	11/14/97
Checked By:	John Pellicer	11/14/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

Project Number: 602-0200
Sheet 1 of 5
Prepared By: P. Pellicer
Date: 14-Nov-97
Checked By: J. Pellicer
Date: 14-Nov-97

Puncture Resistance of Geotextile / Geocomposite

Objective: Determine puncture resistance of geotextile

Calculation:

Use formula outlined in "Designing with Geosynthetics" 3rd Ed. Koerner, 1995, pg 165 (see pg 4)

$$F_{Req} = p' d_a^2 S_1 S_2 S_3$$

F_R = required vertical force to be resisted
p' = pressure exerted on geotextile
d_a = average diameter of puncturing aggregate
S_1 = protrusion factor, h_h/d_a
h_h = protrusion height $\leq d_a$
S_2 = scale factor to adjust ASTM D4833 test value using 5/16" dia. puncture probe to actual puncturing object = $0.31 d_a$
S_3 = shape factor to adjust flat puncture probe of ASTM D4833 to actual shape of puncturing object = $1 - A_P/A_C$
A_P = projected area of particle
A_C = area of smallest circumscribed circle.

Worst Case Scenario occurs in sump area w/ sump drainage gravel (see specification for grain size) and ≈ 160 ft of waste (conservative)

Sump Gravel is 1" minus to be conservative set d_a = 1" (Largest grain size)

$p' = (160\,ft)(110\,psf) = 17{,}600\,psf\left(\frac{1\,ft^2}{144\,in^2}\right) = 122\,psi$ ✓

$S_1 = h_h/d_a$, assume $h_h = d_a$, $\Rightarrow S_1 = 1$ (conservative) ✓

$S_2 = 0.31 d_a = (0.31)(1") = 0.31"$ ✓

$S_3 = 1 - A_P/A_C$, assume $A_P/A_C = 0.4$ (crushed rock see pg 5)
$= 1 - .4 = .6$ ✓

$F_R = (122\,psi)(1")^2(1)(0.31)(.6) = 22.7\,lbs.$ ✓

Project Name [illegible]
Project Number 602-0200 Sheet: 2 Of 5
Prepared By: P. Pellizer Date: 14-Nov-97
Checked By: J. Pellicer Date: 14-Nov-97

See attached spec. sheet for geotextile minimum Puncture Resistance (see pg 3).

Trevira Geotextile	Min. Puncture Resistance (lb)	F_R (lb)	S.F.	
011/120	45	22.7	2.0	Low
011/140	50	22.7	2.2	Low
011/200	80	22.7	3.5	o.k.
011/250	95	22.7	4.2	o.k.
011/280	100	22.7	4.4	o.k.

NSC Geocomposite comes w/ Trevira 011/250 geotextile standard. from the table above this has a F.S. = 3.6 against puncture. o.k.

Conclusion: Trevira 011/200 or better (or equivalent) will be o.k. to use anywhere on the site where it comes in contact w/ soils w/ a $d_a \leq 1''$ and has a contact pressure $p' \leq 122$ psi.

Trevira• Spunbond nonwoven engineering products are highly needled fabrics with excellent tensile properties, high filtration potential and outstanding permeability.

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Trevira® Spunbond nonwoven engineering fabrics offer excellent performance where the requirement is tensile reinforcement, planar flow, filtration, or seperation. They are ideal for roadways, railbeds, drainage systems, lining systems, retaining walls. And much more.

TYPICAL PHYSICAL PROPERTIES OF TREVIRA® TYPE 11 PRODUCTS

Fabric Property	Unit	Test Method	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fabric Weight	oz/yd^2	ASTM D-5261	3.5	4.2	6.0	7.5	8.5	10.5	12.4	13.5	16.5
Fabric Thickness, t	mils	ASTM D-5199	60	70	90	110	120	140	165	170	210
Grab Strength (MD/CD)[1]	lbs	ASTM D-4632	120/105	150/125	230/180	300/235	320/260	420/350	475/400	540/450	650/570
Grab Elongation (MD/CD)[1]	%	ASTM D-4632	75/85	75/85	75/85	75/80	75/80	75/80	75/80	80/80	85/85
Trapezoid Tear Strength (MD/CD)[1]	lbs	ASTM D-4533	50/40	55/50	80/75	105/95	110/100	140/125	170/145	180/165	225/200
Puncture Resistance	lbs	ASTM D-4833	55	65	95	115	125	155	170	185	225
Mullen Burst Strength	psi	ASTM D-3786	195	225	330	400	435	580	600	700	855
Water Flow Rate	gpm/ft^2	ASTM D-4491	195	190	170	150	130	120	105	100	80
Permittivity, Ψ	sec^{-1}	ASTM D-4491	2.61	2.54	2.27	2.01	1.76	1.6	1.47	1.34	1.07
Permeability, k = Ψxt	cm/sec	ASTM D-4491	.40	.45	.52	.56	.53	.57	.62	.58	.57
AOS	Sieve Size mm	ASTM D-4751	70-100 .210-.149	70-100 .210-.149	70-100 .210-.149	70-100 .210-.149	70-120 .210-.125	100-120 .149-.125	100-140 .149-.106	120-140 .125-.106	140-170 .106-.088
Standard Roll Width[2]	ft		12.5 and 15.0								
Standard Roll Length[2]	ft		400	400	300	300	300	300	300	300	300

[1] MD = Machine Direction, CD = Cross Machine Direction.

[2] Other width and length rolls are available upon request.

MINIMUM† PHYSICAL PROPERTIES OF TREVIRA® TYPE 11 PRODUCTS

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fabric Weight	oz/yd^2	ASTM D-5261	3.3	4.0	5.7	7.1	8.0	10.0	12.0	13.0	16.0
Fabric Thickness, t	mils	ASTM D-5199	50	55	75	95	105	125	145	150	185
Grab Strength	lbs	ASTM D-4632	90	110	180	210	230	305	350	390	500
Grab Elongation	%	ASTM D-4632	60	60	60	60	60	60	60	65	70
Trapezoid Tear Strength	lbs	ASTM D-4533	30	40	60	75	80	100	120	130	150
Puncture Resistance	lbs	ASTM D-4833	45	50	80	95	100	130	150	155	195
Mullen Burst Strength	psi	ASTM D-3786	170	190	285	360	380	510	550	640	780
Water Flow Rate	gpm/ft^2	ASTM D-4491	155	150	130	110	90	80	65	60	40
Permittivity, Ψ	sec^{-1}	ASTM D-4491	2.07	2.01	1.74	1.47	1.20	1.07	0.87	0.80	0.53
Permeability, k = Ψxt	cm/sec	ASTM D-4491	.26	.29	.33	.35	.32	.34	.32	.31	.25
AOS	Sieve Size mm	ASTM D-4751	50 .300	50 .300	70 .210	70 .210	70 .210	70 .210	70 .210	100 .149	100 .149

† These minimum values represent minimum test values as determined from Quality Control (Q.C.) testing.

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Solution: (a) Using a maximum strain of 33%, the value of $f(\epsilon) = 0.52$. Thus the required grab tensile strength is as follows:

$$\begin{aligned} T_{reqd} &= p'(d_v)^2(0.52) \\ &= p'(0.33\ d_a)^2(0.52) \\ &= 0.057\ p'd_a^2 \\ &= 0.057(100)(2.0)^2 \\ &= 22.6 \text{ lb.} \end{aligned}$$

(b) The global factor of safety on a 125-lb. ultimate grab tensile geotextile with partial factors of safety of 2.5 is as follows:

$$\begin{aligned} FS &= \frac{T_{allow}}{T_{reqd}} \\ &= \frac{125/2.5}{22.6} \\ &= 2.2, \text{ which is acceptable.} \end{aligned}$$

2.5.4 Puncture Resistance

Although not only related to the separation function, the geotextile during its placement must survive the installation process. Indeed, fabric survivability is critical in all types of applications; without it, the best of designs are futile (recall Section 2.2.5.1). In this regard, sharp stones, tree stumps, roots, miscellaneous debris, and other things on the ground beneath the geotextile could puncture through the geotextile after stone base and traffic loads are imposed above it. The design method suggested for this situation is shown schematically in Figure 2.29. For these conditions, the vertical force exerted on the geotextile (which is gradually tightening around the protruding object) is as follows:

$$F_{reqd} = p'd_a^2 S_1 S_2 S_3 \tag{2.30}$$

where F_{reqd} = the required vertical force to be resisted,
p' = the pressure exerted on the geotextile (approximately 100% of tire inflation pressure at the ground surface for small stone thicknesses),
d_a = the average diameter of the puncturing aggregate or sharp object,
S_1 = protrusion factor = h_h/d_a,
h_h = protrusion height $\leq d_a$,
S_2 = scale factor to adjust ASTM D4833 test value using 5/16-in.-diameter puncture probe to actual puncturing object = $0.31/d_a$,
S_3 = shape factor to adjust flat puncture probe of ASTM D4833 to actual shape of puncturing object = $1 - A_p/A_c$ (values of A_p/A_c to be used

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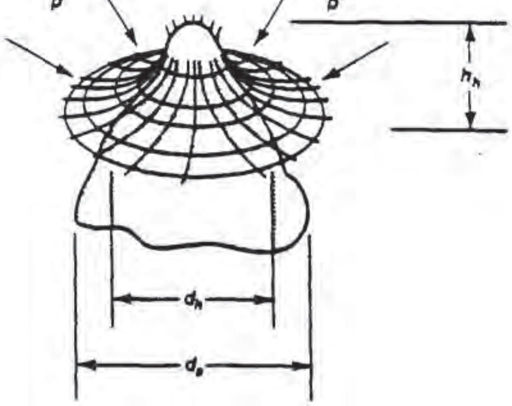

Figure 2.28 Visualization of a stone puncturing a geotextile as pressure is applied from above.

range from 0.8 for Ottawa sand, 0.7 for run-of-bank gravel, 0.4 for crushed rock, and 0.3 for shot rock),
A_p = projected area of particle, and
A_c = area of smallest circumscribed circle.

Example:

What is the factor of safety against puncture of a geotextile from a 2.0-in. stone by a loaded truck with tire inflation pressure of 80 lb./in.^{2} traveling on the surface of the stone base? The geotextile has an ultimate puncture strength of 45 lb. according to ASTM D4833.

Solution: Using the full stress on the geotextile of 80 lb./in.^{2} and factors of 0.33, 0.155, and 0.6 for S_1, S_2, and S_3, respectively,

$$\begin{aligned} F_{\text{reqd}} &= p' d_a^2 S_1 S_2 S_3 \\ &= 80 \times (2.0)^2 (0.33)(0.155)(0.6) \\ &= 9.82 \text{ lb.} \end{aligned}$$

Assuming that the cumulative partial factor of safety is 2.0, the global factor of safety is as follows:

$$\begin{aligned} FS &= \frac{F_{\text{allow}}}{F_{\text{reqd}}} \\ &= \frac{45/2.0}{9.82} \\ &= 2.3, \text{ which is acceptable.} \end{aligned}$$

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-22

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: GCL Material Properties

	Name	Date
Prepared By:	Paul Pellicer	11/14/97
Checked By:	John Pellicer	11/14/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

Project Number 622-0200
Prepared By: J. Pellicer
Checked By: P. Pellicer
Sheet 1 of 2
Date: 14-Nov-97
Date: 14-Nov-97

GCL Material Properties

The material properties for the GCL are presented in the construction specifications. A copy of the required GCL properties are attached (pg 2).

The GCL material strengths are given in the attached specification. Shear strength characteristics of the material are addressed in the slope stability calculations. For further information regarding shear strength/slope, reference slope stability calculations.

Foundation and cover material associated with placement of the GCL are presented in the construction specifications.

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3.07 PROTECTION OF THE WORK

A. The Contractor shall use all means necessary to protect all materials and partially completed and completed work.

B. In the event of damage, the Contractor shall make repairs and replacements necessary to the approval of the Owner and at no additional cost to the Owner.

C. The CQA Engineer will issue an approval of the GCL liner installation to the Owner in accordance with the CQA Plan prior to placement of any material over the GCL.

TABLE 02780-1
REQUIRED GCL PROPERTIES(4)

Geotextile Properties	Test Method	Manufacturer's QC Minimum Test Frequency	Value -English-	Value -SI-
Nonwoven Mass/Unit Area	ASTM D 5261	1/ 200,000 sq. ft (1/20,000 sq. m)	7.4 oz./yd^2 Typical 6.0 oz./yd^2 MARV	250 g/m^2 Typical 200 g/m^2 MARV
Woven	ASTM D 5261	1/ 200,000 sq. ft (1/20,000 sq. m)	3.4 oz./yd^2 Typical 3.1 oz./yd^2 MARV	115 g/m^2 Typical 105 g/m^2 MARV
BENTONITE				
Swell Index	ASTM D 5890	1/100,000 lbs. (50,000 kg)	24 ml/2g min.	24 ml/2g min.
Moisture Content	ASTM D 4643	1/100,000 lbs. (50,000 kg)	12% max.	12% max.
Fluid Loss	ASTM D 5891	1/100,000 lbs. (50,000 kg)	18 ml max.	18 ml max.
FINISHED GCL (4)				
Bentonite Mass Per Unit Area[1]	ASTM D 5261	1/ 40,000 sq. ft (1/4,000 sq. m)	0.90 lb./sq. Ft MARV	4.39 kg/m^2 MARV
Grab Strength[2]	ASTM D 4362	1/ 40,000 sq. ft (1/4,000 sq. m)	95 lbs MARV	422 N MARV
Grab Elongation[2]	ASTM D 4632	1/ 40,000 sq. ft (1/4,000 sq. m)	75% Typical	75% Typical
Peel Strength	ASTM D 4632	1/ 40,000 sq. ft (1/4,000 sq. m)	15 lbs. min.	66 N min.
Permeability[3]	ASTM D 5084	1/100,000 sq. ft (1/10,000 sq. m)	5 x 10^{-9} cm/secec max	5 x 10^{-9} cm/secec max

Notes:

1. Oven-dried measurement reflecting a moisture content of zero.
2. Measured at maximum peak, in the weakest principal direction.
3. De-Aired Tap Water @ 5 psi maximum effective confining stress and 2 psi head.
4. Internal shear strength testing (ASTM D 5321) of QA conformance samples or proposed equal material will be performed by the CQA Engineer as described in this specification.

[END OF SECTION]

MONTGOMERY WATSON

Calculation Cover Sheet **Appendix E-23**

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Clay Liner Properties

	Name	Date
Prepared By:	Paul Pellicer	11/14/97
Checked By:	John Pellicer	11/14/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

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Project Number 522-02.0
Prepared By: J. Pellicer
Checked By: P. Pellicer
Sheet __ of 1
Date 4-Nov-97
Date: 14-Nov-97

Clay Liner Properties

Clay Liner Borrow Area: Clay liner material will be obtained from the landfill or evaporation pond excavation in Upper Dockum material.

Placement Specificat Window: Refer to the Construction Specifica for material placement window.

THE PLACEMENT SPECIFICATION WINDOW IS BASED ON SITE SPECIFIC TESTING OF CLAY LINER MATERIALS OBTAINED FROM THE SITE. THE RECOMPACTED PERMEABILITY TESTS ARE PRESENTED IN TH APPENDIX TO THE ENGINEERING REPORT.

COMPATIBILITY OF CLAY + WASTE: SINCE SAMPLES OF THE ACTUAL SITE LEACHATE IS NOT AVAILABLE, ACTUAL COMPATIBILITY TESTS COULD NOT BE CONDUCTED. HOWEVER, PREVIOUS TESTING OF CLAY LINER MATERIALS WITH TYPICAL HAZARDOUS WASTE LANDFILL LEACHATES DOES NOT INDICATES SUBSTANTIA CHANGES IN PERMEABILITY.

TYPICAL CHARACTERISTICS OF CLAY:

- USCS CLASSIFICATION - CL to CH
- PLASTICITY INDEX - 27%
- % LT #200 SIEVE - 83%
- RE-COMPACTED PERMEABILITY - 5.1×10^{-2} cm/sec

MONTGOMERY WATSON

Calculation Cover Sheet — Appendix E-24

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Wheel Loading on Access Ramp

	Name	Date
Prepared By:	Paul Pellicer	11/13/97
Checked By:	John Pellicer	11/13/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

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Project Number 602-020 Sheet 1 of 7
Prepared By: P. Pellizer Date 13-Nov, 1997
Checked By: J. Pellicer Date: 13-Nov-97

Wheel Loading on Access Ramp.

Objective: verify that wheel loading will not Damage Geomembrane.

Assumptions: 631 scraper will generate the largest pressure on the Geomembrane.

Calculations: Define contact stress on liner.

Assume 2:1 Distribution slope

$$\sigma_c' = \sigma_c\left[\frac{R^2}{(R+D)^2}\right]$$

σ_c' = Contact stress on liner
σ_c : Tire contact pressure
R = effective Radius of tire contact = $[P/\pi\sigma_c]^{1/2}$
P = Axle load.
D = Roadway Thickness = 3' (see pg 3)

631 Scraper wt = 93,410 lb
Rated load = 75,000 lb
Total = 168,410 lb
wt distribution loaded ⇒ drive axle = 54%

} Cat handbook see pg 4

P = Axle load = 168,410 lb (.54) = 90,941 lb ✓

Tire Pressure 80psi (see pg 5)

$$R = \left[90{,}941\text{ lb}/\pi\ 80\right]^{1/2} = 19\text{ in} ✓$$

$$\sigma_c' = 80\text{psi}\left[\frac{(19\text{ in})^2}{(19\text{ in}+36\text{ in})^2}\right] = 9.5\text{ psi} ✓$$

Estimate Puncture pressure for 60mil THDPE Liner.

Puncture Resistance load = 108 lb (see pg 6)
Puncture Resistance specimen area = $\frac{d^2\pi}{4}$

d = diameter of specimen = 45mm = 1.77in (see pg 7
area = $\frac{(1.77)^2\pi}{4} = 2.46\text{ in}^2$
Puncture resistance pressure = $108\text{ lb}/2.46\text{ in}^2$ = 44 psi ✓

Project Number 602-0200
Prepared By: P. Pellizza
Checked By: J. Pellich

Sheet 2 of 7
Date: 13-Nov-97
Date: 13-Nov-97

$$F.S. = \frac{44\,psi}{9.5\,psi} = 4.6 \quad o.k.$$

Conclusions: wheel loading on the ramp should have no detrimental effects on the liner system. This calculation is conservative because the cushioning effect of the Geosythetics over the Geomembrane was not utilized.

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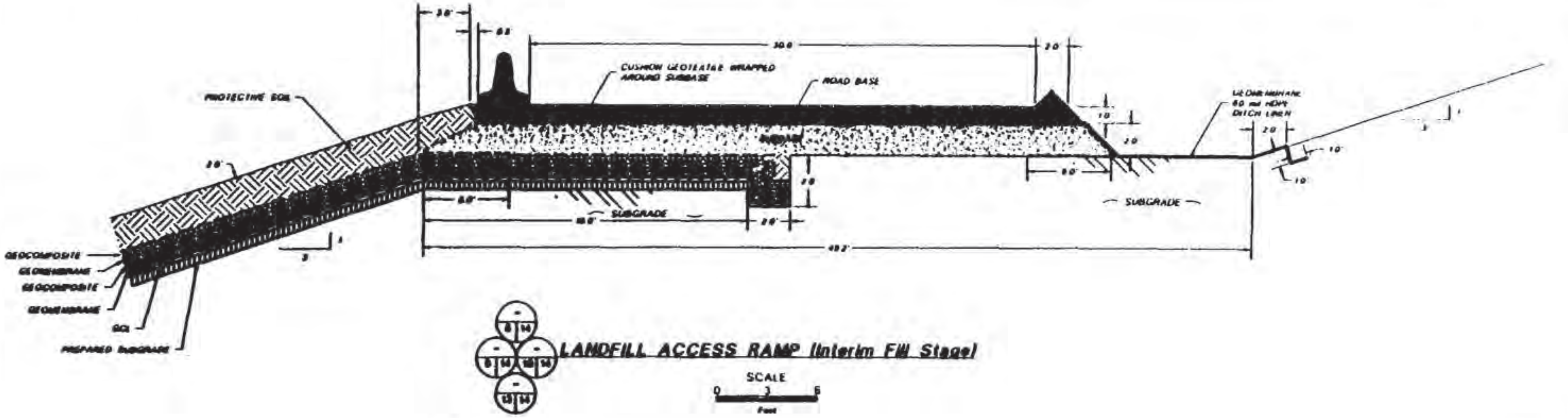
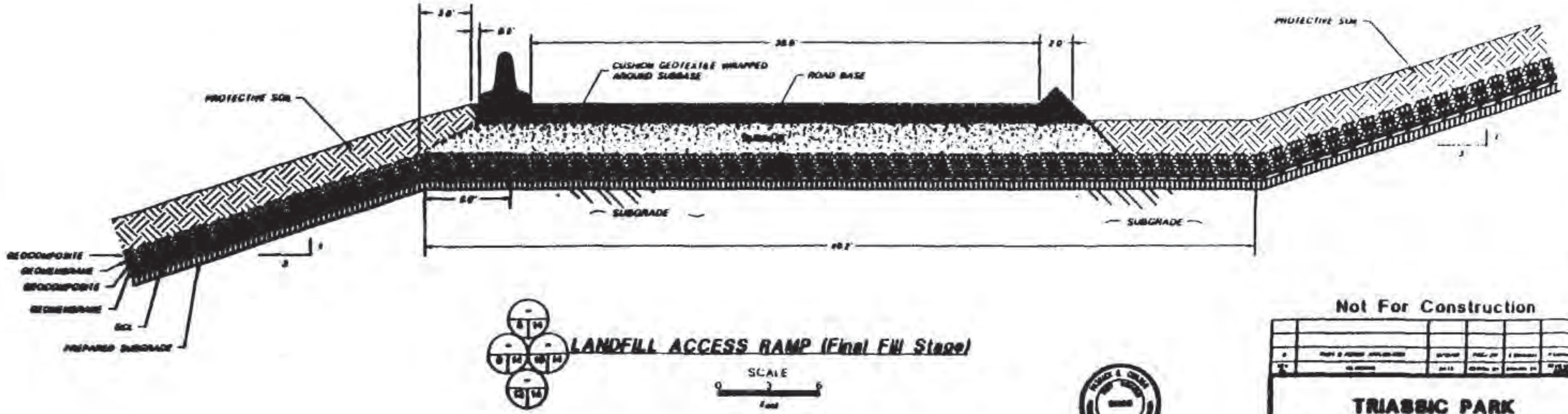


LANDFILL ACCESS RAMP (Interim Fill Stage)



LANDFILL ACCESS RAMP (Final Fill Stage)

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this map was prepared under my supervision and all the information provided hereon is true and correct to the [illegible] knowledge

Not For Construction

TRIASSIC PARK

WASTE DISPOSAL FACILITY

DRAWING TITLE

TYPICAL LANDFILL ACCESS RAMP DETAILS



	621B		631D		651E	
Flywheel power	246 kW	330 HP	336 kW	450 HP	410 kW	550 HP
Operating weight (empty)◄	30 205 kg	66,580 lb	42 370 kg	93,410 lb	59 420 kg	131,000 lb
Scraper capacity —						
Struck	10.7 m³	14 yd³	16 m³	21 yd³	24.5 m³	32 yd³
Heaped	15.3 m³	20 yd³	23.7 m³	31 yd³	33.6 m³	44 yd³
Rated load	21 770 kg	48,000 lb	34 000 kg	75,000 lb	47 170 kg	104,000 lb
Weight distribution — Empty						
Drive	70%		69%		69%	
Rear	30%		31%		31%	
Weight distribution — Loaded						
Drive	55%		54%		54%	
Rear	45%		46%		46%	
Engine model	3406		3408		3412	
Rated engine RPM	1900		2000		1900	
Displacement	14.6 L	893 in³	18.0 L	1099 in³	27.0 L	1649 in³
Top speed (loaded)	48 km/h	30 mph	50 km/h	31 mph	50 km/h	31 mph
Non-stop turning circle	11.1 m	36'6"	12.2 m	40'1"	13.6 m	44'7"
With ROPS restriction	—		—		14.5 m	47'7"
Tires — Tractor drive	29.5-29, 28 PR (E-3)		33.25-35, 38 PR (E-3)		37.5R39 Radial ★ ★ (E-3)	
Scraper	29.5-29, 28 PR (E-3)		33.25-35, 38 PR (E-3)		37.5R39 Radial ★ ★ (E-3)	
Width of cut	3.02 m	9'11"	3.50 m	11'6"	3.68 m	12'1"
Maximum depth of cut	340 mm	13.4"	483 mm	19"	440 mm	17.3"
Maximum depth of spread	460 mm	18"	425 mm	16.7"	660 mm	26"
Fuel tank refill capacity	511 L	135 gal	760 L	200 gal	1083 L	286 gal
GENERAL DIMENSIONS:						
Height to top of scraper	3.63 m	11'11"	4.17 m	13'8"	4.70 m	15'5"
Wheelbase	7.72 m	25'4"	8.74 m	28'8"	9.96 m	32'8"
Overall length	12.7 m	41'7"	14.25 m	46'9"	16.13 m	52'11"
Overall width	3.45 m	11'4"	3.96 m	13'	4.34 m	14'3"
Shipping width (draft arm on inside of bowl)	—		3.66 m	12'0"	3.91 m	12'10"
Scraper tread	2.18 m	7'2"	2.46 m	8'1"	2.82 m	9'3"
Tractor tread	2.21 m	7'3"	2.46 m	8'1"	2.64 m	8'8"

◄Operating weight includes coolant, lubricants, full fuel tank, ROPS canopy and operator.

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600 . . . WHEEL TRACTOR-SCRAPERS — Bias and Bias Belted Tires

Model	Tire Size	Ply Rating	Pressure Front		Rear	
			kPa	psi	kPa	psi
613C	18.00-25*	16	345	50	379	55
	23.5-25	16	241	35	276	40
615	26.5-25*	26	413	60	345	50
	29.5-25	22	276	40	241	35
621B	29.5-29*	28	413	60	276	40
	29.5-29	34	413	60	276	40
	29.5-35	28	345	50	241	35
	33.25-29	26	310	45	207	30
623B	29.5-29*	28	448	65	345	50
	29.5-29	34	448	65	345	50
	29.5-35	28	379	55	310	45
627B	29.5-29*	28	413	60	413	60
	29.5-29	34	413	60	413	60
	29.5-35	28	345	50	345	50
	33.25-29	26	310	45	310	45
631D	33.25-35*	38	482	70	379	55
	37.25-35	30	345	50	276	40
633D	33.25-35*	38	517	75	448	65
	37.25-35	30	379	55	310	45
637D	33.25-35*	38	517	75	482	70
	37.25-35	30	379	55	345	50
651E	37.5-39	36	482	70	413	60
	37.5-39	44	482	70	413	60
657E	37.5-39	44	517	75	551	80
	37.5-39	52	517	75	551	80

*Standard tire and ply rating.

600 . . . WHEEL TRACTOR-SCRAPERS — Radial Tires

Model	Tire Size	Strength Index	Michelin Front		Rear		Pressure Goodyear Front		Rear		Fro
			kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa
613C	18.00R25		413	60	448	65	—	—	—	—	—
	23.5R25	★	310	45	345	50	310	45	345	50	—
615	26.5R25	★ ★	413	60	379	55	—	—	—	—	
	29.5R25	★ ★	345	50	310	45	—	—	—	—	—
621B	29.5R29	★ ★	448	65	379	55	482	70	345	50	—
	29.5R35	★ ★	448	65	379	55	—	—	—	—	—
	33.25R29	★ ★	413	60	345	50	—	—	—	—	—
623B	29.5R29	★ ★	482	70	413	60	517	75	413	60	—
	29.5R35	★ ★	448	65	379	55	—	—	—	—	—
627B	29.5R29	★ ★	413	60	413	60	448	65	448	65	—
	29.5R35	★ ★	413	60	413	60	—	—	—	—	—
	33.25R29	★ ★	379	55	379	55	—	—	—	—	—
631D	33.25R35	★ ★	551	80	517	75	551	80	448	65	551
	37.25R35	★ ★	517	75	413	60	—	—	—	—	—
633D	33.25R35	★ ★	551	80	517	75	586	85	517	75	586
	37.25R35	★ ★	517	75	482	70	—	—	—	—	—
637D	33.25R35	★ ★	551	80	551	80	586	85	551	80	586
	37.25R35	★ ★	517	75	517	75	—	—	—	—	—
651E	37.5R39*	★ ★	689	100	551	80	551	80	482	70	551
	40.5/75R39	★ ★	517	75	482	70	482	70	482	70	—
657E	37.5R39*	★ ★	689	100	689	100	586	85	620	90	586
	40.5/75R39	★ ★	517	75	517	75	517	75	517	75	—

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17 Nov

FRICTION SEAL™ HD GEOMEMBRANE
QUALITY CONTROL SPECIFICATIONS
60 mil

FRICTION SEAL HD, National Seal Company's advanced textured high density polyethylene (HDPE) geomembran is manufactured by attaching a friction surface to NSC's high quality HDPE geomembrane. The friction surface made from high molecular weight polyethylene resin compounded specifically for use in NSC geomembranes. Tl resin has been formulated to provide stress crack, chemical and ultraviolet resistance for fluid containment. NS produces FRICTION SEAL HD with a textured surface on one or both sides of the parent sheet.

The following properties are tested as a part of NSC's quality control program. Certified test results for properties this page are available upon request. Refer to NSC's Quality Control Manual for exact test methods and frequencie

RESIN PROPERTIES	METHOD	UNITS	MINIMUM[1]	TYPICAL
Melt Flow Index[2]	ASTM D 1238	g/10 min	0.50	0.25
Oxidative Induction Time	ASTM D 3895, Al pan, 200°C, 1 atm O_2	minutes	100	120

SHEET PROPERTIES	METHOD	UNITS	MINIMUM[1]	TYPICAL
Mass per Unit Area[3]	ASTM D 3776	lb/ft²	0.31	0.32
Thickness[4]	ASTM D 751, NSF mod.			
Average		mils	60.0	61.5
Individual		mils	57.0	59.7
Density[4]	ASTM D 1505	g/cm³	0.940	0.948
Carbon Black Content[4]	ASTM D 1603	percent	2.0-3.0	2.35
Carbon Black Dispersion[4]	ASTM D 3015, NSF mod.	rating	A1, A2, B1	A1
Tensile Properties[5]	ASTM D 638			
Stress at Yield		psi	2200	2750
		ppi	132	169
Stress at Break		psi	2200	3240
		ppi	132	199
Strain at Yield	1.3" gage length (NSF)	percent	13.0	17.5
Strain at Break	2.0" gage or extensometer	percent	200	540
	2.5" gage length (NSF)	percent	160	432
Dimensional Stability[2,4]	ASTM D 1204, NSF mod.	percent	1.5.	0.4
Tear Resistance	ASTM D 1004	ppi	750	1000
		lbs	45	62
Puncture Resistance	ASTM D 4833	ppi	1800	2276
		lbs	108	140
Constant Load ESCR, Single Point[4]	GRI, GM-5a	hours	200	>400
Friction Angle, Index	GRI, GS-7	degrees	40	56

[1] This value represents the minimum acceptable test value for a roll as tested according to NSC's Manufacturing Quality Control Man Individual test specimen values are not addressed in this specification except thickness.

[2] Indicates Maximum Value

[3] Friction Coating on both sides of base sheet

[4] Testing performed on base sheet

[5] Stress and strength values are normalized to the nominal base sheet thickness. NSC certifies properties based on values calculated us nominal thickness only. Stress values calculated using actual product thickness is not guaranteed due to the lack of industry accep thickness test procedures for friction sheet.

3 Nov-97

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pmd

stant-rate-of extension (CRE) type, with autographic recorder conforming to the requirements of Specification D 76. See Fig. 1.

6.2 *Ring Clamp Attachment*, consisting of concentric plates with an open internal diameter of 45 ± 0.025 mm (1.772 ± 0.001 in.), capable of clamping the test specimen without slippage. A suggested clamping arrangement is shown in Figs. 1 and 2. The external diameter is suggested to be 100 ± 0.025 mm (3.937 ± 0.001 in.). The diameter of the six holes used for securing the ring clamp assembly is suggested to be 8 mm (0.135 in.) and equally spaced at a radius of 37 mm (2.95 in.). The surfaces of these plates can consist of grooves with O-rings or coarse sandpaper bonded onto opposing surfaces.

6.3 *Solid Steel Rod*, with a diameter of 8 ± 0.01 mm (0.35 ± 0.005 in.) having a flat end with a 45° = 0.8 mm (0.315 in.) chamfered edge contacting the test specimen's surface. See Figs. 1 and 3.

7. Sampling

7.1 *Lot Sample*—Divide the product into lots and take the lot sample as directed in Practice D 4354.

7.2 *Laboratory Sample*—For the laboratory sample take a swatch extending the full width of the geotextile, of sufficient length along the selvage from each sample roll so that the requirements of 7.3 and 8.1 can be met. Take a sample that will exclude material from the outer wrap and inner wrap around the core unless the sample is taken at the production site, then inner and outer wrap material may be used.

7.3 *Test Specimens*—Select from the laboratory sample the number of specimens directed in Section 8. Minimum specimen diameter is 100 mm (4 in.) to facilitate clamping. Space the specimens along a diagonal on the unit of

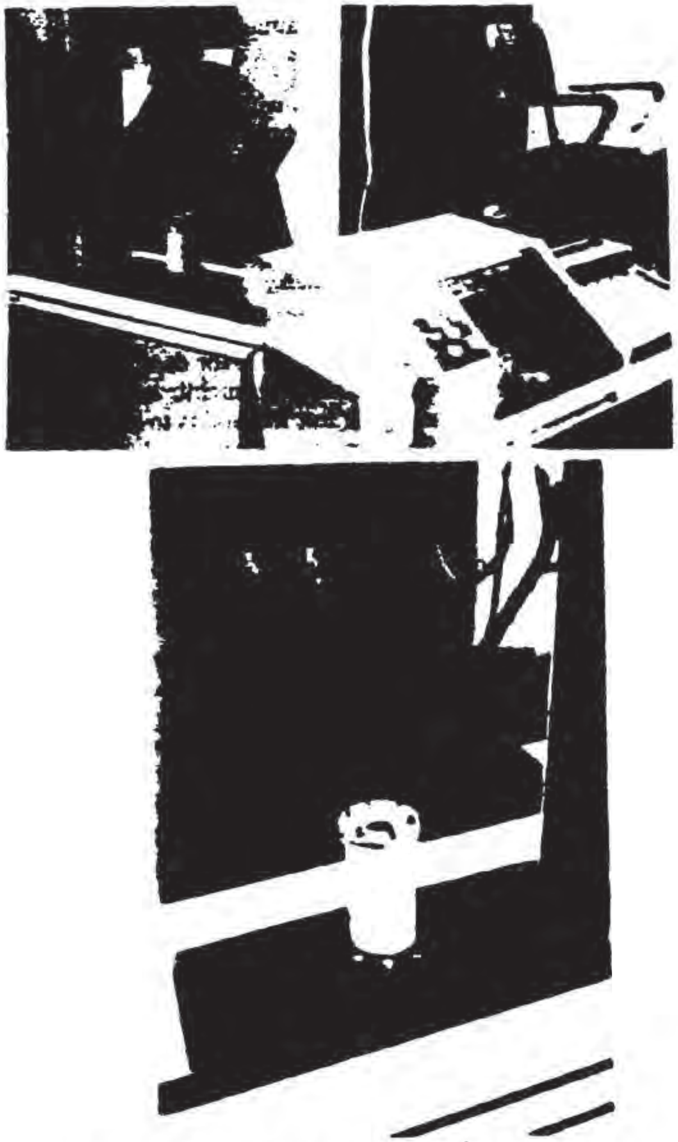

FIG. 1 Photographs of Test Setup and Fixture

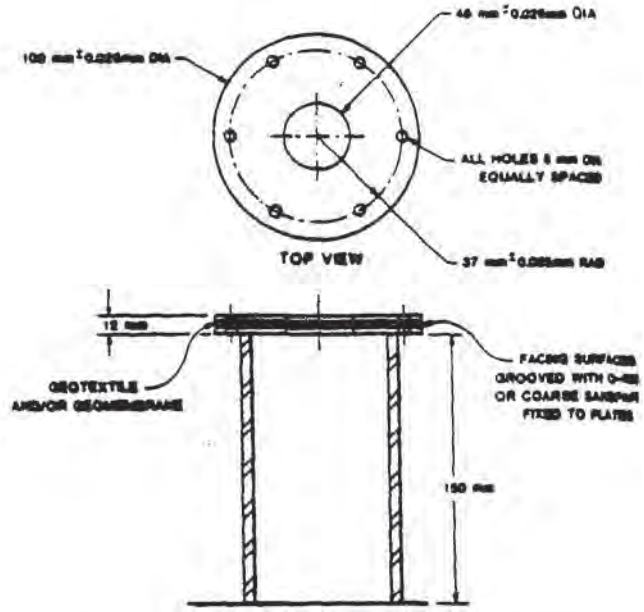

FIG. 2 Test Fixture Detail (Not to Scale)

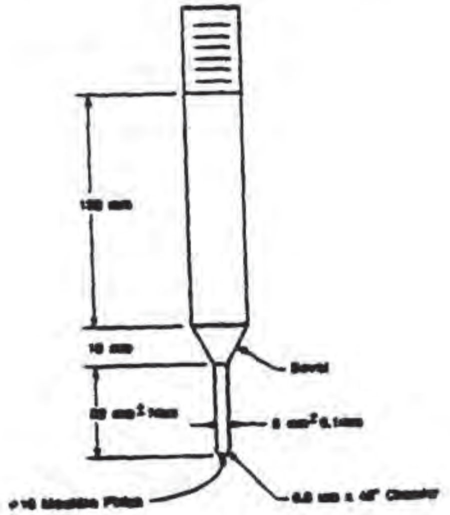

FIG. 3 Test Probe Detail (Not to Scale)

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-25

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Frost Penetration

	Name	Date
Prepared By:	Paul Pellicer	10/24/97
Checked By:	John Pellicer	10/29/97
Reviewed By:	Pat Corser	11/14/97

Revisions	Date	By	Checked By	Reviewed By

TerraMatrix
Engineering & Environmental Services
P.O. Box 774018, 1475 Pine Grove Road
Steamboat Springs, Colorado 80477
Phone 970.879.6260 Fax 970.879.9048

Project Number: 632
Prepared By: J. Pelican
Checked By:
Sheet 1 of
Date 4-OCT-97
Date: 29Oct97

OBJECTIVE: Determine depth of freeze for protective/cover soil which will be placed over the liner/cover system.

METHODOLOGY: Modified Berggren Equation

DATA: Use coldest high and low temperatures from historical data. Data obtained from the Utah Climate Center

REFERENCE: Department of the Army and the Air Force, 1966 "Calculation Methods for Determination of Depths of Freeze and Thaw in Soils" - TM 5-8526

See attached spreadsheet for calculation.

RESULT: Based on the most conservative temperature. Frost is expected to penetrate 2.3 ft into the ground. Vegetative Soil cover is 2.5 ft Thick.

CONCLUSION: Antsipated frost penetration does not exceed The depth of the vegetative Cover Therefore frost should not affect The cover GCL. The protective Soil on The liner slopes should be sufficient protection for the liner GCL's due to limited length of exposure.

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TITLE: DEPTH OF FREEZE CALCULATIONS FOR MULTIPLE LAYERED SOIL
JOB NAME: GANDY/TRIASSIC PARK LANDFILL
JOB NUMBER: 602
PREPARED BY: JOHN PELLICER
DATE PREPARED: 24 OCT 1997
FILENAME: H:\JOHN PELLICER\GANDY\SPREAD\FROST DEPTH CALCULATION FOR TRIASSIC PARK LANDFILL 2

REF: CALCULATION METHODS FOR DETERMINATION
OF DEPTHS OF FREEZE AND THAW IN SOILS
DEPARTMENT OF THE ARMY TECHNICAL MANUAL TM 5-852-6
JANUARY 1966

MULTI-LAYERED SOLUTION OF MODIFIED B

Air Temperature Data
Bitter Lakes Wildlife Refuge, New Mexico
1950 - 1997

MEAN ANNUAL TEMPERATURE: 59
n-factor: 0.5
air freezing index (F): 1138
SURFACE FREEZING INDEX nF = 569
Length of Freezing Season (t): 136 (days)
Vs (nF/t) 4.2
Vo, |Tmean-T(32)| 27
"Alpha" (Vo/Vs) = 6.46

Freezing Surface n-factor	Type
1	Snow
0.9	Pavement (ice/snow-free)
0.9	Sand & gravel
0.7	Pavement (II)
0.5	Turf

Material	UW Unit Weight pcf	w Water Content %	d Thickness Ft	Sd Sum Thick. Ft	C Volumetric Heat Capacity BTU/Ft^3-F	K Thermal Conduct. unfrozen	K Thermal Conduct. frozen	Kave Thermal Cond. BTU/Ft-Hr-F	L Vol. Latent Heat of Fusion BTU/Ft^3	L*d BTU/Ft^2	Σ(L*d) BTU/Ft^2	Lave Ave. BTU/Ft^3	C*d	Σ(C*d)	Cave	μ [(C/L)*Vs]	α (Vo/Vs)	λ	λ^2	Rn (d/K)	ΣRn	ΣRn+Rn/2	nI	ΣnI
Vegetative Cover	100.00	10.00	2.3220	2.32	24.50	0.92	0.90	0.91	1440.00	3343.68	3343.68	1440.00	56.89	56.89	24.50	0.07	6.46	0.56	0.31	2.56	2.56	1.28	569.27	569

THE DEPTH OF FROST IS DETERMINED WHEN THE SUM OF THE FROST INDICES IS EQUAL TO THE FREEZE INDEX.
THE THICKNESS OF THE LAYERS CAN BE MANIPULATED TO DETERMINE THE EXACT DEPTH OF FROST.

MEASURED DAILY TEMPERATURES BITTER LAKES WILDLIFE REFUGE, NEW MEXICO 1950 to 1997

3a+

				AIR TEMPERATURE				SUM		
							FREEZE	FREEZE		
	DAY	MONTH	DAY	HIGH	LOW	MEAN	INDEX	INDEX		
OCTOBER	1	10	1	62	35	49	16.5	17	0	0
	2	10	2	67	35	51	19	36	0	0
	3	10	3	59	30	45	12.5	48	0	0
	4	10	4	61	31	46	14	62	0	0
	5	10	5	59	30	45	12.5	75	0	0
	6	10	6	62	30	46	14	89	0	0
	7	10	7	62	30	46	14	103	0	0
	8	10	8	59	19	39	7	110	0	0
	9	10	9	62	24	43	11	121	0	0
	10	10	10	57	27	42	10	131	0	0
	11	10	11	57	29	43	11	142	0	0
	12	10	12	58	28	43	11	153	0	0
	13	10	13	56	30	43	11	164	0	0
	14	10	14	56	30	43	11	175	0	0
	15	10	15	53	30	42	9.5	184	0	0
	16	10	16	53	25	39	7	191	0	0
	17	10	17	56	27	42	9.5	201	0	0
	18	10	18	59	21	40	8	209	0	0
	19	10	19	58	19	39	6.5	215	0	0
	20	10	20	55	17	36	4	219	0	0
	21	10	21	56	21	39	6.5	226	0	0
	22	10	22	55	24	40	7.5	233	0	0
	23	10	23	52	23	38	5.5	239	0	0
	24	10	24	56	25	41	8.5	247	0	0
	25	10	25	50	23	37	4.5	252	0	0
	26	10	26	51	25	38	6	258	0	0
	27	10	27	51	25	38	6	264	0	0
	28	10	28	52	17	35	2.5	266	0	0
	29	10	29	49	17	33	1	267	0	0
	30	10	30	49	20	35	2.5	270	0	0
	31	10	31	51	10	31	-1.5	268	0	0
NOVEMBER	32	11	1	54	13	34	1.5	270	0	0
	33	11	2	54	14	34	2	272	0	0
	34	11	3	56	13	35	2.5	274	0	0
	35	11	4	53	12	33	0.5	275	0	0
	36	11	5	51	22	37	4.5	279	36	0
	37	11	6	46	10	28	-4	275	0	0
	38	11	7	45	11	28	-4	271	0	0
	39	11	8	48	13	31	-1.5	270	0	0
	40	11	9	48	16	32	0	270	0	0
	41	11	10	45	17	31	-1	269	0	0
	42	11	11	45	15	30	-2	267	0	0
	43	11	12	45	15	30	-2	265	0	0
	44	11	13	49	9	29	-3	262	0	0

	45	11	14	49	11	30	-2	260	0	0
	46	11	15	50	-3	24	-8.5	251	0	0
	47	11	16	43	-1	21	-11	240	0	0
	48	11	17	49	4	27	-5.5	235	0	0
	49	11	18	43	9	26	-6	229	0	0
	50	11	19	42	9	26	-6.5	222	0	0
	51	11	20	50	13	32	-0.5	222	0	0
	52	11	21	44	9	27	-5.5	216	0	0
	53	11	22	45	7	26	-6	210	0	0
	54	11	23	45	5	25	-7	203	0	0
	55	11	24	48	10	29	-3	200	0	0
	56	11	25	45	13	29	-3	197	0	0
	57	11	26	47	1	24	-8	189	0	0
	58	11	27	42	3	23	-9.5	180	0	0
	59	11	28	42	8	25	-7	173	0	0
	60	11	29	44	2	23	-9	164	0	0
	61	11	30	43	8	26	-6.5	157	0	0
DECEMBER	62	12	1	44	7	26	-6.5	151	0	0
	63	12	2	43	10	27	-5.5	145	0	0
	64	12	3	38	8	23	-9	136	0	0
	65	12	4	42	8	25	-7	129	0	0
	66	12	5	39	4	22	-10.5	119	0	0
	67	12	6	49	2	26	-6.5	112	0	0
	68	12	7	47	6	27	-5.5	107	0	0
	69	12	8	37	12	25	-7.5	99	0	0
	70	12	9	39	-11	14	-18	81	0	0
	71	12	10	49	-11	19	-13	68	0	0
	72	12	11	36	7	22	-10.5	58	0	0
	73	12	12	38	-3	18	-14.5	43	0	0
	74	12	13	40	2	21	-11	32	0	0
	75	12	14	38	3	21	-11.5	21	0	0
	76	12	15	37	-8	15	-17.5	3	0	0
	77	12	16	32	-7	13	-19.5	-17	0	0
	78	12	17	38	4	21	-11	-28	0	0
	79	12	18	41	0	21	-11.5	-39	0	0
	80	12	19	40	1	21	-11.5	-51	0	0
	81	12	20	38	-4	17	-15	-66	0	0
	82	12	21	36	0	18	-14	-80	0	0
	83	12	22	38	3	21	-11.5	-91	0	0
	84	12	23	44	-5	20	-12.5	-104	0	0
	85	12	24	48	-10	19	-13	-117	0	0
	86	12	25	46	3	25	-7.5	-124	0	0
	87	12	26	42	-3	20	-12.5	-137	0	0
	88	12	27	36	1	19	-13.5	-150	0	0
	89	12	28	39	-6	17	-15.5	-166	0	0
	90	12	29	42	2	22	-10	-176	0	0
	91	12	30	50	-7	22	-10.5	-186	0	0
	92	12	31	54	-2	26	-6	-192	0	0
JANUARY	93	1	1	41	5	23	-9	-201	0	0

	94	1	2	34	-18	8	-24	-225	0	0
	95	1	3	34	-18	8	-24	-249	0	0
	96	1	4	42	-1	21	-11.5	-261	0	0
	97	1	5	38	-9	15	-17.5	-278	0	0
	98	1	6	32	-4	14	-18	-296	0	0
	99	1	7	49	-3	23	-9	-305	0	0
	100	1	8	49	2	26	-6.5	-312	0	0
	101	1	9	49	-2	24	-8.5	-320	0	0
	102	1	10	32	-4	14	-18	-338	0	0
	103	1	11	44	-22	11	-21	-359	0	0
	104	1	12	44	-11	17	-15.5	-375	0	0
	105	1	13	38	-22	8	-24	-399	0	0
	106	1	14	45	-14	16	-16.5	-415	0	0
	107	1	15	43	-4	20	-12.5	-428	0	0
	108	1	16	32	3	18	-14.5	-442	0	0
	109	1	17	53	0	27	-5.5	-448	0	0
	110	1	18	41	2	22	-10.5	-458	0	0
	111	1	19	49	0	25	-7.5	-466	0	0
	112	1	20	39	5	22	-10	-476	0	0
	113	1	21	42	7	25	-7.5	-483	0	0
	114	1	22	37	-12	13	-19.5	-503	0	0
	115	1	23	35	-6	15	-17.5	-520	0	0
	116	1	24	36	-5	16	-16.5	-537	0	0
	117	1	25	41	0	21	-11.5	-548	0	0
	118	1	26	38	5	22	-10.5	-559	0	0
	119	1	27	49	8	29	-3.5	-562	0	0
	120	1	28	44	3	24	-8.5	-571	0	0
	121	1	29	42	5	24	-8.5	-579	0	0
	122	1	30	41	8	25	-7.5	-587	0	0
	123	1	31	40	7	24	-8.5	-595	0	0
FEBRUARY	124	2	1	44	-12	16	-16	-611	0	0
	125	2	2	48	-12	18	-14	-625	0	0
	126	2	3	43	-1	21	-11	-636	0	0
	127	2	4	41	9	25	-7	-643	0	0
	128	2	5	41	0	21	-11.5	-655	0	0
	129	2	6	36	2	19	-13	-668	0	0
	130	2	7	48	2	25	-7	-675	0	0
	131	2	8	43	5	24	-8	-683	0	0
	132	2	9	50	4	27	-5	-688	0	0
	133	2	10	40	1	21	-11.5	-699	0	0
	134	2	11	40	2	21	-11	-710	0	0
	135	2	12	42	6	24	-8	-718	0	0
	136	2	13	45	-2	22	-10.5	-729	0	0
	137	2	14	49	6	28	-4.5	-733	0	0
	138	2	15	50	8	29	-3	-736	0	0
	139	2	16	45	8	27	-5.5	-742	0	0
	140	2	17	41	9	25	-7	-749	0	0
	141	2	18	44	16	30	-2	-751	0	0
	142	2	19	41	13	27	-5	-756	0	0

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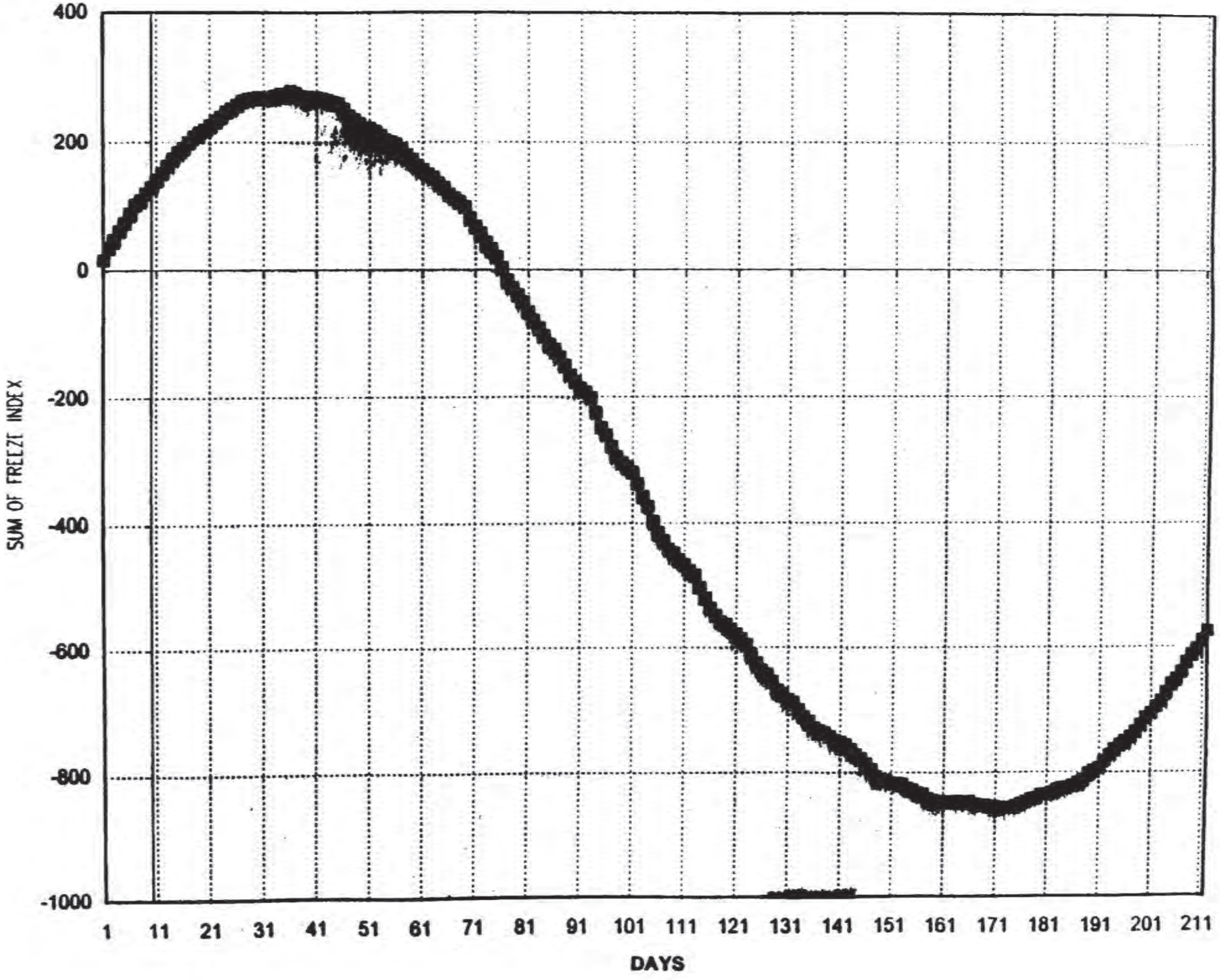
	143	2	20	44	6	25	-7	-763	0	0
	144	2	21	42	4	23	-9	-772	0	0
	145	2	22	45	7	26	-6	-778	0	0
	146	2	23	43	4	24	-8.5	-786	0	0
	147	2	24	50	-5	23	-9.5	-796	0	0
	148	2	25	46	-5	21	-11.5	-807	0	0
	149	2	26	46	6	26	-6	-813	0	0
	150	2	27	49	15	32	0	-813	0	0
	151	2	28	46	9	28	-4.5	-818	0	0
MARCH	152	3	1	48	17	33	0.5	-817	0	0
	153	3	2	48	13	31	-1.5	-819	0	0
	154	3	3	47	5	26	-6	-825	0	0
	155	3	4	45	12	29	-3.5	-828	0	0
	156	3	5	45	11	28	-4	-832	0	0
	157	3	6	50	9	30	-2.5	-835	0	0
	158	3	7	43	6	25	-7.5	-842	0	0
	159	3	8	47	12	30	-2.5	-845	0	0
	160	3	9	49	8	29	-3.5	-848	0	0
	161	3	10	51	16	34	1.5	-847	0	0
	162	3	11	49	15	32	0	-847	0	0
	163	3	12	54	10	32	0	-847	0	0
	164	3	13	49	17	33	1	-846	0	0
	165	3	14	49	11	30	-2	-848	0	0
	166	3	15	49	17	33	1	-847	0	0
	167	3	16	43	14	29	-3.5	-850	0	0
	168	3	17	44	16	30	-2	-852	0	0
	169	3	18	46	16	31	-1	-853	0	0
	170	3	19	47	11	29	-3	-856	0	0
	171	3	20	55	11	33	1	-855	0	0
	172	3	21	44	13	29	-3.5	-859	0	172
	173	3	22	52	16	34	2	-857	0	0
	174	3	23	52	12	32	0	-857	0	0
	175	3	24	49	20	35	2.5	-854	0	0
	176	3	25	51	20	36	3.5	-851	0	0
	177	3	26	53	18	36	3.5	-847	0	0
	178	3	27	50	21	36	3.5	-844	0	0
	179	3	28	54	14	34	2	-842	0	0
	180	3	29	55	20	38	5.5	-836	0	0
	181	3	30	57	9	33	1	-835	0	0
	182	3	31	52	17	35	2.5	-833	0	0
APRIL	183	4	1	53	20	37	4.5	-828	0	0
	184	4	2	51	18	35	2.5	-826	0	0
	185	4	3	47	19	33	1	-825	0	0
	186	4	4	54	16	35	3	-822	0	0
	187	4	5	52	20	36	4	-818	0	0
	188	4	6	52	22	37	5	-813	0	0
	189	4	7	60	24	42	10	-803	0	0
	190	4	8	52	21	37	4.5	-798	0	0
	191	4	9	55	19	37	5	-793	0	0

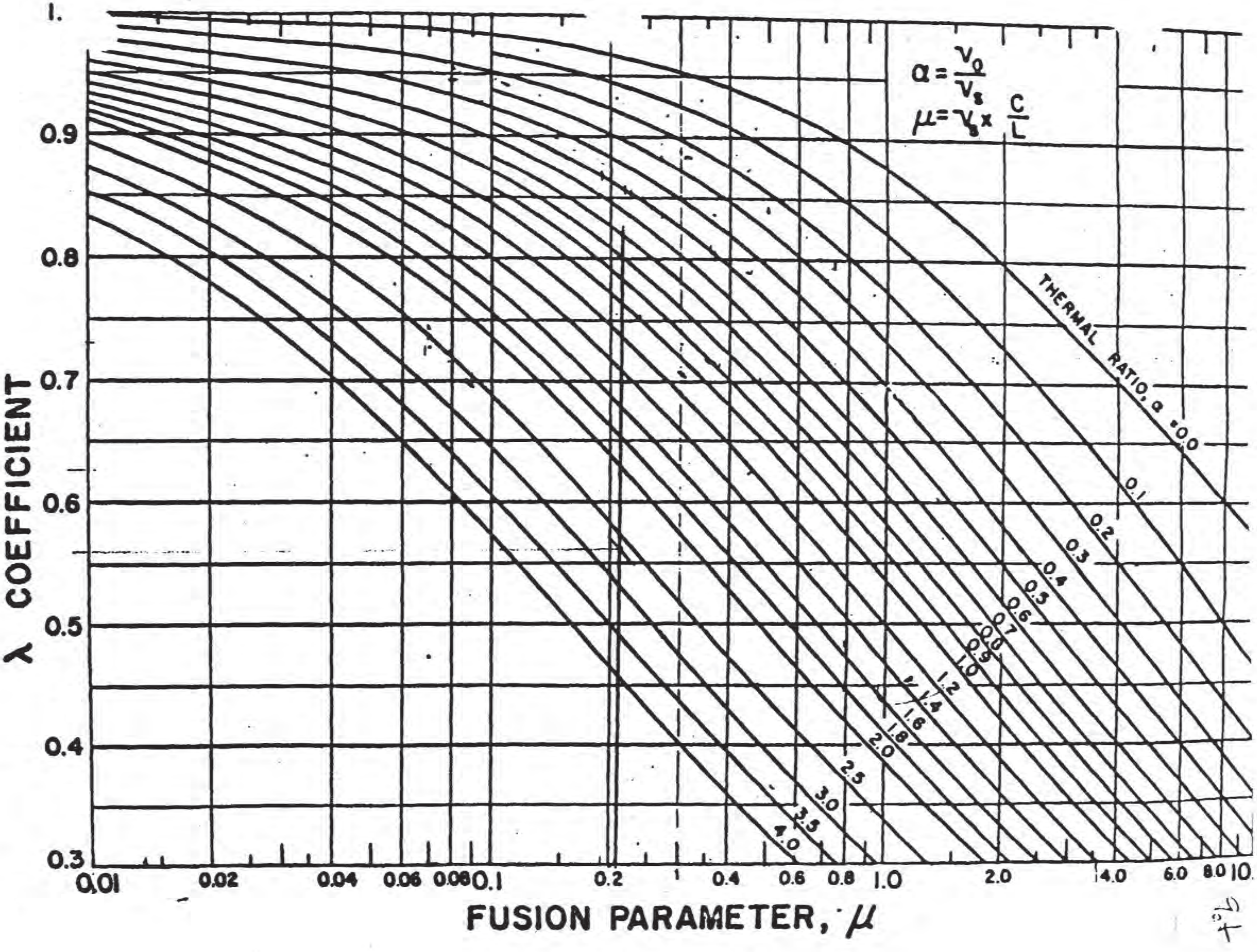
192	4	10	58	28	43	11	-782	0	0
193	4	11	60	23	42	9.5	-773	0	0
194	4	12	61	23	42	10	-763	0	0
195	4	13	57	20	39	6.5	-756	0	0
196	4	14	57	19	38	6	-750	0	0
197	4	15	52	26	39	7	-743	0	0
198	4	16	54	26	40	8	-735	0	0
199	4	17	55	30	43	10.5	-725	0	0
200	4	18	58	31	45	12.5	-712	0	0
201	4	19	52	26	39	7	-705	0	0
202	4	20	58	25	42	9.5	-696	0	0
203	4	21	56	28	42	10	-686	0	0
204	4	22	59	30	45	12.5	-673	0	0
205	4	23	62	30	46	14	-659	0	0
206	4	24	56	24	40	8	-651	0	0
207	4	25	57	31	44	12	-639	0	0
208	4	26	63	30	47	14.5	-625	0	0
209	4	27	60	28	44	12	-613	0	0
210	4	28	57	27	42	10	-603	0	0
211	4	29	63	27	45	13	-590	0	0
212	4	30	64	30	47	15	-575	0	0

MAXIMUM	279
MINIMUM	-859

FREEZING INDEX:	1138
FREEZING SEASON:	136

BITTER LAKES WILDLIFE REFUGE, NEW MEXICO
FREEZING INDEX




λ COEFFICIENT
FUSION PARAMETER, μ
$\alpha = \frac{\nu_0}{\nu_s}$
$\mu = \gamma_s x \frac{C}{L}$
THERMAL RATIO, α = 0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.2
1.4
1.6
1.8
2.0
2.5
3.0
3.5
4.0
1.
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.01
0.02
0.04
0.06
0.08
0.1
0.2
0.4
0.6
0.8
1.0
2.0
4.0
6.0
8.0
10.

BITTER LAKES WL REFUGE, NEW MEXICO (290992)

Period of Record Monthly Climate Summary

Period of Record : 12/1/1950 to 6/30/1997

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	56.7	62.6	69.9	79.1	86.9	95.1	95.7	93.8	87.1	78.2	65.7	57.9	77.4
Average Min. Temperature (F)	20.5	25.1	31.2	40.2	49.6	59.0	63.2	61.5	53.8	40.6	28.3	21.0	41.2
Average Total Precipitation (in.)	0.41	0.43	0.32	0.47	1.06	1.36	2.18	2.22	1.79	1.17	0.50	0.44	12.35
Average Total SnowFall (in.)	2.2	2.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	1.7	7.4
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Western Regional Climate Center, Greg McCurdy, gmwrcc@sage.dri.edu

BITTER LAKES WL REFUGE, NEW MEXICO

NCDC 1961-1990 Monthly Normals

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Max. Temperature (F)	55.7	61.1	69.3	78.4	86.4	94.1	95.2	92.9	85.6	77.5	65.4	56.9	76.5
Highest Mean Max. Temperature (F)	64.8	69.9	78.5	83.0	92.1	102.5	102.0	97.7	91.5	84.0	71.6	67.0	79.3
Year Highest Occurred	1967	1962	1967	1986	1962	1980	1980	1983	1983	1963	1981	1970	1963
Lowest Mean Max. Temperature (F)	46.4	53.0	57.9	71.0	82.3	89.9	88.6	87.1	76.3	71.2	55.5	48.5	74.5
Year Lowest Occurred	1979	1964	1969	1983	1976	1986	1975	1971	1974	1984	1961	1983	1978
Mean Temperature (F)	37.6	42.6	50.3	59.4	67.8	76.4	79.2	77.2	69.9	59.0	47.3	38.7	58.8
Highest Mean Temperature (F)	44.5	49.0	56.5	64.1	72.3	83.7	83.6	81.6	74.6	62.6	51.4	45.7	60.1
Year Highest Occurred	1969	1962	1967	1967	1989	1990	1980	1969	1983	1963	1965	1970	1967
Lowest Mean Temperature (F)	31.1	35.0	42.1	53.3	62.7	72.8	73.6	73.4	63.1	52.3	40.9	32.3	56.3
Year Lowest Occurred	1966	1964	1969	1983	1975	1979	1975	1974	1974	1976	1976	1989	1975
Mean Min. Temperature (F)	19.4	24.1	31.1	40.3	49.3	58.6	63.2	61.5	54.2	40.4	29.1	20.5	41.0
Highest Mean Min. Temperature (F)	24.8	28.4	35.7	45.9	53.4	65.5	67.2	65.6	59.0	46.7	37.4	27.6	42.9
Year Highest Occurred	1965	1987	1985	1967	1989	1990	1966	1969	1990	1983	1978	1984	1986
Lowest Mean Min. Temperature (F)	9.4	17.0	26.3	34.0	41.2	53.4	56.6	56.1	48.1	32.8	22.4	12.8	36.7
Year Lowest Occurred	1963	1964	1969	1975	1975	1975	1988	1975	1975	1976	1975	1989	1975
Mean Precipitation (in.)	0.43	0.48	0.33	0.46	0.97	1.75	1.89	2.52	1.96	1.10	0.62	0.49	13.00
Highest Precipitation (in.)	2.15	1.54	1.63	2.41	3.81	5.96	5.15	7.19	5.68	5.61	2.02	2.11	23.72
Year Highest Occurred	1968	1975	1968	1966	1981	1978	1968	1977	1974	1983	1961	1969	1986

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BITTER LAKES WL REFUGE, NEW MEXICO

Period of Record Daily Climate Summary

```
 Daily Records for station 290992  BITTER LAKES WL REFUGE        state: nm

 For temperature and precipitation, multi-day accumulations
   are not considered either for records or averages.
 The year given is the year of latest occurrence.

 Period requested -- Begin :  1/ 1/1890 -- End : 12/31/2000
 Period       used -- Begin : 12/ 1/1950 -- End :  6/30/1997

  Cooling degree threshold =   65.00  Heating degree threshold =   65.00

AVG    Multi-year unsmoothed average of the indicated quantity
HI     Highest value of indicated quantity for this day of year
LO     Lowest  value of indicated quantity for this day of year
YR     Latest year of occurrence of the extreme value
NO     Number of years with data for this day of year.
       Units: English (inches and degrees F)

      |---Maximum Temperature---|---Minimum Temperature---|----Precipitation---|------
MO DY AVG  NO  HI   YR  LO   YR AVG  NO  HI   YR  LO   YR   AVG  NO  HIGH   YR   AVG
 1  1  55  37  78 1966  24 1979  20  38  41 1952   5 1990 0.002  46  0.07 1979  0.10
 1  2  52  39  81 1997  20 1979  19  39  34 1952 -18 1979 0.010  45  0.19 1973  0.10
 1  3  54  44  86 1997  26 1979  17  44  34 1997 -18 1979 0.012  47  0.13 1973  0.02
 1  4  53  46  70 1954  26 1971  19  45  42 1997  -1 1974 0.016  47  0.56 1958  0.09
 1  5  53  44  70 1989  22 1971  19  45  38 1989  -9 1971 0.020  46  0.62 1958  0.04
 1  6  55  46  82 1994  24 1971  20  46  32 1982  -4 1970 0.011  46  0.50 1997  0.11
 1  7  57  41  80 1969  25 1971  21  41  49 1965  -3 1971 0.032  46  0.53 1986  0.17
 1  8  54  42  85 1969  27 1971  22  42  49 1965   2 1971 0.010  46  0.36 1968  0.11
 1  9  55  45  77 1969  31 1979  18  45  49 1957  -2 1964 0.008  47  0.14 1974  0.05
 1 10  53  46  77 1953  13 1962  18  46  32 1991  -4 1977 0.017  47  0.66 1973  0.00
 1 11  53  46  73 1953  11 1962  18  46  44 1960 -22 1962 0.011  47  0.31 1960  0.01
 1 12  54  46  74 1953  13 1963  20  46  44 1960 -11 1962 0.005  46  0.17 1963  0.08
 1 13  55  45  79 1976  20 1997  20  45  38 1980 -22 1963 0.022  46  0.70 1982  0.26
 1 14  58  41  79 1957  38 1963  20  42  45 1952 -14 1963 0.010  46  0.25 1960  0.23
 1 15  58  40  77 1980  32 1984  19  41  43 1969  -4 1982 0.000  47  0.00 1997  0.00
 1 16  57  41  74 1967  30 1992  19  42  32 1969   3 1964 0.005  47  0.22 1960  0.05
 1 17  57  45  80 1974  25 1982  21  46  53 1996   0 1957 0.000  47  0.01 1991  0.00
 1 18  58  44  83 1974  29 1981  21  45  41 1952   2 1957 0.020  47  0.39 1979  0.06
 1 19  57  45  83 1953  26 1984  21  45  49 1952   0 1984 0.030  47  0.66 1990  0.11
 1 20  56  44  75 1985  32 1984  23  45  39 1983   5 1963 0.028  47  0.50 1968  0.08
 1 21  55  43  80 1953  28 1978  22  43  42 1969   7 1976 0.042  45  0.95 1968  0.16
 1 22  57  43  80 1974  23 1966  22  45  37 1974 -12 1966 0.030  45  0.88 1980  0.20
 1 23  57  43  73 1971  30 1966  20  45  35 1977  -6 1980 0.004  46  0.17 1980  0.00
 1 24  60  44  83 1972  36 1966  19  42  36 1967  -5 1980 0.008  45  0.32 1961  0.03
 1 25  60  44  82 1952  31 1978  20  45  41 1962   0 1980 0.013  46  0.34 1962  0.00
 1 26  62  46  79 1969  33 1961  23  47  38 1954   5 1966 0.006  47  0.08 1976  0.01
 1 27  60  44  84 1975  32 1961  24  45  49 1953   8 1963 0.013  46  0.32 1989  0.04
 1 28  61  43  80 1956  29 1961  22  43  44 1968   3 1963 0.000  46  0.00 1996  0.00
 1 29  63  42  78 1986  42 1966  23  41  42 1969   5 1961 0.000  46  0.00 1996  0.00
 1 30  61  43  80 1963  29 1951  23  43  41 1954   8 1951 0.010  46  0.48 1964  0.00
 1 31  59  44  83 1963  29 1951  23  45  40 1954   7 1977 0.011  46  0.42 1978  0.10
 2  1  57  44  84 1963  11 1985  24  44  44 1963 -12 1951 0.003  47  0.06 1990  0.00
 2  2  59  45  79 1963  20 1985  22  45  48 1963 -12 1951 0.015  47  0.52 1975  0.03
 2  3  57  44  78 1987  19 1956  22  44  43 1992  -1 1972 0.015  47  0.45 1964  0.17
 2  4  60  42  80 1963  18 1956  24  41  41 1957   9 1956 0.039  47  1.30 1956  0.33
 2  5  59  42  80 1963  27 1982  24  41  41 1958   0 1956 0.031  47  1.43 1988  0.36
```

										HI YK		Lo						
2	6	59	45	80	1995	20	1982	22	44	36	1951	2	1956	0.007	47	0.29	1979	0.08
2	7	58	46	84	1963	13	1989	22	45	48	1957	2	1956	0.010	47	0.39	1997	0.00
2	8	61	47	85	1957	23	1989	22	46	43	1966	5	1956	0.015	47	0.41	1973	0.15
2	9	62	46	86	1957	28	1980	24	46	50	1960	4	1967	0.010	47	0.29	1980	0.11
2	10	61	43	86	1957	29	1973	23	44	40	1976	1	1956	0.007	47	0.26	1986	0.07
2	11	64	43	83	1962	33	1986	24	44	40	1976	2	1981	0.016	47	0.29	1963	0.04
2	12	62	43	85	1962	29	1986	24	44	42	1957	6	1981	0.030	47	0.62	1968	0.18
2	13	63	42	84	1962	30	1986	26	43	45	1991	-2	1963	0.018	46	0.41	1997	0.00
2	14	67	43	86	1967	37	1951	27	44	49	1962	6	1966	0.021	46	0.44	1962	0.00
2	15	64	44	86	1979	31	1978	26	44	50	1967	8	1951	0.001	46	0.04	1978	0.02
2	16	64	45	80	1986	45	1990	25	45	45	1986	8	1990	0.010	47	0.18	1975	0.05
2	17	63	45	78	1982	29	1979	27	45	41	1986	9	1990	0.006	47	0.25	1989	0.07
2	18	64	43	86	1970	33	1980	27	43	44	1955	16	1966	0.009	46	0.32	1957	0.02
2	19	63	42	85	1986	42	1978	28	42	41	1994	13	1964	0.016	46	0.39	1987	0.00
2	20	63	43	88	1986	39	1987	27	42	44	1980	6	1953	0.019	46	0.26	1964	0.13
2	21	62	42	89	1986	34	1971	25	42	42	1958	4	1964	0.019	47	0.45	1997	0.05
2	22	63	44	84	1996	42	1966	24	45	45	1958	7	1987	0.062	47	1.04	1973	0.13
2	23	63	46	87	1996	27	1975	25	46	43	1958	4	1976	0.006	47	0.14	1975	0.25
2	24	63	45	82	1982	37	1953	26	45	50	1951	-5	1965	0.009	47	0.19	1992	0.02
2	25	65	44	82	1976	36	1997	26	43	46	1951	-5	1960	0.006	46	0.19	1951	0.01
2	26	67	43	87	1986	37	1982	28	43	46	1996	6	1952	0.000	46	0.00	1997	0.00
2	27	67	42	88	1986	43	1984	29	42	49	1981	15	1964	0.006	45	0.11	1997	0.00
2	28	67	43	79	1976	48	1990	28	43	46	1981	9	1962	0.023	46	0.34	1968	0.00
2	29	67	12	85	1972	42	1996	27	12	42	1952	14	1984	0.000	12	0.00	1996	0.00
3	1	65	45	84	1972	31	1960	29	46	48	1973	17	1984	0.009	47	0.22	1993	0.00
3	2	67	45	84	1967	34	1995	29	47	48	1976	13	1962	0.000	47	0.01	1971	0.02
3	3	66	46	89	1974	35	1965	29	47	47	1986	5	1971	0.001	47	0.04	1958	0.00
3	4	65	44	86	1974	29	1978	27	45	45	1974	12	1971	0.007	47	0.19	1981	0.00
3	5	64	42	86	1956	34	1969	27	42	45	1983	11	1953	0.010	46	0.18	1958	0.03
3	6	66	44	85	1991	34	1984	28	43	50	1991	9	1989	0.029	46	1.13	1958	0.00
3	7	69	43	86	1972	52	1984	29	45	43	1968	6	1996	0.001	47	0.03	1996	0.01
3	8	69	43	87	1972	48	1996	29	45	47	1962	12	1967	0.009	47	0.19	1994	0.00
3	9	70	46	86	1986	36	1996	29	44	49	1986	8	1996	0.004	46	0.11	1994	0.00
3	10	70	44	86	1954	44	1994	31	46	51	1990	16	1964	0.038	47	1.35	1973	0.00
3	11	69	43	85	1982	40	1969	32	44	49	1980	15	1979	0.024	46	0.52	1968	0.00
3	12	69	43	88	1972	41	1958	31	44	54	1982	10	1959	0.004	46	0.07	1981	0.03
3	13	69	43	89	1972	37	1993	30	44	49	1990	17	1959	0.003	47	0.12	1975	0.00
3	14	69	45	85	1971	40	1962	30	46	49	1967	11	1988	0.006	47	0.16	1982	0.01
3	15	70	45	86	1972	49	1969	31	46	49	1972	17	1988	0.003	47	0.09	1969	0.02
3	16	69	44	89	1974	36	1969	31	46	43	1987	14	1976	0.006	47	0.19	1969	0.04
3	17	70	45	86	1984	48	1969	30	45	44	1953	16	1959	0.004	46	0.13	1961	0.00
3	18	71	41	90	1974	45	1988	30	43	46	1994	16	1980	0.003	46	0.12	1958	0.00
3	19	72	44	89	1982	39	1965	32	44	47	1994	11	1965	0.014	46	0.55	1961	0.00
3	20	72	43	88	1995	46	1965	32	44	55	1994	11	1965	0.049	47	0.81	1957	0.06
3	21	70	43	86	1988	37	1968	31	44	44	1979	13	1965	0.023	47	0.42	1974	0.16
3	22	73	45	92	1995	46	1952	33	46	52	1954	16	1955	0.008	47	0.22	1958	0.00
3	23	74	46	86	1978	51	1952	33	47	52	1972	12	1952	0.003	47	0.08	1958	0.00
3	24	73	46	88	1971	53	1957	34	47	49	1994	20	1980	0.006	47	0.13	1958	0.00
3	25	71	45	84	1993	40	1990	33	45	51	1995	20	1996	0.003	47	0.14	1958	0.00
3	26	72	42	88	1976	49	1987	34	42	53	1953	18	1959	0.004	47	0.12	1987	0.00
3	27	73	46	90	1967	50	1982	34	47	50	1972	21	1955	0.009	47	0.37	1977	0.00
3	28	74	46	95	1971	38	1994	35	46	54	1985	14	1994	0.016	47	0.45	1966	0.00
3	29	73	45	90	1967	35	1975	35	45	55	1985	20	1975	0.005	46	0.14	1987	0.02
3	30	71	45	86	1989	30	1987	35	45	57	1968	9	1987	0.013	46	0.19	1975	0.04
3	31	73	45	92	1974	50	1991	35	45	52	1956	17	1972	0.005	46	0.11	1992	0.00
4	1	76	44	91	1986	59	1992	36	44	53	1964	20	1955	0.004	47	0.11	1988	0.00
4	2	76	44	91	1959	44	1988	35	44	51	1965	18	1970	0.004	47	0.18	1992	0.00
4	3	75	45	88	1959	51	1987	35	46	47	1997	19	1987	0.026	47	0.94	1997	0.00
4	4	74	44	92	1961	53	1973	35	43	54	1985	16	1979	0.005	47	0.22	1995	0.00
4	5	74	44	92	1959	36	1983	35	44	52	1953	20	1973	0.004	47	0.11	1983	0.00
4	6	76	44	93	1954	41	1987	35	45	52	1967	22	1994	0.016	47	0.29	1983	0.00
4	7	79	46	98	1972	42	1983	40	46	60	1967	24	1971	0.002	47	0.08	1983	0.00
4	8	78	46	96	1963	35	1983	38	46	52	1967	21	1973	0.012	47	0.18	1984	0.00
4	9	77	45	92	1963	42	1973	38	45	55	1967	19	1973	0.004	47	0.09	1997	0.00
4	10	76	44	94	1963	55	1997	38	44	58	1972	28	1988	0.003	47	0.09	1997	0.00

HI YR LO

4	11	78	45	93	1972	50	1989	39	45	60	1967	23	1995	0.027	47	1.48	1969	0.00
4	12	77	47	93	1972	43	1997	39	46	61	1960	23	1953	0.015	47	0.48	1980	0.00
4	13	76	46	96	1972	40	1980	39	46	57	1981	20	1959	0.026	47	0.52	1958	0.00
4	14	79	46	93	1986	52	1980	39	46	57	1992	19	1959	0.021	47	0.52	1977	0.00
4	15	79	46	95	1963	51	1981	39	46	52	1971	26	1996	0.021	47	0.50	1981	0.00
4	16	81	47	96	1962	58	1981	40	47	54	1979	26	1961	0.002	47	0.07	1976	0.00
4	17	81	47	92	1978	63	1988	43	47	55	1979	30	1960	0.007	46	0.22	1958	0.00
4	18	81	45	94	1987	49	1990	42	45	58	1979	31	1953	0.016	47	0.39	1952	0.00
4	19	82	45	95	1987	51	1990	44	45	52	1977	26	1953	0.006	47	0.22	1992	0.00
4	20	80	46	93	1954	57	1992	42	46	58	1962	25	1995	0.009	47	0.22	1992	0.00
4	21	80	45	97	1965	58	1982	40	45	56	1965	28	1964	0.012	47	0.57	1959	0.00
4	22	81	46	100	1965	56	1987	43	46	59	1957	30	1967	0.023	47	0.50	1990	0.00
4	23	80	44	98	1965	47	1982	43	45	62	1958	30	1963	0.014	46	0.62	1953	0.00
4	24	82	46	98	1989	49	1982	42	46	56	1965	24	1995	0.026	47	0.79	1966	0.00
4	25	83	44	97	1996	67	1980	45	44	57	1955	31	1995	0.063	47	1.53	1997	0.00
4	26	83	45	96	1996	46	1997	45	45	63	1951	30	1980	0.033	47	0.95	1965	0.00
4	27	82	46	93	1974	64	1973	45	46	60	1959	28	1973	0.007	47	0.16	1997	0.00
4	28	81	46	96	1996	64	1995	43	45	57	1993	27	1975	0.028	47	1.26	1985	0.00
4	29	83	46	96	1996	60	1957	46	46	63	1990	27	1975	0.013	47	0.21	1985	0.00
4	30	82	45	95	1962	59	1994	44	45	64	1955	30	1968	0.021	47	0.33	1955	0.00
5	1	82	41	93	1995	59	1974	45	41	60	1981	32	1970	0.026	47	0.48	1976	0.00
5	2	80	43	95	1992	62	1990	44	42	61	1986	25	1967	0.037	47	1.07	1981	0.00
5	3	82	45	97	1964	48	1978	45	45	57	1986	28	1983	0.043	47	1.40	1981	0.00
5	4	82	43	97	1971	57	1979	46	42	61	1965	30	1979	0.004	45	0.13	1980	0.00
5	5	85	44	99	1962	67	1953	46	44	61	1977	32	1953	0.019	46	0.58	1976	0.00
5	6	84	44	98	1962	63	1976	46	45	58	1952	24	1959	0.056	47	1.22	1981	0.00
5	7	85	43	98	1979	67	1951	48	44	60	1979	27	1975	0.021	47	1.01	1959	0.00
5	8	87	44	100	1952	60	1976	48	44	60	1996	32	1984	0.010	47	0.24	1959	0.00
5	9	86	44	104	1989	60	1976	48	43	58	1985	31	1975	0.000	47	0.01	1992	0.00
5	10	87	43	101	1962	71	1981	50	43	64	1991	36	1981	0.018	47	0.45	1955	0.00
5	11	86	45	102	1974	69	1994	48	44	67	1991	36	1986	0.023	47	0.45	1972	0.00
5	12	87	44	102	1984	68	1997	49	45	60	1989	38	1957	0.041	47	0.70	1955	0.00
5	13	88	44	102	1996	60	1953	48	44	60	1995	37	1957	0.026	47	0.69	1977	0.00
5	14	87	40	100	1974	66	1996	49	42	61	1951	34	1975	0.009	47	0.38	1973	0.00
5	15	86	42	99	1988	52	1973	50	41	61	1960	34	1973	0.023	47	0.37	1959	0.00
5	16	88	40	101	1978	67	1973	50	39	61	1995	33	1983	0.033	46	1.10	1984	0.00
5	17	88	44	100	1996	67	1984	49	42	60	1996	40	1986	0.035	46	0.70	1979	0.00
5	18	85	45	100	1974	52	1986	50	45	62	1966	32	1986	0.085	47	1.33	1954	0.00
5	19	86	43	97	1991	63	1997	51	43	65	1972	34	1971	0.062	47	1.20	1963	0.00
5	20	88	41	100	1974	70	1988	51	42	61	1991	38	1963	0.050	46	1.22	1951	0.00
5	21	89	43	101	1953	74	1997	50	44	65	1991	35	1967	0.059	47	1.20	1992	0.00
5	22	90	44	106	1996	67	1979	52	42	64	1989	40	1974	0.122	47	3.14	1992	0.00
5	23	89	43	105	1996	68	1963	52	41	68	1984	40	1960	0.027	47	0.58	1992	0.00
5	24	89	45	103	1989	70	1992	52	44	64	1984	39	1975	0.022	47	0.52	1987	0.00
5	25	89	44	104	1989	62	1992	53	44	63	1984	42	1954	0.027	47	1.11	1992	0.00
5	26	90	44	101	1989	62	1997	52	44	60	1964	40	1960	0.043	47	1.04	1966	0.00
5	27	89	42	104	1951	66	1997	53	41	62	1989	40	1960	0.024	47	0.63	1964	0.00
5	28	90	41	102	1951	74	1986	54	40	68	1991	40	1973	0.019	46	0.37	1953	0.00
5	29	91	43	104	1951	67	1992	54	43	68	1989	39	1973	0.040	47	0.38	1972	0.00
5	30	90	40	103	1968	63	1992	53	39	69	1989	38	1975	0.014	47	0.45	1960	0.00
5	31	90	41	102	1977	70	1975	53	40	65	1985	32	1975	0.046	47	0.91	1986	0.00
6	1	89	45	103	1969	58	1983	54	43	62	1994	39	1964	0.016	47	0.29	1986	0.00
6	2	91	43	102	1993	71	1979	54	42	62	1994	44	1992	0.046	47	0.78	1989	0.00
6	3	91	45	102	1990	67	1978	55	44	63	1956	44	1970	0.044	47	1.35	1978	0.00
6	4	90	44	103	1990	64	1951	56	43	68	1990	42	1957	0.111	47	3.00	1967	0.00
6	5	92	44	104	1961	71	1970	56	43	71	1990	40	1962	0.055	47	1.29	1997	0.00
6	6	93	45	108	1990	71	1985	56	44	70	1956	45	1985	0.077	47	1.82	1985	0.00
6	7	94	45	110	1980	70	1983	57	45	65	1980	48	1971	0.019	46	0.55	1976	0.00
6	8	95	44	105	1980	81	1997	58	43	70	1980	48	1975	0.005	47	0.14	1992	0.00
6	9	94	44	110	1981	80	1997	56	42	67	1990	45	1993	0.063	47	0.76	1987	0.00
6	10	92	43	110	1981	76	1997	56	43	65	1980	44	1951	0.023	46	0.52	1985	0.00
6	11	93	42	105	1959	79	1991	57	41	68	1952	43	1979	0.074	46	1.19	1975	0.00
6	12	94	45	106	1981	77	1975	58	44	72	1958	44	1979	0.060	47	1.59	1985	0.00
6	13	94	45	103	1958	73	1985	60	44	69	1954	46	1979	0.057	47	0.74	1978	0.00
6	14	96	47	105	1980	81	1969	59	45	71	1990	49	1969	0.054	47	1.71	1984	0.00

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6	15	96	46	107	1983	81	1996	59	44	70	1952	43	1969	0.013	47	0.29	1961	0.00
6	16	95	45	106	1980	69	1961	59	43	74	1960	45	1981	0.015	47	0.39	1967	0.00
6	17	96	42	109	1977	76	1997	59	40	71	1965	44	1997	0.019	47	0.48	1984	0.00
6	18	98	43	110	1960	82	1997	60	42	71	1990	45	1997	0.010	47	0.25	1953	0.00
6	19	98	44	106	1974	78	1984	61	42	69	1993	53	1975	0.037	47	0.55	1982	0.00
6	20	97	46	107	1996	79	1984	61	44	70	1993	48	1979	0.036	47	0.65	1984	0.00
6	21	98	45	109	1981	80	1982	61	44	70	1990	46	1953	0.025	47	0.50	1993	0.00
6	22	98	46	113	1981	77	1970	61	45	71	1996	50	1969	0.012	47	0.22	1993	0.00
6	23	97	45	107	1958	65	1989	62	44	72	1976	49	1973	0.015	47	0.38	1981	0.00
6	24	98	45	109	1980	69	1986	62	43	70	1972	51	1973	0.042	47	0.61	1986	0.00
6	25	97	44	110	1990	73	1986	62	43	69	1987	50	1973	0.094	47	1.67	1986	0.00
6	26	96	46	110	1990	79	1986	62	45	69	1990	52	1976	0.030	47	0.51	1987	0.00
6	27	97	46	112	1994	82	1966	62	46	72	1990	46	1983	0.030	47	0.77	1996	0.00
6	28	97	47	114	1994	78	1996	63	47	72	1991	48	1983	0.092	47	2.00	1978	0.00
6	29	98	45	112	1980	82	1966	63	45	71	1991	48	1983	0.031	47	0.72	1988	0.00
6	30	98	47	107	1957	84	1978	62	47	72	1993	41	1995	0.158	47	1.89	1989	0.00
7	1	96	45	108	1957	77	1970	63	45	72	1968	52	1975	0.026	46	0.34	1970	0.00
7	2	97	43	108	1994	84	1988	63	43	72	1955	53	1985	0.050	45	1.83	1986	0.00
7	3	97	42	109	1994	78	1986	64	42	74	1990	55	1975	0.032	45	0.63	1968	0.00
7	4	97	43	108	1980	75	1968	63	44	75	1990	40	1988	0.069	45	1.15	1976	0.00
7	5	96	44	109	1994	71	1968	63	44	69	1994	54	1995	0.107	46	2.96	1968	0.00
7	6	96	44	106	1971	75	1972	63	44	72	1966	56	1985	0.055	46	1.05	1960	0.00
7	7	97	45	106	1992	71	1960	63	45	72	1993	53	1958	0.095	46	2.46	1960	0.00
7	8	97	44	110	1951	72	1952	63	44	72	1993	54	1952	0.060	46	0.88	1952	0.00
7	9	96	42	109	1951	82	1952	64	42	72	1996	56	1985	0.078	46	2.25	1981	0.00
7	10	96	42	106	1951	78	1981	64	42	70	1991	57	1995	0.064	46	1.11	1988	0.00
7	11	96	42	106	1963	79	1988	64	42	71	1990	57	1994	0.049	46	0.88	1975	0.00
7	12	96	46	106	1970	83	1975	64	46	71	1951	56	1975	0.063	46	0.96	1959	0.00
7	13	95	46	112	1958	74	1991	63	46	71	1996	53	1975	0.088	45	1.04	1959	0.00
7	14	95	45	112	1958	73	1991	63	45	71	1958	54	1962	0.063	45	1.43	1976	0.00
7	15	95	45	106	1958	78	1991	62	45	70	1970	52	1959	0.158	45	1.42	1993	0.00
7	16	96	44	106	1980	85	1991	63	44	73	1970	53	1975	0.061	44	1.42	1993	0.00
7	17	96	45	108	1980	83	1975	63	45	73	1983	50	1955	0.104	46	1.30	1959	0.00
7	18	95	43	108	1978	84	1984	63	43	71	1996	52	1988	0.020	46	0.48	1953	0.00
7	19	95	45	105	1978	84	1984	64	45	73	1965	49	1988	0.025	44	0.24	1984	0.00
7	20	96	44	106	1963	80	1979	64	44	74	1970	48	1988	0.092	45	1.22	1988	0.00
7	21	95	45	105	1951	75	1988	63	45	69	1966	43	1988	0.049	46	1.38	1989	0.00
7	22	95	44	105	1996	78	1975	63	44	73	1996	55	1988	0.103	45	1.57	1953	0.00
7	23	95	45	108	1963	82	1976	63	45	69	1979	57	1988	0.063	45	0.65	1978	0.00
7	24	95	44	108	1963	81	1978	63	44	72	1963	51	1961	0.104	45	1.13	1978	0.00
7	25	96	44	106	1963	77	1991	63	43	73	1969	54	1975	0.088	46	1.90	1991	0.00
7	26	95	45	106	1995	77	1991	62	45	73	1969	46	1988	0.092	46	1.63	1985	0.00
7	27	96	45	109	1995	83	1973	63	45	71	1966	47	1988	0.037	46	0.41	1992	0.00
7	28	95	45	110	1995	85	1955	63	45	75	1954	51	1988	0.117	46	1.15	1981	0.00
7	29	95	45	104	1983	84	1981	63	45	73	1966	48	1988	0.049	46	0.62	1962	0.00
7	30	95	45	106	1995	81	1990	63	45	70	1966	56	1953	0.052	46	1.70	1971	0.00
7	31	95	46	104	1972	70	1971	64	46	77	1969	47	1988	0.071	45	2.03	1965	0.00
8	1	95	44	107	1966	83	1973	64	44	75	1972	55	1990	0.083	45	1.00	1971	0.00
8	2	95	45	103	1987	85	1995	64	45	73	1972	56	1971	0.062	46	2.05	1974	0.00
8	3	96	45	106	1980	83	1971	64	45	70	1970	56	1961	0.091	46	1.44	1984	0.00
8	4	95	44	103	1980	76	1974	63	44	72	1969	51	1988	0.087	46	2.54	1993	0.00
8	5	95	46	107	1977	78	1974	63	46	74	1989	51	1988	0.029	46	0.36	1991	0.00
8	6	97	45	103	1980	86	1971	62	44	67	1993	50	1975	0.017	46	0.35	1980	0.00
8	7	97	43	104	1985	73	1990	62	44	69	1996	48	1988	0.067	46	1.67	1972	0.00
8	8	95	44	105	1994	75	1990	62	44	70	1987	49	1990	0.070	46	1.68	1996	0.0
8	9	95	45	103	1977	71	1984	62	45	70	1995	53	1990	0.102	46	1.42	1984	0.00
8	10	94	44	105	1977	71	1984	61	43	70	1951	50	1988	0.155	46	2.02	1967	0.00
8	11	93	43	102	1992	74	1984	62	43	69	1983	48	1988	0.019	46	0.35	1955	0.00
8	12	92	46	100	1969	77	1981	60	46	69	1993	52	1988	0.148	46	2.80	1977	0.00
8	13	93	45	102	1969	72	1980	61	46	70	1989	48	1988	0.017	46	0.28	1980	0.00
8	14	94	45	103	1969	83	1981	62	44	67	1991	55	1960	0.051	45	1.10	1990	0.00
8	15	94	44	103	1962	81	1991	62	44	69	1986	54	1960	0.051	46	0.51	1980	0.00
8	16	94	45	104	1982	82	1991	62	45	70	1982	48	1988	0.050	46	1.17	1986	0.00
8	17	95	44	107	1978	80	1979	62	45	68	1991	50	1973	0.095	46	1.67	1981	0.00
8	18	95	41	105	1969	79	1979	62	42	70	1969	53	1962	0.040	46	0.69	1990	0.00

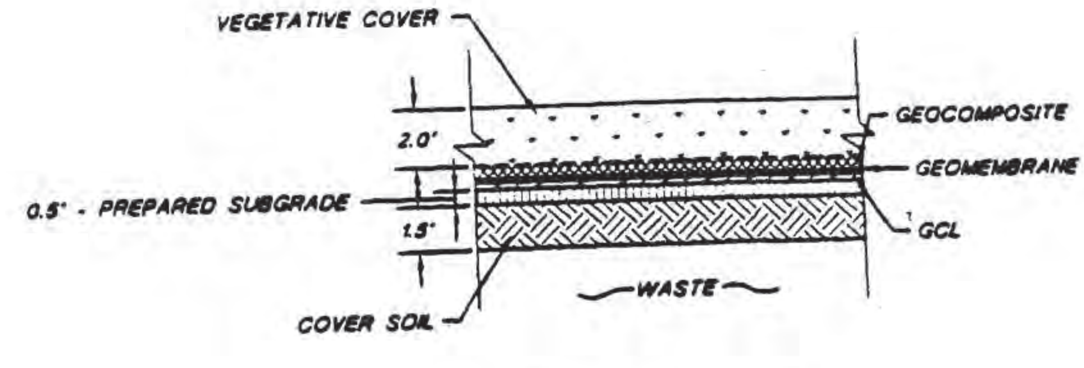
										HI	YR	LO						
8	19	94	44	107	1969	82	1961	62	45	67	1994	55	1962	0.029	46	0.23	1961	0.00
8	20	93	44	104	1970	80	1961	62	44	71	1995	54	1979	0.111	46	2.80	1977	0.00
8	21	93	44	103	1986	82	1979	61	44	71	1982	47	1988	0.073	46	1.00	1977	0.00
8	22	93	43	104	1983	82	1958	61	43	69	1952	53	1967	0.156	46	2.02	1951	0.00
8	23	92	44	104	1985	66	1966	61	44	68	1952	53	1976	0.090	46	2.04	1966	0.00
8	24	92	44	102	1985	67	1974	60	44	68	1992	52	1960	0.079	45	0.33	1974	0.00
8	25	93	45	103	1985	74	1974	61	45	68	1969	51	1973	0.110	46	2.50	1971	0.00
8	26	92	46	103	1985	76	1974	60	46	67	1977	49	1975	0.053	46	2.16	1972	0.00
8	27	93	45	102	1985	74	1972	60	43	68	1977	49	1970	0.062	46	1.64	1986	0.00
8	28	93	42	104	1962	78	1980	61	42	69	1952	53	1980	0.103	46	2.00	1989	0.00
8	29	93	40	102	1962	82	1974	59	43	67	1969	40	1988	0.010	46	0.19	1951	0.00
8	30	92	45	103	1962	71	1963	60	44	68	1969	44	1988	0.038	46	0.97	1968	0.00
8	31	92	44	101	1964	74	1963	59	43	65	1989	41	1988	0.071	46	1.29	1963	0.00
9	1	91	42	103	1952	74	1993	60	42	69	1983	46	1988	0.050	44	0.85	1953	0.00
9	2	91	43	101	1982	80	1969	58	43	68	1989	48	1988	0.075	45	1.75	1962	0.0
9	3	92	41	101	1979	64	1972	59	41	68	1979	47	1955	0.038	46	0.65	1982	0.
9	4	91	42	104	1983	69	1974	58	42	67	1983	42	1961	0.025	46	0.48	1991	0.
9	5	91	43	102	1992	77	1967	57	43	67	1983	44	1961	0.117	46	1.40	1963	0.0
9	6	91	41	106	1983	70	1981	57	41	65	1990	43	1984	0.047	45	0.79	1981	0.00
9	7	90	42	105	1983	72	1973	57	42	66	1990	44	1952	0.088	45	1.04	1993	0.00
9	8	90	40	100	1970	65	1973	57	41	65	1979	45	1952	0.108	46	2.30	1969	0.00
9	9	89	44	101	1970	70	1981	57	44	66	1991	41	1953	0.058	46	1.10	1995	0.00
9	10	88	45	102	1992	57	1976	57	45	67	1983	42	1956	0.086	45	1.04	1990	0.00
9	11	89	43	99	1963	69	1980	56	42	64	1972	42	1960	0.030	46	0.42	1964	0.00
9	12	88	42	99	1974	75	1989	56	42	65	1993	40	1959	0.070	46	0.91	1961	0.00
9	13	87	45	98	1956	52	1975	55	45	63	1991	40	1959	0.075	46	0.83	1983	0.00
9	14	87	44	98	1960	55	1975	55	44	64	1986	37	1959	0.060	45	1.25	1980	0.00
9	15	86	43	104	1956	62	1979	54	43	63	1992	36	1959	0.065	45	0.66	1985	0.00
9	16	86	44	101	1956	64	1979	53	44	63	1985	41	1951	0.017	46	0.29	1995	0.00
9	17	88	43	99	1956	61	1979	53	43	63	1970	37	1951	0.030	46	0.75	1965	0.00
9	18	88	43	98	1983	59	1971	53	43	64	1995	37	1951	0.018	46	0.33	1991	0.00
9	19	87	43	99	1954	49	1971	54	43	66	1960	39	1968	0.075	46	0.94	1974	0.00
9	20	87	44	99	1951	49	1991	53	44	63	1990	34	1971	0.041	46	0.56	1985	0.00
9	21	85	44	98	1977	52	1991	52	44	63	1990	34	1983	0.057	46	0.95	1988	0.00
9	22	82	43	97	1959	50	1995	51	43	64	1990	33	1975	0.063	46	0.88	1974	0.00
9	23	82	44	97	1961	53	1974	51	44	67	1993	36	1975	0.058	45	1.02	1974	0.00
9	24	83	39	98	1953	54	1974	51	40	65	1993	39	1975	0.059	44	0.90	1971	0.00
9	25	84	42	97	1951	58	1974	49	41	59	1964	38	1975	0.081	46	0.97	1962	0.00
9	26	85	42	101	1953	62	1978	50	42	61	1967	40	1975	0.162	46	4.11	1955	0.00
9	27	84	42	99	1982	59	1980	48	41	59	1982	37	1989	0.071	46	1.80	1958	0.00
9	28	84	43	98	1953	62	1980	48	43	62	1982	33	1973	0.035	45	0.72	1984	0.00
9	29	84	43	98	1994	52	1984	48	43	60	1983	34	1976	0.025	46	0.65	1995	0.00
9	30	84	43	97	1994	54	1985	48	42	62	1983	34	1996	0.010	45	0.29	1990	0.00
10	1	84	38	99	1977	53	1985	48	38	62	1983	35	1963	0.034	46	1.45	1982	0.00
10	2	84	41	94	1969	56	1985	47	41	67	1954	35	1975	0.051	46	1.25	1955	0.00
10	3	83	42	95	1973	67	1959	47	42	59	1981	30	1961	0.044	46	0.72	1955	0.00
10	4	82	44	93	1991	69	1959	46	42	61	1955	31	1961	0.035	46	1.24	1984	0.00
10	5	82	42	94	1993	62	1966	46	43	59	1954	30	1959	0.014	46	0.28	1962	0.00
10	6	81	44	95	1967	62	1986	46	44	62	1977	30	1995	0.044	46	0.93	1954	0.00
10	7	80	45	94	1956	62	1986	44	46	62	1977	30	1952	0.117	46	3.92	1954	0.00
10	8	82	45	98	1979	54	1976	44	44	59	1968	19	1976	0.018	45	0.62	1994	0.00
10	9	83	42	98	1979	60	1970	44	42	62	1961	24	1970	0.032	46	0.37	1985	0.00
10	10	82	42	93	1969	62	1990	43	42	57	1954	27	1992	0.032	46	1.25	1986	0.00
10	11	83	43	93	1969	67	1982	42	44	57	1972	29	1976	0.017	46	0.37	1974	0.00
10	12	82	44	93	1996	58	1986	42	44	58	1972	28	1977	0.073	46	1.30	1974	0.00
10	13	81	45	95	1968	48	1986	42	44	56	1953	30	1977	0.016	46	0.28	1974	0.00
10	14	81	42	94	1996	57	1969	41	43	56	1996	30	1969	0.010	46	0.44	1974	0.00
10	15	79	42	94	1962	57	1974	40	41	53	1996	30	1952	0.033	46	0.90	1994	0.00
10	16	77	40	90	1989	42	1970	39	41	53	1981	25	1975	0.018	46	0.55	1960	0.00
10	17	78	41	95	1979	61	1969	40	41	56	1993	27	1976	0.093	46	3.53	1960	0.00
10	18	77	44	95	1988	53	1989	40	44	59	1972	21	1966	0.020	46	0.53	1956	0.00
10	19	77	44	88	1995	55	1989	39	45	58	1969	19	1989	0.033	46	0.42	1951	0.00
10	20	75	45	89	1979	42	1972	38	45	55	1986	17	1976	0.078	46	2.55	1983	0.00
10	21	76	44	92	1979	46	1972	38	44	56	1985	21	1989	0.071	46	0.85	1969	0.00
10	22	75	42	90	1961	52	1996	38	41	55	1985	24	1990	0.040	46	0.90	1969	0.00

										HI	YR	LO						
10	23	75	41	90	1959	47	1984	37	41	52	1974	23	1996	0.050	46	1.15	1974	0.00
10	24	74	41	85	1973	43	1979	37	42	56	1992	25	1996	0.044	46	1.11	1979	0.39
10	25	75	42	94	1959	43	1984	38	42	50	1992	23	1993	0.017	46	0.29	1992	0.00
10	26	74	45	91	1959	50	1957	38	45	51	1951	25	1981	0.022	46	0.43	1951	0.00
10	27	74	45	89	1979	53	1993	37	45	51	1974	25	1953	0.032	46	1.17	1969	0.00
10	28	73	44	88	1988	38	1976	35	44	52	1977	17	1970	0.012	46	0.28	1969	0.07
10	29	73	42	87	1987	38	1976	35	42	49	1956	17	1980	0.026	46	0.34	1958	0.02
10	30	72	41	87	1968	43	1993	34	41	49	1977	20	1993	0.016	46	0.22	1979	0.00
10	31	71	44	86	1968	34	1991	33	44	51	1983	10	1991	0.025	46	0.50	1961	0.04
11	1	72	44	85	1975	45	1991	36	45	54	1987	13	1993	0.017	45	0.24	1963	0.00
11	2	68	44	89	1973	40	1951	33	45	54	1983	14	1989	0.017	45	0.48	1987	0.01
11	3	68	45	82	1988	33	1991	31	46	56	1994	13	1989	0.050	46	0.95	1983	0.00
11	4	67	44	80	1984	37	1991	32	44	53	1983	12	1991	0.033	46	0.84	1986	0.00
11	5	67	40	84	1973	50	1992	32	40	51	1983	22	1991	0.033	46	0.75	1983	0.00
11	6	68	41	87	1988	45	1961	30	40	46	1983	10	1959	0.002	46	0.04	1987	0.00
11	7	69	41	85	1975	50	1993	33	41	45	1977	11	1959	0.013	46	0.45	1977	0.00
11	8	67	41	86	1980	33	1990	32	42	48	1981	13	1993	0.003	46	0.07	1990	0.01
11	9	71	43	89	1980	49	1990	31	43	48	1965	16	1962	0.014	46	0.35	1961	0.00
11	10	69	43	84	1985	50	1957	30	43	45	1982	17	1953	0.000	46	0.02	1957	0.[illegible]
11	11	69	39	84	1956	52	1957	29	39	45	1982	15	1968	0.009	46	0.32	1978	0.[illegible]
11	12	69	42	82	1956	47	1991	30	42	45	1958	15	1987	0.010	46	0.37	1994	0.00
11	13	68	41	84	1955	34	1976	30	41	49	1958	9	1975	0.035	46	0.78	1961	0.11
11	14	68	41	84	1973	27	1976	30	42	49	1968	11	1975	0.026	46	0.59	1961	0.00
11	15	68	43	85	1988	35	1976	28	44	50	1962	-3	1961	0.002	46	0.04	1968	0.00
11	16	65	46	86	1963	38	1961	28	46	43	1971	-1	1961	0.046	46	1.24	1991	0.00
11	17	64	45	85	1981	33	1980	28	45	49	1967	4	1959	0.031	45	0.42	1957	0.00
11	18	64	45	82	1981	39	1980	27	45	43	1986	9	1959	0.011	46	0.14	1964	0.00
11	19	66	42	80	1981	44	1980	27	43	42	1992	9	1987	0.005	46	0.14	1962	0.00
11	20	65	42	87	1996	47	1991	26	42	50	1977	13	1987	0.002	45	0.07	1991	0.00
11	21	65	42	87	1996	40	1972	26	41	44	1978	9	1953	0.006	46	0.12	1972	0.00
11	22	64	43	77	1989	36	1992	26	43	45	1978	7	1953	0.003	46	0.08	1957	0.07
11	23	65	45	83	1965	42	1984	26	44	45	1978	5	1957	0.000	46	0.01	1992	0.00
11	24	62	43	79	1993	36	1952	27	43	48	1951	10	1979	0.014	45	0.29	1972	0.04
11	25	63	40	83	1959	30	1982	25	40	45	1978	13	1975	0.021	45	0.66	1980	0.00
11	26	65	40	83	1990	32	1980	25	40	47	1985	1	1975	0.037	45	0.18	1982	0.01
11	27	63	39	84	1995	34	1982	25	40	42	1977	3	1980	0.022	45	0.72	1982	0.15
11	28	57	37	77	1954	32	1976	23	38	42	1981	8	1992	0.010	45	0.25	1976	0.09
11	29	58	42	78	1966	26	1976	20	43	44	1981	2	1976	0.017	46	0.38	1976	0.09
11	30	58	44	76	1966	40	1976	23	44	43	1970	8	1976	0.011	46	0.29	1981	0.00
12	1	62	46	82	1970	37	1991	22	45	44	1962	7	1975	0.008	47	0.14	1971	0.00
12	2	62	47	78	1951	31	1991	22	46	43	1955	10	1991	0.011	46	0.19	1971	0.04
12	3	61	43	78	1973	35	1971	23	43	38	1955	8	1979	0.001	47	0.03	1964	0.00
12	4	62	42	85	1958	37	1964	24	43	42	1962	8	1990	0.007	47	0.18	1967	0.00
12	5	62	45	80	1958	32	1992	22	45	39	1969	4	1990	0.016	47	0.45	1992	0.10
12	6	62	45	75	1975	30	1992	22	46	49	1956	2	1950	0.021	47	0.97	1969	0.02
12	7	58	45	76	1981	29	1960	23	46	47	1980	6	1992	0.007	47	0.14	1961	0.03
12	8	61	45	78	1958	28	1978	23	45	37	1961	12	1978	0.039	47	0.48	1960	0.11
12	9	58	45	83	1950	17	1978	23	45	39	1965	-11	1978	0.029	47	0.71	1960	0.29
12	10	58	42	77	1970	29	1978	22	43	49	1965	-11	1978	0.011	47	0.26	1982	0.00
12	11	59	42	79	1950	31	1986	20	43	36	1965	7	1960	0.005	47	0.13	1986	0.01
12	12	57	41	84	1950	26	1972	20	42	38	1981	-3	1989	0.020	47	0.55	1991	0.09
12	13	61	45	82	1950	31	1985	22	47	40	1984	2	1989	0.007	47	0.19	1981	0.00
12	14	56	44	82	1950	31	1987	22	44	38	1951	3	1985	0.043	47	0.65	1984	0.41
12	15	56	43	74	1956	29	1987	19	44	37	1950	-8	1987	0.020	46	0.22	1970	0.09
12	16	55	44	74	1957	24	1967	18	45	32	1990	-7	1987	0.010	45	0.45	1959	0.00
12	17	56	40	75	1977	25	1989	20	41	38	1957	4	1979	0.006	46	0.18	1986	0.00
12	18	55	43	75	1980	32	1964	20	44	41	1962	0	1996	0.011	47	0.37	1986	0.00
12	19	57	44	81	1980	23	1983	20	43	40	1962	1	1996	0.007	47	0.33	1991	0.00
12	20	57	43	74	1994	19	1983	21	43	38	1991	-4	1973	0.012	47	0.31	1984	0.00
12	21	57	45	75	1981	34	1980	21	45	36	1962	0	1973	0.027	47	0.85	1967	0.00
12	22	56	45	83	1981	22	1989	20	46	38	1959	3	1963	0.022	46	0.58	1986	0.00
12	23	56	43	81	1964	21	1989	19	43	44	1965	-5	1990	0.005	47	0.19	1983	0.05
12	24	57	43	75	1969	33	1953	20	41	48	1964	-10	1953	0.000	47	0.00	1996	0.00
12	25	56	40	81	1955	21	1983	19	40	46	1959	3	1990	0.003	46	0.08	1962	0.00
12	26	55	40	74	1996	25	1987	20	40	42	1959	-3	1990	0.027	47	0.35	1982	0.19

										HI	YR	LO						
12	27	55	42	75	1980	23	1983	20	42	36	1979	1	1973	0.008	47	0.19	1968	0.00
12	28	57	45	73	1980	35	1965	21	45	39	1984	-6	1987	0.005	47	0.19	1990	0.03
12	29	58	46	76	1980	29	1982	22	46	42	1984	2	1966	0.026	47	0.57	1969	0.16
12	30	56	44	80	1965	23	1983	20	44	50	1951	-7	1983	0.016	46	0.37	1969	0.08
12	31	57	41	75	1965	19	1969	20	41	54	1951	-2	1983	0.007	46	0.12	1974	0.03

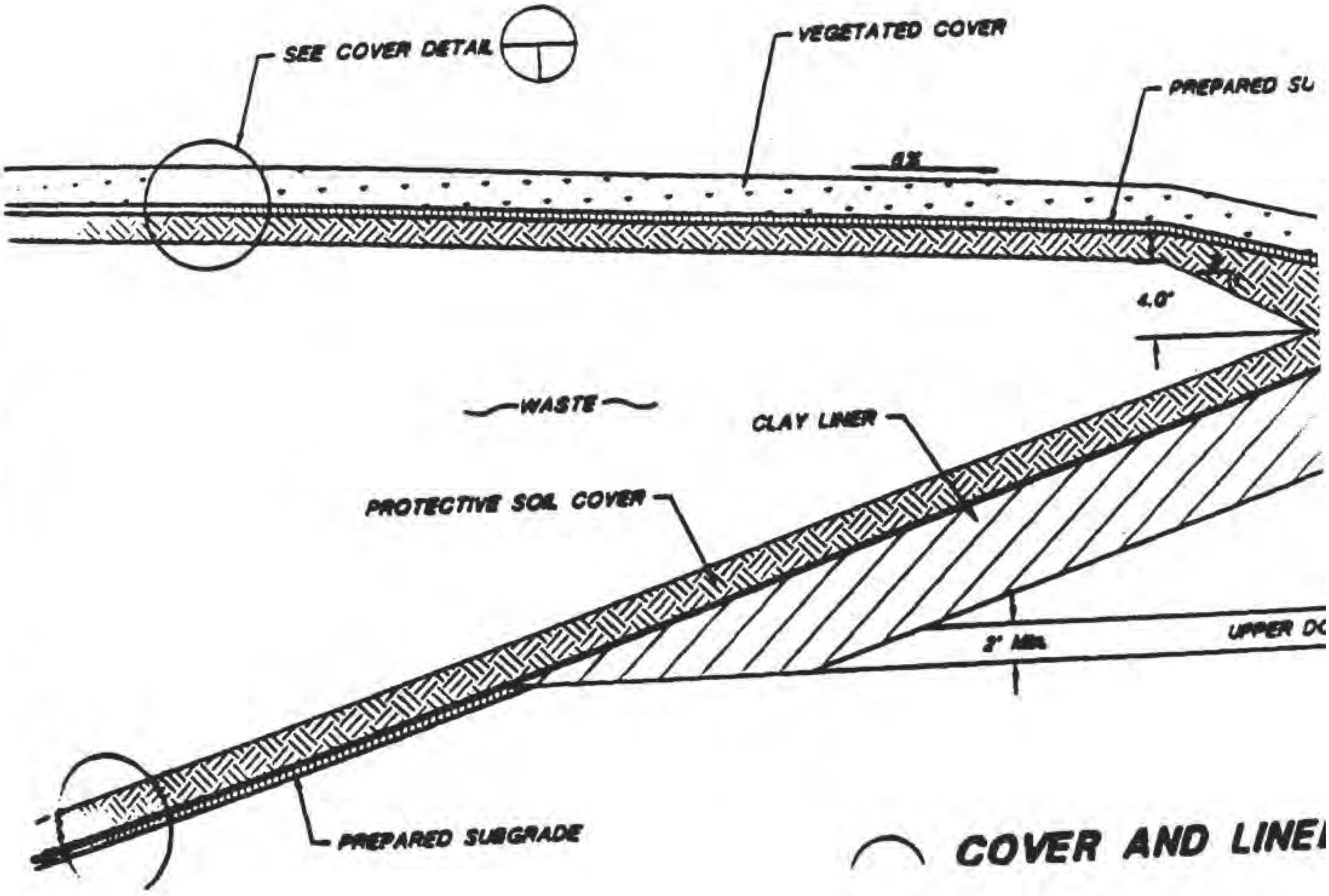
Western Regional Climate Center, Greg McCurdy, gmwrcc@sage.dri.edu

19A



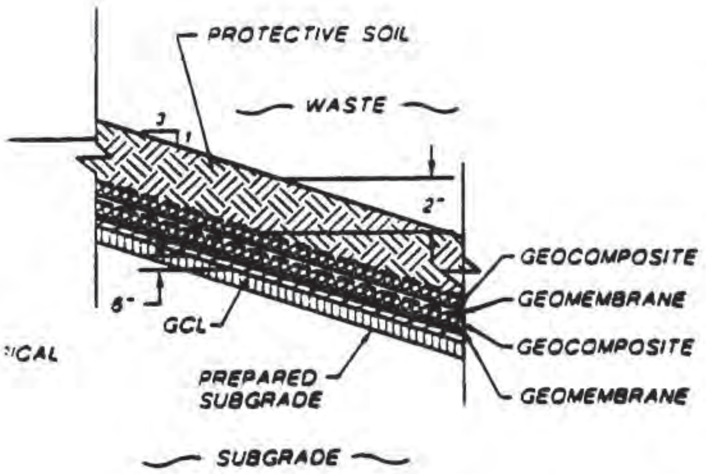
COVER DETAIL

NOT TO SCALE

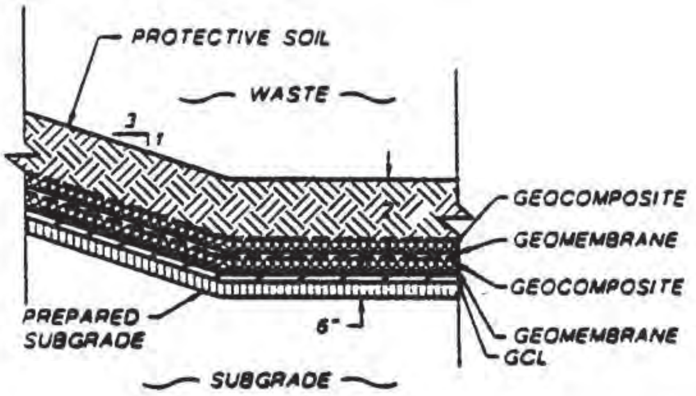


COVER AND LINE

20 A

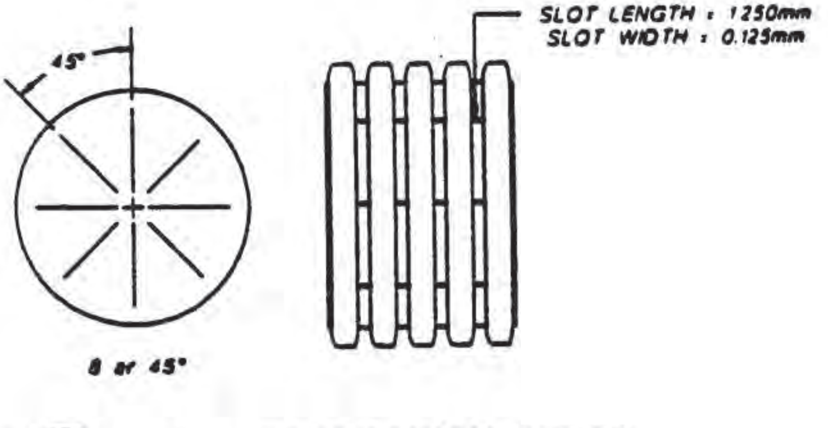


A **SLOPE DETAIL**
7 12 **Not To Scale**



E **TOE OF SLOPE DETAIL**
7 12 **Not To Scale**

7



G **PIPE PERFORATION DETAIL**

MONTGOMERY WATSON

Calculation Cover Sheet **Appendix E-26**

Project Title: Triassic Park

Project No.: 602-0200

Calculation Title: Pipe Crushing

	Name	Date
Prepared By:	Paul Pellicer	11/15/97
Checked By:	John Pellicer	11/15/97
Reviewed By:	Pat Corser	11/15/97

Revisions	Date	By	Checked By	Reviewed By

TerraMatrix
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P.O. Box 774018, 1475 Pine Grove Road
Steamboat Springs, Colorado 80477
Phone 970.879.6260 Fax 970.879.9048

Project Name: Trinssic Park
Project Number: 602-0200 Sheet: 1 Of 8
Prepared By: P. Pellicer Date: 15-Nov-97
Checked By: J. Pellicer Date: 15-Nov-97

Pipe Crushing.

Objective: Evaluate adequacy of 12" + 18" SDR 11 pipe against crushing.

Method: Compare Estimated Strains in the sump gravels placed around the sump pipes to allowable strains in the HDPE Pipe. Pipe should not strain more than than surrounding soils due to bridging.

$\sigma = E\epsilon$

σ = stress (overburden pressure)
E = Modulus of Elasticity
ϵ = strain.

Worst case 18" pipe, 160 ft of waste.

Estimate strain in gravel:

Gravel Thickness same as pipe diameter.

$\sigma = (160\ ft)(110\ pcf) = 17600\ psf \Rightarrow 122\ psi$ ✓

$\epsilon = \frac{\sigma}{E}$

E = 4000 ksf for gravel (see pg 2)
= 27,7000 psi ✓

$\epsilon_{gravel} = \frac{122}{27,700} = 0.004 \Rightarrow 0.4\%$

Allowable Ring deflection (ϵ_{pipe}) = 2.7% for SDR 11 pipe (see pg 3)

$S.F. = \frac{2.7\%}{0.4\%} = 6.75$

Conclusions: Pipes will not exceed recommended allowable deflections. Therefore pipe will be o.k. This is consistant w/ the attached paper (see pg 4-8) which suggests allowable burial depth are much greater than suggested burial depth. Our exsperience also suggests that HDPE pipes perform well at large burial depth.

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TABLE 2-7 **Typical range of values for the static stress-strain modulus E_s for selected soils**

Field values depend on stress history, water content, density, etc.

Soil	E_s ksf	E_s Mpa
Clay		
Very soft	50–250	2–15
Soft	100–500	5–25
Medium	300–1000	15–50
Hard	1000–2000	50–100
Sandy	500–5000	25–250
Glacial till		
Loose	200–3200	10–150
Dense	3000–15 000	150–720
Very dense	10 000–30 000	500–1440
Loess	300–1200	15–60
Sand		
Silty	150–450	5–20
Loose	200–500	10–25
Dense	1000–1700	50–81
Sand and gravel		
Loose	1000–3000	50–150
Dense	2000–4000 ←	100–200
Shale	3000–300 000	150–5000
Silt	40–400	2–20

The *modulus of subgrade reaction* k_s is defined as the ratio of stress to deformation as shown on Fig. 2-37*c*. The units of k_s are the same as unit weight.

The shear modulus G' (and may be subscripted) is defined as the ratio of shear stress to shear strain. It is related to E_s and μ as

$$G'_s = \frac{s}{\epsilon_s} = \frac{E_s}{2(1+\mu)} \qquad (b)$$

The shearing strain ϵ_s is the change in right angle at any corner of an element as in Fig. 2-37*b* such that

$$\epsilon_s = \text{angle } BCD - \text{angle } B'C'D' \qquad (c)$$

Another concept occasionally used is the volumetric strain, defined as

$$\epsilon_v = \frac{\Delta V}{V} = \epsilon_1 + \epsilon_2 + \epsilon_3 \qquad (d)$$

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15-Nov-97
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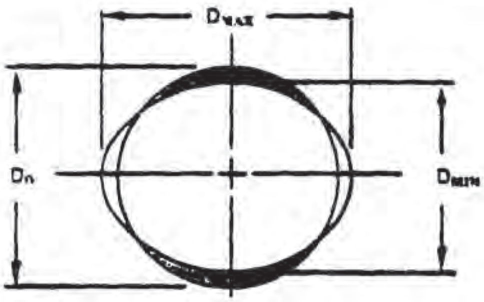
Design by Ring Deflection: Ring deflection is defined as the ratio of the vertical change in diameter to the original diameter. It is often expressed as a percentage. Ring deflection for buried Driscopipe is conservatively the same as (no more than) the vertical compression of the soil envelope around the pipe. Design by ring deflection matches the ability of Driscopipe to accommodate, without structural distress, the vertical compression of the soil enveloping the buried pipeline. *Design by ring deflection comprises a calculation of vertical soil strain to insure it will be less than the allowable ring deflection of the pipe.* See Chart 27. The tabulation shows that with lower values of SDR, the allowable deflection is less. For installations which require this thicker wall to resist the external soil pressure, actual ring deflection can easily be limited to the tabular values by proper compaction of the backfill around the pipe. The recommended allowable deflection for the various SDR's are:

CHART 27

SDR	ALLOWABLE RING DEFLECTION
32.5	8.1%
26.0	6.5%
21.0	5.2%
19.0	4.7%
17.0	4.2%
15.5	3.9%
13.5	3.4%
11.0	2.7%



$$\% \text{ RING DEFLECTION} = \left(1 - \frac{D_{MIN}}{D_O}\right) \times 100\%$$

NOTE: 5% deflection decreases flow-area by ¼%. 10% deflection decreases flow-area by 1%.

The allowable ring deflection of polyethylene pipe is a function of the allowable tangential strain in the outer surface of the pipe wall. A conservative limit of 1 - 1¼% tangential strain in the outer surface of the pipe wall due to vertical deflection of the pipe "ring" by soil compression can be understood by comparing two pipes of the same diameter but different wall thickness.

Assume each of the pipes is equally deflected under loads required to achieve that result. The tangential surface strain developed in the thickwall pipe is much greater than the surface strain in the thinwall pipe. The tangential strain varies directly as the wall thickness (i.e.: distance from the neutral axis) and is proportional to the amount of ring deflection. For a given ring deflection, the thicker the wall, the higher the strain.

Alternately, assume that each of the pipes are subjected to loads such that the tangential surface strain in the pipe's wall surface is equal for both pipes. For equal surface strain, the degree of vertical deflection of the pipe ring is different for the two pipes. Under these circumstances, the degree of deflection would be less for the thickwall pipe and greater for the thinwall pipe.

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UoC 5
302-0200
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K.C. PUBLIC WORKS
Solid Waste Division
ENGINEERING SECTION

Report on the

STRUCTURAL PERFORMANCE OF PERFORATED AND SLOTTED HIGH-DENSITY POLYETHYLENE PIPES UNDER HIGH SOIL COVER

Submitted to: King County Solid Waste
601 FX McRory Building
419 Occidental Avenue South

Attention: Mr. Gerald D. Walken , P.E., Senior Engineer

Submitted by: Department of Civil and Environmental Engineering
Utah State University
Logan, UT 84322

Principal Investigator: Reynold K. Watkins, Professor

Date: 1987 Aug 31

Introduction:

High density polyethylene pipes are an attractive alternative for the collection and transmission of fluids under sanitary land fills. Polyethylene pipes are classified as flexible. They do not have pipe stiffness equal to clay tile pipes, concrete pipes, ductile pipes, etc. Nevertheless, despite the low pipe stiffness, if polyethlene pipe is buried in a select granular soil backfill, it can provide a successful conduit by the interaction of pipe and soil. The height of sanitary land fills is often so great that pipes underneath are subjected to enormous soil pressure. The question has been raised as to the competence of polyethylene pipes to resist the external soil pressure. Soil pressure is the pressure caused by the high embankment of soil and refuse. Tests conducted at Utah State University reveal that when buried in well-compacted, select, pipe zone backfill, high density polyethylene pipes perform well under very high soil cover — even into the hundreds of ft. Moreover, the polyethylene is not corroded by chemicals that percolate out of the sanitary land fill.

In order to collect and drain off the liquids and methane gas that is generated in the sanitary land fill, the pipes can be perforated or slotted. However, it is not known what effect perforations or slots may have on the structural performance of the pipe under high soil cover. Clearly, stress concentrations will occur, but the polyethylene may relax enough that fracture does not occur. The best investigation is actual testing. Therefore tests similar to the tests on non-perforated pipes, were conducted on samples of perforated and slotted pipes in the USU small soil cell. The pipe zone backfill was washed, pit-run gravel passing a three-fourths sieve. This is typical of soil used in most installations of polyethylene pipe.

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Objectives:

The primary objective of the tests was to observe the structural performance under high soil pressures of high-density polyethylene pipes that are perforated and slotted. Pipe zone backfill was shovel-sliced under the haunches of the pipes.

A secondary objective was to observe the structural performance of a non-perforated pipe under high soil pressure if pipe zone backfill is merely dumped over the pipe in a windrow with no attempt to place the soil under the haunches of the pipe.

Procedure:

Four specimens of six inch diameter, SDR 9.33, high density polyethylene pipes, each 5.5 ft long, were provided by King County Solid Waste. One of these pipes was unperforated. It served as a control for comparison of the other pipes. It also provided information as to the performance of the pipe if no soil is placed under the haunches. One of the other specimens was perforated and two were slotted as described in Appendix A. Soil was placed under the haunches of these pipes by shovel-slicing.

Tests were conducted in the USU small soil cell. The bedding was well-compacted soil on which the pipe specimen was laid. Pipe zone backfill was washed pit-run gravel that passed a three-fourths inch sieve. The pipe zone backfill was not compacted. Two different methods of pipe installation were used as shown on Figures 2 and 3. Both perforated and slotted pipe specimens were tested in a trench as shown in Figure 2. With the first lift of backfill placed to approximately the top of the pipe, a hand shovel was used to shovel-slice the soil under the haunches. After shovel-slicing, pipe zone backfill was placed over the pipe to a depth of about 1.25 ft. In the sanitary land fill, the overburden would be refuse and/or soil. In these tests, uncompacted soil was used. The unperforated pipe specimen was tested in an embankment as shown in Figure 3. After the pipe was placed on a compacted bedding, pipe zone backfill was poured onto the top of the pipe until a windrow reached a height of 1.0 ft above the top of the pipe. No effort was made to place soil under the haunches. This simulates a very typical method of installation of pipes. An embankment of overburden was then brought up to the top of the soil cell and leveled off. The overburden was uncompacted soil used in the test to simulate the refuse overburden in the sanitary land fill. Figures 4 and 5 are photographs of the soil cell as a pipe specimen is placed and backfilled for testing. After the cell was filled to the top with overburden, the loading beams were placed and load was applied to the overburden in increments. After each increment, the pipe was carefully observed for any evidence of distress. Vertical and horizontal diameters were measured near the mid-length of the pipe specimen.

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Pipe Dimensions:

Nominal six inch diameter, SDR = 9.3
Measured: SDR = 8.5 standard dimension ratio
OD = 6.555 in average outside diameter
ID = 5.013 in average inside diameter
t = 0.771 in average wall thickness
s = 0.039 in standard deviation of wall thickness (plus or minus)
Minimum wall thickness = 0.731 in
Maximum wall thickness = 0.847 in

Perforations: Diameter = 0.475 in
Orientation when buried is such that two rows of slots are on the spring lines.

Slots: Widths = 0.106 in
Orientation when buried is such that the ends of the slots are at the spring line, i.e. at the horizontal diameter.

See Appendix A for location and orientation of perforations and slots. The reason for positioning two rows of perforations and one end of each row of slots on the spring lines is to assure the worst conditions for stress concentration. The maximum compressive stress occurs at the spring line, and the maximum stress concentration occurs at the side of a perforation and the corner of a sawed slot on the surface of the pipe wall.

Theoretical Stresses:

For plastics in general, and for polyethylene in particular, the stress theory of design is not appropriate. Even if stresses exceed the proportional limit, the material only yields, and creeps, and comes to equilibrium. Nevertheless, a theoretical stress analysis is possible as included in Appendix A. Assuming a height of cover of 200 ft at 50 lbs per cubic ft, the average compressive stress at the spring line is 2.6 ksi for perforations and for slots is 2.3 ksi for four slots per ft, and 2.5 ksi for fourteen slots per ft. This is the sum of both ring compression stress and flexural stress based on ring deflection. The ring deflection is assumed to be 3.5% These average stresses are close to yield point but are not excessive in light of the relaxation properties of polyethylene. Including stress concentrations, stress at the sides of the perforations would be 6.45 ksi if the material didn't yield. At the ends of the slots, the stress concentrations would not be significantly greater than the average stresses. If any stress were considered excessive, it would be the stress at the sides of the perforations. But no evidence of distress was observed from the physical tests.

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than a day. As the pipe deflection comes to equilibrium, the stresses in the pipe relax, and the gravel backfill is forced to take a greater share of the load. Even loose gravel is able to support high vertical pressure with little compression.

5. Performance limits for the test specimens were not reached. Load limits were not achieved. Consequently, a sample of the perforated pipe was tested by parallel plate test to observe performance at high ring deflection. The results are shown in the load-deflection diagram of Figure 11. Localized stress at the sides of the perforations was not visible even at a ring deflection of 30%. It would be impossible for gravel to compress enough to allow 30% ring deflection without crushing of the gravel particles. Crushing could not occur for typical gravels at less than some 400 ksf which is equivalent to 4000 ft of soil cover at 100 pcf. This is far above any anticipated fill heights for sanitary land fills at present. Furthermore, yielding of polyethylene is not a performance limit. It does not forebode pipe failure. It allows pipe to conform with the soil.

Conclusions:

1. When buried in washed gravel, six inch SDR 9.33 polyethylene pipes perform satisfactorily under cover of 200 ft of fill at 50 lbs per cubic ft even though the gravel is not compacted. Shovel-slicing gravel under the haunches may be advisable. It assures a better bedding for the pipe, especially if the surface on which the pipe is laid is not a plane. Shovel-slicing could be specified. Nevertheless, pipe laid on a plane surface, without gravel being shovel-sliced under the haunches, still performs adequately. With the pipe on a firm plane surface, shovel-slicing only serves to increase the margin of safety by some small, unknown amount.

2. The upper limit of vertical soil pressure on six inch SDR 9.33 polyethylene pipe buried in gravel is unknown, but a parallel plate test on the perforated pipe indicates that the upper limit is many times greater than 200 ft at 50 pcf.

3. Ring deflection of six inch SDR 9.33 polyethylene pipe buried in loose, washed gravel is less than the vertical compression of the gravel. Under a fill height of 200 ft at 50 lbs per cubic ft, ring deflection is less than about 3.3%.

4. Distress, such as concentrated stress at the sides of perforations, is not a performance limit in these tests. There is no evidence of cracking or tearing, or even that cracking or tearing could occur if the pipe is confined by burial in gravel.

5. Six inch SDR 9.33 polyethylene pipes are an attractive alternative as drain pipes under sanitary land fills. Perforations and slots do not reduce load carrying capacity significantly except for the small reduction in cross sectional area of the pipe wall.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

March 14, 1996

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RECEIVED

Mr. Benito Garcia, Chief
Hazardous and Radioactive Bureau
New Mexico Environment Department
P.O. Box 26110
Santa Fe, New Mexico 87502

RE: **Gandy Marley Inc., Triassic Park Hazardous Waste Facility, Part B Application and the Corresponding Revisions**

Dear Mr. Garcia:

The Environmental Protection Agency (EPA) has completed a technical review of the landfill design for Gandy Marley Inc. and has determined that it meets the requirements of 40 CFR 264.300 thru 264.317. If you have any further questions, please contact Mr. Rich Mayer at (214) 665-7442.

Sincerely yours,

Rich Mayer

for David Neleigh, Section Chief
New Mexico - Federal Facilities

1912

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ENVIRONMENT DEPARTMENT
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GARY E. JOHNSON
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MARK E. WEIDLER
SECRETARY

EDGAR T. THORNTON, III
DEPUTY SECRETARY

DATE: March 11, 1996

MEMORANDUM

TO: Bob Sweeney, Hazardous Waste Bureau

FROM: Rich Stafford, Solid Waste Bureau

SUBJECT: Triassic Park liner and cover design
HELP model review

The HELP model output files dated February 28, 1996 submitted by TerraMatrix in a report dated March, 1996 in fulfillment of the requirements for an alternate liner demonstration show a leakage rate of 0.008 cubic feet per year and 0.002 cubic feet per year for the bottom and the slope, respectively. The comparable values for the §264.301(c)(1)(i)(B) liner are 2.587 and 0.042. This satisfies the "alternative design" requirement of §264.301(b).

Attached are the final cover HELP model output files submitted by TerraMatrix on March 8 and 9. The copy received by the Solid Waste Bureau by FAX dated March 9 is modeled with (1) a minimum grade of 5%, (2) a maximum drainage distance of 1000 feet, and (3) poor grass. This cover shows an infiltration rate through the FML of 0.001 cubic feet per year. This is less than the percolation rate through the alternate liner, 0.008 cubic feet per year through the bottom and 0.002 on the slope, and thus meets the requirements of §264.310(5).

Please note these comments are restricted to the demonstrations required by §264 and do not specifically address the other design items we discussed last week. It is my understanding the Solid Waste Bureau has no further outstanding issues pertaining to the Triassic Park facility.

xc: Dale Gandy, Gandy Marley, Inc.
John J. Kendall, TerraMatrix
Mark Weidler, NMED Secretary
Pete Maggiore
Ed Kelley
Gerald Silva
J. David Duran

attachments

Prepared for:

Gandy Marley, Inc.
P.O. Box 872
1109 E. Broadway
Tatum, NM 88267

Triassic Park Hazardous Waste Facility Landfill Alternative Liner System HELP Analysis

(Revision 1)

March 1996

Prepared By:

TerraMatrix Inc.
Engineering and Environmental Services
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Lakewood, Colorado 80228

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1.0 INTRODUCTION

In conjunction with engineering design and permitting tasks associated with the Gandy Marley Incorporated Triassic Park Hazardous Waste Facility RCRA Part B Permit Application, TerraMatrix Inc. has conducted a hydrologic evaluation of a potential landfill liner design alternative. This analysis was performed using the Hydrologic Evaluation of Landfill Performance (HELP) model, a computer program developed by the United States Environmental Protection Agency (EPA). Contained herein are descriptions of the liner alternatives, a discussion of the HELP program input parameters and modeling methodologies employed, and a discussion of the modeling results.

1.1 BACKGROUND

The proposed Triassic Park Facility is a full service hazardous waste treatment, storage, and disposal facility. Its primary disposal unit will be a large multi-phase lined landfill with an expected life of 30 years. A conceptual design for the proposed landfill liner system and a request and justification for a waiver from minimum technology requirements (MTR) was submitted in the RCRA Part B Permit Application. Per the request of Gandy Marley Inc., an additional waiver justification report was prepared and submitted to the New Mexico Environmental Department (NMED) to clarify hydrologic concerns related to the liner. Following review of these documents, NMED rejected the original proposed landfill liner presented in the Part B Application. TerraMatrix then prepared an analysis of five potential liner alternatives using EPA's HELP model, three of which were shown to provide equivalent leakage protection as the MTR liner system. This report, revision 1 of the above mentioned HELP analysis, presents the alternative landfill liner design selected by Gandy Marley, Inc. and the Revision 0 results of the hydrologic modeling conducted to compare its effectiveness in preventing leakage of hazardous constituents to that of the MTR liner system defined in 40 CFR 264.301(c). This report presents an alternative cover performance demonstration requested by NMED.

1.2 HELP PROGRAM DESCRIPTION

The HELP model is a computer program which models the water movement into, through, and out of landfills. The model accepts climatic, soil, and design data, and utilizes a solution technique that accounts for the effects of surface storage, run-off, infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage. Landfill systems including various combinations of vegetation, cover soils, waste cells, special drainage layers, and low permeability barrier soils, as well as, special synthetic membrane covers and liners, may be modeled.

HELP was developed by the U.S. Army Corps of Engineers Waterways Experiment Station (WES) for the EPA Municipal Research Laboratory, Cincinnati, OH. HELP Version 3.04a dated July, 1995 was used in this analysis. HELP version 3.03 dated December 1994 was used in the Revision 0 analysis. The latest version, HELP Version 3.04a, incorporates new weather data handling capabilities , drainage layer routines, peak daily head routines, and evapotranspiration routines.

1.3 REPORT ORGANIZATION

Including this section, this report is organized into seven Sections. Section 2.0 presents the landfill liner designs including detailed descriptions of the construction materials contemplated. Section 3.0 discusses the HELP modeling methodologies used to evaluate the liner alternative and MTR. Section 4.0 presents the HELP inputs and selection rationale. Section 5.0 discusses the HELP analysis results. Section 6.0 presents the conclusions of the analysis and Section 7.0 presents report references. Summary tables, figures, and appendices follow the report.

2.0 TRIASSIC PARK LANDFILL LINER ALTERNATIVES

The liner designs considered in this analysis include the RCRA Subtitle C minimum technology liner system described in 40 CFR 301 and proposed alternative. Figures 1 and 2, following the text, illustrate the slope and floor liner material components for each design approach.

The MTR consists of primary and secondary liners with leachate collection and removal systems (LCRS) above and between the liners. The LCRS system between the liners is also referred to as a leak detection system (LDS). The LCRS and LDS drainage systems consist of a sand drainage layer surrounded by geotextile filter fabric where required. The primary barrier layer consists of a single flexible membrane liner (FML). The secondary barrier layer is a composite liner consisting of 3 feet of compacted clay overlain by an FML.

The proposed alternative is a double high density polyethylene (HDPE) liner design with LCRS and LDS which incorporate geocomposite drainage layers instead of sand geotextile layers. Additionally, a geosynthetic clay liner (GCL) and a 6 inch layer of prepared subgrade is used instead of 3 feet of compacted clay in the bottom barrier layer.

The cover design shown in Figure 3 consists of, from the top down, a vegetative cover, a geocomposite drainage layer, a HDPE flexible membrane cover (FMC), a GCL, 6 inches of prepared subgrade, and 1.5 feet of cover soil. It should be noted that a GCL in combination with 6 inches of prepared subgrade is substituted for a processed clay layer in the cover section.

The sections below present additional design details and discuss the materials contemplated for use in each alternative.

2.1 RCRA SUBTITLE C MINIMUM TECHNOLOGY LINER SYSTEM

40 CFR 301(1)(I) defines what is nominally referred to as the minimum technology liner system , or MTR. The liner system must include the following:

- A top liner (e.g., a geomembrane).
- A composite bottom liner, consisting of at least two components (e.g., a geomembrane upper component with a 3 foot thick clay bottom layer with a maximum hydraulic conductivity of $1x10^{-7}$cm/sec).
- A LCRS on top of the top liner and a leachate collection and detection system between the liners (also referred to as a LDS).

The MTR system presented in this analysis consists of the following components, from the top down:

- A 2 foot protective soil layer.
- LCRS: geotextile - 1 foot thickness of drainage sand - geotextile (optional) .
- FML top liner: HDPE.
- LDS: geotextile - 1 foot thickness of drainage sand - geotextile (optional).
- Composite bottom liner: HDPE - 3 foot clay layer ($1x10^{-7}$cm/sec).

2.2 PROPOSED ALTERNATIVE LINER SYSTEM

The proposed alternative is a double liner system similar to MTR with material substitutions made for the bottom clay barrier layer and the LCRS and LDS drainage layers. A GCL replaces the 3 foot thick clay layer in the MTR and 6 inches of prepared subgrade is included below the GCL for structural support. The sand/geotextile LCRS and LDS drainage layers are replaced with geotextile/geonet/geotextile materials. The protective soil and FMLs are as described above in the MTR design.

The geocomposite drainage material contemplated for all alternatives consists of a non-woven geotextile bonded to a geonet webbing. The geotextile component of this material acts as a filter allowing moisture to pass to the geonet while keeping soil sediments out. Moisture flows along the ribs of the geonet transporting water to the sump collection areas. The geocomposite provides an effective drainage medium with transmissivities in the order of 1×10^{-3} m^2/sec. Sand material can be processed to achieve hydraulic conductivities of 1×10^{-2}cm/sec while gravels can achieve 10.0cm/sec. Because the geonet and geotextile materials are essentially inert, they offer greater resistance to clogging due to biological activity or chemical reactions with leachate than do sand and gravel materials which typically contain small factions of organic materials. Sand and gravel layers, however, offer a greater cushioning to the FML than do geocomposites which under very high loading conditions (which are not expected for the Triassic Park Landfill) can deform the FML.

2.3 COVER

40 CFR 264.310 outlines several performance criteria which landfill cover designs must meet once constructed. These criteria include the following:

- Provide long term minimization migration of liquids through the closed landfill;
- Function with minimum maintenance;
- Promote drainage and minimize erosion or abrasion of the cover;
- Accommodate settling and subsidence so that the cover's integrity is maintained; and,
- Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present

The cover design proposed here for the Triassic Park Landfill was used in this HELP analysis. It consists of the following components, from top down:

- 2 foot thick vegetative cover layer
- Geocomposite drainage layer: geotextile/geonet
- Flexible membrane cover: HDPE
- Geosynthetic clay liner (geotextile/bentonite/geotextile)
- 6 inches of prepared subgrade
- 1.5 foot thick cover soil

This cover section differs from the cover section originally presented in the Part B Application. In this case, a GCL and 6 inches of prepared subgrade replaces a 3 foot layer of processed clay. Because this clay is near to the surface in a cover application, it may be subject to desiccation and frost cracking. This problem is avoided with the use of a GCL.

3.0 HELP ANALYSIS METHODOLOGY

The HELP modeling approach used to evaluate the hydrologic performance of the proposed liner alternative and MTR follows the NMED's Draft Guidance Document for Performance Demonstration for an Alternative Liner Design Using the HELP Modeling Program Under the New Mexico Solid Waste Management Regulations (20 NMAC 9.1). This approach was selected because it allows a direct comparison between MTR and an alternative liner system, the results can be used to demonstrate performance equivalency required under 40 CFR 264.301(d). This methodology is paraphrased below. A complete version of these protocols is presented in Appendix C.

3.1 ALTERNATE LINER EQUIVALENCY DEMONSTRATION METHOD

1. In order to demonstrate that the alternative liner design provides equivalent protection as the MTR composite liner, a computer modeling analysis of the MTR and the proposed alternative liner must be performed. Equivalent protection in terms of leakage through the secondary liner must be demonstrated through a comparison of the alternative liner with the MTR.

2. Justification for all input parameters in the model must be provided. Characteristics of soils proposed for the construction and operation of the landfill and the parameter values used in the model must be consistent. Soil and waste moisture content parameters as well as geomembrane liner data and storm water run-off fraction must also be consistent with the expected conditions and materials contemplated for use.

3. Actual design conditions and operation development of the landfill must be simulated as closely as possible by doing a succession of model simulations. This succession must attempt to simulate moisture conditions in the landfill by using the previous simulation's moisture content output as the input for the following simulation. The duration of the simulation periods must be consistent with the landfill's expected filling rates as follows:

    3.1 Initial simulation of the open landfill at start-up when landfill has little to no waste. The time period should extend for the anticipated duration of this condition, a minimum of one year and a probable maximum of five years.

    3.2 A succeeding simulation to model conditions of the partially full landfill for some anticipated time period, most probably five years. This would incorporate daily cover and intermediate cover.

    3.3 Perform subsequent computer simulations to model the landfill in the closed condition for the duration of the entire post-closure care period.

        3.3.1 Model bare ground for the time period expected until vegetation becomes established.

        3.3.2 Model the vegetated condition for the remainder of the post-closure care period.

4. Compliance with the regulatory requirement of not exceeding a 12-inch hydraulic head on the bottom liner must be demonstrated given design drainage layer slopes and drainage distances.

5. If the infiltration through the alternative liner system for the simulation(s) is less than or equal to infiltration through the MTR liner system, then these HELP Model simulation(s) will serve to demonstrate equivalent performance of the alternative liner system compared to the MTR.

In addition to demonstrating performance equivalency with MTR, the performance of the proposed alternative liner must also be compared to the performance of the proposed final cover. 40 CFR 264.310 (a) (5) requires that the final cover must be designed and constructed to have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

3.2 ALTERNATE COVER DEMONSTRATION METHOD

As in the above case, a proposed alternate landfill cover must achieve the equivalent protection as the liner. If an alternative final cover is proposed for the landfill, it must be demonstrated that the proposed final cover design includes an infiltration layer that achieves an equivalent reduction in infiltration as the bottom liner. A HELP Model simulation comparison is acceptable for this demonstration for a 5 year period with vegetation. Precipitation, evapotranspiration, temperature, and solar radiation data must be site specific and identical for both liner and cover design simulations. Justification for all input parameters in the model must be provided. It is expected that the cover's design slopes and run-off distances will be modeled.

Further descriptions of the HELP program inputs for both of these modeling approaches is presented in Section 4.0.

4.0 HELP PROGRAM INPUTS

Inputs for the HELP program are made in a series of data files which the main program uses during its simulation runs. Default inputs are available for most data categories and these were used where appropriate. In certain cases default inputs were not used, for example, the initial soil moisture contents were manually set for each run as mentioned above. The following sections describe the inputs used and their selection rationale for both HELP modeling approaches. HELP input data sheets which summarize inputs for each run are presented in Appendix A, HELP Data Input Sheets.

4.1 CLIMATIC DATA

The HELP program provides a weather generator to simulate changing weather conditions over time for various locations in the United States based on historical weather data. The location selected for this analysis was Roswell, NM. Roswell is located 42 miles west of the Triassic Park site and is the closest default city available in the HELP program.

Once the default city has been selected, weather inputs for precipitation and temperature can be automatically assigned by the program or input by the user. For the original analysis in Revision 0 of this report, the default values for precipitation and temperature for Roswell, NM were used. For this analysis, weather inputs for precipitation and temperature for the Roswell, NM area were obtained from the National Oceanic and Atmospheric Association (NOAA). Thirty year averages (period 1964 to 1994) for precipitation and temperature were used instead of the HELP default values for Roswell. These weather records indicate a slightly wetter environment and inputting them would tend to make the results of HELP runs slightly higher, but would not change the relative performance of the various liner alternatives.

Evapotranspiration inputs to define the vegetation conditions and evaporative zone depth can also be input into the HELP model. For this analysis, these inputs were changed to represent likely vegetative conditions. During the operational period of the landfill when there is no cover present and for a short period immediately after the cover is installed there will be little vegetation present. The vegetation input used for this period was "bare ground". In selecting this option, the program provides Roswell area default values for an evaporative zone depth of 14 inches, growing season start and end on days 76 and 310, and maximum leaf area index of 0. After cover vegetation is established on the cover, typically after 1 year, the vegetative input was changed to "poor stand or grass". Vegetation at the Triassic Park site is sparse and this input was felt to best approximate the semi-arid site conditions. The evaporative zone depth was changed to 24 inches which corresponds to the design thickness of the vegetative cover layer and the maximum leaf area index was changed to 1 which was also felt to be appropriate for the site.

4.2 SOIL AND DESIGN DATA

Inputs for soil characteristics and design data include the percent run-off expected and the physical characteristics for each layer in the landfill model. In this analysis, 100 percent potential run-off was assumed when the landfill was covered and 0 percent run-off was assumed during the operational periods when the landfill cover was not in place. The layer characteristics are summarized below and in Appendix A .

4.2.1 Waste

The waste layer type, soil "texture" number, initial moisture content, and thickness define how moisture will percolate through waste layer and how much will be stored there. Because the waste layer is typically the thickest layer present, the outcome of landfill water flow analysis can be influenced greatly by its hydrologic properties.

The hydrologic properties of hazardous waste have not been studied to the same extent that municipal waste has been studied and therefore literature information is limited. The HELP model does not provide specific default values for hazardous waste and it is left to the program user to define these characteristics.

The waste was assigned soil texture numbers, initial moisture contents, and hydraulic conductivities which reflect expected actual conditions. The soil texture number of 7 corresponds to a silty sand material (SM) with default porosity of 0.473, field capacity of 0.222, wilting point of 0.104, and hydraulic conductivity of 5.4 x 10^{-4}cm/sec. The initial moisture content was set at 0.2055.

The hydraulic properties of the waste fill will depend on the characteristics of the incoming waste and the nature of the daily cover soil used. The physical characteristics of landfilled hazardous waste can vary widely from sludges to solids and debris. Contaminated soils and bulk solid materials, however, will make up a major proportion of these materials. Typically, the waste material is placed and compacted and covered with daily cover soil material. Since the surface of the waste fill must be trafficable to waste hauler trucks and other heavy earthmoving equipment, it is not an uncommon practice to increase the amount of daily cover soil placed when softer or sludgy type wastes are received. At the Triassic Park site sand and siltstone will be predominantly used as daily cover materials and incoming contaminated soils are also likely to have a high sand content. Bulk solid wastes such as filter cake material, bag house wastes, and other process wastes are fine grained with particle sizes in the silt range. Based on this, the soil texture corresponding to a sandy silt was selected for the waste material.

Based on previous experience at hazardous waste sites, the initial moisture contents of the waste for Years 0 through 1 were set at 0.2055 which corresponds to a moisture content of 15 percent.

4.2.2 Protective Soil

The protective soil layer placed on top of the liner prior to waste filling will be the same material used for daily soil cover with the exception that it will be screened to remove oversize rocks and cobbles. Based on evaluation of bulk samples taken at the site from the upper sand unit, a soil texture number of 4 corresponding to a silty sand was selected to model the protective soil layer. This soil texture has the following defaults: porosity of 0.473, field capacity of 0.0105, wilting point of 0.047, and hydraulic conductivity of 1.7 x 10^{-3}cm/sec. The initial moisture content for this layer was set at 0.0863 which is consistent with the average moisture contents of 5.9 percent for the site's silty sand samples.

4.2.3 Lateral Drainage (Sand)

The lateral drainage sand material considered for use at the site will have to meet minimum hydraulic conductivities of 1 x 10^{-2}cm/sec. Although no hydraulic testing of candidate site materials has been conducted, it is believed that this performance standard can be met with available material sources either in their natural state or with a minimal amount of screening and washing. The soil texture number of 1 which corresponds to a poorly graded sand was selected for this layer. This soil texture has the following defaults: porosity of 0.417, field capacity of 0.045, wilting point of 0.018, and hydraulic conductivity of 1 x 10^{-2}cm/sec. Initial moisture content for this layer was set at 0.045 which equals the field capacity and therefore does not allow for water storage in the lateral drainage layer. It should be noted that the geotextile components of the sand drainage layer were not included in the this evaluation. Transmissities of this material exceeds those of the sand material and therefore this assumption is conservative.

4.2.4 Lateral Drainage (Geocomposite)

The geocomposite drainage material used in this analysis was a geotextile bonded to a geonet. The HELP model does not have a specific default for geocomposites so the default for the geonet was selected for this layer. The added capacity of the geotextile in this case is ignored and, as above, this assumption is conservative. The soil texture number of 20 which corresponds to a drainage net was selected for this layer. This soil texture has the following defaults: porosity of 0.850, field capacity of 0.010, wilting point of 0.005, and hydraulic conductivity of 10.0cm/sec. The initial moisture content for this layer was set at 0.010 which equals the field capacity and therefore does not allow for water storage in the lateral drainage

4.2.5 Barrier (FML: HDPE)

The FML barrier layer considered is a 60 mil HDPE geomembrane. HELP model defaults for this layer are thickness 0.06 inch and soil texture number 35. For geomembranes, the HELP model also provides input capabilities for pinhole density, installation defects, and installation quality assurance. Input values for these parameters are recommended in the HELP Manual. Values used in this analysis were pinhole density of 1.0, geomembrane defect number 3, and liner installation quality of 3. All of these inputs correspond to a good geomembrane installation under good construction quality control.

4.2.6 Barrier (Clay)

The clay barrier layer material considered is a typical fine grained clay material which when moisture conditioned and compacted under controlled conditions is capable of achieving an in-place hydraulic conductivity of 1 x 10^{-7} cm/sec. HELP program defaults for soil texture number 26 with porosity of 0.445, field capacity of 0.393, wilting point of 0.445, and modified hydraulic conductivity of 1 x 10^{-7}cm/sec were used for the clay layer. The moisture content was set equal to the porosity to allow for immediate saturated flow through the clay layer.

For the MTR case, the thickness of the clay barrier layer was set at 3 feet.

Permeability testing of the clay material samples gathered at the site indicate that hydraulic conductivities of 1 x 10^{-7}cm/sec can be achieved.

4.2.7 Barrier (GCL)

The GCL material considered is a composite geotextile/bentonite/geotextile layer. These liner products, although relatively new compared to geotextiles and geomembranes, have become popular substitutes for clay layers in cover systems and recently in liner systems. The soil texture number of 17 was selected for the GCL with a porosity of 0.750, field capacity of 0.747, wilting point of 0.400, and hydraulic conductivity of 3 x 10^{-9}cm/sec. The initial moisture content for this layer was set at 0.7500 which equals the porosity to allow for immediate saturated flow thought the clay layer.

4.2.8 Prepared Subgrade

The prepared subgrade material considered is essentially the same material considered for the clay barrier material described above. The difference between these materials is the level processing and moisture conditions prior to placement and the resultant increased permeability of the prepared subgrade. The primary function of this layer is to provide a smooth stable surface upon which to install the overlying geosynthetics but it is not envisaged that extensive moisture conditioning or processing will be done. However, because this material is the same material proposed for the clay barrier layer, it will exhibit some barrier layer characteristics by inhibiting flow through holes in the FML.

For the prepared subgrade layer, the same soil texture number and defaults were input as the clay layer described above including the conductivity. Permeability tests done on samples from the Upper Dockum Unit indicated hydraulic conductivities in this range.

4.3 LANDFILL COVER DATA

Landfill cover data inputs include the cover layer materials, the type of vegetative cover on the surface of the cover, the percentage of moisture that is subject to run-off, the slope of the cover and maximum drainage distance. Materials contemplated for the cover design are discussed above and their arrangement is illustrated in Figure 3. As discussed previously for covered conditions, 100 percent potential run-off was input, the vegetative condition for the newly installed cover assumed a "bare ground" and a 14 inch evaporative zone depth for the first year, and "poor stand of grass" with a 24 inch evaporative zone for the remaining years. A maximum drainage distance of 550 feet at 4H:1V slope (25 percent) was computed from conceptual drawings in the presented RCRA Permit Application for the Triassic Park Facility. The HELP soil texture classification number 6 was selected for the vegetative cover for the cover performance demonstration. This soil type is consistent with the Alma series soil found at the site. It should be noted that the vegetative soil type used in the Revision 0 HELP analysis has a soil texture number of 4 with a porosity of 0.4270, field capacity of 0.1050, wilting point of 0.0470, and hydraulic conductivity of 1.7 x 10^{-3} cm/sec. These lateral drainage values are consistent with the Roswell - Association also found at the Triassic Park site. The material is a silty sand with default porosity of 0.453, field capacity of 0.190, wilting point of 0.085, and saturated hydraulic conductivity of 7.2 x 10^{-4}. Initial moisture content for the vegetative soil was set at 0.0863.

5.0 HELP PROGRAM RESULTS

5.1 ALTERNATE LINER EQUIVALENCY DEMONSTRATION

Results for the individual HELP model runs are summarized in Tables 5 and 6. Actual printouts of the HELP model summary output files are presented in Appendix B. As previously mentioned, these results were originally presented in Revision 0 of this report. For completeness, they are also included in this revision.

Review of the results presented in the summary table below and Tables 5 and 6 indicates there is little difference in leakage rates between the various liner alternatives for the final closed landfill. Further inspection of the modeling results for the operational phase, Years 0 through 10, reveals insignificantly small leakage in the proposed alternate liner. For this period the proposed alternate and MTR liners are considered equivalent and leakages are rounded to three decimal points in the table below. For Years 11 though 40 with the landfill cover in place, very little precipitation enters the system and the waste mass begins to drain with this water being removed from the system in the LCRS layer. Bottom barrier layer leakage rates at this point become negligible for both the proposed liner alternative and MTR.

MODELING APPROACH LEAKAGE RATE SUMMARY
Operational Period (Years 0 - 10)

Alternatives	Floor Leakage (g/a/d)	Slope Leakage (g/a/d)
Proposed Alternate	0.000	0.000
MTR	0.000	0.000

NOTE: 1. Values shown are final leakage rates after period Years 0 through 10
2. Results shown are from Revision 0 of the Alternative Liner System HELP Analysis

MODELING APPROACH LEAKAGE RATE SUMMARY
Covered Period (Years 11 - 40)

Alternatives	Floor Leakage (g/a/d)	Slope Leakage (g/a/d)
Proposed Alternate	0	0
MTR	0	0

NOTE: 1. Values shown are final leakage rates after period Years 31 through 40
2. Results shown are from Revision 0 of the Alternative Liner System HELP Analysis

Review of Tables 5 and 6 show head values for both the proposed alternate and MTR indicate pressure development on the primary and secondary liners in the range of 0.000 to 0.001 inches which are well below the regulatory maximum of 12 inches.

5.2 ALTERNATE COVER DEMONSTRATION

Results of HELP model runs for the alternate cover demonstration of Years 0 through 5 are summarized in Tables 1 through 4. Actual printouts of the HELP model summary output are presented in Appendix B.

Review of these results indicated leakages through the proposed cover in the order of 0.00002 g/a/d while leakage through the proposed alternate liner are 0.000164 for the floor area and 0.000041 for the slope area. Once again, the difference between these two leakage rates is insignificantly small and the proposed cover can be considered at least as impermeable as the proposed alternate liner.

6.0 CONCLUSIONS

Based on the HELP model results, the following conclusions can be made:

- There is little difference between the proposed alternative and MTR in terms of percolation rates through the bottom liner over the life of the facility. The differences that exist in Years 0 through 10 are insignificantly small. The proposed alternate liner performance can therefore be considered equivalent to the MTR liner performance.
- Hydraulic pressure on the primary and secondary liners of both the MTR and proposed alternate liner system is well below the regulatory maximum of 12 inches.
- The cover system leakage is less than or equal to the leakage of the liner system. It effectively reduces precipitation infiltration which will the waste to drain once the cover is in place.

  allow

7.0 REFERENCES

Gandy Marley Inc., *RCRA Permit Application for the Triassic Park Waste Disposal Facility*, November 1994. Prepared for Gandy Marley Inc. By S.M. Stoller Corporation and TerraMatrix Inc.

New Mexico Environment Department, Solid Waste Bureau, Permit Section. *Guidance Document for Performance Demonstration for an Alternative Cover Design Using the HELP Modeling Program Under the New Mexico Solid Waste Management Regulations (20 NMAC 9.1) and Performance Demonstration for an Alternative Liner Design Using the HELP Modeling Program Under the New Mexico Solid Waste Management Regulations (20 NMAC 9.1)*

Schroeder, P.R., Dozier, T.S., Zappi, P.A., McEnroe, B.M., Sjostrom, J.W., and Peyton, R.L. (1994). *The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation For Version 3* EPA/600/9-94/xxx, U.S. Environmental Protection Agency Risk Reduction Engineering Laboratory, Cincinnati, OH.

TABLE 1

SUMMARY TABLES

TABLE 1

YEARS	LINER SECTION	PRIMARY LATERAL DRAINAGE (gal/acre/day)(1)	PRIMARY LINER LEAKAGE (gal/acre/day)(1)	SECONDARY LATERAL DRAINAGE (gal/acre/day)(1)	SECONDARY LINER LEAKAGE (gal/acre/day)(1)	COMMENTS
FLOOR						
	MTR	33.704579	64.212128	58.712736	0.053019	
0-5	2	48.011289	51.814221	51.801597	0.000164	
SLOPE						
	MTR	87.717213	11.815266	11.772023	0.000861	
0-5	2	544.995355	43.131039	43.131018	0.000041	
COVER						
0-5	COVER	18.240582	0.000020	NA	NA	

Notes:

(1) Values based on average annual totals.

(2) Liner section 2 is referred to as Proposed Alternate in the text.

TABLE 2

FLOOR/SLOPE LINER ALTERNATIVE 2 (PROPOSED ALTERNATE)

TABLE 2
GANDY LANDFILL FLOOR LINER ALTERNATIVE #2 (PROPOSED ALTERNATE)

YEARS	PRECIPITATION (gal/acre/day)(1)	LAYER	LAYER TYPE	THICKNESS (inches)	INITIAL M.C.(3) (vol/vol)	FINAL M.C.(3) (vol/vol)	LATERAL DRAINAGE (gal/acre/day)(1)	PERCOLATION (gal/acre/day)(1)	HEAD ON LAYER (inches)(1)	COMMENTS
0-5	963.716416	1	Soil	24	0.0863	0.1240	NA	NA	NA	
		2	Geocomposite	0.2	0.0100	0.0120	48.011289	NA	NA	
		3	Geomembrane	0.06	0.0000	0.0000	NA	51.814221	0.0010	
		4	Geocomposite	0.2	0.0100	0.0142	51.801597	NA	NA	
		5	Geomembrane	0.06	0.0000	0.0000	NA	NA	0.0001	
		6	GCL	0.24	0.7500	0.7500	NA	0.000164	NA	

Notes:

(1) Values based on average annual totals.

(2) Peak daily values may be higher due to storm events.

TABLE 2
GANDY LANDFILL SLOPE LINER ALTERNATIVE # 2 (PROPOSED ALTERNATE)

YEARS	PRECIPITATION (gal/acre/day)(1)	LAYER	LAYER TYPE	THICKNESS (inches)	INITIAL M.C.(3) (vol/vol)	FINAL M.C.(3) (vol/vol)	LATERAL DRAINAGE (gal/acre/day)(1)	PERCOLATION (gal/acre/day)(1)	HEAD ON LAYER (inches)(1)	COMMENTS
0-5	963.716416	1	Soil	24	0.0863	0.1007	NA	NA	NA	
		2	Geocomposite	0.2	0.0100	0.0112	544.995355	NA	NA	
		3	Geomembrane	0.06	0.0000	0.0000	NA	43.131039	0.0000	
		4	Geocomposite	0.2	0.0100	0.0100	43.131018	NA	NA	
		5	Geomembrane	0.06	0.0000	0.0000	NA	NA	0.0000	
		6	GCL	0.24	0.7500	0.7500	NA	0.000041	NA	

Notes:

(1) Values based on average annual totals.
(2) Peak daily values may be higher due to storm events.

TABLE 3

FLOOR/SLOPE MTR LINER SUMMARY TABLES

TABLE 3
GANDY LANDFILL FLOOR MTR LINER

YEARS	PRECIPITATION (gal/acre/day)(1)	LAYER	LAYER TYPE	THICKNESS (inches)	INITIAL M.C.(3) (vol/vol)	FINAL M.C.(3) (vol/vol)	LATERAL DRAINAGE (gal/acre/day)(1)	PERCOLATION (gal/acre/day)(1)	HEAD ON LAYER (inches)(1)	COMMENTS
0-5	963.716416	1	Soil	24	0.0863	0.1240	NA	NA	NA	
		2	Sand	12	0.0450	0.0557	33.704579	NA	NA	
		3	Geomembrane	0.06	0.0000	0.0000	NA	64.212128	0.5230	
		4	Sand	12	0.0450	0.0755	58.712736	NA	NA	
		5	Geomembrane	0.06	0.0000	0.0000	NA	NA	0.9120	
		6	Clay	36	0.4450	0.4450	NA	0.053019	NA	

Notes:

(1) Values based on average annual totals.
(2) Peak daily values may be higher due to storm events.

TABLE 3
GANDY LANDFILL SLOPE MTR LINER

YEARS	PRECIPITATION (gal/acre/day)(1)	LAYER	LAYER TYPE	THICKNESS (inches)	INITIAL M.C.(3) (vol/vol)	FINAL M.C.(3) (vol/vol)	LATERAL DRAINAGE (gal/acre/day)(1)	PERCOLATION (gal/acre/day)(1)	HEAD ON LAYER (inches)(1)	COMMENTS
0-5	963.716416	1	Soil	24	0.0863	0.1240	NA	NA	NA	
		2	Sand	12	0.0450	0.0467	87.717213	NA	NA	
		3	Geomembrane	0.06	0.0000	0.0000	NA	11.815266	0.0600	
		4	Sand	12	0.0450	0.0452	11.772023	NA	NA	
		5	Geomembrane	0.06	0.0000	0.0000	NA	NA	0.0080	
		6	Clay	36	0.4450	0.4450	NA	0.000861	NA	

Notes:

(1) Values based on average annual totals.
(2) Peak daily values may be higher due to storm events.

TABLE 4

COVER ALTERNATIVE

TABLE 4
GANDY LANDFILL COVER ALTERNATIVE

YEARS	PRECIPITATION (gal/acre/day)(1)	LAYER	LAYER TYPE	THICKNESS (inches)	INITIAL M.C.(3) (vol/vol)	FINAL M.C.(3) (vol/vol)	LATERAL DRAINAGE (gal/acre/day)(1)	PERCOLATION (gal/acre/day)(1)	HEAD ON LAYER (inches)(1)	COMMENTS
0-5	963.716416	1	Veg. Soil	24	0.0863	0.0866	NA	NA	NA	
		2	Geocomposite	0.2	0.0100	0.0150	18.240582	NA	0.0000	
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		4	GCL	0.24	0.7500	0.7500	NA	0.000020	NA	
		5.00000	Soil	6	0.0863	0.0860	NA	NA	NA	
		6.00000	Soil	18	0.0863	0.0860	NA	NA	NA	

Notes:

(1) Values based on average annual totals.

(2) Peak daily values may be higher due to storm events.

TABLE 5

ALTERNATE 2 (PROPOSED ATERNATE)

FLOOR/SLOPE LINER SUMMARY TABLES

(ALTERNATIVE LINER SYSTEM HELP ANALYSIS REVISION 0)

TABLE 5
GANDY LANDFILL SLOPE LINER ALTERNATIVE #2 (PROPOSED ALTERNATE)

YEARS	PRECIPITATION (gal/acre/day)(1)	LAYER	LAYER TYPE	THICKNESS (inches)	INITIAL M.C.(3) (vol/vol)	FINAL M.C.(3) (vol/vol)	LATERAL DRAINAGE (gal/acre/day)(1)	PERCOLATION (gal/acre/day)(1)	HEAD ON LAYER (inches)(1)	COMMENTS
0-1	647.239184	1	Waste	60	0.2055	0.2080	NA	NA	NA	
		2	Soil	24	0.0863	0.1406	NA	NA	NA	
		3	Geocomposite	0.2	0.0100	0.0100	0.000000	NA	NA	
		4	Geomembrane	0.06	0.0000	0.0000	NA	0.000000	0.0000	
		5	Geocomposite	0.2	0.0100	0.0100	0.000000	NA	NA	
		6	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		7	GCL	0.24	0.7500	0.7500	NA	0.000000	0.0000	
2-5	718.472179	1	Waste	840	0.2080	0.2192	NA	NA	NA	
		2	Soil	24	0.1406	0.1131	NA	NA	NA	
		3	Geocomposite	0.2	0.0100	0.0100	6.574209	NA	NA	
		4	Geomembrane	0.06	0.0000	0.0000	NA	5.722065	0.0000	
		5	Geocomposite	0.2	0.0100	0.0100	5.770240	NA	NA	
		6	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		7	GCL	0.24	0.7500	0.7500	NA	0.000041	0.0000	
6-10	718.808290	1	Waste	1080	0.2192	0.2284	NA	NA	NA	
		2	Soil	24	0.1131	0.1488	NA	NA	NA	
		3	Geocomposite	0.2	0.0100	0.0102	25.495047	NA	NA	
		4	Geomembrane	0.06	0.0000	0.0000	NA	7.833662	0.0000	
		5	Geocomposite	0.2	0.0100	0.0100	7.833642	NA	NA	
		6	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		7	GCL	0.24	0.7500	0.7500	NA	0.000041	0.0000	

TABLE 5
GANDY LANDFILL SLOPE LINER ALTERNATIVE #2 (PROPOSED ALTERNATE)

11	647.239184	1	Veg. Soil	24	0.0863	0.0938	NA	NA	NA	
		2	Geocomposite	0.2	0.0100	0.0110	539.163562	NA	NA	
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		4	Clay	36	0.4450	0.4450	NA	0.000205	0.0010	
		5	Soil	24	0.0863	0.0863	NA	NA	NA	
		6	Waste	1440	0.2284	0.2269	NA	NA	NA	
		7	Soil	24	0.1488	0.1712	NA	NA	NA	
		8	Geocomposite	0.2	0.0102	0.0100	116.866483	NA	NA	
		9	Geomembrane	0.06	0.0000	0.0000	NA	5.764161	0.0010	
		10	Geocomposite	0.2	0.0100	0.0100	5.764161	NA	NA	
		11	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		12	GCL	0.24	0.7500	0.7500	NA	0.000020	0.0000	
12-31	673.203761	1	Veg. Soil	24	0.0938	0.0709	NA	NA	NA	
		2	Geocomposite	0.2	0.0110	0.0166	538.388928	NA	NA	
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		4	Clay	36	0.4450	0.4450	NA	0.000246	0.0010	
		5	Soil	24	0.0863	0.0863	NA	NA	NA	
		6	Waste	1440	0.2269	0.2220	NA	NA	NA	
		7	Soil	24	0.1712	0.1050	NA	NA	NA	
		8	Geocomposite	0.2	0.0100	0.0100	30.262782	NA	NA	
		9	Geomembrane	0.06	0.0000	0.0000	NA	1.893904	0.0000	
		10	Geocomposite	0.2	0.0100	0.0100	1.893883	NA	NA	
		11	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		12	GCL	0.24	0.7500	0.7500	NA	0.000000	0.0000	

TABLE 5
GANDY LANDFILL SLOPE LINER ALTERNATIVE #2 (PROPOSED ALTERNATE)

32-40	699.481906	1	Veg. Soil	24	0.0709	0.0652	NA	NA	NA	
		2	Geocomposite	0.2	0.0166	0.0109	560.267933	NA	NA	
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		4	Clay	36	0.4450	0.4450	NA	0.000266	0.0010	
		5	Soil	24	0.0863	0.0863	NA	NA	NA	
		6	Waste	1440	0.2220	0.2220	NA	NA	NA	
		7	Soil	24	0.1050	0.1050	NA	NA	NA	
		8	Geocomposite	0.2	0.0100	0.0100	0.000000	NA	NA	
		9	Geomembrane	0.06	0.0000	0.0000	NA	0.000000	0.0000	
		10	Geocomposite	0.2	0.0100	0.0100	0.000000	NA	NA	
		11	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		12	GCL	0.24	0.7500	0.7500	NA	0.000000	0.0000	

Notes:
(1) Values based on average annual totals.
(2) Peak daily values may be higher due to storm events.
(3) Final moisture contents from each run were used as initial moisture contents for subsequent runs.
(4) Results from Alternative Liner System HELP Analysis Revision 0

TABLE 5
GANDY LANDFILL FLOOR LINER ALTERNATIVE #2 (PROPOSED ALTERNATE)

YEARS	PRECIPITATION (gal/acre/day)(1)	LAYER	LAYER TYPE	THICKNESS (inches)	INITIAL M.C.(3) (vol/vol)	FINAL M.C.(3) (vol/vol)	LATERAL DRAINAGE (gal/acre/day)(1)	PERCOLATION (gal/acre/day)(1)	HEAD ON LAYER (inches)(1)	COMMENTS
0-1	647.239184	1	Waste	60	0.2055	0.2080	NA	NA	NA	
		2	Soil	24	0.0863	0.1406	NA	NA	NA	
		3	Geocomposite	0.2	0.0100	0.0100	0.000000	NA	NA	
		4	Geomembrane	0.06	0.0000	0.0000	NA	0.000000	0.0000	
		5	Geocomposite	0.2	0.0100	0.0100	0.000000	NA	NA	
		6	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		7	GCL	0.24	0.7500	0.7500	NA	0.000000	0.0000	
2-5	718.472179	1	Waste	840	0.2080	0.2192	NA	NA	NA	
		2	Soil	24	0.1406	0.1131	NA	NA	NA	
		3	Geocomposite	0.2	0.0100	0.0100	1.239286	NA	NA	
		4	Geomembrane	0.06	0.0000	0.0000	NA	11.056946	0.0000	
		5	Geocomposite	0.2	0.0100	0.0103	11.055676	NA	NA	
		6	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		7	GCL	0.24	0.7500	0.7500	NA	0.000184	0.0000	
6-10	718.808290	1	Waste	1080	0.2192	0.2284	NA	NA	NA	
		2	Soil	24	0.1131	0.1488	NA	NA	NA	
		3	Geocomposite	0.2	0.0100	0.0122	10.902438	NA	NA	
		4	Geomembrane	0.06	0.0000	0.0000	NA	22.420307	0.0000	
		5	Geocomposite	0.2	0.0103	0.0144	22.408092	NA	NA	
		6	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		7	GCL	0.24	0.7500	0.7500	NA	0.000164	0.0000	

TABLE 5
GANDY LANDFILL FLOOR LINER ALTERNATIVE #2 (PROPOSED ALTERNATE)

11	647.239184	1	Veg. Soil	24	0.0863	0.0938	NA	NA	NA
		2	Geocomposite	0.2	0.0100	0.0110	539.163562	NA	NA
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA
		4	Clay	36	0.4450	0.4450	NA	0.000205	0.0010
		5	Soil	24	0.0863	0.0863	NA	NA	NA
		6	Waste	1440	0.2284	0.2269	NA	NA	NA
		7	Soil	24	0.1488	0.1712	NA	NA	NA
		8	Geocomposite	0.2	0.0122	0.0149	50.885120	NA	NA
		9	Geomembrane	0.06	0.0000	0.0000	NA	71.702075	0.0010
		10	Geocomposite	0.2	0.0144	0.0165	71.670903	NA	NA
		11	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA
		12	GCL	0.24	0.7500	0.7500	NA	0.000164	0.0010
12-31	673.203761	1	Veg. Soil	24	0.0938	0.0709	NA	NA	NA
		2	Geocomposite	0.2	0.0110	0.0166	538.388928	NA	NA
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA
		4	Clay	36	0.4450	0.4450	NA	0.000246	0.0010
		5	Soil	24	0.0863	0.0863	NA	NA	NA
		6	Waste	1440	0.2269	0.2220	NA	NA	NA
		7	Soil	24	0.1712	0.1050	NA	NA	NA
		8	Geocomposite	0.2	0.0149	0.0100	12.279714	NA	NA
		9	Geomembrane	0.06	0.0000	0.0000	NA	19.880619	0.0000
		10	Geocomposite	0.2	0.0165	0.0100	19.885333	NA	NA
		11	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA
		12	GCL	0.24	0.7500	0.7500	NA	0.000123	0.0000

TABLE 5
GANDY LANDFILL FLOOR LINER ALTERNATIVE #2 (PROPOSED ALTERNATE)

11	647.239184	1	Veg. Soil	24	0.0863	0.0938	NA	NA	NA
		2	Geocomposite	0.2	0.0100	0.0110	539.163562	NA	NA
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA
		4	Clay	36	0.4450	0.4450	NA	0.000205	0.0010
		5	Soil	24	0.0863	0.0863	NA	NA	NA
		6	Waste	1440	0.2284	0.2269	NA	NA	NA
		7	Soil	24	0.1488	0.1712	NA	NA	NA
		8	Geocomposite	0 2	0.0122	0.0149	50.885120	NA	NA
		9	Geomembrane	0.06	0.0000	0.0000	NA	71.702075	0.0010
		10	Geocomposite	0.2	0.0144	0.0165	71.670903	NA	NA
		11	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA
		12	GCL	0.24	0.7500	0.7500	NA	0.000164	0.0010
12-31	673.203761	1	Veg. Soil	24	0.0938	0.0709	NA	NA	NA
		2	Geocomposite	0.2	0.0110	0.0166	538.388928	NA	NA
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA
		4	Clay	36	0.4450	0.4450	NA	0.000246	0.0010
		5	Soil	24	0.0863	0.0863	NA	NA	NA
		6	Waste	1440	0.2269	0.2220	NA	NA	NA
		7	Soil	24	0.1712	0.1050	NA	NA	NA
		8	Geocomposite	0.2	0.0149	0.0100	12.279714	NA	NA
		9	Geomembrane	0.06	0.0000	0.0000	NA	19.880619	0.0000
		10	Geocomposite	0.2	0.0165	0.0100	19.885333	NA	NA
		11	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA
		12	GCL	0.24	0.7500	0.7500	NA	0.000123	0.0000

TABLE 5
GANDY LANDFILL FLOOR LINER ALTERNATIVE #2 (PROPOSED ALTERNATE)

32-40	699.481906	1	Veg. Soil	24	0.0709	0.0652	NA	NA	NA	
		2	Geocomposite	0.2	0.0166	0.0109	560.267933	NA	NA	
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		4	Clay	36	0.4450	0.4450	NA	0.000266	0.0010	
		5	Soil	24	0.0863	0.0863	NA	NA	NA	
		6	Waste	1440	0.2220	0.2220	NA	NA	NA	
		7	Soil	24	0.1050	0.1050	NA	NA	NA	
		8	Geocomposite	0.2	0.0100	0.0100	0.000000	NA	NA	
		9	Geomembrane	0.06	0.0000	0.0000	NA	0.000000	0.0000	
		10	Geocomposite	0.2	0.0100	0.0100	0.000000	NA	NA	
		11	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		12	GCL	0.24	0.7500	0.7500	NA	0.000000	0.0000	

Notes:
(1) Values based on average annual totals.
(2) Peak daily values may be higher due to storm events.
(3) Final moisture contents from each run were used as initial moisture contents for subsequent runs.
(4) Results from Alternative Liner System HELP Analysis Revision 0

TABLE 6

MTR

FLOOR/SLOPE LINER SUMMARY TABLES

(ALTERNATIVE LINER SYSTEM HELP ANALYSIS REVISION 0)

TABLE 6
GANDY LANDFILL FLOOR MTR LINER

YEARS	PRECIPITATION (gal/acre/day)(1)	LAYER	LAYER TYPE	THICKNESS (inches)	INITIAL M.C.(3) (vol/vol)	FINAL M.C.(3) (vol/vol)	LATERAL DRAINAGE (gal/acre/day)(1)	PERCOLATION (gal/acre/day)(1)	HEAD ON LAYER (inches)(1)	COMMENTS
0-1	0.000000	1	Waste	60	0.2055	0.2092	NA	NA	NA	
		2	Soil	24	0.0863	0.1065	NA	NA	NA	
		3	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		4	Geomembrane	0.06	0.0000	0.0000	NA	0.000000	0.0000	
		5	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		6	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		7	Clay	36	0.4450	0.4450	NA	0.000000	0.0000	
2-5	0.000000	1	Waste	840	0.2092	0.2128	NA	NA	NA	
		2	Soil	24	0.1065	0.1050	NA	NA	NA	
		3	Sand	12	0.0450	0.0450	0.084028	NA	NA	
		4	Geomembrane	0.06	0.0000	0.0000	NA	0.585530	0.0010	
		5	Sand	12	0.0450	0.0450	0.582927	NA	NA	
		6	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		7	Clay	36	0.4450	0.4450	NA	0.000902	0.0090	
6-10	0.000000	1	Waste	1080	0.2128	0.2164	NA	NA	NA	
		2	Soil	24	0.1050	0.1050	NA	NA	NA	
		3	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		4	Geomembrane	0.06	0.0000	0.0000	NA	0.000000	0.0000	
		5	Sand	12	0.0450	0.4500	0.000000	NA	NA	
		6	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		7	Clay	36	0.4450	0.4450	NA	0.000000	0.0000	

TABLE 6
GANDY LANDFILL FLOOR MTR LINER

11	0.000000	1	Veg. Soil	24	0.0863	0.0938	NA	NA	NA	
		2	Geocomposite	0.2	0.0100	0.0110	539.163562	NA	NA	
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		4	Clay	36	0.4450	0.4450	NA	0.000205	0.0010	
		5	Soil	24	0.0863	0.0863	NA	NA	NA	
		6	Waste	1440	0.2164	0.2164	NA	NA	NA	
		7	Soil	24	0.1050	0.1050	NA	NA	NA	
		8	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		9	Geomembrane	0.06	0.0000	0.0000	NA	0.000000	0.0000	
		10	Sand	12	0.4500	0.0450	0.000000	NA	NA	
		11	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		12	Clay	36	0.4450	0.4450	NA	0.000000	0.0000	
12-31	0.000000	1	Veg. Soil	24	0.0938	0.0709	NA	NA	NA	
		2	Geocomposite	0.2	0.0110	0.0166	538.388928	NA	NA	
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		4	Clay	36	0.4450	0.4450	NA	0.000246	0.0010	
		5	Soil	24	0.0863	0.0863	NA	NA	NA	
		6	Waste	1440	0.2164	0.2164	NA	NA	NA	
		7	Soil	24	0.1050	0.1050	NA	NA	NA	
		8	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		9	Geomembrane	0.06	0.0000	0.0000	NA	0.000000	0.0000	
		10	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		11	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		12	Clay	36	[illegible]	0.4450	NA	0.000000	0.0000	

TABLE 6
GANDY LANDFILL FLOOR MTR LINER

32-40	0.000000	1	Veg. Soil	24	0.0709	0.0652	NA	NA	NA	
		2	Geocomposite	0.2	0.0166	0.0109	560.267933	NA	NA	
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		4	Clay	36	0.4450	0.4450	NA	0.000266	0.0010	
		5	Soil	24	0.0863	0.0863	NA	NA	NA	
		6	Waste	1440	0.2164	0.2164	NA	NA	NA	
		7	Soil	24	0.1050	0.1050	NA	NA	NA	
		8	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		9	Geomembrane	0.06	0.0000	0.0000	NA	0.000000	0.0000	
		10	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		11	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		12	Clay	36	0.4450	0.4450	NA	0.000000	0.0000	

Note:
(1) Values based on average annual totals.
(2) Peak daily values may be higher due to storm events.
(3) Final moisture contents from each run were used as initial moisture contents for subsequent runs.
(4) Results from Alternative Liner System HELP Analysis Revision 0

TABLE 6
GANDY LANDFILL SLOPE MTR LINER

YEARS	PRECIPITATION (gal/acre/day)(1)	LAYER	LAYER TYPE	THICKNESS (inches)	INITIAL M.C.(3) (vol/vol)	FINAL M.C.(3) (vol/vol)	LATERAL DRAINAGE (gal/acre/day)(1)	PERCOLATION (gal/acre/day)(1)	HEAD ON LAYER (inches)(1)	COMMENTS
0-1	0.000000	1	Waste	60	0.2055	0.2092	NA	NA	NA	
		2	Soil	24	0.0863	0.1065	NA	NA	NA	
		3	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		4	Geomembrane	0.06	0.0000	0.0000	NA	0.000000	0.0000	
		5	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		6	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		7	Clay	36	0.4450	0.4450	NA	0.000000	0.0000	
2-5	0.000000	1	Waste	840	0.2092	0.2128	NA	NA	NA	
		2	Soil	24	0.1065	0.1050	NA	NA	NA	
		3	Sand	12	0.0450	0.0450	0.467215	NA	NA	
		4	Geomembrane	0.06	0.0000	0.0000	NA	0.202343	0.0000	
		5	Sand	12	0.0450	0.0450	0.202240	NA	NA	
		6	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		7	Clay	36	0.4450	0.4450	NA	0.000123	0.0000	
6-10	0.000000	1	Waste	1080	0.2128	0.2164	NA	NA	NA	
		2	Soil	24	0.1050	0.1050	NA	NA	NA	
		3	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		4	Geomembrane	0.06	0.0000	0.0000	NA	0.000000	0.0000	
		5	Sand	12	0.0450	0.4500	0.000000	NA	NA	
		6	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		7	Clay	36	0.4450	0.4450	NA	0.000000	0.0000	

TABLE 6
GANDY LANDFILL SLOPE MTR LINER

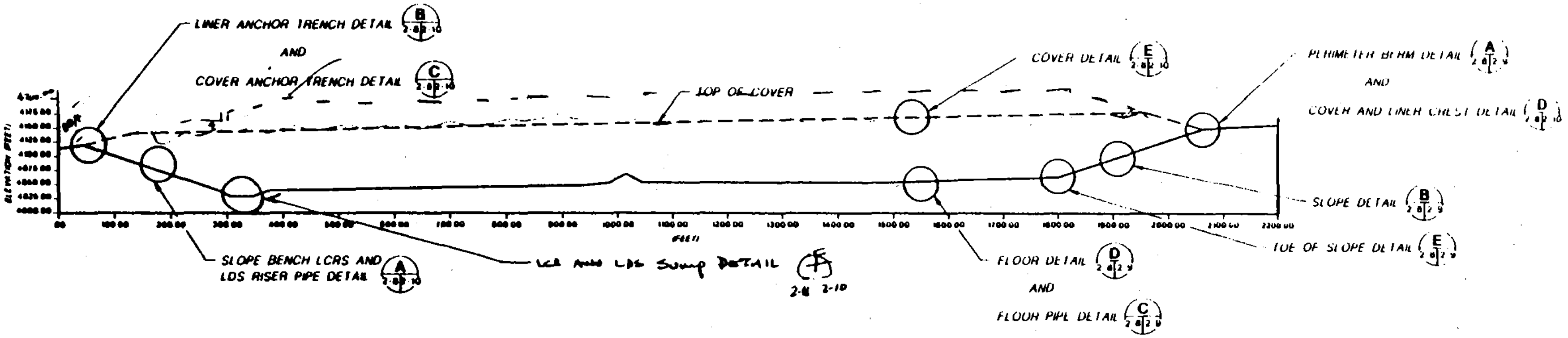
11	0.000000	1	Veg. Soil	24	0.0863	0.0938	NA	NA	NA	
		2	Geocomposite	0.2	0.0100	0.0110	539.163562	NA	NA	
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		4	Clay	36	0.4450	0.4450	NA	0.000205	0.0010	
		5	Soil	24	0.0863	0.0863	NA	NA	NA	
		6	Waste	1440	0.2164	0.2164	NA	NA	NA	
		7	Soil	24	0.1050	0.1050	NA	NA	NA	
		8	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		9	Geomembrane	0.06	0.0000	0.0000	NA	0.000000	0.0000	
		10	Sand	12	0.4500	0.0450	0.000000	NA	NA	
		11	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		12	Clay	36	0.4450	0.4450	NA	0.000000	0.0000	
12-31	0.000000	1	Veg. Soil	24	0.0938	0.0709	NA	NA	NA	
		2	Geocomposite	0.2	0.0110	0.0166	538.388928	NA	NA	
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		4	Clay	36	0.4450	0.4450	NA	0.000246	0.0010	
		5	Soil	24	0.0863	0.0863	NA	NA	NA	
		6	Waste	1440	0.2164	0.2164	NA	NA	NA	
		7	Soil	24	0.1050	0.1050	NA	NA	NA	
		8	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		9	Geomembrane	0.06	0.0000	0.0000	NA	0.000000	0.0000	
		10	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		11	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		12	Clay	36	0.4450	0.4450	NA	0.000000	0.0000	

TABLE 6
GANDY LANDFILL SLOPE MTR LINER

32-40	0.000000	1	Veg. Soil	24	0.0709	0.0652	NA	NA	NA	
		2	Geocomposite	0.2	0.0166	0.0109	560.267933	NA	NA	
		3	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		4	Clay	36	0.4450	0.4450	NA	0.000266	0.0010	
		5	Soil	24	0.0863	0.0863	NA	NA	NA	
		6	Waste	1440	0.2164	0.2164	NA	NA	NA	
		7	Soil	24	0.1050	0.1050	NA	NA	NA	
		8	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		9	Geomembrane	0.06	0.0000	0.0000	NA	0.000000	0.0000	
		10	Sand	12	0.0450	0.0450	0.000000	NA	NA	
		11	Geomembrane	0.06	0.0000	0.0000	NA	NA	NA	
		12	Clay	36	0.4450	0.4450	NA	0.000000	0.0000	

Notes:

(1) Values based on average annual totals.
(2) Peak daily values may be higher due to storm events.
(3) Final moisture contents from each run were used as initial moisture contents for subsequent runs.
(4) Results from Alternative Liner System HELP Analysis Revision 0



A 2-8 CROSS-SECTION A-A'

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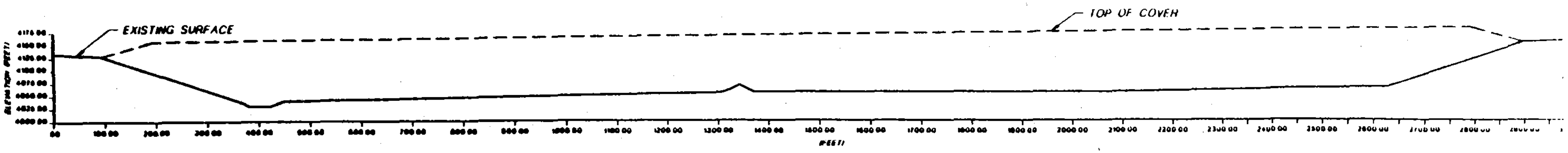

B 2-8 CROSS-SECTION B-B'

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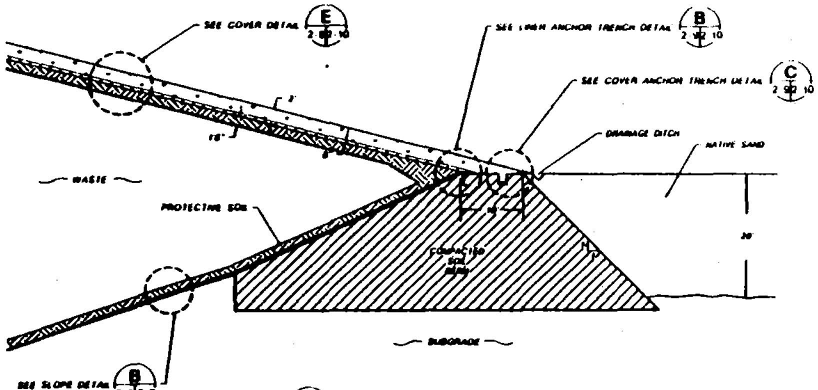
0	CONCEPTUAL DESIGN FOR PART B APPLICATION		

SCALE
SEE SCALE BAR
DESIGN BY
J.KENDALL
DRAWN BY
L SIMONSEN
CHECK BY
P CORSER
PROJECT No
602 0100
FILE NAME
AS GAND

GM inc

PROJECT
TRIASSIC PARK WASTE DISPOSAL FA

DRAWING TITLE
CONCEPTUAL LANDFIL
FILL PLAN CROSS-SECTIO



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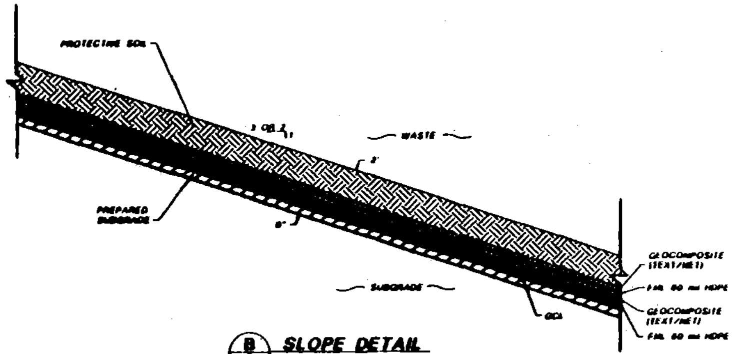

(B) SLOPE DETAIL
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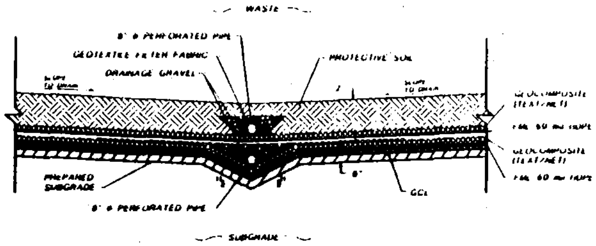

(C) FLOOR PIPE DETAIL
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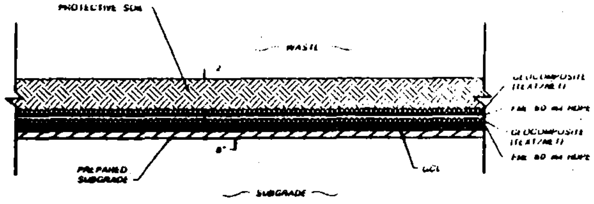

(D) FLOOR DETAIL
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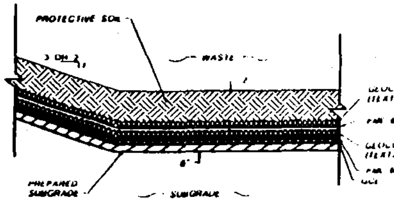
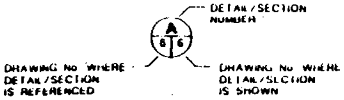


(E) TOE OF SLOPE DETAIL
Not To Scale

NOTES
1) PROTECTIVE SOIL CONSISTS OF SELECT SOILS
2) GEOMEMBRANE IS A MIN 60 mil HDPE
3) GEOCOMPOSITE CONSISTS OF GEOTEXTILE BONDED TO GEONET



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AS NOTED
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[illegible]
DRAWN BY
[illegible]
CHECK BY
[illegible]
PROJECT No
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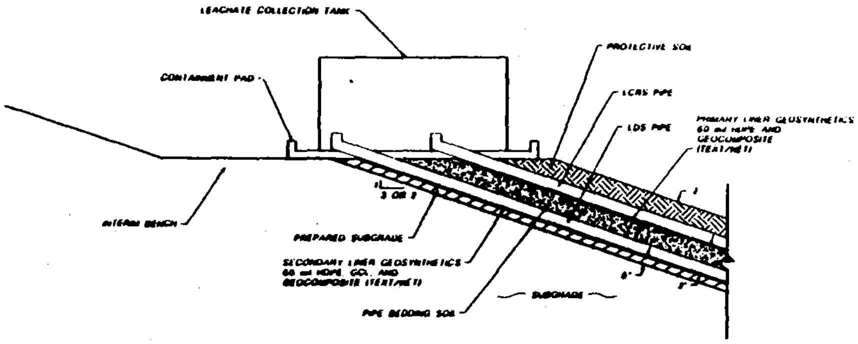
FILE NAME
[illegible]

GM inc

PROJECT
TRIASSIC PARK WASTE DISPOSAL

DRAWING TITLE
CONCEPTUAL
LANDFILL LINER DETAI



(A 2-80 10) SLOPE BENCH LCRS AND LDS RISER PIPE DETAIL
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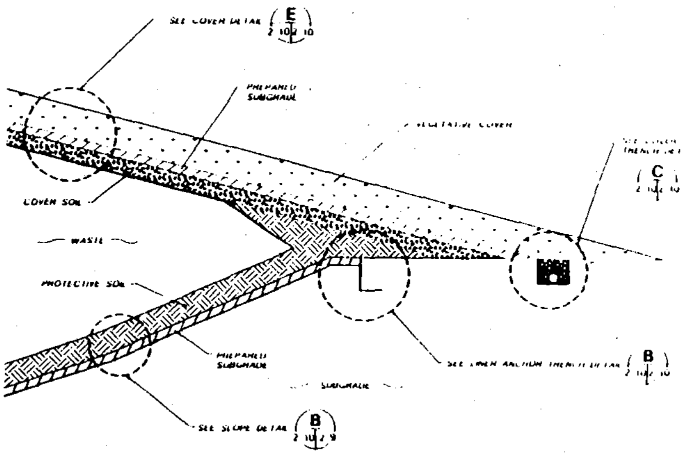

(D 2-8 2-10) COVER AND LINER CREST DETAIL
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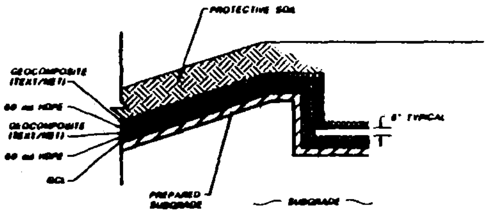

(B 2-80 10) LINER ANCHOR TRENCH DETAIL
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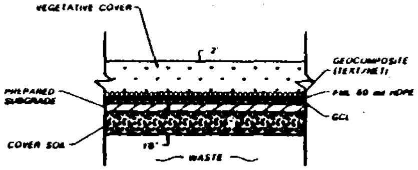

(E 2-80 10) COVER DETAIL
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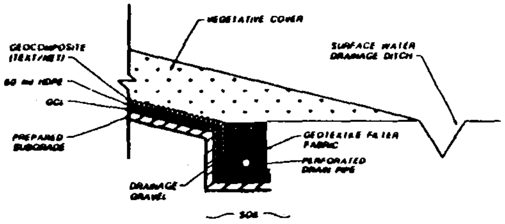
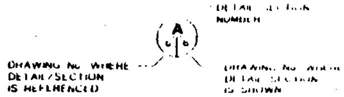


(C 2-80 10) COVER ANCHOR TRENCH DETAIL
Not To Scale

NOTES
1) PROTECTIVE SOIL CONSISTS OF SELECT SOILS
2) GEOMEMBRANE IS A MIN 60 mil HDPE
3) GEOCOMPOSITE CONSISTS OF GEOTEXTILE BONDED TO GEONET
4) ACTUAL SIZE, LOCATION, TYPE AND ORIENTATION OF LCRS PIPES AND TANKS ON SLOPE BENCHES AND ON LANDFILL CREST TO BE DETERMINED DURING FINAL DESIGN



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SCALE AS NOTED
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DRAWN BY [illegible]
CHECK BY [illegible]
PROJECT No [illegible]
FILE NAME [illegible]

GM inc

PROJECT
TRIASSIC PARK WASTE DISPOSAL FACI

DRAWING TITLE
CONCEPTUAL LANDFILL LCRS DETAILS

APPENDIX A

HELP INPUT DATA SHEETS

TABLE 1
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
CLIMATOLOGICAL DATA		
city	Roswell, NM	Nearby City
precipitation & source of data (default or synthetic)	Synthetic	Only option for Roswell, NM
temperature & source of data	Synthetic	Roswell, NM
latitude	33.24	HELP default for Roswell, NM
maximum leaf area index	0	Bare Ground
evaporate zone depth	14 in.	HELP default for Roswell, NM
growing season start and end day	76/310	HELP default for Roswell, NM
LANDFILL COVER DATA		
type of vegetative cover	NA	Bare Ground
SCS runoff curve number	NA	0% allowable runoff CN does not affect results
active (uncovered)	Yes	
% of surface runoff that drains from landfill	0%	
surface area	1 acre	Unit area, (outputs to be converted to gallons/acre/day)
SOIL AND DESIGN DATA		
source of soil characteristics		HELP defaults, useing lab data for onsite soils
number of layers	6	
NOTES:		

PROJECT: Triassic Park Disposal Facility, Alternative #2 Floor Liner System

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 1		
layer type	1	Protective soil, (Vertical percolation layer)
thickness	24 in	See liner section
soil texture	4	HELP Default for a SM, (lab data indicates onsite soil to be a SM)
porosity	0.473	HELP default for texture 4
field capacity	0.0105	HELP default for texture 4
wilting point	0.047	HELP default for texture 4
moisture content	0.0863	Based on a avg. M.C.= 5.9% for Natural moisture contents of Silty Sands tested from the site.
saturated hydraulic conductivity	1.7E-3cm/s	HELP default for texture 4
Is layer compacted?	No	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Alternative #2 floor liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 2		
layer type	2	Geocomposite (lateral drainage layer)
thickness	0.2 in	HELP default thickness for texture 20(consistant w/ materials on the market)
soil texture	20	HELP Default for drainage net.(conservative, ignores added capacity of geotextile
porosity	0.850	HELP default for texture 20
field capacity	0.010	HELP default for texture 20
wilting point	0.005	HELP default for texture 20
moisture content	0.010	Moisture content equal to field capacity, does not allow for water storage in Lateral drainage layer
saturated hydraulic conductivity	1.0E1cm/s	HELP default for texture 20
is layer compacted?	NA	
slope (if lateral drainage layer)	2.3%	Floor grade from cell layout drawing
maximum horizontal drainage distance (if lateral drainage layer)	550 ft	Maximum drainage length for phase 1 floor (scaled from drawings)
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Alternative #2 floor Liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 3		
layer type	4	FML, (HDPE Geomembrane)
thickness	0.06 in	60 mil (typical geomembrane thickness)
soil texture	35	HELP Default texture for HDPE geomembrane.
porosity	NA	
field capacity	NA	
wilting point	NA	
moisture content	NA	
saturated hydraulic conductivity	2.0E-13cm/s	HELP default for texture 35
Is layer compacted?	NA	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	1	Typical value recommended by HELP manual.
geomembrane installation defects	3	Typical value recommended by HELP manual for good installation.
liner installation quality (if geomembrane)	3	Good installation
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Alternative #2 floor liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 4		
layer type	2	Geocomposite (lateral drainage layer)
thickness	0.2 in	HELP default thickness for texture 20(consistant w/ materials on the market)
soil texture	20	HELP Default for drainage net.(conservative, ignores added capacity of geotextile
porosity	0.850	HELP default for texture 20
field capacity	0.010	HELP default for texture 20
wilting point	0.005	HELP default for texture 20
moisture content	0.010	Moisture content equal to field capacity, does not allow for water storage in Lateral drainage layer
saturated hydraulic conductivity	1.0E1cm/s	HELP default for texture 20
is layer compacted?	NA	
slope (if lateral drainage layer)	2.3%	Floor grade from cell layout drawing
maximum horizontal drainage distance (if lateral drainage layer)	550 ft	Maximum drainage length for phase 1 floor (scaled from drawings)
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Alternative #2 floor Liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 5		
layer type	4	FML, (HDPE Geomembrane)
thickness	0.06 in	60 mil (typical geomembrane thickness)
soil texture	35	HELP Default texture for HDPE geomembrane.
porosity	NA	
field capacity	NA	
wilting point	NA	
moisture content	NA	
saturated hydraulic conductivity	2.0E-13cm/s	HELP default for texture 35
is layer compacted?	NA	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	1	Typical value recommended by HELP manual.
geomembrane installation defects	3	Typical value recommended by HELP manual for good installation.
liner installation quality (if geomembrane)	3	Good installation
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Alternative #2 floor liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 6		
layer type	3	GCL
thickness	0.24 in	HELP default thickness for bentonite mat
soil texture	17	HELP Default texture for bentonite mat
porosity	0.750	HELP default for texture 17
field capacity	0.747	HELP default for texture 17
wilting point	0.400	HELP default for texture 17
moisture content	0.750	Moisture content equal to porosity, allows for imediate saturated flow (HELP default).
saturated hydraulic conductivity	3.0E-9cm/s	HELP default for bentonite mat
is layer compacted?	No	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Alternative #2 floor liner system

TABLE 1
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
CLIMATOLOGICAL DATA		
city	Roswell, NM	Nearby City
precipitation & source of data (default or synthetic)	Synthetic	Only option for Roswell, NM
temperature & source of data	Synthetic	Roswell, NM
latitude	33.24	HELP default for Roswell, NM
maximum leaf area index	0	Bare Ground
evaporate zone depth	14 in.	HELP default for Roswell, NM
growing season start and end day	76/310	HELP default for Roswell, NM
LANDFILL COVER DATA		
type of vegetative cover	NA	Bare Ground
SCS runoff curve number	NA	0% allowable runoff CN does not affect results
active (uncovered)	Yes	
% of surface runoff that drains from landfill	0%	
surface area	1 acre	Unit area, (outputs to be converted to gallons/acre/day)
SOIL AND DESIGN DATA		
source of soil characteristics		HELP defaults, useing lab data for onsite soils
number of layers	6	
NOTES:		

PROJECT: Triassic Park Disposal Facility, Alternative #2 slope Liner System

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 1		
layer type	1	Protective soil, (Vertical percolation layer)
thickness	24 in	See liner section
soil texture	4	HELP Default for a SM, (lab data indicates onsite soil to be a SM)
porosity	0.473	HELP default for texture 4
field capacity	0.0105	HELP default for texture 4
wilting point	0.047	HELP default for texture 4
moisture content	0.0863	Based on a avg. M.C. = 5.9% for Natural moisture contents of Silty Sands tested from the site.
saturated hydraulic conductivity	1.7E-3cm/s	HELP default for texture 4
is layer compacted?	No	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	
NOTES: (make additional copies for each layer as required)		

PROJECT: Triassic Park Disposal Facility, Alternative #2 slope liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 2		
layer type	2	Geocomposite (lateral drainage layer)
thickness	0.2 in	HELP default thickness for texture 20(consistant w/ materials on the market)
soil texture	20	HELP Default for drainage net.(conservative, ignores added capacity of geotextile
porosity	0.850	HELP default for texture 20
field capacity	0.010	HELP default for texture 20
wilting point	0.005	HELP default for texture 20
moisture content	0.010	Moisture content equal to field capacity, does not allow for water storage in Lateral drainage layer
saturated hydraulic conductivity	1.0E1cm/s	HELP default for texture 20
is layer compacted?	NA	
slope (if lateral drainage layer)	33%	slope grade from cell layout drawing
maximum horizontal drainage distance (if lateral drainage layer)	316 ft	Maximum drainage length for phase 1 slope (scaled from drawings)
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Alternative #2 slope Liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 3		
layer type	4	FML, (HDPE Geomembrane)
thickness	0.06 in	60 mil (typical geomembrane thickness)
soil texture	35	HELP Default texture for HDPE geomembrane.
porosity	NA	
field capacity	NA	
wilting point	NA	
moisture content	NA	
saturated hydraulic conductivity	2.0E-13cm/s	HELP default for texture 35
is layer compacted?	NA	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	1	Typical value recommended by HELP manual.
geomembrane installation defects	3	Typical value recommended by HELP manual for good installation.
liner installation quality (if geomembrane)	3	Good installation
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Alternative #2 slope liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 4		
layer type	2	Geocomposite (lateral drainage layer)
thickness	0.2 in	HELP default thickness for texture 20(consistant w/ materials on the market)
soil texture	20	HELP Default for drainage net.(conservative, ignores added capacity of geotextile
porosity	0.850	HELP default for texture 20
field capacity	0.010	HELP default for texture 20
wilting point	0.005	HELP default for texture 20
moisture content	0.010	Moisture content equal to field capacity, does not allow for water storage in Lateral drainage layer
saturated hydraulic conductivity	1.0E1cm/s	HELP default for texture 20
Is layer compacted?	NA	
slope (if lateral drainage layer)	33%	Slope grade from cell layout drawing
maximum horizontal drainage distance (if lateral drainage layer)	316 ft	Maximum drainage length for phase 1 slope (scaled from drawings)
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Alternative #2 slope Liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 5		
layer type	4	FML, (HDPE Geomembrane)
thickness	0.06 in	60 mil (typical geomembrane thickness)
soil texture	35	HELP Default texture for HDPE geomembrane.
porosity	NA	
field capacity	NA	
wilting point	NA	
moisture content	NA	
saturated hydraulic conductivity	2.0E-13cm/s	HELP default for texture 35
Is layer compacted?	NA	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	1	Typical value recommended by HELP manual.
geomembrane installation defects	3	Typical value recommended by HELP manual for good installation.
liner installation quality (if geomembrane)	3	Good installation
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Alternative #2 slope liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 6		
layer type	3	GCL
thickness	0.24 in	HELP default thickness for bentonite mat
soil texture	17	HELP Default texture for bentonite mat
porosity	0.750	HELP default for texture 17
field capacity	0.747	HELP default for texture 17
wilting point	0.400	HELP default for texture 17
moisture content	0.750	Moisture content equal to porosity, allows for imediate saturated flow (HELP default).
saturated hydraulic conductivity	3.0E-9cm/s	HELP default for bentonite mat
Is layer compacted?	No	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Alternative #2 slope liner system

TABLE 1
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
CLIMATOLOGICAL DATA		
city	Roswell, NM	Nearby City
precipitation & source of data (default or synthetic)	Synthetic	Only option for Roswell, NM, using 30 yr mean monthly inputs
temperature & source of data	Synthetic	Roswell, NM using 30yr mean monthly inputs
latitude	33.24	HELP default for Roswell, NM
maximum leaf area index	1	Poor stand of grass
evaporate zone depth	24 in.	Maximum depth of vegetative soil
growing season start and end day	76/310	HELP default for Roswell, NM
LANDFILL COVER DATA		
type of vegetative cover	1	Poor stand of grass
SCS runoff curve number	74.9	HELP model generated, Soil texture 4, 25% slope, poor stand of grass
active (uncovered)	No	
% of surface runoff that drains from landfill	100%	
surface area	1 acre	Unit area, (outputs to be converted to gallons/acre/day)
SOIL AND DESIGN DATA		
source of soil characteristics		HELP defaults, useing lab data for onsite soils
number of layers	6	
NOTES:		

PROJECT: Triassic Park Disposal Facility, Cover Liner System

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 1		
layer type	1	Vegetative soil, (Vertical percolation layer)
thickness	24 in	See liner section
soil texture	6	HELP Default for a SM, (geologic data indicates some onsite soil to be a SM w/ a lower permeability than other SM's on site)
porosity	0.453	HELP default for texture 6
field capacity	0.190	HELP default for texture 6
wilting point	0.085	HELP default for texture 6
moisture content	0.0863	Based on a avg. M.C. = 5.9% for Natural moisture contents of Silty Sands tested from the site.
saturated hydraulic conductivity	7.2E-4cm/s	HELP default for texture 4
Is layer compacted?	No	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Cover Alternative

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 2		
layer type	2	Geocomposite (lateral drainage layer)
thickness	0.2 in	HELP default thickness for texture 20(consistant w/ materials on the market)
soil texture	20	HELP Default for drainage net.(conservative, ignores added capacity of geotextile
porosity	0.850	HELP default for texture 20
field capacity	0.010	HELP default for texture 20
wilting point	0.005	HELP default for texture 20
moisture content	0.010	Moisture content equal to field capacity, does not allow for water storage in Lateral drainage layer
saturated hydraulic conductivity	1.0E1cm/s	HELP default for texture 20
is layer compacted?	NA	
slope (if lateral drainage layer)	25%	See cover section
maximum horizontal drainage distance (if lateral drainage layer)	550 ft	Estimate
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Cover Alternative

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 3		
layer type	4	FMC, (HDPE Geomembrane)
thickness	0.06 in	60 mil (typical geomembrane thickness)
soil texture	35	HELP Default texture for HDPE geomembrane.
porosity	NA	
field capacity	NA	
wilting point	NA	
moisture content	NA	
saturated hydraulic conductivity	2.0E-13cm/s	HELP default for texture 35
Is layer compacted?	NA	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	1	Typical value recommended by HELP manual.
geomembrane installation defects	3	Typical value recommended by HELP manual for good installation.
liner installation quality (if geomembrane)	3	Good installation
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Cover Alternative

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 4		
layer type	3	GCL
thickness	0.24 in	See Cover section
soil texture	17	HELP Default for bentonite mat
porosity	0.750	HELP default for texture 17
field capacity	0.747	HELP default for texture 17
wilting point	0.400	HELP default for texture 17
moisture content	0.750	Moisture content equal to porosity, allows for imediate saturated flow (HELP default).
saturated hydraulic conductivity	3.0E-9cm/s	HELP default for bentonite mat.
Is layer compacted?	No	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Cover Alternative

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 5		
layer type	1	Protective soil, (Vertical percolation layer)
thickness	6 in	See cover section
soil texture	4	HELP Default for a SM, (lab data indicates onsite soil to be a SM)
porosity	0.473	HELP default for texture 4
field capacity	0.0105	HELP default for texture 4
wilting point	0.047	HELP default for texture 4
moisture content	0.0863	Based on a avg. M.C. = 5.9% for Natural moisture contents of Silty Sands tested from the site.
saturated hydraulic conductivity	1.7E-3cm/s	HELP default for texture 4
Is layer compacted?	Yes	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, Cover Alternative

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 6		
layer type	1	Protective soil, (Vertical percolation layer)
thickness	18 in	See cover section
soil texture	4	HELP Default for a SM, (lab data indicates onsite soil to be a SM)
porosity	0.473	HELP default for texture 4
field capacity	0.0105	HELP default for texture 4
wilting point	0.047	HELP default for texture 4
moisture content	0.0863	Based on a avg. M.C. = 5.9% for Natural moisture contents of Silty Sands tested from the site.
saturated hydraulic conductivity	1.7E-3cm/s	HELP default for texture 4
Is layer compacted?	No	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	
NOTES: (make additional copies for each layer as required)		

PROJECT: Triassic Park Disposal Facility, Cover Alternative

TABLE 1
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
CLIMATOLOGICAL DATA		
city	Roswell, NM	Nearby City
precipitation & source of data (default or synthetic)	Synthetic	Only option for Roswell, NM Using 30yr avg mean monthly inputs
temperature & source of data	Synthetic	Roswell, NM using 30 yr avg. mean monthly inputs
latitude	33.24	HELP default for Roswell, NM
maximum leaf area index	0	Bare Ground
evaporate zone depth	14 in.	HELP default for Roswell, NM
growing season start and end day	76/310	HELP default for Roswell, NM
LANDFILL COVER DATA		
type of vegetative cover	NA	Bare Ground
SCS runoff curve number	NA	0% allowable runoff CN does not affect results
active (uncovered)	Yes	
% of surface runoff that drains from landfill	0%	
surface area	1 acre	Unit area, (outputs to be converted to gallons/acre/day)
SOIL AND DESIGN DATA		
source of soil characteristics		HELP defaults, useing lab data for onsite soils
number of layers	6	
NOTES:		

PROJECT: Triassic Park Disposal Facility, MTR Floor Liner System

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 1		
layer type	1	Protective soil, (Vertical percolation layer)
thickness	24 in	See liner section
soil texture	4	HELP Default for a SM, (lab data indicates onsite soil to be a SM)
porosity	0.473	HELP default for texture 4
field capacity	0.0105	HELP default for texture 4
wilting point	0.047	HELP default for texture 4
moisture content	0.0863	Based on avg moisture content of bulk samples taken from site
saturated hydraulic conductivity	1.7E-3cm/s	HELP default for texture 4
Is layer compacted?	No	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	
NOTES: (make additional copies for each layer as required)		

PROJECT: Triassic Park Disposal Facility, MTR floor liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 2		
layer type	2	Sand lateral drainage layer
thickness	12 in	See liner section, (ignore geotextile cushion & seperation layers)
soil texture	1	HELP Default for a poorly graded sand, (typical drainage material).
porosity	0.417	HELP default for texture 1
field capacity	0.045	HELP default for texture 1
wilting point	0.018	HELP default for texture 1
moisture content	0.045	Moisture content equal to field capacity (does not allow storage)
saturated hydraulic conductivity	1.0E-2cm/s	HELP default for texture 1 (also EPA minimum required value)
Is layer compacted?	No	
slope (if lateral drainage layer)	2.3%	Floor grade from cell layout drawing
maximum horizontal drainage distance (if lateral drainage layer)	550 ft	Maximum drainage length for phase 1 floor (scaled from drawings)
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, MTR floor liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 3		
layer type	4	FML, (HDPE Geomembrane)
thickness	0.06 in	60 mil (typical geomembrane thickness)
soil texture	35	HELP Default texture for HDPE geomembrane.
porosity	NA	
field capacity	NA	
wilting point	NA	
moisture content	NA	
saturated hydraulic conductivity	2.0E-13cm/s	HELP default for texture 35
is layer compacted?	NA	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	1	Typical value recommended by HELP manual.
geomembrane installation defects	3	Typical value recommended by HELP manual for good installation.
liner installation quality (if geomembrane)	3	Good installation
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, MTR floor liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 4		
layer type	2	Sand lateral drainage layer
thickness	12 in	See liner section, (ignore geotextile cushion & seperation layers)
soil texture	1	HELP Default for a poorly graded sand, (typical drainage material).
porosity	0.417	HELP default for texture 1
field capacity	0.045	HELP default for texture 1
wilting point	0.018	HELP default for texture 1
moisture content	0.045	Moisture content equal to field capacity (does not allow storage)
saturated hydraulic conductivity	1.0E-2cm/s	HELP default for texture 1 (also EPA minimum required value)
is layer compacted?	No	
slope (if lateral drainage layer)	2.3%	Floor grade from cell layout drawing
maximum horizontal drainage distance (if lateral drainage layer)	550 ft	Maximum drainage length for phase 1 floor (scaled from drawings)
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	
NOTES: (make additional copies for each layer as required)		

PROJECT: Triassic Park Disposal Facility, MTR floor liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 5		
layer type	4	FML, (HDPE Geomembrane)
thickness	0.06 in	60 mil (typical geomembrane thickness)
soil texture	35	HELP Default texture for HDPE geomembrane.
porosity	NA	
field capacity	NA	
wilting point	NA	
moisture content	NA	
saturated hydraulic conductivity	2.0E-13cm/s	HELP default for texture 35
Is layer compacted?	NA	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	1	Typical value recommended by HELP manual.
geomembrane installation defects	3	Typical value recommended by HELP manual for good installation.
liner installation quality (if geomembrane)	3	Good installation
geotextile transmissivity	NA	

<u>NOTES:</u> (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, MTR floor liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 6		
layer type	3	Compacted Clay Liner
thickness	36 in	See liner section
soil texture	0	HELP Default texture 26 (compacted CL) w/ a modified k value. (lab data indicates soil to be a CL)
porosity	0.445	HELP default for texture 26
field capacity	0.393	HELP default for texture 26
wilting point	0.445	HELP default for texture 26
moisture content	0.445	Moisture content equal to porosity (allows for immediate saturated flow)
saturated hydraulic conductivity	1.0E-7cm/s	Lab data indicates this permeability is possible w/ this soil.
is layer compacted?	YES	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, MTR floor liner system

TABLE 1
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
CLIMATOLOGICAL DATA		
city	Roswell, NM	Nearby City
precipitation & source of data (default or synthetic)	Synthetic	Only option for Roswell, NM using 30 yr avg. mean monthly inputs
temperature & source of data	Synthetic	Roswell, NM using 30 yr avg. mean monthly inputs
latitude	33.24	HELP default for Roswell, NM
maximum leaf area index	0	Bare Ground
evaporate zone depth	14 in.	HELP default for Roswell, NM
growing season start and end day	76/310	HELP default for Roswell, NM
LANDFILL COVER DATA		
type of vegetative cover	NA	Bare Ground
SCS runoff curve number	NA	0% allowable runoff CN does not affect results
active (uncovered)	Yes	
% of surface runoff that drains from landfill	0%	
surface area	1 acre	Unit area, (outputs to be converted to gallons/acre/day)
SOIL AND DESIGN DATA		
source of soil characteristics		HELP defaults, useing lab data for onsite soils
number of layers	6	
NOTES:		

PROJECT: Triassic Park Disposal Facility, Slope MTR Liner System

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 1		
layer type	1	Protective soil, (Vertical percolation layer)
thickness	24 in	See liner section
soil texture	4	HELP Default for a SM, (lab data indicates onsite soil to be a SM)
porosity	0.473	HELP default for texture 4
field capacity	0.0105	HELP default for texture 4
wilting point	0.047	HELP default for texture 4
moisture content	0.0863	Based on a avg. M.C. = 5.9% for Natural moisture contents of Silty Sands tested from the site.
saturated hydraulic conductivity	1.7E-3cm/s	HELP default for texture 4
Is layer compacted?	No	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	
NOTES: (make additional copies for each layer as required)		

PROJECT: Triassic Park Disposal Facility, MTR slope liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 2		
layer type	2	Sand lateral drainage layer
thickness	12 in	See liner section, (ignore geotextile cushion & seperation layers)
soil texture	1	HELP Default for a poorly graded sand, (typical drainage material).
porosity	0.417	HELP default for texture 1
field capacity	0.045	HELP default for texture 1
wilting point	0.018	HELP default for texture 1
moisture content	0.045	Moisture content equal to field capacity, does not allow for water storage in lateral drainage layer.
saturated hydraulic conductivity	1.0E-2cm/s	HELP default for texture 1 (also EPA minimum required value)
Is layer compacted?	No	
slope (if lateral drainage layer)	33%	slope grade from cell layout drawing
maximum horizontal drainage distance (if lateral drainage layer)	316 ft	Maximum drainage length for phase 1 slope (scaled from drawings)
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, MTR slope liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 3		
layer type	4	FML, (HDPE Geomembrane)
thickness	0.06 in	60 mil (typical geomembrane thickness)
soil texture	35	HELP Default texture for HDPE geomembrane.
porosity	NA	
field capacity	NA	
wilting point	NA	
moisture content	NA	
saturated hydraulic conductivity	2.0E-13cm/s	HELP default for texture 35
is layer compacted?	NA	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	1	Typical value recommended by HELP manual.
geomembrane installation defects	3	Typical value recommended by HELP manual for good installation.
liner installation quality (if geomembrane)	3	Good installation
geotextile transmissivity	NA	
NOTES: (make additional copies for each layer as required)		

PROJECT: Triassic Park Disposal Facility, MTR slope liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 4		
layer type	2	Sand lateral drainage layer
thickness	12 in	See liner section, (ignore geotextile cushion & seperation layers)
soil texture	1	HELP Default for a poorly graded sand, (typical drainage material).
porosity	0.417	HELP default for texture 1
field capacity	0.045	HELP default for texture 1
wilting point	0.018	HELP default for texture 1
moisture content	0.045	Moisture content equal to field capacity, does not allow for water storage in lateral drainage layer.
saturated hydraulic conductivity	1.0E-2cm/s	HELP default for texture 1 (also EPA minimum required value)
is layer compacted?	No	
slope (if lateral drainage layer)	33%	Slope grade from cell layout drawing
maximum horizontal drainage distance (if lateral drainage layer)	316 ft	Maximum drainage length for phase 1 slope (scaled from drawings)
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, MTR slope liner system

TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 5		
layer type	4	FML, (HDPE Geomembrane)
thickness	0.06 in	60 mil (typical geomembrane thickness)
soil texture	35	HELP Default texture for HDPE geomembrane.
porosity	NA	
field capacity	NA	
wilting point	NA	
moisture content	NA	
saturated hydraulic conductivity	2.0E-13cm/s	HELP default for texture 35
is layer compacted?	NA	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	1	Typical value recommended by HELP manual.
geomembrane installation defects	3	Typical value recommended by HELP manual for good installation.
liner installation quality (if geomembrane)	3	Good installation
geotextile transmissivity	NA	

NOTES: (make additional copies for each layer as required)

PROJECT: Triassic Park Disposal Facility, MTR slope liner system

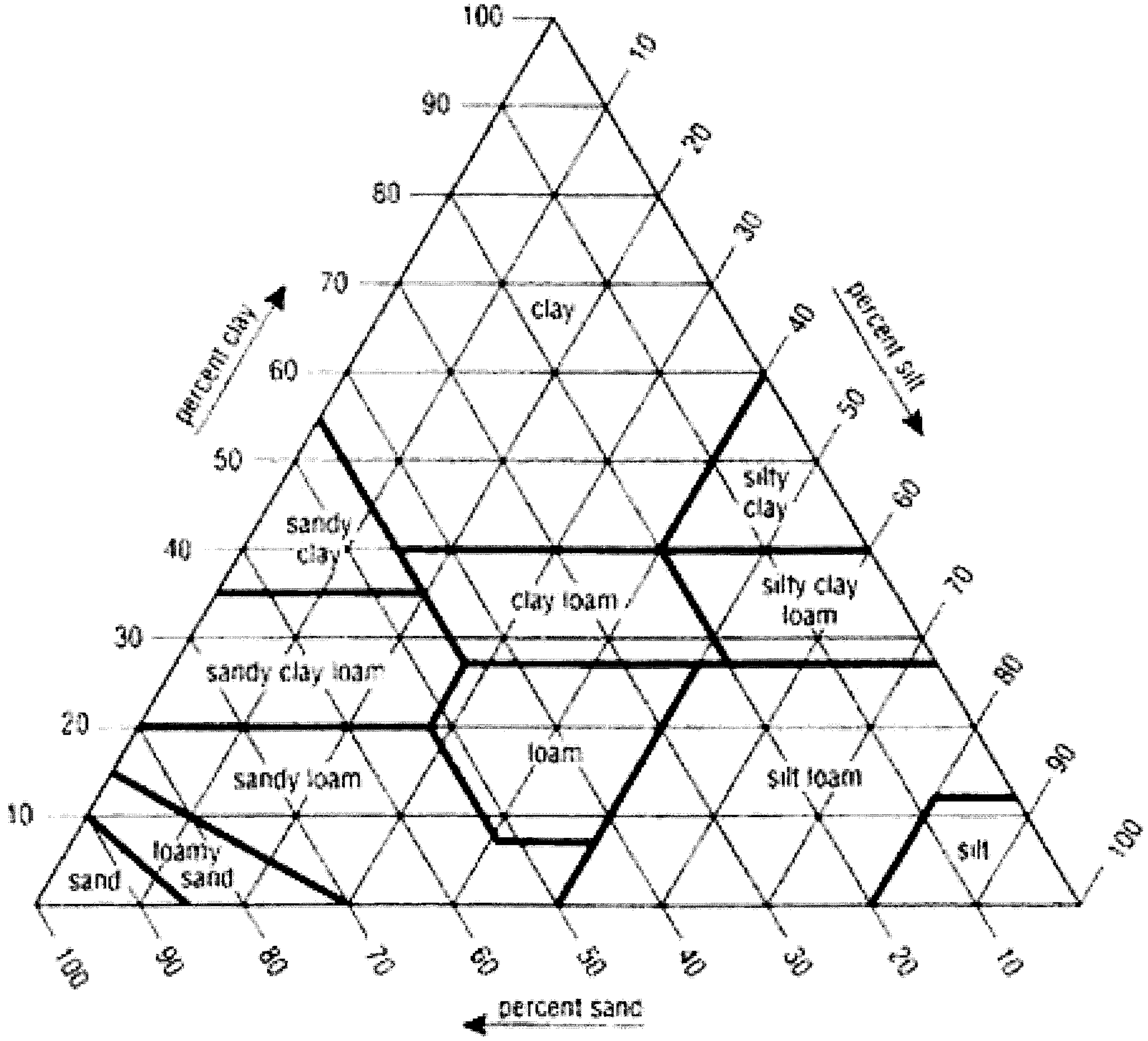
TABLE 2
LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER: 6		
layer type	3	Compacted Clay Liner
thickness	36 in	See liner section
soil texture	0	HELP Default texture 26 (compacted CL) w/ a modified k value. (lab data indicates soil to be a CL)
porosity	0.445	HELP default for texture 26
field capacity	0.393	HELP default for texture 26
wilting point	0.445	HELP default for texture 26
moisture content	0.445	Moisture content equal to porosity, allows for imediate saturated flow (HELP default).
saturated hydraulic conductivity	1.0E-7cm/s	Lab data indicates this permeability is possible w/ this soil.
is layer compacted?	YES	
slope (if lateral drainage layer)	NA	
maximum horizontal drainage distance (if lateral drainage layer)	NA	
geomembrane pinhole density	NA	
geomembrane installation defects	NA	
liner installation quality (if geomembrane)	NA	
geotextile transmissivity	NA	
NOTES: (make additional copies for each layer as required)		

PROJECT: Triassic Park Disposal Facility, MTR slope liner system

APPENDIX B

HELP SIMULATION SUMMARY PRINTOUTS



percent clay
percent silt
percent sand
100
90
80
70
60
50
40
30
20
10
clay
silty clay
sandy clay
clay loam
silty clay loam
sandy clay loam
loam
sandy loam
silt loam
silt
loamy sand
sand

```
****************************************************************************
****************************************************************************
**                                                                        **
                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE             **
**                 HELP MODEL VERSION 3.04a  (10 JULY 1995)               **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                  **
**                     USAE WATERWAYS EXPERIMENT STATION                  **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
**                                                                        **
**                                                                        **
****************************************************************************
****************************************************************************


PRECIPITATION DATA FILE:     d:\602\in\flr.D4
TEMPERATURE DATA FILE:       d:\602\in\flr.D7
SOLAR RADIATION DATA FILE:   d:\602\in\flr.D13
EVAPOTRANSPIRATION DATA:     d:\602\in\flr.D11
SOIL AND DESIGN DATA FILE:   d:\602\in\ALT2FLR.D10
OUTPUT DATA FILE:            d:\602\out\alt2flr.OUT


TIME:  15: 5     DATE:   2/28/1996


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

     TITLE:  gandy alternative 2, year 0-5, floor

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


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                              LAYER  1
                              --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   4
          THICKNESS                 =     24.00   INCHES
          POROSITY                  =      0.4370 VOL/VOL
          FIELD CAPACITY            =      0.1050 VOL/VOL
          WILTING POINT             =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.0863 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.170000002000E-02 CM/SEC
```

```
                          LAYER  2
                          --------

                 TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER  20
      THICKNESS                    =      0.20   INCHES
      POROSITY                     =      0.8500 VOL/VOL
      FIELD CAPACITY               =      0.0100 VOL/VOL
      WILTING POINT                =      0.0050 VOL/VOL
      INITIAL SOIL WATER CONTENT   =      0.0100 VOL/VOL
      EFFECTIVE SAT. HYD. COND.    =   10.0000000000      CM/SEC
      SLOPE                        =      2.30   PERCENT
      DRAINAGE LENGTH              =    550.0    FEET


                          LAYER  3
                          --------

                 TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
      THICKNESS                    =      0.06   INCHES
      POROSITY                     =      0.0000 VOL/VOL
      FIELD CAPACITY               =      0.0000 VOL/VOL
      WILTING POINT                =      0.0000 VOL/VOL
      INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
      EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
      FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
      FML INSTALLATION DEFECTS     =      3.00   HOLES/ACRE
      FML PLACEMENT QUALITY        =  3 - GOOD


                          LAYER  4
                          --------

                 TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER  20
      THICKNESS                    =      0.20   INCHES
      POROSITY                     =      0.8500 VOL/VOL
      FIELD CAPACITY               =      0.0100 VOL/VOL
      WILTING POINT                =      0.0050 VOL/VOL
      INITIAL SOIL WATER CONTENT   =      0.0100 VOL/VOL
      EFFECTIVE SAT. HYD. COND.    =   10.0000000000      CM/SEC
      SLOPE                        =      2.30   PERCENT
      DRAINAGE LENGTH              =    550.0    FEET
```

```
                             LAYER  5
                             --------

                  TYPE 4 - FLEXIBLE MEMBRANE LINER
                    MATERIAL TEXTURE NUMBER  35
     THICKNESS                  =       0.06   INCHES
     POROSITY                   =       0.0000 VOL/VOL
     FIELD CAPACITY             =       0.0000 VOL/VOL
     WILTING POINT              =       0.0000 VOL/VOL
     INITIAL SOIL WATER CONTENT =       0.0000 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
     FML PINHOLE DENSITY        =       1.00   HOLES/ACRE
     FML INSTALLATION DEFECTS   =       3.00   HOLES/ACRE
     FML PLACEMENT QUALITY      =  3 - GOOD


                             LAYER  6
                             --------

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


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

   NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 4 WITH BARE
          GROUND CONDITIONS, A SURFACE SLOPE OF  2.% AND
          A SLOPE LENGTH OF  550. FEET.

   SCS RUNOFF CURVE NUMBER            =    80.50
   FRACTION OF AREA ALLOWING RUNOFF   =     0.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =    14.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =     1.208  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =     6.118  INCHES
```

```
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.658  INCHES
   INITIAL SNOW WATER                  =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =      2.255  INCHES
   TOTAL INITIAL WATER                 =      2.255  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               ----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           ROSWELL               NEW MEXICO

        STATION LATITUDE                         = 33.24 DEGREES
        MAXIMUM LEAF AREA INDEX                  =  0.00
        START OF GROWING SEASON (JULIAN DATE)    =    76
        END OF GROWING SEASON (JULIAN DATE)      =   310
        EVAPORATIVE ZONE DEPTH                   = 14.0  INCHES
        AVERAGE ANNUAL WIND SPEED                =  8.70 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY    = 49.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY    = 40.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY    = 53.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY    = 52.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
           COEFFICIENTS FOR    ROSWELL              NEW MEXICO

           NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

 JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
 -------     -------     -------     -------     -------     -------
   0.42        0.47        0.49        0.69        1.14        1.43
   1.99        1.90        1.87        1.13        0.57        0.53


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
           COEFFICIENTS FOR    ROSWELL              NEW MEXICO

       NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

 JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
 -------     -------     -------     -------     -------     -------
  39.60       44.10       51.30       59.80       68.30       76.80
  79.30       77.90       71.00       60.10       48.00       40.10
```

```
     NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    ROSWELL             NEW MEXICO
                  AND STATION LATITUDE  =  33.24 DEGREES




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

          AVERAGE MONTHLY VALUES IN INCHES FOR YEARS     1 THROUGH    5
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  0.30     0.29     0.54     0.49     1.17     0.99
                           2.39     1.68     1.79     0.90     1.44     0.97

   STD. DEVIATIONS         0.34     0.07     0.47     0.39     1.10     1.20
                           1.12     1.16     1.14     1.04     1.76     0.67

 RUNOFF
 ------
   TOTALS                 0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

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

 .APOTRANSPIRATION
 ------------------
   TOTALS                 0.438    0.303    0.412    0.280    1.097    0.882
                          1.825    1.797    1.517    1.018    1.082    0.779

   STD. DEVIATIONS        0.190    0.068    0.364    0.162    0.930    1.074
                          0.881    1.256    0.771    0.663    0.810    0.425

 LATERAL DRAINAGE COLLECTED FROM LAYER  2
 ----------------------------------------
   TOTALS                0.0416   0.0342   0.0209   0.0120   0.0095   0.0120
                         0.0301   0.0626   0.0505   0.0703   0.2054   0.0964

   STD. DEVIATIONS       0.0397   0.0333   0.0164   0.0092   0.0072   0.0110
                         0.0406   0.0592   0.0375   0.0667   0.2849   0.1230

 PERCOLATION/LEAKAGE THROUGH LAYER  3
 ------------------------------------
   TOTALS                0.0569   0.0502   0.0434   0.0307   0.0252   0.0237
                         0.0399   0.0722   0.0681   0.0770   0.1117   0.0973
```

```
   STD. DEVIATIONS          0.0402   0.0412   0.0311   0.0230   0.0179   0.0196
                            0.0460   0.0552   0.0445   0.0424   0.0755   0.0673

 LATERAL DRAINAGE COLLECTED FROM LAYER  4
 ----------------------------------------
   TOTALS                   0.0568   0.0505   0.0434   0.0308   0.0254   0.0237
                            0.0396   0.0716   0.0685   0.0768   0.1109   0.0983

   STD. DEVIATIONS          0.0400   0.0416   0.0312   0.0231   0.0180   0.0194
                            0.0452   0.0549   0.0448   0.0424   0.0746   0.0684

 PERCOLATION/LEAKAGE THROUGH LAYER  6
 ------------------------------------
   TOTALS                   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

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


-------------------------------------------------------------------------------
              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  3
 -------------------------------------
   AVERAGES                 0.0006   0.0005   0.0003   0.0002   0.0001   0.0002
                            0.0004   0.0009   0.0007   0.0010   0.0029   0.0013

   STD. DEVIATIONS          0.0005   0.0005   0.0002   0.0001   0.0001   0.0002
                            0.0006   0.0008   0.0005   0.0009   0.0040   0.0017

 DAILY AVERAGE HEAD ON TOP OF LAYER  5
 -------------------------------------
   AVERAGES                 0.0008   0.0008   0.0006   0.0004   0.0003   0.0003
                            0.0005   0.0010   0.0010   0.0010   0.0016   0.0013

   STD. DEVIATIONS          0.0005   0.0006   0.0004   0.0003   0.0002   0.0003
                            0.0006   0.0007   0.0006   0.0006   0.0010   0.0009

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


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

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------
                                          INCHES          CU. FEET      PERCENT
                                    -------------------  ------------  ---------
```

```
PRECIPITATION                  12.95     (   2.076)      47023.0       100.00

   OFF                          0.000    (  0.0000)         0.00         0.000

EVAPOTRANSPIRATION             11.431    (  1.9467)      41494.45       88.243

LATERAL DRAINAGE COLLECTED      0.64535 (  0.56767)      2342.634      4.98189
  FROM LAYER  2

PERCOLATION/LEAKAGE THROUGH     0.69647 (  0.36897)      2528.192      5.37650
  LAYER  3

AVERAGE HEAD ON TOP             0.001 (     0.001)
  OF LAYER  3

LATERAL DRAINAGE COLLECTED      0.69630 (  0.36874)      2527.576      5.37519
  FROM LAYER  4

PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.008      0.00002
  LAYER  6

AVERAGE HEAD ON TOP             0.001 (     0.000)
  OF LAYER  5

CHANGE IN WATER STORAGE         0.181    (  0.4414)       658.36        1.400
***********************************************************************************
```

```
******************************************************************************

          PEAK DAILY VALUES FOR YEARS     1 THROUGH    5
------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------    -------------
  PRECIPITATION                                 1.40         5082.000

  RUNOFF                                        0.000           0.0000

  DRAINAGE COLLECTED FROM LAYER  2              0.10664       387.11032

  PERCOLATION/LEAKAGE THROUGH LAYER  3          0.022506       81.69557

  AVERAGE HEAD ON TOP OF LAYER  3               0.045

  MAXIMUM HEAD ON TOP OF LAYER  3               0.088

  LOCATION OF MAXIMUM HEAD IN LAYER  2
        (DISTANCE FROM DRAIN)                  11.6 FEET

  DRAINAGE COLLECTED FROM LAYER  4              0.02105        76.40586

  PERCOLATION/LEAKAGE THROUGH LAYER  6          0.000000        0.00003

  AVERAGE HEAD ON TOP OF LAYER  5               0.009

  MAXIMUM HEAD ON TOP OF LAYER  5               0.025

  LOCATION OF MAXIMUM HEAD IN LAYER  4
        (DISTANCE FROM DRAIN)                   0.0 FEET

  SNOW WATER                                    1.36         4944.3652


  MAXIMUM VEG. SOIL WATER (VOL/VOL)                     0.2317

  MINIMUM VEG. SOIL WATER (VOL/VOL)                     0.0470


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

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

******************************************************************************
```

```
*******************************************************************************

                  FINAL WATER STORAGE AT END OF YEAR    5
----------------------------------------------------------------------
                  LAYER        (INCHES)        (VOL/VOL)
                  -----        --------        ---------
                    1            2.9768           0.1240

                    2            0.0024           0.0120

                    3            0.0000           0.0000

                    4            0.0028           0.0142

                    5            0.0000           0.0000

                    6            0.1800           0.7500

                 SNOW WATER      0.000

*******************************************************************************
*******************************************************************************
```

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                 HELP MODEL VERSION 3.04a  (10 JULY 1995)                 **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    d:\602\in\flr.D4
TEMPERATURE DATA FILE:      d:\602\in\flr.D7
SOLAR RADIATION DATA FILE:  d:\602\in\flr.D13
EVAPOTRANSPIRATION DATA:    d:\602\in\flr.D11
SOIL AND DESIGN DATA FILE:  d:\602\in\ALT2slp.D10
OUTPUT DATA FILE:           d:\602\out\alt2slp.OUT


TIME:  15: 6     DATE:   2/28/1996


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

     TITLE:  gandy alternative 2, year 0-5, slope

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


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   4
           THICKNESS                 =     24.00   INCHES
           POROSITY                  =       0.4370 VOL/VOL
           FIELD CAPACITY            =       0.1050 VOL/VOL
           WILTING POINT             =       0.0470 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0863 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.170000002000E-02 CM/SEC
```

```
                              LAYER  2
                              --------

                  TYPE 2 - LATERAL DRAINAGE LAYER
                    MATERIAL TEXTURE NUMBER  20
        THICKNESS                   =       0.20   INCHES
        POROSITY                    =       0.8500 VOL/VOL
        FIELD CAPACITY              =       0.0100 VOL/VOL
        WILTING POINT               =       0.0050 VOL/VOL
        INITIAL SOIL WATER CONTENT  =       0.0100 VOL/VOL
        EFFECTIVE SAT. HYD. COND.   =    10.0000000000      CM/SEC
        SLOPE                       =      33.00   PERCENT
        DRAINAGE LENGTH             =     316.0    FEET


                              LAYER  3
                              --------

                  TYPE 4 - FLEXIBLE MEMBRANE LINER
                    MATERIAL TEXTURE NUMBER  35
        THICKNESS                   =       0.06   INCHES
        POROSITY                    =       0.0000 VOL/VOL
        FIELD CAPACITY              =       0.0000 VOL/VOL
        WILTING POINT               =       0.0000 VOL/VOL
        INITIAL SOIL WATER CONTENT  =       0.0000 VOL/VOL
        EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
        FML PINHOLE DENSITY         =       1.00   HOLES/ACRE
        FML INSTALLATION DEFECTS    =       3.00   HOLES/ACRE
        FML PLACEMENT QUALITY       =  3 - GOOD


                              LAYER  4
                              --------

                  TYPE 2 - LATERAL DRAINAGE LAYER
                    MATERIAL TEXTURE NUMBER  20
        THICKNESS                   =       0.20   INCHES
        POROSITY                    =       0.8500 VOL/VOL
        FIELD CAPACITY              =       0.0100 VOL/VOL
        WILTING POINT               =       0.0050 VOL/VOL
        INITIAL SOIL WATER CONTENT  =       0.0100 VOL/VOL
        EFFECTIVE SAT. HYD. COND.   =    10.0000000000      CM/SEC
        SLOPE                       =      33.00   PERCENT
        DRAINAGE LENGTH             =     316.0    FEET
```

```
                        LAYER  5
                        --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
     THICKNESS                    =      0.06   INCHES
     POROSITY                     =      0.0000 VOL/VOL
     FIELD CAPACITY               =      0.0000 VOL/VOL
     WILTING POINT                =      0.0000 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
     FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
     FML INSTALLATION DEFECTS     =      3.00   HOLES/ACRE
     FML PLACEMENT QUALITY        =  3 - GOOD


                        LAYER  6
                        --------

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


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

    NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
             SOIL DATA BASE USING SOIL TEXTURE # 4 WITH BARE
             GROUND CONDITIONS, A SURFACE SLOPE OF 33.% AND
             A SLOPE LENGTH OF  316. FEET.

   SCS RUNOFF CURVE NUMBER            =      82.40
   FRACTION OF AREA ALLOWING RUNOFF   =       0.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =       1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =      14.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =       1.208  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =       6.118  INCHES
```

```
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.658  INCHES
   INITIAL SNOW WATER                  =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =      2.255  INCHES
   TOTAL INITIAL WATER                 =      2.255  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               --------,---------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             ROSWELL               NEW MEXICO

        STATION LATITUDE                        =  33.24 DEGREES
        MAXIMUM LEAF AREA INDEX                 =   0.00
        START OF GROWING SEASON (JULIAN DATE)   =    76
        END OF GROWING SEASON (JULIAN DATE)     =   310
        EVAPORATIVE ZONE DEPTH                  =  14.0  INCHES
        AVERAGE ANNUAL WIND SPEED               =   8.70 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  49.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  40.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  53.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  52.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    ROSWELL             NEW MEXICO

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  0.42        0.47        0.49        0.69        1.14        1.43
  1.99        1.90        1.87        1.13        0.57        0.53


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    ROSWELL             NEW MEXICO

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 39.60       44.10       51.30       59.80       68.30       76.80
 79.30       77.90       71.00       60.10       48.00       40.10
```

```
     NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    ROSWELL              NEW MEXICO
                  AND STATION LATITUDE  =  33.24 DEGREES




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

      AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  0.30     0.29     0.54     0.49     1.17     0.99
                           2.39     1.68     1.79     0.90     1.44     0.97

   STD. DEVIATIONS         0.34     0.07     0.47     0.39     1.10     1.20
                           1.12     1.16     1.14     1.04     1.76     0.67

 RUNOFF
 ------
   TOTALS                 0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

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

  /APOTRANSPIRATION
 ------------------
   TOTALS                 0.223    0.121    0.144    0.096    0.318    0.413
                          1.261    0.557    0.702    0.341    0.405    0.398

   STD. DEVIATIONS        0.157    0.088    0.153    0.175    0.325    0.765
                          0.644    0.326    0.848    0.432    0.413    0.439

 LATERAL DRAINAGE COLLECTED FROM LAYER  2
 ----------------------------------------
   TOTALS                0.2838   0.1530   0.3144   0.1666   0.7463   0.5542
                         0.7122   1.3258   0.9034   0.5961   1.1245   0.4454

   STD. DEVIATIONS       0.2299   0.1388   0.3029   0.0962   0.6884   0.5561
                         0.5288   0.9396   0.3697   0.3540   1.3388   0.2356

 PERCOLATION/LEAKAGE THROUGH LAYER  3
 ------------------------------------
   TOTALS                0.0338   0.0244   0.0337   0.0259   0.0528   0.0428
                         0.0557   0.0793   0.0653   0.0540   0.0660   0.0459
```

```
  STD. DEVIATIONS           0.0218   0.0167   0.0253   0.0152   0.0350   0.0287
                            0.0235   0.0266   0.0129   0.0137   0.0312   0.0100

 LATERAL DRAINAGE COLLECTED FROM LAYER  4
 ----------------------------------------
  TOTALS                    0.0338   0.0244   0.0337   0.0259   0.0528   0.0428
                            0.0557   0.0793   0.0653   0.0540   0.0660   0.0459

  STD. DEVIATIONS           0.0218   0.0167   0.0253   0.0152   0.0350   0.0287
                            0.0235   0.0266   0.0129   0.0137   0.0312   0.0100

 PERCOLATION/LEAKAGE THROUGH LAYER  6
 ------------------------------------
  TOTALS                    0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

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


-------------------------------------------------------------------------------
              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  3
 -------------------------------------
  AVERAGES                  0.0002   0.0001   0.0002   0.0001   0.0005   0.0003
                            0.0004   0.0008   0.0006   0.0004   0.0007   0.0003

  STD. DEVIATIONS           0.0001   0.0001   0.0002   0.0001   0.0004   0.0003
                            0.0003   0.0006   0.0002   0.0002   0.0008   0.0001

 DAILY AVERAGE HEAD ON TOP OF LAYER  5
 -------------------------------------
  AVERAGES                  0.0001   0.0001   0.0001   0.0001   0.0002   0.0001
                            0.0002   0.0003   0.0002   0.0002   0.0002   0.0001

  STD. DEVIATIONS           0.0001   0.0001   0.0001   0.0001   0.0001   0.0001
                            0.0001   0.0001   0.0000   0.0000   0.0001   0.0000

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


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

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------
                                      INCHES           CU. FEET        PERCENT
                               -------------------   -------------    ---------
```

```
PRECIPITATION                  12.95    (   2.076)     47023.0     100.00

   NOFF                         0.000   (  0.0000)        0.00      0.000

EVAPOTRANSPIRATION              4.979   (  0.8403)    18074.46     38.437

LATERAL DRAINAGE COLLECTED      7.32567 (  2.24924)   26592.176   56.55140
  FROM LAYER  2

PERCOLATION/LEAKAGE THROUGH     0.57975 (  0.16004)    2104.510    4.47549
  LAYER  3

AVERAGE HEAD ON TOP             0.000 (    0.000)
  OF LAYER  3

LATERAL DRAINAGE COLLECTED      0.57975 (  0.16004)    2104.509    4.47549
  FROM LAYER  4

PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)       0.002    0.00000
  LAYER  6

AVERAGE HEAD ON TOP             0.000 (    0.000)
  OF LAYER  5

CHANGE IN WATER STORAGE         0.069   (  0.3656)      251.88      0.536

***************************************************************************
```

```
******************************************************************************

           PEAK DAILY VALUES FOR YEARS    1 THROUGH    5
----------------------------------------------------------------------------
                                                (INCHES)       (CU. FT.)
                                               ----------    ------------
  PRECIPITATION                                   1.40          5082.000

  RUNOFF                                          0.000            0.0000

  DRAINAGE COLLECTED FROM LAYER  2                0.55831       2026.65674

  PERCOLATION/LEAKAGE THROUGH LAYER  3            0.010151        36.84814

  AVERAGE HEAD ON TOP OF LAYER  3                 0.010

  MAXIMUM HEAD ON TOP OF LAYER  3                 0.094

  LOCATION OF MAXIMUM HEAD IN LAYER  2
       (DISTANCE FROM DRAIN)                      0.0 FEET

  DRAINAGE COLLECTED FROM LAYER  4                0.01015         36.84814

  PERCOLATION/LEAKAGE THROUGH LAYER  6            0.000000         0.00001

  AVERAGE HEAD ON TOP OF LAYER  5                 0.001

  MAXIMUM HEAD ON TOP OF LAYER  5                 0.000

  LOCATION OF MAXIMUM HEAD IN LAYER  4
       (DISTANCE FROM DRAIN)                      0.0 FEET

  SNOW WATER                                      1.36          4944.3652


  MAXIMUM VEG. SOIL WATER (VOL/VOL)                     0.1804

  MINIMUM VEG. SOIL WATER (VOL/VOL)                     0.0470


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

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

******************************************************************************
```

```
******************************************************************************

                 FINAL WATER STORAGE AT END OF YEAR    5
    ----------------------------------------------------------------------
                 LAYER        (INCHES)        (VOL/VOL)
                 -----        --------        ---------
                   1           2.4179           0.1007

                   2           0.0022           0.0112

                   3           0.0000           0.0000

                   4           0.0020           0.0100

                   5           0.0000           0.0000

                   6           0.1800           0.7500

               SNOW WATER      0.000

******************************************************************************
******************************************************************************
```

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                 HELP MODEL VERSION 3.04a  (10 JULY 1995)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    d:\602\in\cov.D4
TEMPERATURE DATA FILE:      d:\602\in\cov.D7
SOLAR RADIATION DATA FILE:  d:\602\in\cov.D13
EVAPOTRANSPIRATION DATA:    d:\602\in\cov.D11
SOIL AND DESIGN DATA FILE:  d:\602\in\coverU.D10
OUTPUT DATA FILE:           d:\602\out\coverU.OUT


TIME:   8:31     DATE:   2/29/1996


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

     TITLE:  gandy cover alternative, year 0-5

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


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER   6
           THICKNESS                 =     24.00   INCHES
           POROSITY                  =      0.4530 VOL/VOL
           FIELD CAPACITY            =      0.1900 VOL/VOL
           WILTING POINT             =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.0863 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
    NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
           FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                             LAYER  2
                             --------

                   TYPE 2 - LATERAL DRAINAGE LAYER
                    MATERIAL TEXTURE NUMBER  20
      THICKNESS                  =      0.20   INCHES
      POROSITY                   =      0.8500 VOL/VOL
      FIELD CAPACITY             =      0.0100 VOL/VOL
      WILTING POINT              =      0.0050 VOL/VOL
      INITIAL SOIL WATER CONTENT =      0.0100 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  =   10.0000000000     CM/SEC
      SLOPE                      =     25.00   PERCENT
      DRAINAGE LENGTH            =    550.0    FEET


                             LAYER  3
                             --------

                   TYPE 4 - FLEXIBLE MEMBRANE LINER
                    MATERIAL TEXTURE NUMBER  35
      THICKNESS                  =      0.06   INCHES
      POROSITY                   =      0.0000 VOL/VOL
      FIELD CAPACITY             =      0.0000 VOL/VOL
      WILTING POINT              =      0.0000 VOL/VOL
      INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
      FML PINHOLE DENSITY        =      1.00   HOLES/ACRE
      FML INSTALLATION DEFECTS   =      3.00   HOLES/ACRE
      FML PLACEMENT QUALITY      =  3 - GOOD


                             LAYER  4
                             --------

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

```
                              LAYER  5
                              --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   4
     THICKNESS                  =      6.00   INCHES
     POROSITY                   =      0.4370 VOL/VOL
     FIELD CAPACITY             =      0.1050 VOL/VOL
     WILTING POINT              =      0.0470 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0863 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.170000002000E-02 CM/SEC


                              LAYER  6
                              --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   4
     THICKNESS                  =     18.00   INCHES
     POROSITY                   =      0.4370 VOL/VOL
     FIELD CAPACITY             =      0.1050 VOL/VOL
     WILTING POINT              =      0.0470 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0863 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.170000002000E-02 CM/SEC


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

   NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
            SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A
            POOR STAND OF GRASS, A SURFACE SLOPE OF 25.%
            AND A SLOPE LENGTH OF  550. FEET.

   SCS RUNOFF CURVE NUMBER            =     80.50
   FRACTION OF AREA ALLOWING RUNOFF   =    100.0   PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =      1.000 ACRES
   EVAPORATIVE ZONE DEPTH             =     24.0   INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =      2.071 INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =     10.872 INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =      2.040 INCHES
   INITIAL SNOW WATER                 =      0.000 INCHES
   INITIAL WATER IN LAYER MATERIALS   =      4.324 INCHES
```

```
   TOTAL INITIAL WATER                    =      4.324  INCHES
   TOTAL SUBSURFACE INFLOW                =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               ----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             ROSWELL              NEW MEXICO

        STATION LATITUDE                         =  33.24 DEGREES
        MAXIMUM LEAF AREA INDEX                  =   1.00
        START OF GROWING SEASON (JULIAN DATE)    =    76
        END OF GROWING SEASON (JULIAN DATE)      =   310
        EVAPORATIVE ZONE DEPTH                   =  24.0  INCHES
        AVERAGE ANNUAL WIND SPEED                =   8.70 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  49.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  40.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  53.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  52.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    ROSWELL              NEW MEXICO

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  0.42        0.47        0.49        0.69        1.14        1.43
  1.99        1.90        1.87        1.13        0.57        0.53


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    ROSWELL              NEW MEXICO

         NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 39.60       44.10       51.30       59.80       68.30       76.80
 79.30       77.90       71.00       60.10       48.00       40.10


    NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    ROSWELL              NEW MEXICO
               AND STATION LATITUDE  =  33.24 DEGREES
```

```
******************************************************************************

      AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    5
------------------------------------------------------------------------------

                           JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                           -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                    0.30     0.29     0.54     0.49     1.17     0.99
                             2.39     1.68     1.79     0.90     1.44     0.97

   STD. DEVIATIONS           0.34     0.07     0.47     0.39     1.10     1.20
                             1.12     1.16     1.14     1.04     1.76     0.67

 RUNOFF
 ------
   TOTALS                    0.000    0.000    0.000    0.000    0.000    0.000
                             0.001    0.000    0.000    0.000    0.000    0.000

   STD. DEVIATIONS           0.000    0.000    0.000    0.000    0.000    0.001
                             0.001    0.000    0.000    0.001    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                    0.660    0.265    0.558    0.266    1.236    1.117
                             2.254    1.850    1.519    0.938    1.055    0.987

   STD. DEVIATIONS           0.399    0.087    0.467    0.422    1.021    1.293
                             1.297    1.206    1.094    0.856    0.675    0.419

 LATERAL DRAINAGE COLLECTED FROM LAYER  2
 ----------------------------------------
   TOTALS                    0.0161   0.0040   0.0138   0.0068   0.0091   0.0063
                             0.0347   0.0368   0.0203   0.0122   0.0433   0.0417

   STD. DEVIATIONS           0.0295   0.0059   0.0168   0.0102   0.0110   0.0087
                             0.0224   0.0189   0.0086   0.0077   0.0579   0.0250

 PERCOLATION/LEAKAGE THROUGH LAYER  4
 ------------------------------------
   TOTALS                    0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

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

```
 RCOLATION/LEAKAGE THROUGH LAYER  6
 ----------------------------------
 TOTALS                   0.0001   0.0001   0.0001   0.0001   0.0001   0.0001
                          0.0001   0.0001   0.0001   0.0001   0.0001   0.0001

 STD. DEVIATIONS          0.0001   0.0001   0.0001   0.0001   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-------------------------------------------------------------------------------
           AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  3
  -------------------------------------
    AVERAGES              0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0001   0.0001

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0001   0.0000

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


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

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET      PERCENT
                               -------------------   ------------   ---------
 PRECIPITATION                  12.95    (  2.076)      47023.0      100.00

 RUNOFF                          0.001   ( 0.0023)         4.94       0.011

 EVAPOTRANSPIRATION             12.706   ( 1.7289)     46122.80      98.086

 LATERAL DRAINAGE COLLECTED      0.24518 ( 0.12170)      890.020     1.89273
   FROM LAYER  2

 PERCOLATION/LEAKAGE THROUGH     0.00000 ( 0.00000)        0.001     0.00000
   LAYER  4

 AVERAGE HEAD ON TOP             0.000 (    0.000)
   OF LAYER  3

 PERCOLATION/LEAKAGE THROUGH     0.00153 ( 0.00028)        5.554     0.01181
   LAYER  6

 CHANGE IN WATER STORAGE         0.000   ( 0.5820)        -0.29      -0.001
```

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*******************************************************************************
```

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

          PEAK DAILY VALUES FOR YEARS    1 THROUGH    5
------------------------------------------------------------------------
                                          (INCHES)      (CU. FT.)
                                         ----------   -------------
  PRECIPITATION                             1.40         5082.000

  RUNOFF                                    0.003          12.1114

  DRAINAGE COLLECTED FROM LAYER  2          0.04743       172.17372

  PERCOLATION/LEAKAGE THROUGH LAYER  4      0.000000        0.00003

  AVERAGE HEAD ON TOP OF LAYER  3           0.002

  MAXIMUM HEAD ON TOP OF LAYER  3           0.192

  LOCATION OF MAXIMUM HEAD IN LAYER  2
        (DISTANCE FROM DRAIN)               0.0 FEET

  PERCOLATION/LEAKAGE THROUGH LAYER  6      0.000005        0.01711

  SNOW WATER                                1.36         4944.3652


  MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.2101

  MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0850


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

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

******************************************************************************
```

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

                 FINAL WATER STORAGE AT END OF YEAR    5
    ----------------------------------------------------------------------
                 LAYER        (INCHES)       (VOL/VOL)
                 -----        --------       ---------
                   1           2.0774          0.0866

                   2           0.0030          0.0150

                   3           0.0000          0.0000

                   4           0.1800          0.7500

                   5           0.5159          0.0860

                   6           1.5477          0.0860

                SNOW WATER     0.000

******************************************************************************
******************************************************************************
```

```
******************************************************************************
******************************************************************************
**                                                                          **
                                                                            **
             HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                  **
**                HELP MODEL VERSION 3.04a  (10 JULY 1995)                  **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**            FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     d:\602\in\flr.D4
TEMPERATURE DATA FILE:       d:\602\in\flr.D7
SOLAR RADIATION DATA FILE:   d:\602\in\flr.D13
EVAPOTRANSPIRATION DATA:     d:\602\in\flr.D11
SOIL AND DESIGN DATA FILE:   d:\602\in\MTRFL.D10
OUTPUT DATA FILE:            d:\602\out\mtrfl.OUT


TIME: 14:59     DATE:  2/28/1996


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

    TITLE:  Gandy Landfill  - MTR - Floor (0-5 yrs)

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


    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
             WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER   4
           THICKNESS                  =     24.00   INCHES
           POROSITY                   =      0.4370 VOL/VOL
           FIELD CAPACITY             =      0.1050 VOL/VOL
           WILTING POINT              =      0.0470 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0863 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.170000002000E-02 CM/SEC
```

```
                              LAYER  2
                              --------

                   TYPE 2 - LATERAL DRAINAGE LAYER
                    MATERIAL TEXTURE NUMBER   1
     THICKNESS                    =       12.00    INCHES
     POROSITY                     =        0.4170 VOL/VOL
     FIELD CAPACITY               =        0.0450 VOL/VOL
     WILTING POINT                =        0.0180 VOL/VOL
     INITIAL SOIL WATER CONTENT   =        0.0450 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.999999978000E-02 CM/SEC
     SLOPE                        =        2.30    PERCENT
     DRAINAGE LENGTH              =      550.0     FEET


                              LAYER  3
                              --------

                   TYPE 4 - FLEXIBLE MEMBRANE LINER
                    MATERIAL TEXTURE NUMBER  35
     THICKNESS                    =        0.06    INCHES
     POROSITY                     =        0.0000 VOL/VOL
     FIELD CAPACITY               =        0.0000 VOL/VOL
     WILTING POINT                =        0.0000 VOL/VOL
     INITIAL SOIL WATER CONTENT   =        0.0000 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
     FML PINHOLE DENSITY          =        1.00    HOLES/ACRE
     FML INSTALLATION DEFECTS     =        3.00    HOLES/ACRE
     FML PLACEMENT QUALITY        =  3 - GOOD


                              LAYER  4
                              --------

                   TYPE 2 - LATERAL DRAINAGE LAYER
                    MATERIAL TEXTURE NUMBER   1
     THICKNESS                    =       12.00    INCHES
     POROSITY                     =        0.4170 VOL/VOL
     FIELD CAPACITY               =        0.0450 VOL/VOL
     WILTING POINT                =        0.0180 VOL/VOL
     INITIAL SOIL WATER CONTENT   =        0.0450 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.999999978000E-02 CM/SEC
     SLOPE                        =        2.30    PERCENT
     DRAINAGE LENGTH              =      550.0     FEET
```

```
                          LAYER  5
                          --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
     THICKNESS                    =        0.06   INCHES
     POROSITY                     =        0.0000 VOL/VOL
     FIELD CAPACITY               =        0.0000 VOL/VOL
     WILTING POINT                =        0.0000 VOL/VOL
     INITIAL SOIL WATER CONTENT   =        0.0000 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
     FML PINHOLE DENSITY          =        1.00   HOLES/ACRE
     FML INSTALLATION DEFECTS     =        3.00   HOLES/ACRE
     FML PLACEMENT QUALITY        =  3 - GOOD


                          LAYER  6
                          --------

                 TYPE 3 - BARRIER SOIL LINER
                  MATERIAL TEXTURE NUMBER   0
     THICKNESS                    =       36.00   INCHES
     POROSITY                     =        0.4450 VOL/VOL
     FIELD CAPACITY               =        0.3930 VOL/VOL
     WILTING POINT                =        0.2770 VOL/VOL
     INITIAL SOIL WATER CONTENT   =        0.4450 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.100000001000E-06 CM/SEC


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

  NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
           SOIL DATA BASE USING SOIL TEXTURE # 4 WITH BARE
           GROUND CONDITIONS, A SURFACE SLOPE OF  2.% AND
           A SLOPE LENGTH OF  550. FEET.

  SCS RUNOFF CURVE NUMBER            =     80.50
  FRACTION OF AREA ALLOWING RUNOFF   =      0.0    PERCENT
  AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
  EVAPORATIVE ZONE DEPTH             =     14.0    INCHES
  INITIAL WATER IN EVAPORATIVE ZONE  =      1.208  INCHES
  UPPER LIMIT OF EVAPORATIVE STORAGE =      6.118  INCHES
```

```
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.658  INCHES
   INITIAL SNOW WATER                  =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =     19.171  INCHES
   TOTAL INITIAL WATER                 =     19.171  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


             EVAPOTRANSPIRATION AND WEATHER DATA
             -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             ROSWELL                NEW MEXICO

        STATION LATITUDE                          =  33.24 DEGREES
        MAXIMUM LEAF AREA INDEX                   =   0.00
        START OF GROWING SEASON (JULIAN DATE)     =    76
        END OF GROWING SEASON (JULIAN DATE)       =   310
        EVAPORATIVE ZONE DEPTH                    =  14.0  INCHES
        AVERAGE ANNUAL WIND SPEED                 =   8.70 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  49.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  40.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  53.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  52.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    ROSWELL             NEW MEXICO

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
-------      -------      -------      -------      -------      -------
  0.42         0.47         0.49         0.69         1.14         1.43
  1.99         1.90         1.87         1.13         0.57         0.53


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    ROSWELL             NEW MEXICO

          NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
-------      -------      -------      -------      -------      -------
 39.60        44.10        51.30        59.80        68.30        76.80
 79.30        77.90        71.00        60.10        48.00        40.10
```

```
        NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    ROSWELL              NEW MEXICO
                   AND STATION LATITUDE  =  33.24 DEGREES




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

        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  0.30     0.29     0.54     0.49     1.17     0.99
                           2.39     1.68     1.79     0.90     1.44     0.97

   STD. DEVIATIONS         0.34     0.07     0.47     0.39     1.10     1.20
                           1.12     1.16     1.14     1.04     1.76     0.67

 RUNOFF
 ------
   TOTALS                  0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

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

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                  0.438    0.303    0.412    0.280    1.097    0.882
                           1.825    1.797    1.517    1.018    1.082    0.779

   STD. DEVIATIONS         0.190    0.068    0.364    0.162    0.930    1.074
                           0.881    1.256    0.771    0.663    0.810    0.425

 LATERAL DRAINAGE COLLECTED FROM LAYER  2
 ----------------------------------------
   TOTALS                  0.0621   0.0457   0.0407   0.0298   0.0227   0.0161
                           0.0169   0.0237   0.0320   0.0360   0.0495   0.0777

   STD. DEVIATIONS         0.0705   0.0472   0.0388   0.0260   0.0188   0.0130
                           0.0100   0.0158   0.0204   0.0216   0.0344   0.0772

 PERCOLATION/LEAKAGE THROUGH LAYER  3
 ------------------------------------
   TOTALS                  0.1049   0.0816   0.0768   0.0603   0.0495   0.0378
                           0.0402   0.0519   0.0652   0.0729   0.0922   0.1296
```

```
   STD. DEVIATIONS         0.1025   0.0723   0.0638   0.0470   0.0373   0.0279
                           0.0233   0.0328   0.0394   0.0399   0.0523   0.1029

 LATERAL DRAINAGE COLLECTED FROM LAYER  4
 ----------------------------------------
   TOTALS                  0.0693   0.0661   0.0750   0.0716   0.0707   0.0638
                           0.0611   0.0582   0.0568   0.0606   0.0623   0.0737

   STD. DEVIATIONS         0.0625   0.0590   0.0659   0.0617   0.0598   0.0530
                           0.0492   0.0428   0.0379   0.0375   0.0358   0.0413

 PERCOLATION/LEAKAGE THROUGH LAYER  6
 ------------------------------------
   TOTALS                  0.0001   0.0001   0.0001   0.0001   0.0001   0.0001
                           0.0001   0.0001   0.0001   0.0001   0.0001   0.0001

   STD. DEVIATIONS         0.0001   0.0001   0.0001   0.0001   0.0001   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  3
 -------------------------------------
   AVERAGES                0.8312   0.6892   0.5543   0.4196   0.3096   0.2268
                           0.2301   0.3233   0.4497   0.4901   0.6959   1.0576

   STD. DEVIATIONS         0.9305   0.7113   0.5279   0.3656   0.2563   0.1824
                           0.1359   0.2155   0.2866   0.2939   0.4840   1.0507

 DAILY AVERAGE HEAD ON TOP OF LAYER  5
 -------------------------------------
   AVERAGES                0.9310   0.9967   1.0206   1.0072   0.9627   0.8973
                           0.8323   0.7929   0.7990   0.8257   0.8757   1.0028

   STD. DEVIATIONS         0.8338   0.8893   0.8971   0.8686   0.8136   0.7451
                           0.6699   0.5832   0.5332   0.5109   0.5034   0.5618

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


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

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------
                                       INCHES          CU. FEET      PERCENT
                                  -------------------  ------------  ---------
```

```
ECIPITATION                   12.95    (   2.076)      47023.0      100.00

  .OFF                         0.000   (  0.0000)         0.00        0.000

EVAPOTRANSPIRATION            11.431   (  1.9467)      41494.45      88.243

LATERAL DRAINAGE COLLECTED     0.45305 (  0.31273)      1644.561     3.49735
  FROM LAYER  2

PERCOLATION/LEAKAGE THROUGH    0.86312 (  0.52877)      3133.128      6.66297
  LAYER  3

AVERAGE HEAD ON TOP            0.523 (    0.361)
  OF LAYER  3

LATERAL DRAINAGE COLLECTED     0.78920 (  0.59140)      2864.794     6.09232
  FROM LAYER  4

PERCOLATION/LEAKAGE THROUGH    0.00071 (  0.00051)         2.587      0.00550
  LAYER  6

AVERAGE HEAD ON TOP            0.912 (    0.683)
  OF LAYER  5

CHANGE IN WATER STORAGE        0.280   (  0.8130)      1016.64       2.162

*******************************************************************************
```

```
******************************************************************************

          PEAK DAILY VALUES FOR YEARS     1 THROUGH    5
----------------------------------------------------------------------------
                                           (INCHES)     (CU. FT.)
                                           ---------    ----------
PRECIPITATION                                1.40        5082.000

RUNOFF                                       0.000          0.0000

DRAINAGE COLLECTED FROM LAYER  2             0.00669       24.27183

PERCOLATION/LEAKAGE THROUGH LAYER  3         0.009581      34.77909

AVERAGE HEAD ON TOP OF LAYER  3              2.822

MAXIMUM HEAD ON TOP OF LAYER  3              5.131

LOCATION OF MAXIMUM HEAD IN LAYER  2
       (DISTANCE FROM DRAIN)                49.7 FEET

DRAINAGE COLLECTED FROM LAYER  4             0.00517       18.76339

PERCOLATION/LEAKAGE THROUGH LAYER  6         0.000004       0.01610

AVERAGE HEAD ON TOP OF LAYER  5              2.181

MAXIMUM HEAD ON TOP OF LAYER  5              4.028

LOCATION OF MAXIMUM HEAD IN LAYER  4
       (DISTANCE FROM DRAIN)                41.9 FEET

SNOW WATER                                   1.36        4944.3652


MAXIMUM VEG. SOIL WATER (VOL/VOL)                   0.2317

MINIMUM VEG. SOIL WATER (VOL/VOL)                   0.0470


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

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

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

              FINAL WATER STORAGE AT END OF YEAR    5
    ----------------------------------------------------------------------
               LAYER        (INCHES)       (VOL/VOL)
               -----        --------       ---------
                 1           2.9768          0.1240

                 2           0.6687          0.0557

                 3           0.0000          0.0000

                 4           0.9060          0.0755

                 5           0.0000          0.0000

                 6          16.0200          0.4450

              SNOW WATER     0.000

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*******************************************************************************
```

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******************************************************************************
******************************************************************************
**                                                                          **
                                                                            **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                 HELP MODEL VERSION 3.04a  (10 JULY 1995)                 **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      d:\602\in\flr.D4
TEMPERATURE DATA FILE:        d:\602\in\flr.D7
SOLAR RADIATION DATA FILE:    d:\602\in\flr.D13
EVAPOTRANSPIRATION DATA:      d:\602\in\flr.D11
SOIL AND DESIGN DATA FILE:    d:\602\in\MTRSLP.D10
OUTPUT DATA FILE:             d:\602\out\mtrslp.OUT


TIME:  15: 5      DATE:   2/28/1996


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

     TITLE:  Gandy Landfill  - MTR - Side Slope (0-5yrs)

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


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
            WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   4
          THICKNESS                  =    24.00    INCHES
          POROSITY                   =     0.4370 VOL/VOL
          FIELD CAPACITY             =     0.1050 VOL/VOL
          WILTING POINT              =     0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.0863 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =   0.170000002000E-02 CM/SEC
```

```
                              LAYER  2
                              --------

                   TYPE 2 - LATERAL DRAINAGE LAYER
                    MATERIAL TEXTURE NUMBER   1
      THICKNESS                  =     12.00   INCHES
      POROSITY                   =      0.4170 VOL/VOL
      FIELD CAPACITY             =      0.0450 VOL/VOL
      WILTING POINT              =      0.0180 VOL/VOL
      INITIAL SOIL WATER CONTENT =      0.0450 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.999999978000E-02 CM/SEC
      SLOPE                      =     33.00   PERCENT
      DRAINAGE LENGTH            =    316.0    FEET


                              LAYER  3
                              --------

                   TYPE 4 - FLEXIBLE MEMBRANE LINER
                    MATERIAL TEXTURE NUMBER  35
      THICKNESS                  =      0.06   INCHES
      POROSITY                   =      0.0000 VOL/VOL
      FIELD CAPACITY             =      0.0000 VOL/VOL
      WILTING POINT              =      0.0000 VOL/VOL
      INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.199999996000E-12 CM/SEC
      FML PINHOLE DENSITY        =      1.00   HOLES/ACRE
      FML INSTALLATION DEFECTS   =      3.00   HOLES/ACRE
      FML PLACEMENT QUALITY      = 3 - GOOD


                              LAYER  4
                              --------

                   TYPE 2 - LATERAL DRAINAGE LAYER
                    MATERIAL TEXTURE NUMBER   1
      THICKNESS                  =     12.00   INCHES
      POROSITY                   =      0.4170 VOL/VOL
      FIELD CAPACITY             =      0.0450 VOL/VOL
      WILTING POINT              =      0.0180 VOL/VOL
      INITIAL SOIL WATER CONTENT =      0.0450 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.999999978000E-02 CM/SEC
      SLOPE                      =     33.00   PERCENT
      DRAINAGE LENGTH            =    316.0    FEET
```

```
                              LAYER  5
                              --------

                  TYPE 4 - FLEXIBLE MEMBRANE LINER
                     MATERIAL TEXTURE NUMBER  35
       THICKNESS                    =       0.06   INCHES
       POROSITY                     =       0.0000 VOL/VOL
       FIELD CAPACITY               =       0.0000 VOL/VOL
       WILTING POINT                =       0.0000 VOL/VOL
       INITIAL SOIL WATER CONTENT   =       0.0000 VOL/VOL
       EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
       FML PINHOLE DENSITY          =       1.00   HOLES/ACRE
       FML INSTALLATION DEFECTS     =       3.00   HOLES/ACRE
       FML PLACEMENT QUALITY        =  3 - GOOD


                              LAYER  6
                              --------

                    TYPE 3 - BARRIER SOIL LINER
                     MATERIAL TEXTURE NUMBER   0
       THICKNESS                    =      36.00   INCHES
       POROSITY                     =       0.4450 VOL/VOL
       FIELD CAPACITY               =       0.3930 VOL/VOL
       WILTING POINT                =       0.2770 VOL/VOL
       INITIAL SOIL WATER CONTENT   =       0.4450 VOL/VOL
       EFFECTIVE SAT. HYD. COND.    =  0.100000001000E-06 CM/SEC


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

     NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
              SOIL DATA BASE USING SOIL TEXTURE # 4 WITH BARE
              GROUND CONDITIONS, A SURFACE SLOPE OF  2.% AND
              A SLOPE LENGTH OF  316. FEET.

     SCS RUNOFF CURVE NUMBER              =      81.00
     FRACTION OF AREA ALLOWING RUNOFF     =       0.0    PERCENT
     AREA PROJECTED ON HORIZONTAL PLANE   =       1.000  ACRES
     EVAPORATIVE ZONE DEPTH .             =      14.0    INCHES
     INITIAL WATER IN EVAPORATIVE ZONE    =       1.208  INCHES
     UPPER LIMIT OF EVAPORATIVE STORAGE   =       6.118  INCHES
```

```
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.658  INCHES
   INITIAL SNOW WATER                  =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =     19.171  INCHES
   TOTAL INITIAL WATER                 =     19.171  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


                EVAPOTRANSPIRATION AND WEATHER DATA
                -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                ROSWELL              NEW MEXICO

        STATION LATITUDE                         =  33.24 DEGREES
        MAXIMUM LEAF AREA INDEX                  =   0.00
        START OF GROWING SEASON (JULIAN DATE)    =    76
        END OF GROWING SEASON (JULIAN DATE)      =   310
        EVAPORATIVE ZONE DEPTH                   =  14.0  INCHES
        AVERAGE ANNUAL WIND SPEED                =   8.70 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  49.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  40.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  53.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  52.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    ROSWELL              NEW MEXICO

                NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
-------      -------      -------      -------      -------      -------
  0.42         0.47         0.49         0.69         1.14         1.43
  1.99         1.90         1.87         1.13         0.57         0.53


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    ROSWELL              NEW MEXICO

            NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
-------      -------      -------      -------      -------      -------
 39.60        44.10        51.30        59.80        68.30        76.80
 79.30        77.90        71.00        60.10        48.00        40.10
```

```
     NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    ROSWELL              NEW MEXICO
                  AND STATION LATITUDE  =  33.24 DEGREES




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

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS     1 THROUGH    5
-------------------------------------------------------------------------------

                              JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                              -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                       0.30     0.29     0.54     0.49     1.17     0.99
                                2.39     1.68     1.79     0.90     1.44     0.97

   STD. DEVIATIONS              0.34     0.07     0.47     0.39     1.10     1.20
                                1.12     1.16     1.14     1.04     1.76     0.67

 RUNOFF
 ------
   TOTALS                      0.000    0.000    0.000    0.000    0.000    0.000
                               0.000    0.000    0.000    0.000    0.000    0.000

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

 /APOTRANSPIRATION
 -----------------
   TOTALS                      0.438    0.303    0.412    0.280    1.097    0.882
                               1.825    1.797    1.517    1.018    1.082    0.779

   STD. DEVIATIONS             0.190    0.068    0.364    0.162    0.930    1.074
                               0.881    1.256    0.771    0.663    0.810    0.425

 LATERAL DRAINAGE COLLECTED FROM LAYER  2
 ----------------------------------------
   TOTALS                     0.0900   0.0779   0.0593   0.0394   0.0317   0.0282
                              0.0550   0.1046   0.1121   0.1128   0.2302   0.2378

   STD. DEVIATIONS            0.0779   0.0721   0.0454   0.0298   0.0225   0.0211
                              0.0613   0.0858   0.0789   0.0732   0.2175   0.2939

 PERCOLATION/LEAKAGE THROUGH LAYER  3
 ------------------------------------
   TOTALS                     0.0130   0.0113   0.0096   0.0070   0.0060   0.0053
                              0.0086   0.0144   0.0156   0.0159   0.0253   0.0268
```

```
   STD. DEVIATIONS        0.0099   0.0093   0.0068   0.0048   0.0040   0.0036
                          0.0082   0.0109   0.0101   0.0087   0.0188   0.0253

LATERAL DRAINAGE COLLECTED FROM LAYER  4
----------------------------------------
   TOTALS                 0.0143   0.0113   0.0103   0.0075   0.0063   0.0050
                          0.0081   0.0128   0.0159   0.0151   0.0214   0.0300

   STD. DEVIATIONS        0.0124   0.0091   0.0074   0.0052   0.0042   0.0033
                          0.0066   0.0097   0.0103   0.0085   0.0156   0.0300

PERCOLATION/LEAKAGE THROUGH LAYER  6
------------------------------------
   TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

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

-----------------------------------------------------------------------------
             AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------


DAILY AVERAGE HEAD ON TOP OF LAYER  3
-------------------------------------
   AVERAGES               0.0536   0.0521   0.0359   0.0246   0.0191   0.0176
                          0.0332   0.0632   0.0700   0.0682   0.1437   0.1437

   STD. DEVIATIONS        0.0456   0.0482   0.0275   0.0186   0.0136   0.0132
                          0.0370   0.0519   0.0493   0.0442   0.1358   0.1776

DAILY AVERAGE HEAD ON TOP OF LAYER  5
-------------------------------------
   AVERAGES               0.0085   0.0076   0.0062   0.0047   0.0038   0.0031
                          0.0049   0.0077   0.0099   0.0091   0.0134   0.0181

   STD. DEVIATIONS        0.0073   0.0061   0.0045   0.0032   0.0025   0.0020
                          0.0040   0.0059   0.0064   0.0051   0.0097   0.0181

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


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

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    5
-----------------------------------------------------------------------------
                                    INCHES          CU. FEET       PERCENT
                               -------------------  ------------   ---------
```

```
PRECIPITATION                  12.95    (  2.076)     47023.0     100.00

  .OFF                          0.000   ( 0.0000)        0.00      0.000

EVAPOTRANSPIRATION             11.431   ( 1.9467)    41494.45     88.243

LATERAL DRAINAGE COLLECTED      1.17907 ( 0.81329)    4280.021    9.10197
  FROM LAYER  2

PERCOLATION/LEAKAGE THROUGH     0.15882 ( 0.09008)     576.507    1.22601
  LAYER  3

AVERAGE HEAD ON TOP             0.060 (    0.042)
  OF LAYER  3

LATERAL DRAINAGE COLLECTED      0.15824 ( 0.08907)     574.397    1.22152
  FROM LAYER  4

PERCOLATION/LEAKAGE THROUGH     0.00001 ( 0.00001)       0.042    0.00009
  LAYER  6

AVERAGE HEAD ON TOP             0.008 (    0.005)
  OF LAYER  5

CHANGE IN WATER STORAGE         0.186   ( 0.4322)      674.12      1.434

*******************************************************************************
```

```
*******************************************************************************

              PEAK DAILY VALUES FOR YEARS    1 THROUGH    5
------------------------------------------------------------------------
                                               (INCHES)    (CU. FT.)
                                              ----------  ------------
  PRECIPITATION                                 1.40        5082.000

  RUNOFF                                        0.000          0.0000

  DRAINAGE COLLECTED FROM LAYER  2              0.05930      215.27205

  PERCOLATION/LEAKAGE THROUGH LAYER  3          0.004617      16.76041

  AVERAGE HEAD ON TOP OF LAYER  3               1.111

  MAXIMUM HEAD ON TOP OF LAYER  3               2.196

  LOCATION OF MAXIMUM HEAD IN LAYER  2
       (DISTANCE FROM DRAIN)                    0.0 FEET

  DRAINAGE COLLECTED FROM LAYER  4              0.00353       12.80457

  PERCOLATION/LEAKAGE THROUGH LAYER  6          0.000000       0.00068

  AVERAGE HEAD ON TOP OF LAYER  5               0.066

  MAXIMUM HEAD ON TOP OF LAYER  5               0.189

  LOCATION OF MAXIMUM HEAD IN LAYER  4
       (DISTANCE FROM DRAIN)                    0.0 FEET

  SNOW WATER                                    1.36        4944.3652


  MAXIMUM VEG. SOIL WATER (VOL/VOL)                     0.2317

  MINIMUM VEG. SOIL WATER (VOL/VOL)                     0.0470

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

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

*******************************************************************************
```

```
*******************************************************************************

              FINAL WATER STORAGE AT END OF YEAR    5
    ----------------------------------------------------------------------
               LAYER         (INCHES)       (VOL/VOL)
               -----         --------       ---------
                 1            2.9768         0.1240

                 2            0.5601         0.0467

                 3            0.0000         0.0000

                 4            0.5428         0.0452

                 5            0.0000         0.0000

                 6           16.0200         0.4450

             SNOW WATER       0.000

*******************************************************************************
*******************************************************************************
```

APPENDIX C

NEW MEXICO ENVIRONMENTAL DEPARTMENT
DRAFT GUIDANCE DOCUMENT FOR PERFORMANCE DEMONSTRATION

DRAFT

Guidance Document

for

Performance Demonstration for an Alternative Cover Design
Using the HELP Modeling Program Under the New Mexico
Solid Waste Management Regulations (20 NMAC 9.1)

and

Performance Demonstration for an Alternative Liner Design
Using the HELP Modeling Program Under the New Mexico
Solid Waste Management Regulations (20 NMAC 9.1)

**Prepared by the
New Mexico Environment Department
Solid Waste Bureau
Permit Section**

28

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

March 14, 1996

MAR 1996
RECEIVED

Mr. Benito Garcia, Chief
Hazardous and Radioactive Bureau
New Mexico Environment Department
P.O. Box 26110
Santa Fe, New Mexico 87502

RE: Gandy Marley Inc., Triassic Park Hazardous Waste Facility, Part B Application and the Corresponding Revisions

Dear Mr. Garcia:

The Environmental Protection Agency (EPA) has completed a technical review of the landfill design for Gandy Marley Inc. and has determined that it meets the requirements of 40 CFR 264.300 thru 264.317. If you have any further questions, please contact Mr. Rich Mayer at (214) 665-7442.

Sincerely yours,

Rich Mayer

for **David Neleigh, Section Chief**
New Mexico - Federal Facilities

intermediate and alternative cover layers. The two designs are to be simulated for years 1 through 5 with vegetation during the post-closure care period to demonstrate equivalency. Precipitation, evapotranspiration, temperature, and solar radiation data must be site specific and identical for both alternative and prescriptive cover designs simulations. Provide justification for all input parameters in the model utilizing the attached forms. Demonstrate the relationship of the characteristics of on-site or other sources of soil proposed for the construction of cover or liner and the parameter values in the model. It is anticipated that the entire area of the landfill or cell will be modelled.

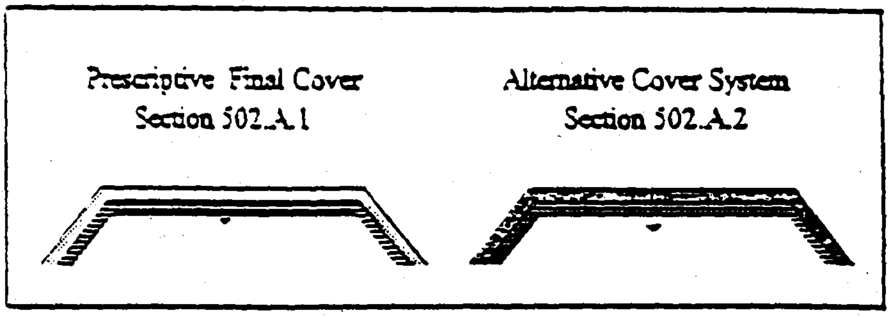


Figure 2.

For example, comparing the prescriptive cover of:

1) 6 inches of topsoil
2) 18 inches of compacted soil (K = 5 x 10^{-4}; to meet natural subsoils K = 5 x 10^{-6})

with a proposed alternative cover system of:

1) 6 inches of topsoils
2) 30 inches of compacted (K = 1 x 10^{-5})
3) 12 inches of uncompacted intermediate cover

2. New Solid Waste Landfills:

As in the above case, the cover for the proposed landfill with a the prescriptive or alternative liner must achieve the equivalent protection as the liner. If an alternative final cover is proposed for the landfill, then a demonstration must be submitted to the Bureau for approval pursuant to Section 502.A.2.a. It must be determined by this demonstration that the proposed final cover design includes an infiltration layer that achieves an equivalent reduction in infiltration as the bottom liner (Figure 3). A HELP Model simulation comparison is acceptable for this demonstration for a 5 year period with vegetation. Precipitation, evapotranspiration, temperature, and solar radiation data must be site specific and identical for both liner and cover design simulations. Provide justification for all input parameters in the model utilizing the attached forms. Demonstrate the relationship of the characteristics of on-site or other sources of soil proposed for the construction of cover or liner and the parameter values in the model. It is anticipated that the entire area of the landfill or cell will be modelled.

DRAF

For example, the comparison must include a HELP Model simulation for the liner and the proposed final cover systems as below.

The simulation for an alternative liner system* could include:

1) the drainage/protective layer of the liner with leachate collection system,
2) the 60-mil HDPE FML,
3) the 0.2 inch (K = 2 x 10^{-9}) GCL (geosynthetic clay liner),
~~[illegible]~~ inches of compacted in situ soil used as the prepared subgrade, and
5) with the solid waste cell open and no runoff.

*Any alternative liner system must meet the demonstration as described in the "Performance Demonstration For An Alternative Liner Design Using The HELP Modeling Program Under the New Mexico Solid Waste Management Regulations (20 NMAC 9.1)."

A liner system is compared with a HELP Model simulation for a proposed final cover:

1) 18 inches uncompacted material (6 inches of topsoil with poor grass and 12 inches of uncompacted soil),
2) the 0.2 inch GCL (K = 2 x 10^{-9}),
3) 12 inches of intermediate cover (6 inches of compacted soil and 6 inches of uncompacted soil), and
4) with the solid waste cell closed and final placement of the cover to include runoff.

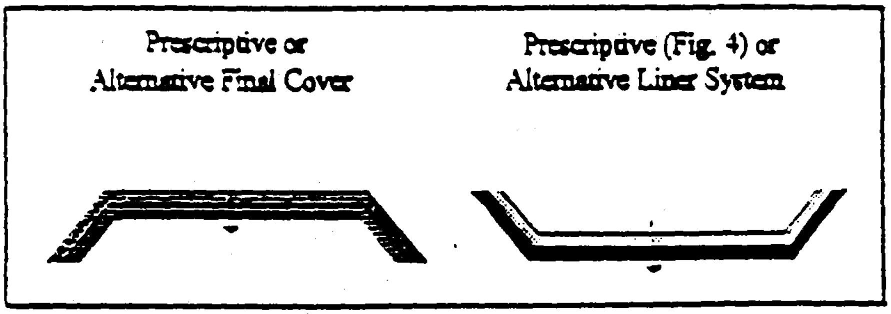


Figure 3.

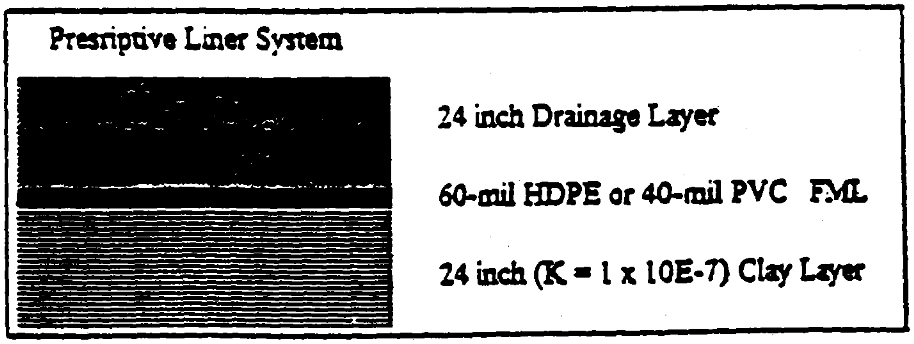


Figure 4.

Performance Demonstration for an Alternative Liner Design Using the HELP Modeling Program Under the New Mexico Solid Waste Management Regulations (20 NMAC 9.1)

1. Section 306.A.2 of the regulations requires the design of the alternative liner must provide equivalent protection as the composite liner defined in Section 306.A.1. Two computer modeling analyses must be performed - an analysis of the composite liner specified in Section 306.A.1 and an analysis of the proposed alternative liner as specified in Section 306.A.2. Equivalent protection must be demonstrated through a comparison of the performance of the Section 306.A.2 alternative liner with the performance of Section 306.A.1 composite liner (Figure 5).

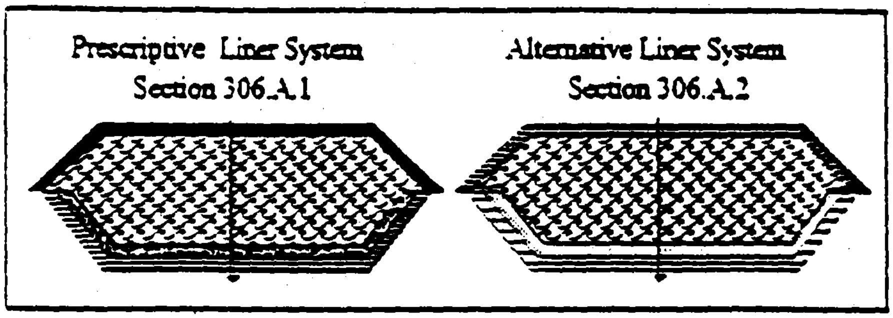


Figure 5.

2. Provide justification for all input parameters in the model utilizing the attached forms. Demonstrate the relationship of the characteristics of on-site or other sources of soil proposed for the construction and operation of the landfill and the parameter values used in the model. Show justification for the soil and waste moisture content parameters as well as geomembrane liner data and storm water runoff fraction.

3. Simulate actual design conditions and operational development of the landfill as closely as possible by doing a succession of model simulations. This succession must attempt to simulate moisture conditions in the landfill as closely as possible. To aid in accomplishing this, each successive computer simulation must use the previous simulation's moisture content output as the input for the following simulation. Describe the design approach modelled.

3.1 Initial simulation of the open landfill at start-up when landfill has little to no waste. The time period should extend for the anticipated duration of this condition, a minimum of one year and a probable maximum of five years.

3.2 A succeeding simulation to model conditions of the partially full landfill for some anticipated time period, most probably five years. This would incorporate daily cover and intermediate cover.

3.3. Perform subsequent computer simulations to model the landfill in the closed condition for the duration of the entire post-closure care period.

3.3.1 Model bare ground for the time period expected until vegetation becomes established.

3.3.2 Model the vegetated condition for the remainder of the post-closure care period.

4. Compliance with the regulatory requirement of not exceeding a 12 inch hydraulic head on the bottom liner must be demonstrated. Consequently, the area modeled must incorporated, at a minimum, one leachate collection "watershed" in order to simulate the leachate drainage distance. It is anticipated that the entire area of the landfill or cell will be modelled.

5. If there is no infiltration through the alternative liner system for the simulation(s), then these HELP Model simulation(s) will serve to demonstrate the concentration values listed in Section 1110 (Appendix K, EIB/SWMR-4) will not be exceeded in the uppermost aquifer or the relative point of compliance.

ATTACHMENT 1

LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS11/23/94 sheet no. 1

rev.1 1/22/96

INPUT PARAMETER	VALUE	JUSTIFICATION
CLIMATOLOGICAL DATA		
city		
precipitation & source of data (default or synthetic)		
temperature & source of data		
latitude		
maximum leaf area index		
evaporative zone depth		
growing season start and end day		
LANDFILL COVER DATA		
type of vegetative cover		
SCS runoff curve number		
active (uncovered)?		
% of surface runoff that drains from landfill		
surface area		
SOIL AND DESIGN DATA		
source of soil charactersitics		
number of layers		

NOTES:

ATTACHMENT 1

LANDFILL ALTERNATIVE LINER OR COVER DESIGN MODELING INPUT PARAMETERS 11/23/94 sheet no. 2

rev. 1 1/22/96

INPUT PARAMETER	VALUE	JUSTIFICATION
LAYER NUMBER:		
layer type		
thickness		
soil texture		
porosity		
field capacity		
wilting point		
moisture content		
saturated hydraulic conductivity		
Is layer compacted?		
slope (if lateral drainage layer)		
maximum horizontal drainage distance (if lateral drainage layer)		
geomembrane pinhole density		
geomembrane installation defects		
liner installation quality (if geomembrane)		
geotextile transmissivity		

(make additional copies for each layer as required)

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-29

Project Title: Triassic Park Waste Disposal Facility

Project No.: 602-0200

Calculation Title: Perimeter Road Design Evaluation

	Name	Date
Prepared By:	John Kendall	12/9/97
Checked By:	John Pellicer	12/10/97
Reviewed By:	Pat Corser	12/10/97

Revisions	Date	By	Checked By	Reviewed By

TerraMatrix
Engineering & Environmental Services
P.O. Box 774018, 1475 Pine Grove Road
Steamboat Springs, Colorado 80477
Phone 970.879.6260 Fax 970.879.9048

Project Name: TRIASSIC PARK HW FACILITY ROAD
Project Number: 602-0200 Sheet 1 Of 10
Prepared By: JJK Date: 12/9/97
Checked By: J. Pellicer Date: 10-Dec-97

OBJECTIVE: EVALUATE PROPOSED PERIMETER ROAD DESIGN FOR OFF HIGHWAY EQUIPMENT LOADING

METHOD: USE CBR CURVES FOR OFF HIGHWAY VEHICLES TO EVALUATE ROAD SUBBASE AND GRAVEL ROAD BASE THICKNESSES

REFERENCES: (1) CHIRONIS, NICHOLAS P., "HOW TO BUILD BETTER HAUL ROADS COAL AGE, JANUARY 1978, PP 122-124.

(2) TERRAMATRIX/MONTGOMERY WATSON, "ENGINEERING REPORT - TRIASSIC PARK HAZARDOUS WASTE FACILITY" DECEMBER 1997.

a) DESIGN DRAWING NO. 27, PERIMETER ROAD DETAILS
b) DESIGN DRAWING NO. 5, INITIAL SITE GRADING PLAN
c) SPECIFICATION NO 02230, SUBBASE
d) APPENDIX D LABORATORY TEST RESULTS

(3) CATERPILLAR HAND BOOK
(4) HOLTZ, RD, "GEOTECHNICAL ENGINEERING", 1981, PP 156

ASSUMPTIONS: (1) FILL AREAS WILL BE COMPACTED TO 95 % ACCORDING TO SPECIFICATION NO , (2c). THIS WILL PROVIDE A SUB GRADE BEARING CAPACITY OF CONSERVATIVELY 3,000 to 5,000 psf. (2b)

(2) CUT AREAS WILL GENERALLY REMOVE SOFT WIND BLOWN SURFICI SANDS AND WILL LIKELY BOTTOM OUT IN THE CALICHE LAYER, THE UPPER DOCKUM CLAY, OR HARDENED SANDS BENEATH THE SURFICIAL SANDS. (2b, 2d). BASED ON POCKET PENETROMETER DATA TAKEN DURING THE TEST PITTING INVESTIGATION (2d), THES AREAS WILL PROVIDE A SUBGRADE BEARING CAPACITY OF CONSERVATIVELY 3,000 to 5,000 psf.

(3) ASSUME OFF HIGHWAY TRUCK IS A CAT 769 C WITH GROSS VEHICLE WEIGHT LOADED OF 130,000 lb AND 67% REAR WEIGHT DISTRIBUTION (3)

(4) SUBGRADE BEARING CAPACITIES BETWEEN 3,000 psf AND 5,000 psf GENERALLY CORRESPOND TO FIRM OR STIFF CLAY AND COMPACT SAND-CLAY MATERIALS, RESPECTIVELY IN TABLE 1 (REF 1). COMPARING THIS TO FIGURE 1 (REF 1) INDICATES A CBR VALUE OF BETWEEN 6 AND 10 FOR THE SUBGRADE. ASSUME AVG VALUE OF 8.

(5) ASSUME COMPACTION OF SUBBASE WILL ACHIEVE CBR = 20 TO 40.

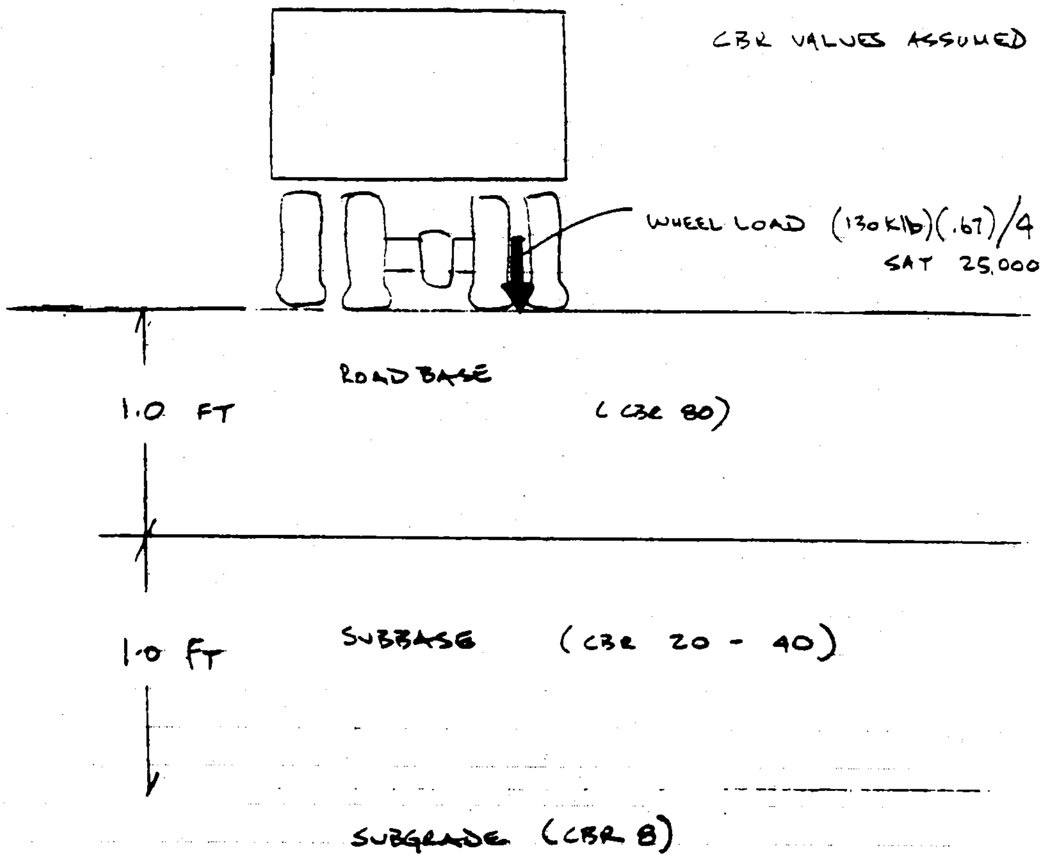
Project Name: TRIASSIC PARK HW FACILITY ROAD DES
Project Number: 602-0200
Sheet: 2 Of 10
Prepared By: JJK
Date: 12/9/97
Checked By: J. Pellicer
Date: 10-Dec-97

CALCULATION

TYPICAL OFF HIGHWAY TRUCK : CAT 76
GROSS VEHICLE WT (LOADED) : 130,50
WT DISTRIBUTION : 67% REAR AXLE

(1) DETERMINE WHEEL LOAD AND SKETCH ROAD SECTION

CBR VALUES ASSUMED



WHEEL LOAD $(130 \text{ klb})(.67)/4 = 21,775 \text{ lb}$
SAY 25,000 LB ←

(2) DETERMINE TOTAL SUBBASE AND ROADBASE THICKNESS REQ'D

FROM FIG 1, REQ'D SUBBASE THICKNESS IS 18 INCHES FOR SUBGRADE CBR = 8

FROM DESIGN, TOTAL SUBBASE AND ROAD BASE THICKNESS IS 24 INCHES
SO OK

(3) DETERMINE TOTAL ROADBASE THICKNESS REQ'D

FROM FIG 1, REQ'D ROADBASE THICKNESS IS 10 INCHES FOR SUBBASE CBR = 20
FROM DESIGN, TOTAL ROADBASE THICKNESS IS 12 INCHES, SO OK

CONCLUSION:

(1) ROADBASE AND SUBBASE THICKNESSES WILL SUPPORT OFF HIGHWAY EQUIPMENT. ACTUAL ROADBASE THICKNESS REQUIRED WILL LIKELY BE LESS BASED ON ACTUAL SUBGRADE CONDITIONS DETERMINED DURING CONSTRUCTION. EVALUATE ROADBASE THICKNES LESS THAN 1 FT DURING CONSTRUCTION AND MODIFY DESIGN ACCORDINGLY.

31

How to Build Better Haul Roads

Making sure the haul road is going to hold up under traffic planned for it mean considering a variety of construction parameters, including subbase and surfac materials, thicknesses, road-adhesion characteristics and hauling widths.

Nicholas P. Chironis, senior editor

Surface mine operators often avoid placing subbase materials under the haul-road surface in the interest of economy. They may believe it is less costly to permit some haul segments that hamper the flow of traffic rather than incur the cost of constructing a good road base. The eventual results, however, often lead to more costly operation.

If the sub-standard road is not constantly maintained, rutting, sinking and overall deterioration usually occurs, and vehicles must slow down considerably to negotiate these conditions. Over a period of time such slow-downs represent a considerable time loss to the production cycle, and can result in the need for additional vehicles and operators.

Need for good subbase

At some mine sites, the road surface is underlain by natural strata capable of supporting the weight of any haulage vehicle. For example, in the case of bedded stone formations, it is only necessary to place the desired road surface material directly on the bedded stone to have a good road. But frequently such base materials are not naturally available and the engineer building the road must look to the possibility of using other materials. The bearing capacity of potential subbase materials has been analyzed as part of a research study for the U.S. Bureau of Mines. The result is a table giving the bearing capacities of rock and other subsurface materials in terms of vehicle tire loads (Table 1).

To use this table, keep in mind that tire loading for most haulage vehicles, when inflated to recommended pressure, will rarely exceed 16,000 psi. Although the tire loading may be somewhat less depending on the number of tires and their size, this figure can be used with some confidence to determine subbase requirements. By checking the loading of 16,000 psi in the table it can be seen that any subgrade less consolidated than soft rock calls for additional material to establish a stable base. The question then is: How much additional material should be placed over the subgrade to adequately support the road surface?

CBR curves

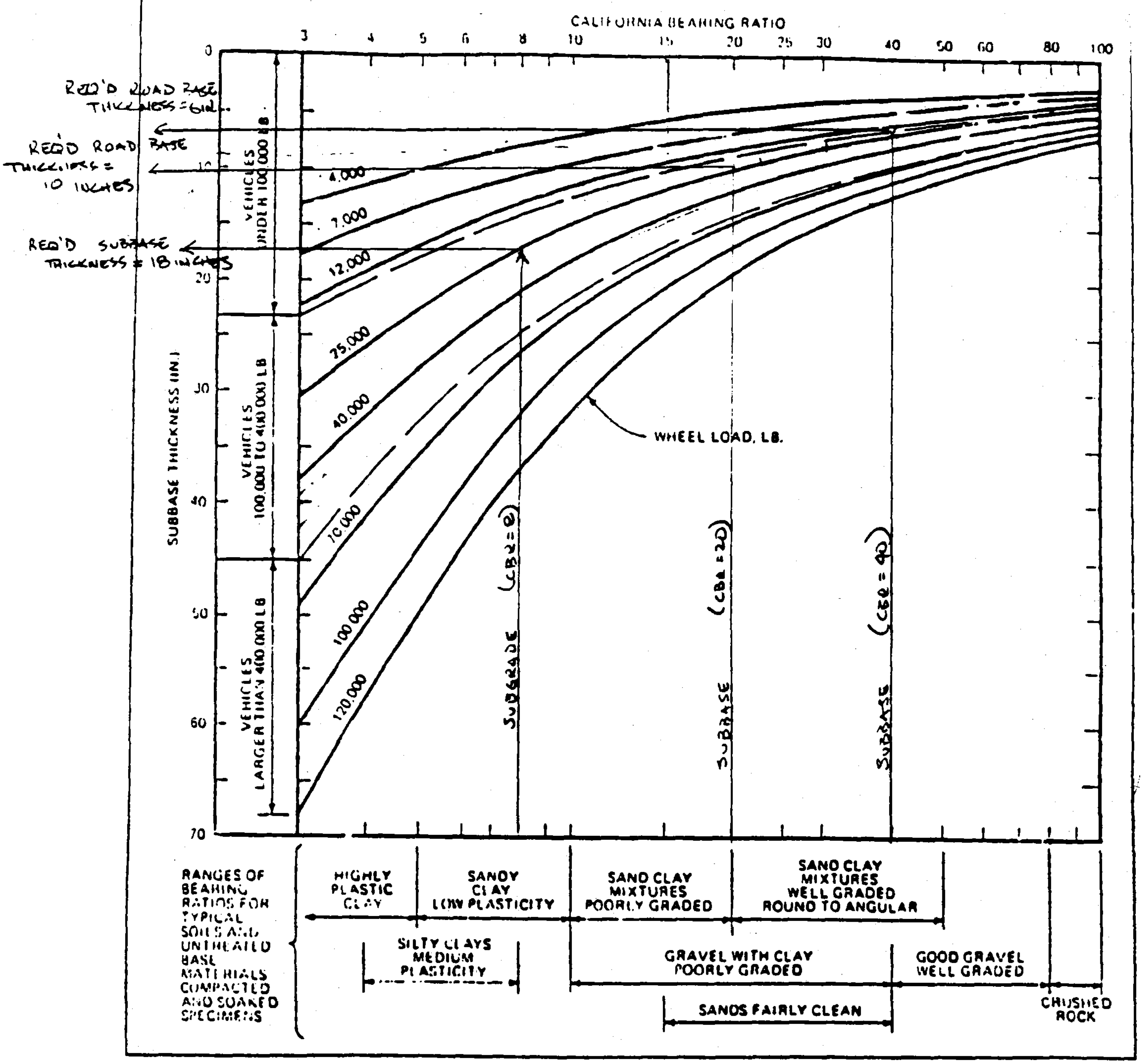
The study engineers found that one of the best methods of making this road-thickness determination is through use of California bearing-ratio (CBR) curves, Fig. 1. In order to b completely accurate, the road designer should obtain CB values from actual tests on both the subgrade and subbas materials the designer plans to use. These tests can b conducted by submitting the samples to a soils testin laboratory, a relatively minimal cost.

The CBR curves provide the subbase-thickness requirements for a wide range of wheel loads, soils and subbase materials. It must be emphasized, however, that the ranges in the CBR curves are not well defined. Actual test results, for example, may prove the bearing ratios for a specific soil group to be considerably better than the low value depicted on the chart. The CBR ranges reflected by the graph, therefore, should be used in lieu of actual test results when only general information is desired. In such cases, pick the lowest possible CBR value for a given soil type.

Table 1. Bearing Capacity of Soils

Material	Capacity in 1,000 lb per sq ft
Hard Sound Rock	120
Medium Hard Rock	80
Hard Pan Overlying Rock	24
Compact Gravel and Boulder-Gravel Formations; Very Compact Sandy Gravel	20
Soft Rock	16
Loose Gravel and Sandy Gravel; Compact Sand and Gravelly Sand; Very Compact Sand—Inorganic Silt Soils	12
Hard Dry Consolidated Clay	10
Loose Coarse to Medium Sand; Medium Compact Fine Sand	8
Compact Sand-Clay Soils	6
Loose Fine Sand; Medium Compact Sand—Inorganic Silt Soils	4
Firm or Stiff Clay	3
Loose Saturated Sand Clay Soils, Medium Soft Clay	2

Fig. 1. Curves for Determining Subbase Thicknesses and CBR Values



As shown by the curves, final subbase thicknesses are influenced by vehicle wheel loads as well as soil type. Maximum wheel loadings for any haulage vehicle are easily computed from manufacturers specifications by dividing the loaded vehicle weight over each axle by the number of tires on that axle. In every case, use the highest wheel loading calculated for the subbase thickness determinations. In fact, when a wheel is mounted on a tandem axle, increase the value by 20%.

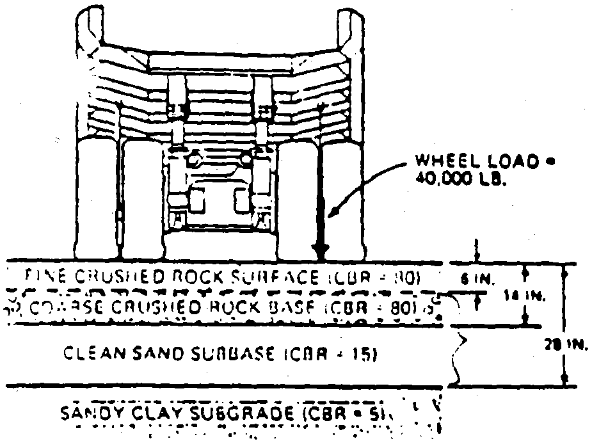
To provide a readily available indication of wheel loading characteristics of currently manufactured vehicles, the chart is divided into three categories. Each category represents the range of wheel loadings under fully loaded conditions that may be anticipated for vehicles in the given weight class.

Sample design problem

Here is how to compute subbase requirements, once the

[illegible]
2-Jan-92 S110

Fig. 2. Thicknesses of Subbase Materials



wheel loading and CBR values have been established. Let us assume the following conditions:

The haulroad is to be constructed over a silty clay of medium plasticity with a CBR of 5. The maximum wheel load for any vehicle using the road is 40,000 lb. Fairly clean sand is available with a CBR of 15 to serve as subbase material. Road surface is to be constructed of good gravel that has a CBR of 80. (If any of these actual CBR values are not known, pick off the CBR values from the chart, and then continue with these steps.)

- Step A. The 40,000-lb, wheel-load curve intersects the vertical line for a CBR of 5 at 28 in. This means that the final road surface must be at least this distance above the subgrade (Fig. 2).
- Step B. The value for a clean sand with a CBR o intersects the 40,000-lb curve at 14 in. below road surfa
- Step C. The intersection of the 80-CBR line for gravel the curve for the 40,000-lb wheel load occurs at 6 in. Bec this thickness constitutes the final surface materia should be placed at the upper 6-in. portion of the road.

For best results, subbase materials should exceed the desired surface width by at least 2 ft and must be compa while moist. Each 8-in. layer should be subjected to repe passes.

Compaction is usually done best with heavy rollers. Bu few surface-mine operators have rollers in their veh fleet, an alternative such as heavy-tracked equipment be employed.

Surface materials

Skelly and Loy engineers conducting the Bureau st visited over 300 mining operations throughout the cou to obtain practical information on haul-road constructi They report that at many of these mine sites, especially small coal mining and quarry operations, the haulway simply built by clearing a path over the existing terrain.

While this practice is undoubtedly inexpensive, the en neers find that the benefits were seldom long-lived. Beca it is difficult to construct a bedded rock surface free jagged edges, greater vehicle maintenance is required a result of excessive tire scuffing and wear. Furthermo unless thoroughly compacted and stabilized, such ea roads cause dust problems, especially during dry seasons. it is not controlled, the dust contaminates air-filtrati components, brakes, and moving parts, making frequ replacement of these items necessary.

Dust also represents a major safety hazard to the vehi operator by reducing visibility. Eliminating the d problem requires continual wetting of the surface, whi represents yet another maintenance expenditure. Wh

Table 2. Road Adhesion Coefficients of Rubber Tired Vehicles

Road Surface	Road Adhesion Coefficients	Road Surface	Road Adhesion Coefficients
Concrete		Rock	
New	0.80 to 1.00	Crushed	0.55 to 0.75
Traveled	0.60 to 0.80	Wet	0.55 to 0.75
Polished	0.55 to 0.75		
Wet	0.45 to 0.80	Cinders	
Asphalt		Packed	0.50 to 0.70
New	0.80 to 1.00	Wet	0.65 to 0.75
Traveled	0.60 to 0.80		
Polished	0.55 to 0.75	Snow	
Excess Tar	0.50 to 0.60	Packed	0.30 to 0.55
Wet	0.30 to 0.80	Loose	0.10 to 0.25
		Wet	0.30 to 0.60
Gravel			
Packed & Oiled	0.55 to 0.85	Ice	
Loose	0.40 to 0.70	Smooth	0.10 to 0.25
Wet	0.40 to 0.80	Wet	0.05 to 0.10

HOLTZ, R.D. "GEOTECHNICAL ENGINEERING", 1981.

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TABLE 5-4 Continued

Major Divisions (1)	(2)	Symbol Letter (3)	Symbol Hatching (4)	Symbol Color (5)	Drainage Characteristics (12)	Compaction Equipment (13)	Unit Dry Densities lbf/ft³ (14)	Unit Dry Densities Mg/m³ (15)	Typical Design Values CBR (16)	Typical Design Values Subgrade Modulus k (lbf/in³) (17)
COARSE-GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	▨	Red	Excellent	Crawler-type tractor, rubber-tired roller, steel-wheeled roller	125-140	2.00–2.24	40-80	300-500
		GP	▨		Excellent	Crawler-type tractor, rubber-tired roller, steel-wheeled roller	110-140	1.76–2.24	30-60	300-500
		GM d	▨	Yellow	Fair to poor	Rubber-tired roller, sheepsfoot roller; close control of moisture	125-145	2.00–2.32	40-60	300-500
		GM u	▨		Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	115-135	1.84-2.16	20-30	200-500
		GC	▨		Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	130-145	2.08-2.32	20-40	200-500
	SAND AND SANDY SOILS	SW	▨	Red	Excellent	Crawler-type tractor, rubber-tired roller	110-130	1.76–2.08	20-40	200-400
		SP	▨		Excellent	Crawler-type tractor, rubber-tired roller	105-135	1.68–2.16	10-40	150-400
		SM d	▨	Yellow	Fair to poor	Rubber-tired roller, sheepsfoot roller; close control of moisture	120-135	1.92-2.16	15-40	150-400
		SM u	▨		Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	100-130	1.60-2.08	10-20	100-300
		SC	▨		Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	100-135	1.60-2.16	5-20	100-300
FINE-GRAINED SOILS	SILTS AND CLAYS LL IS LESS THAN 50	ML	▨	Green	Fair to poor	Rubber-tired roller, sheepsfoot roller; close control of moisture	90-130	1.44-2.08	15 or less	100-200
		CL	▨		Practically impervious	Rubber-tired roller, sheepsfoot roller	90-130	1.44-2.08	15 or less	50-150
		OL	▨		Poor	Rubber-tired roller, sheepsfoot roller	90-105	1.44-1.68	5 or less	50-100
	SILTS AND CLAYS LL IS GREATER THAN 50	MH	▨	Blue	Fair to poor	Sheepsfoot roller, rubber-tired roller	80-105	1.28-1.68	10 or less	50-100
		CH	▨		Practically impervious	Sheepsfoot roller, rubber-tired roller	90-115	1.44-1.84	15 or less	50-150
		OH	▨		Practically impervious	Sheepsfoot roller, rubber-tired roller	80-110	1.28-1.76	5 or less	25-100
HIGHLY ORGANIC SOILS		Pt	▨	Orange	Fair to poor	Compaction not practical				

SUBBASE CBR RANGES 20 - 40

JK
9-Dec-97

SECTION 02230
SUBBASE

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, testing, and installation services necessary for the installation of subbase where shown on the Construction Drawings. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02110 - Site Preparation and Earthwork
B. Section 02225 - Road Base

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. On-site testing as specified in the CQA Plan for the subbase (which does not include quality control testing at the source) will be the responsibility of the CQA Engineer. The Contractor shall cooperate with the CQA Engineer during all sampling and testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor will repair any damage to finished work caused by the CQA Engineer's sampling and testing activities.

D. Quality control testing of the subbase at the source shall be the responsibility of the Contractor.

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9-Dec-97

E. The CQA Engineer will coordinate independent surveying required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

F. If the CQA Engineer's tests indicate work does not meet the requirements of the specification, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results area obtained.

PART 2: PRODUCTS

2.01 MATERIAL FOR SUBBASE

A. Subbase for the work shall obtained from the landfill or surface impoundment excavation or from on-site or off-site borrow sources. Subbase material shall be free of metals, roots, trees, stumps, concrete, construction debris, other organic matter, and deleterious materials and coatings.

B. The subbase shall classify as SM, SW, GM, or GW according to the Unified Soil Classification System (ASTM D2487) and shall have a maximum particle size of 3 inches.

PART 3: EXECUTION

3.01 SUBBASE COMPACTION CRITERIA

A. The compaction moisture content of the subbase shall be between 3 percent and 3 percent above optimum moisture content determined in the modified Proctor compaction test (ASTM D 1557). The minimum dry unit weight of the subbase shall be at least 95 percent of the maximum dry unit weight obtained from the modified Proctor compaction test (ASTM D 1557).

3.02 PLACEMENT AND COMPACTION

A. Subbase shall be placed at the locations and to the thicknesses shown on the Construction Drawings

B. Subbase shall not be placed directly on geosynthetics unless required by the General Specifications or Construction Drawings. Subbase may be placed using a backhoe, front-end loader, belt conveyor, spreader box, or other method approved by the Owner in maximum 12-inch loose lifts.

C. Final spreading of the subbase may be performed using a low ground-pressure dozer (Caterpillar D6H-LGP or other similar equipment approved by the CQA Engineer), low-ground pressure front-end loader, or by hand. The tracked equipment shall operate only over previously-placed subbase or other soil. The Contractor shall not operate equipment directly on geosynthetics.

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D. Unless otherwise specified by the Owner, the equipment used to spread subbase shall not exert ground pressures exceeding the following:

Allowable Equipment Ground Pressure (psi)	*Thickness of Gravel Above Geosynthetic (inches)*
< 5	12
< 10	18
< 20	24
> 20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

E. The Contractor shall operate equipment in a manner that is protective of polyethylene pipes and underlying geosynthetics. If it is suspected that damage to polyethylene pipes or underlying geosynthetics may have occurred, the Owner will instruct the Contractor to remove the overlying material to expose the potentially-damaged materials. The Contractor shall repair, at his own expense, any observed damage, in accordance with the requirements of these General Specifications.

3.03 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.04 PROTECTION OF WORK

A. After the subbase has been incorporated into the work, the Contractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

B. The Contractor shall use all means necessary to protect all prior work, materials and completed and partially completed work of other Sections of these General Specifications.

C. In the event of damage, the CQA Engineer will identify areas requiring repair, and the Contractor shall make repairs and replacements necessary, to the approval of the Owner at no additional cost to the Owner.

JJK
9-Dec-97

3.05 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the road base. Surveying shall be performed in accordance with of Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing to the Owner of the final location and elevation of the final surface of the road base, in accordance with the requirements of Section 01010 of these General Specifications.

[END OF SECTION]

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-30

Project Title: Triassic Park Waste Disposal Facility

Project No.: 602-0200

Calculation Title: Vertical River Bearing Capacity

	Name	Date
Prepared By:	Paul Pellicer	11/13/97
Checked By:	John Pellicer	11/14/97
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

TerraMatrix
Engineering & Environmental Services
P.O. Box 774018, 1475 Pine Grove Road
Steamboat Springs, Colorado 80477
Phone 970.879.6260 Fax 970.879.9048

Project Name: Triassic Park
Project Number: 502 Sheet: 1 Of 6
Prepared By: J. Pellicer Date: 13-Nov-97
Checked By: Zd Date: 14 Nov 97

Vertical Riser Bearing Capacity

OBJECTIVE: Determine bearing capacity safety factor of vertical riser pipe.

METHOD: Treat the vertical riser pipe as a pile. Assume waste settlement will cause downdrag forces on the pipe. Use Vesics Method outlined in Principles of Foundation Engineering.

ASSUMPTIONS: Waste $\phi = 29°$

Waste $\gamma = 110$ pcf

Riser Pipe Diameter = 24 in

Wrap 2 layers of HDPE around the perimeter of the riser pipe.

HDPE/HDPE $\delta = 10°$

Maximum Depth of Waste: 140 ft

Downdrag: Pipe Area = $\pi d h = (\pi)(2 ft)(140 ft) = 879 ft^2$

Avg. Pressure = $\left(\frac{0+140 ft}{2}\right)(110 pcf)(1-\sin 29)$

$= 3,967$ psf

Downdrag Load: $(879 ft^2)(3,967 psf)(\tan 10)$

$= 614,850$ lb

Weight of Pipe = $(140 ft)(171 lb/ft) = 23,940$ lbs

Weight of Soil on Pad = $(140 ft)(110 pcf)\left((6 ft)^2 - \frac{\pi (2)^2}{4}\right)$

$= 506,049$ lb

Weight of Concrete = $\left((6 ft)^2 - \pi \frac{(2 ft)^2}{4}\right)(1.5 ft)(150 pcf) = 7,393$ lb (pg

Total Weight = 1,152,227 lb

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P.O. Box 774018, 1475 Pine Grove Road
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Phone 970.879.6260 Fax 970.879.9048

Project Name: [illegible] Park
Project Number: 602
Sheet 2 of 6
Prepared By: I. Pillen
Date: 13-Jul-97
Checked By: RC
Date: 4 Nov 97

Bearing Capacity = $A_p\,(cN_c + \sigma_o' N_\sigma)$

Strength of Bearing Soil = $c = 0$ psf ; $\phi = 30°$

$I_r = 100$ from pg 5

Use table of pg. 6 to obtain N_σ factor

$N_\sigma = 51.02$

$A_p = (6\,ft)^2 - \pi \dfrac{(2ft)^2}{\cancel{2}} = 32.9\ ft^2$

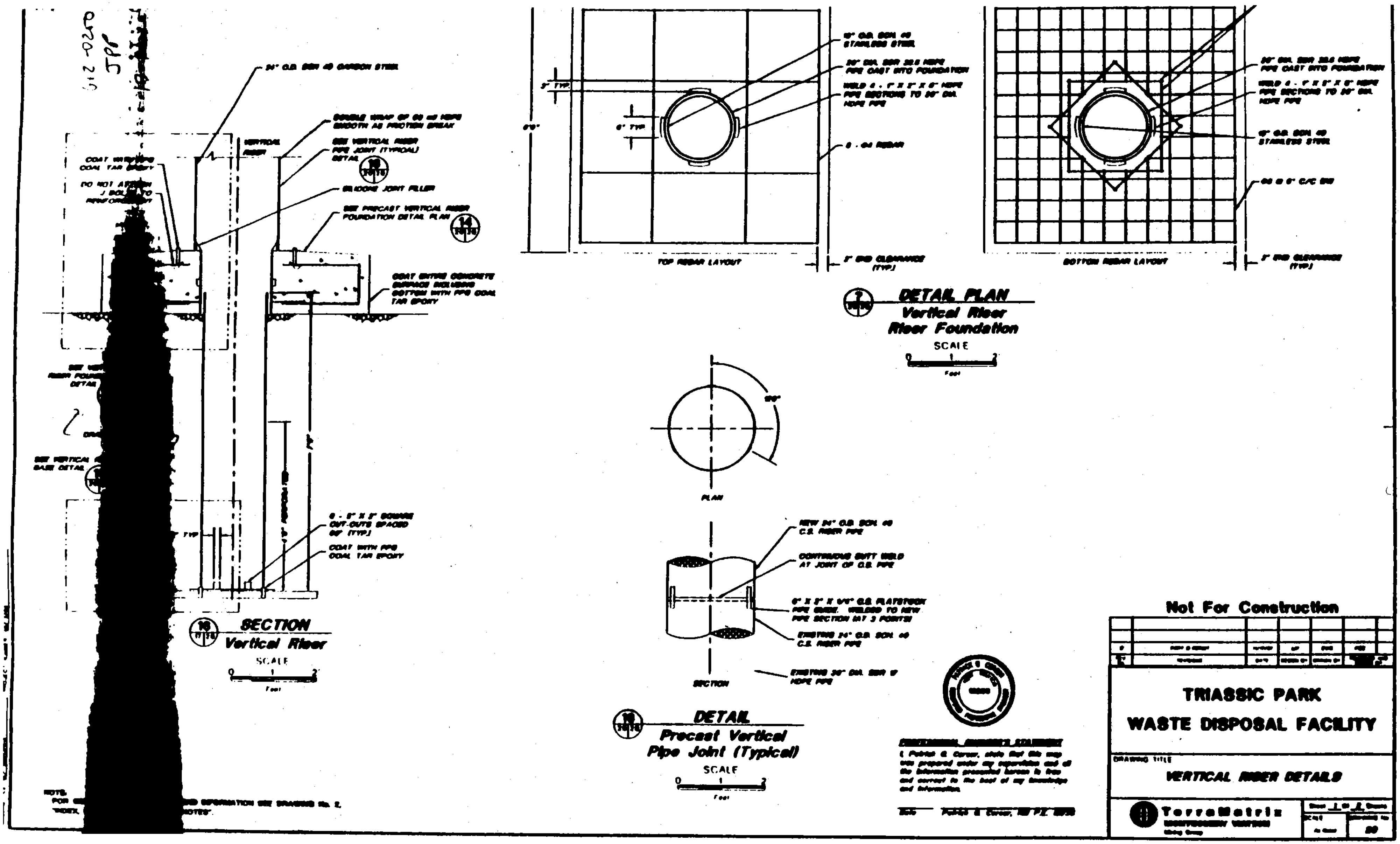
$\sigma_o' = (140\,ft)(110\,pcf) = 15,400\ psf$

$Q_p = (32.9\,ft^2)\left(\cancel{cN_c}^{\,0} + (51.02)(15,400\,psf)\right)$

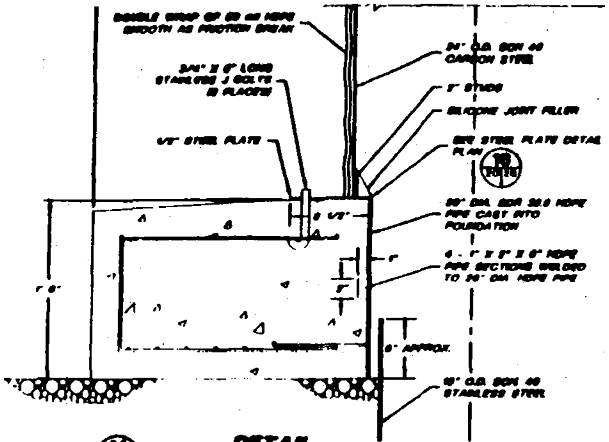
$= 25,849,793$ lbs

$SF = \dfrac{25,849,793\ lb}{1,152,227\ lb} = 22.4$ ok

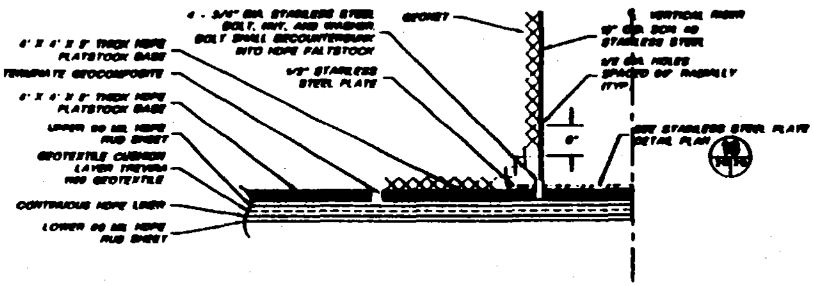
CONCLUSION: Bearing capacity at soil under vertical riser pipe is adequate.


312-0250
JPR
24" O.D. SCH 40 CARBON STEEL
VERTICAL RISER
DOUBLE WRAP OF 60 mil HDPE SMOOTH AS FRICTION BREAK
SEE VERTICAL RISER PIPE JOINT (TYPICAL) DETAIL
16
SILICONE JOINT FILLER
SEE PRECAST VERTICAL RISER FOUNDATION DETAIL PLAN
14
COAT ENTIRE CONCRETE SURFACE INCLUDING BOTTOM WITH PPG COAL TAR EPOXY
COAT WITH PPG COAL TAR EPOXY
DO NOT ATTACH J BOLTS TO REINFORCEMENT
SEE VERTICAL RISER FOUNDATION DETAIL
SEE VERTICAL BASE DETAIL
6 - 3" X 3" SQUARE CUT-OUTS SPACED 60° (TYP.)
COAT WITH PPG COAL TAR EPOXY
TYP
SECTION
Vertical Riser
SCALE
0
1
2
Feet
NOTE:
FOR ... INFORMATION SEE DRAWING No. 2, "INDEX, ... NOTES".
8'0"
3" TYP
6" TYP
16" O.D. SCH 40 STAINLESS STEEL
30" DIA. SDR 32.5 HDPE PIPE CAST INTO FOUNDATION
WELD 4 - 1" X 3" X 6" HDPE PIPE SECTIONS TO 30" DIA. HDPE PIPE
8 - #4 REBAR
3" END CLEARANCE (TYP.)
TOP REBAR LAYOUT
30" DIA. SDR 32.5 HDPE PIPE CAST INTO FOUNDATION
WELD 4 - 1" X 3" X 6" HDPE PIPE SECTIONS TO 30" DIA. HDPE PIPE
16" O.D. SCH 40 STAINLESS STEEL
#4 @ 6" C/C E/W
BOTTOM REBAR LAYOUT
3" END CLEARANCE (TYP.)
DETAIL PLAN
Vertical Riser
Riser Foundation
SCALE
0
1
2
Feet
120°
PLAN
NEW 24" O.D. SCH 40 C.S. RISER PIPE
CONTINUOUS BUTT WELD AT JOINT OF C.S. PIPE
6" X 3" X 1/4" C.S. FLATSTOCK PIPE GUIDE. WELDED TO NEW PIPE SECTION (AT 3 POINTS)
EXISTING 24" O.D. SCH 40 C.S. RISER PIPE
EXISTING 30" DIA. SDR 17 HDPE PIPE
SECTION
16
DETAIL
Precast Vertical
Pipe Joint (Typical)
SCALE
0
1
2
Feet
PROFESSIONAL ENGINEER'S STATEMENT
I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.
Date
Patrick G. Corser, NM P.E.
Not For Construction
TRIASSIC PARK
WASTE DISPOSAL FACILITY
DRAWING TITLE
VERTICAL RISER DETAILS
TerraMatrix
ENGINEERING SERVICES
Sheet 1 of 1 Sheets
SCALE
As Shown
DRAWING No.
20

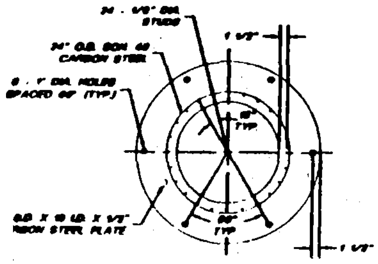
4
SPP 13-NN-97 602-



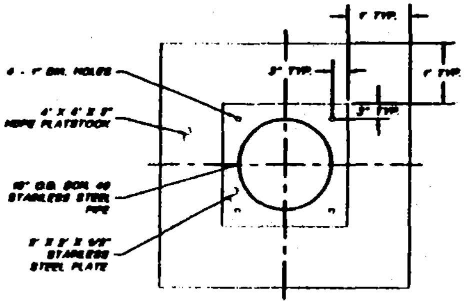
14
DETAIL
Vertical Riser Foundation
SCALE
0 0.5 1
Feet



17
DETAIL
Vertical Riser Base
SCALE
0 0.5 1
Feet



16
DETAIL PLAN
Steel Plate
SCALE
0 1 2
Feet



18
DETAIL PLAN
Stainless Steel Plate

SCALE
0 1 2'
Feet

NOTE
FOR GENE
INDEX, LE

ERAL INFORMATION SEE DRAWING No. 2.
L NOTES"

PROFESSIONAL ENGINEER'S STATEMENT
I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date Patrick G. Corser, NM P.E. [illegible]

Not For Construction

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE
VERTICAL RISER DETAILS

TerraMatrix
Sheet 1 of 1 Sheets
SCALE As Noted
DRAWING No. 30

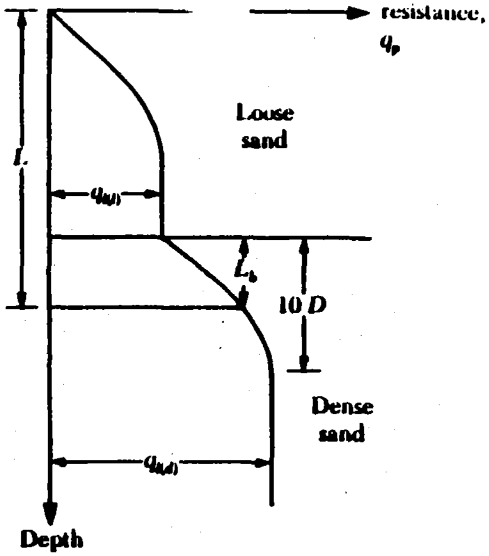


Figure 8.13 Variation of unit point resistance in layered soil

1. Obtain $(L_b/D)_{cr}$ for the given value of ϕ from Figure 8.12.
2. Calculate L_b/D.
3. If $L_b/D \geq (L_b/D)_{cr}/2$, take the maximum values of N_c^* and N_q^* from Figure 8.12.
4. If $L_b/D < (L_b/D)_{cr}/2$, then

$$N_c^* = N^*_{c(\text{at } L_b/D=0)} + [N^*_{c(\text{max})} - N^*_{c(\text{at } L_b/D=0)}] \left[\frac{\left(\frac{L_b}{D}\right)}{0.5\left(\frac{L_b}{D}\right)_{cr}}\right] \tag{8.17}$$

$$N_q^* = N^*_{q(\text{at } L_b/D=0)} + [N^*_{q(\text{max})} - N^*_{q(\text{at } L_b/D=0)}] \left[\frac{\left(\frac{L_b}{D}\right)}{0.5\left(\frac{L_b}{D}\right)_{cr}}\right] \tag{8.18}$$

Vesic's Method*:** Vesic (1977) proposed a method for estimating the pile point bearing capacity based on the theory of ***expansion of cavities. According to this theory, based on effective stress parameters,

$$Q_p = A_p q_p = A_p(cN_c^* + \sigma_o' N_\sigma^*) \tag{8.19}$$

where σ_o' = mean normal ground stress (effective) at the level of the pile point

$$= \left(\frac{1 + 2K_o}{3}\right) q' \tag{8.20}$$

N_c^*, N_σ^* = bearing capacity factors (8.21)

Note that Eq. (8.19) is a modification of Eq. (8.11a) w.. .

$$N_\sigma^* = \frac{3N_q^*}{(1 + 2K_o)} \tag{8.22}$$

The relation for N_c^* given in Eq. (8.19) can be expressed as

$$N_c^* = (N_q^* - 1) \cot \phi \tag{8.23}$$

According to the theory of Vesic

$$N_q^* = f(I_{rr}) \tag{8.24}$$

where I_{rr} = reduced rigidity index for the soil

However

$$I_{rr} = \frac{I_r}{1 + I_r \Delta} \tag{8.25}$$

where I_r = rigidity index $= \dfrac{E_s}{2(1 + \mu_s)(c + q' \tan \phi)} = \dfrac{G_s}{c + q' \tan \phi}$ (8.26)

E_s = Young's modulus of soil
μ_s = Poisson's ratio of soil
G_s = shear modulus of soil
Δ = average volumatic strain in the plastic zone below the pile point

For conditions of no volume change (that is, dense sand or saturated clay), $\Delta = 0$. So

$$I_r = I_{rr} \tag{8.27}$$

Table 8.8 gives the values of N_c^* and N_σ^* for various values of the soil friction angle (ϕ) and I_{rr}. For $\phi = 0$ (that is, undrained condition)

$$N_c^* = \frac{4}{3}(\ln I_{rr} + 1) + \frac{\pi}{2} + 1 \tag{8.28}$$

The values of I_r can be estimated from laboratory consolidation and triaxial tests corresponding to the proper stress levels. However, for preliminary use the following values are recommended:

Soil type	I_r
Sand	70–150
Silts and clays (drained condition)	50–100
Clays (undrained condition)	100–200

I_r value

Irrespective of the theoretical procedure adopted in calculating Q_p, it should be kept in mind that full value cannot be realized until the pile tip has

602-
JPY
13-N

	I_{rr}									
ϕ	10	20	40	60	80	100	200	300	400	500
0	6.97	7.90	8.82	9.36	9.75	10.04	10.97	11.51	11.89	12.19
	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	7.34	8.37	9.42	10.04	10.49	10.83	11.92	12.57	13.03	13.39
	1.13	1.15	1.16	1.18	1.18	1.19	1.21	1.22	1.23	1.23
2	7.72	8.87	10.06	10.77	11.28	11.69	12.96	13.73	14.28	14.71
	1.27	1.31	1.35	1.38	1.39	1.41	1.45	1.48	1.50	1.51
3	8.12	9.40	10.74	11.55	12.14	12.61	14.10	15.00	15.66	16.18
	1.43	1.49	1.56	1.61	1.64	1.66	1.74	1.79	1.82	1.85
4	8.54	9.96	11.47	12.40	13.07	13.61	15.34	16.40	17.18	17.80
	1.60	1.70	1.80	1.87	1.91	1.95	2.07	2.15	2.20	2.24
5	8.99	10.56	12.25	13.30	14.07	14.69	16.69	17.94	18.86	19.59
	1.79	1.92	2.07	2.16	2.23	2.28	2.46	2.57	2.65	2.71
6	9.45	11.19	13.08	14.26	15.14	15.85	18.17	19.62	20.70	21.56
	1.99	2.18	2.37	2.50	2.59	2.67	2.91	3.06	3.18	3.27
7	9.94	11.85	13.96	15.30	16.30	17.10	19.77	12.46	22.71	23.73
	2.22	2.46	2.71	2.88	3.00	3.10	3.43	3.63	3.79	3.91
8	10.45	12.55	14.90	16.41	17.54	18.45	21.51	23.46	24.93	26.11
	2.47	2.76	3.09	3.31	3.46	3.59	4.02	4.30	4.50	4.67
9	10.99	13.29	15.91	17.59	18.87	19.90	23.39	25.64	27.35	28.73
	2.74	3.11	3.52	3.79	3.99	4.15	4.70	5.06	5.33	5.55
10	11.55	14.08	16.97	18.86	20.29	21.46	25.43	28.02	29.99	31.59
	3.04	3.48	3.99	4.32	4.58	4.78	5.48	5.94	6.29	6.57
11	12.14	14.90	18.10	20.20	21.81	23.13	27.64	30.61	32.87	34.73
	3.36	3.90	4.52	4.93	5.24	5.50	6.37	6.95	7.39	7.75
12	12.76	15.77	19.30	21.64	23.44	24.92	30.03	33.41	36.02	38.16
	3.71	4.35	5.10	5.60	5.98	6.30	7.38	8.10	8.66	9.11
13	13.41	16.69	20.57	23.17	25.18	26.84	32.60	36.46	39.44	41.89
	4.09	4.85	5.75	6.35	6.81	7.20	8.53	9.42	10.10	10.67
14	14.08	17.65	21.92	24.80	27.04	28.89	35.38	39.75	43.15	45.96
	4.51	5.40	6.47	7.18	7.74	8.20	9.82	10.91	11.76	12.46
15	14.79	18.66	23.35	26.53	29.02	31.08	38.37	43.32	47.18	50.39
	4.96	6.00	7.26	8.11	8.78	9.33	11.28	12.61	13.64	14.50
16	15.53	19.73	24.86	28.37	31.13	33.43	41.58	47.17	51.55	55.20
	5.45	6.66	8.13	9.14	9.93	10.58	12.92	14.53	15.78	16.83
17	16.30	20.85	26.46	30.33	33.37	35.92	45.04	51.32	56.27	60.42
	5.98	7.37	9.09	10.27	11.20	11.98	14.77	16.69	18.20	19.47
18	17.11	22.03	28.15	32.40	35.76	38.59	48.74	55.80	61.38	66.07
	6.56	8.16	10.15	11.53	12.62	13.54	16.84	19.13	20.94	22.47
19	17.95	23.26	29.93	34.59	38.30	41.42	52.71	60.61	66.89	72.18
	7.18	9.01	11.31	12.91	14.19	15.26	19.15	21.87	24.03	25.85
20	18.83	24.56	31.81	36.92	40.99	44.43	56.97	65.79	72.82	78.78
	7.85	9.94	12.58	14.44	15.92	17.17	21.73	24.94	27.51	29.67
21	19.75	25.92	33.80	39.38	43.85	47.64	61.51	71.34	79.22	85.90
	8.58	10.95	13.97	16.12	17.83	19.29	24.61	28.39	31.41	33.97
22	20.71	27.35	35.89	41.98	46.88	51.04	66.37	77.30	86.09	93.57
	9.37	12.05	15.50	17.96	19.94	21.62	27.82	32.23	35.78	38.81
23	21.71	28.84	38.09	44.73	50.08	54.66	71.56	83.68	93.47	101.83
	10.21	13.24	17.17	19.99	22.26	24.20	31.37	36.52	40.68	44.22
24	22.75	30.41	40.41	47.63	53.48	58.49	77.09	90.51	101.39	110.70
	11.13	14.54	18.99	22.21	24.81	27.04	35.32	41.30	46.14	50.29
25	23.84	32.05	42.85	50.69	57.07	62.54	82.98	97.81	109.88	120.23
	12.12	15.95	20.98	24.64	27.61	30.16	39.70	46.61	52.24	57.06
26	24.98	33.77	45.42	53.93	60.87	66.84	89.25	105.61	118.96	130.44
	13.18	17.47	23.15	27.30	30.69	33.60	44.53	52.51	59.02	64.63
27	26.16	35.57	48.13	57.34	64.88	71.39	95.02	113.92	128.67	141.38
	14.33	19.12	25.52	30.21	34.06	37.37	49.88	59.05	66.56	73.04
28	27.40	37.45	50.96	60.93	69.12	76.20	103.01	122.79	139.04	153.10
	15.57	20.91	28.10	33.40	37.75	41.51	55.77	66.29	74.93	82.40
29	28.69	39.42	53.95	64.71	73.58	81.28	110.54	132.23	150.11	165.61
	16.90	22.85	30.90	36.87	41.79	46.05	62.27	74.30	84.21	92.86
30	30.03	41.49	57.08	68.69	78.30	86.64	118.53	142.27	161.91	178.98
	18.24	24.95	33.95	40.66	46.21	51.02	69.43	83.14	94.48	104.33
31	31.43	43.64	60.37	72.88	83.27	92.31	126.99	152.95	174.49	193.22
	19.88	27.22	37.27	44.79	51.03	56.46	77.31	92.90	105.84	117.11
32	32.89	45.90	63.82	77.29	88.50	98.28	135.96	164.29	187.87	208.43
	21.55	29.68	40.88	49.30	56.30	62.41	85.96	103.66	118.39	131.24
33	34.41	48.26	67.44	81.92	94.01	104.58	145.46	176.33	202.09	224.62
	23.34	32.34	44.80	54.20	62.05	68.92	95.46	115.51	132.24	146.87
34	35.99	50.72	71.24	86.80	99.82	111.22	155.51	189.11	217.21	241.84
	25.28	35.21	49.05	59.54	68.33	76.02	105.90	128.55	147.51	164.12
35	37.65	53.30	75.22	91.91	105.92	118.22	166.14	202.64	233.27	260.15
	27.36	38.32	53.67	65.36	75.17	83.78	117.33	142.89	164.33	183.16
36	39.37	55.99	79.39	97.29	112.34	125.59	177.38	216.98	250.30	279.60
	29.60	41.68	58.68	71.69	82.62	92.24	129.87	158.65	182.85	204.14
37	41.17	58.81	83.77	102.94	119.10	133.34	189.25	232.17	268.36	300.26
	32.02	45.31	64.13	78.57	90.75	101.48	143.61	175.95	203.23	227.28
38	43.04	61.75	88.36	108.86	126.20	141.50	201.78	248.23	287.50	322.17
	34.63	49.24	70.03	86.05	99.60	111.56	158.65	194.94	225.62	252.71
39	44.99	64.83	93.17	115.09	133.66	150.09	215.01	265.23	307.78	345.41
	37.44	53.50	76.45	94.20	109.24	122.54	175.11	215.78	250.23	280.71
40	47.03	68.04	98.21	121.62	141.51	159.13	228.97	283.19	329.24	370.04
	40.47	58.10	83.40	103.05	119.74	134.52	193.13	238.62	277.26	311.50
41	49.16	71.41	103.49	128.48	149.75	168.63	243.69	302.17	351.95	396.12
	43.74	63.07	90.96	112.68	131.18	147.59	212.84	263.67	306.94	345.34
42	51.38	74.92	109.02	135.68	158.41	178.62	259.22	322.22	375.97	423.74
	47.27	68.46	99.16	123.16	143.64	161.83	234.40	291.13	339.52	382.53
43	53.70	78.60	114.82	143.23	167.51	189.13	275.59	343.40	401.36	452.96
	51.08	74.30	108.08	134.56	157.21	177.36	257.99	321.22	375.28	423.39
44	56.13	82.45	120.91	151.16	177.07	200.17	292.85	365.75	428.21	483.88
	55.20	80.62	117.76	146.97	172.00	194.31	283.80	354.20	414.51	468.28
45	58.66	86.48	127.28	159.48	187.12	211.79	311.04	389.35	456.57	516.58
	59.66	87.48	128.28	160.48	188.12	212.79	312.03	390.35	457.57	517.58
46	61.30	90.70	133.97	168.22	197.67	224.00	330.20	414.26	486.54	551.16
	64.48	94.92	139.73	175.20	205.70	232.96	342.94	429.98	504.82	571.74
47	64.07	95.12	140.99	177.40	208.77	236.85	350.41	440.54	518.20	587.72
	69.71	103.00	152.19	191.24	224.88	254.99	376.77	473.42	556.70	631.25
48	66.97	99.75	148.35	187.04	220.43	250.36	371.70	468.28	551.64	626.38
	75.38	111.78	165.76	208.73	245.81	279.06	413.82	521.08	613.65	696.04
49	70.01	104.60	156.09	197.17	232.70	264.58	394.15	497.56	586.96	667.21
	81.54	121.33	180.56	227.82	268.69	305.37	454.42	573.38	676.22	768.53
50	73.19	109.70	164.21	207.83	245.60	279.55	417.82	528.46	624.28	710.30
	88.23	131.73	196.70	248.68	293.70	334.15	498.94	630.80	744.99	847.61

From "Design of Pile Foundations," by A. S. Vesic, in NCHRB *Synthesis of Highway Practice 42*, Transportation Research Board, 1977. Reprinted by permission.

Note: Upper number N_c^*, lower number N_q^*

612-
JP1
13-Nr

Calculation Cover Sheet Appendix E-31

Project Title: Triassic Park Waste Disposal Facility

Project No.: 602-0200

Calculation Title: LCRS Pumping Capacity

	Name	Date
Prepared By:	Paul Pellicer	11/15/97
Checked By:	John Pellicer	11/15/97
Reviewed By:	Pat Corser	11/15/97

Revisions	Date	By	Checked By	Reviewed By

Project Name: Triassic Park
Project Number: 602-0200 Sheet: 1 Of 5
Prepared By: P. Pelkner Date: 11-15-97
Checked By: J. Bellin Date: 15-Nov-97

LCRS Pumping Capacity

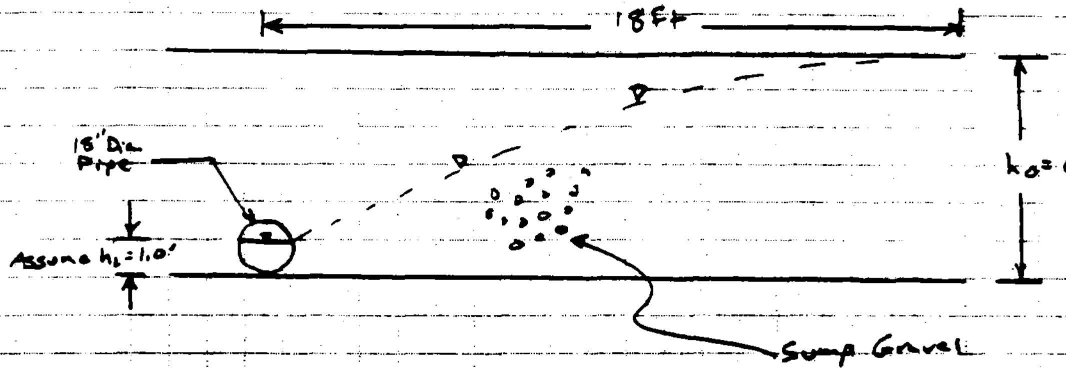
Objective: Check pumping capacity compared to the LCRS Flow Rate

Analysis: Check capacity of sump for LCRS. See pg 3+4 for layout and dimensions.

Use Method described in "Groundwater Hydrology and Hydraulics", 1977

Use Dupuit-Forcheimer Equation.

$$Q = \frac{k}{2L}\left(h_o^2 - h_L^2\right)$$



Q = Flow (Per foot of pipe)
L = 18ft
h_o = 6 ft
h_L = 1 ft
k = Perm of Sump Gravel = 1 cm/sec = 1 cm/sec × $\frac{1\text{ ft}}{30.48\text{ cm}}$ = 0.0328

$$Q = \frac{\left[0.0328\ \text{ft/sec}\right]}{2(18\text{ ft})}\left[6^2 - 1^2\right] = 0.0319\ \text{ft}^3/\text{sec/ft}\ ✓$$

$$Q = 0.0319\ \text{ft}^3/\text{sec/ft} \times \frac{3600\text{ sec}}{\text{hr}} = 114.84\ \text{ft}^3/\text{hr/ft} \times \frac{24\text{ hr}}{\text{day}} \times \frac{7.48}{\text{f}}$$

Q = 20616 gal/day/ft (pipe length = 30 ft see pg 4)

Q = 618,480 gal/day ✓

Project Name: Triassic Park
Project Number: 602-0200
Sheet: 2 Of 5
Prepared By: P. Pellizar
Date: 11-15-97
Checked By: J. Pellicer
Date: 15-Nov-97

Determine flow rate into LCRS sump from the Geocomposite

$Q_{in} = i \Theta w$

i = flow gradient = Maximum floor grade = 3.3% = 0.033 ✓

Θ = Transmisivity = 5×10^{-4} m²/sec (from ALR calc)

w = Maximum width of Floor ~540 ft (see pg 5)

$$Q_{in} = 0.033 \left(5 \times 10^{-4} \, \mathrm{m^2/sec} * \frac{10.76391 \, \mathrm{ft^2}}{\mathrm{m^2}}\right)(540 \, \mathrm{ft}) = 0.096 \, \mathrm{ft^3/sec} \checkmark$$

$$Q_{in} = 0.096 \, \mathrm{ft^3/sec} \left(\frac{7.48 \, \mathrm{gal}}{\mathrm{ft^3}}\right)\left(\frac{3600 \, \mathrm{sec}}{\mathrm{hr}}\right)\left(\frac{24 \, \mathrm{hr}}{\mathrm{day}}\right) = 62{,}042 \, \mathrm{gal/day}$$

$$S.F. = \frac{Q_{out}}{Q_{in}} = \frac{618480 \, \mathrm{gpd}}{62042 \, \mathrm{gpd}} = \underline{\underline{9.9}} \checkmark$$

Conclusion: The LCRS sump has the capacity to pump out the flow Rate coming into the sump.

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15-NOV-97

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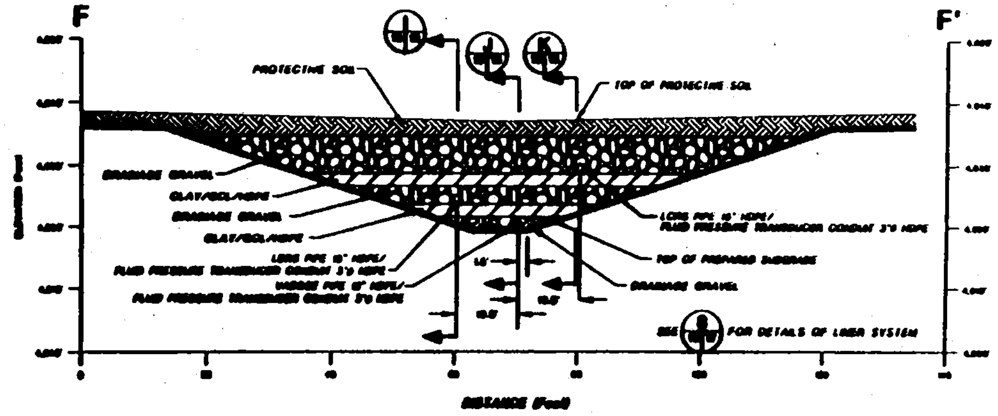
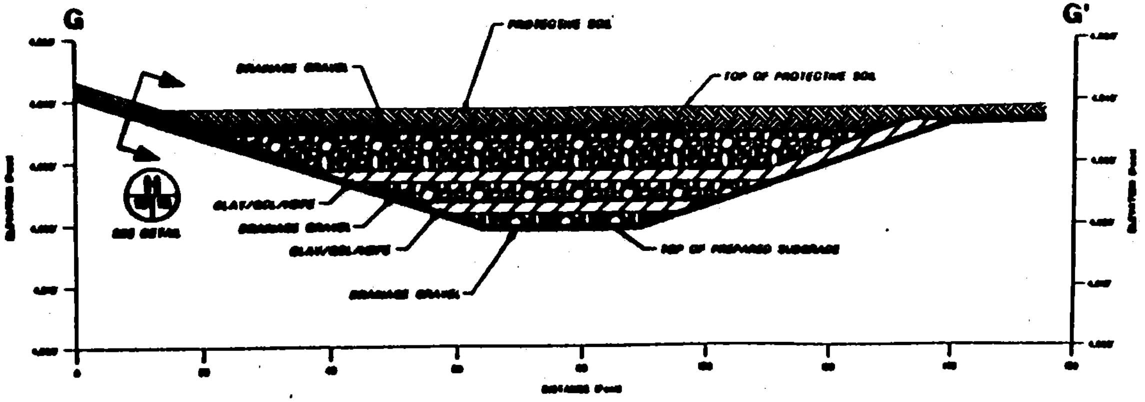


SUMP DETAIL -CROSS-SECTION A-A'

HORIZONTAL SCALE
0 10.0' 20.0'
VERTICAL SCALE
0 10.0' 20.0'



SUMP DETAIL -CROSS-SECTION B-B'

HORIZONTAL SCALE
0 10.0' 20.0'
VERTICAL SCALE
0 10.0' 20.0'

Not For Construction

TRIASSIC PARK
WASTE DISPOSAL FACILITY

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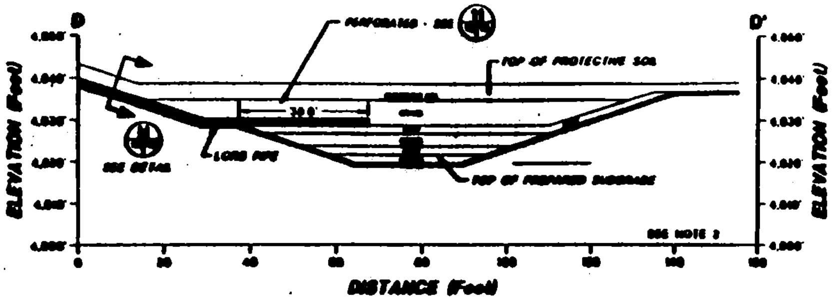
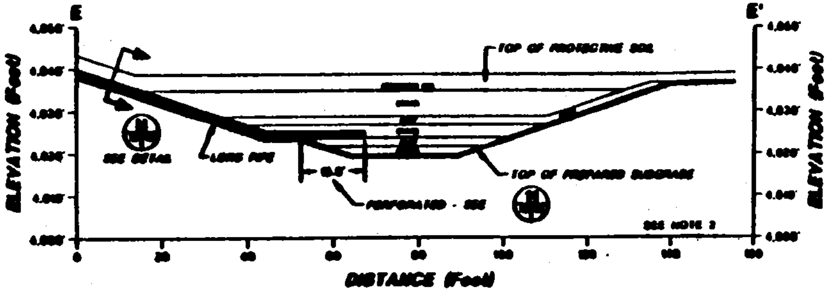


I LCRS PIPE PLACEMENT IN SUMP

HORIZONTAL SCALE
0 15' 30'

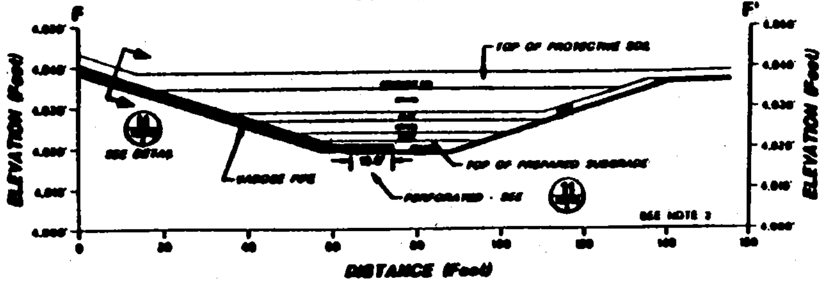
VERTICAL SCALE
0 15' 30'



J LDRS PIPE PLACEMENT IN SUMP

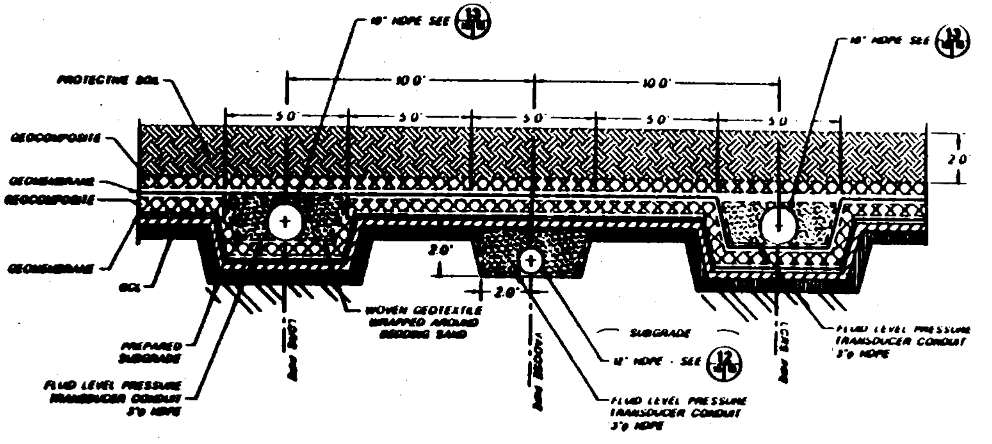
HORIZONTAL SCALE
0 15' 30'

VERTICAL SCALE
0 15' 30'



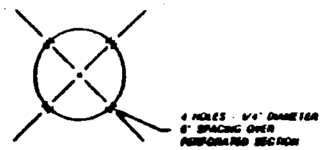
K VADOSE PIPE PLACEMENT IN SUMP

HORIZONTAL SCALE
0 15' 30'



H H LDRS, VADOSE AND LCRS PIPES SLOPE DETAIL

Not To Scale



11 PIPE PERFORATION DETAIL

Not To Scale

NOTE:
1. FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2

K:\602\FINAL\DWGS\LANDFILL

PROFESSIONAL ENGINEER'S STATEMENT
I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Not For Construction

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE
VADOSE, LDRS, LCRS
CROSS-SECTIONS AND DETAILS

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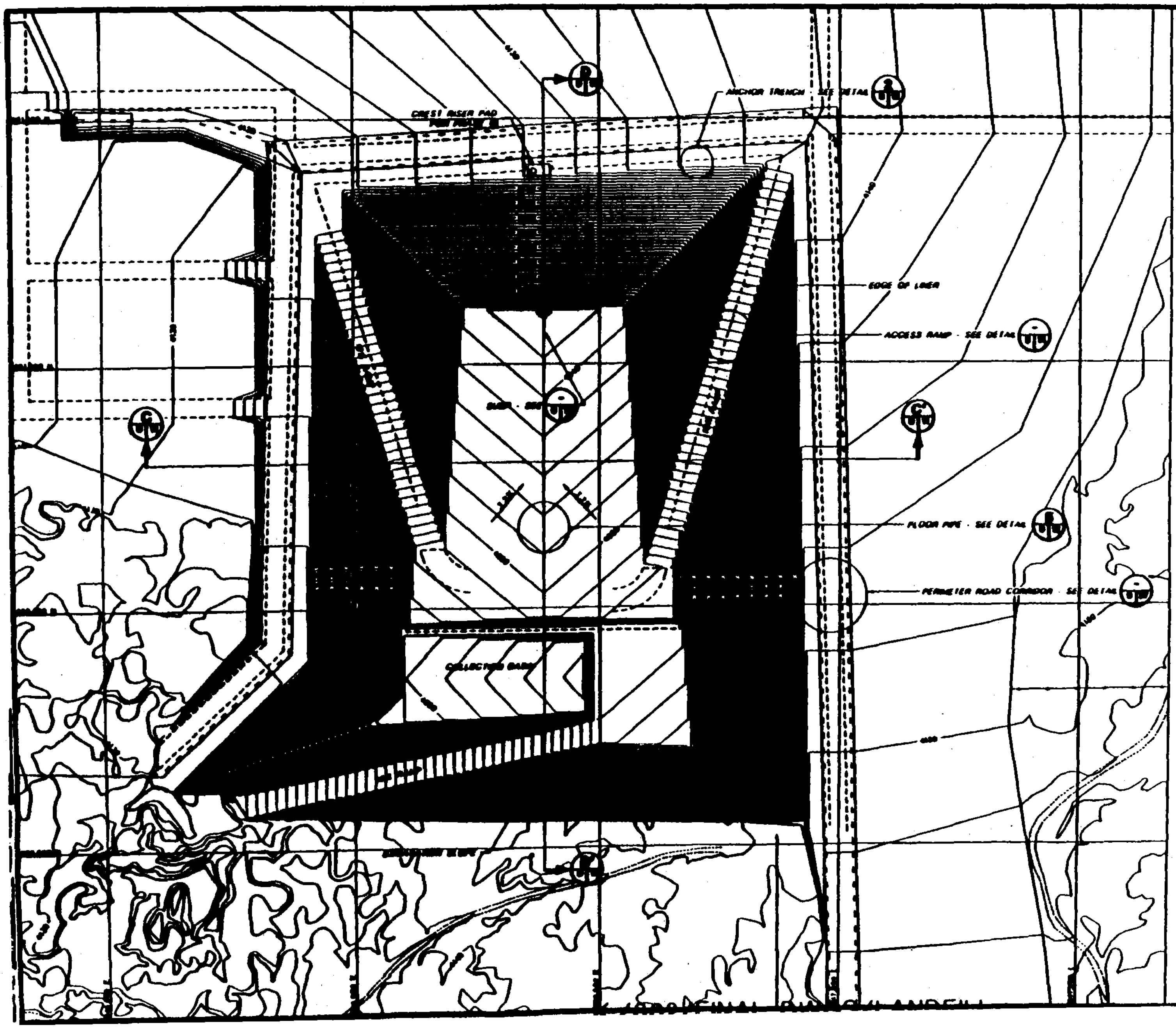
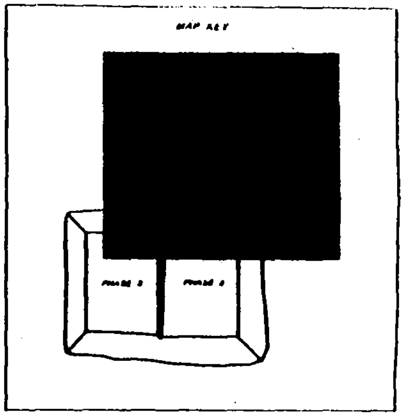




NOTES
1 FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No 2 "INDEX LEGEND AND GENERAL NOTES"
2 TOPOGRAPHY FROM AERIAL SURVEYS PERFORMED AUGUST 1981 BY KOOGLE AND POULS ENGINEERING

PROFESSIONAL ENGINEER'S STATEMENT
I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information

Date Patrick G. Corser, NM P.E. 12236

SCALE
100' 0 100' 200'
CONTOUR INTERVAL 5 FT.

Not For Construction

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE
TOP OF PROTECTIVE SOIL LAYER - PHASE 1A

TerraMatrix

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-34

Project Title: Triassic Park Waste Disposal Facility

Project No.: 602-0200

Calculation Title: Stability Analysis of Exterior Slope on South-West Corner of Landfill

	Name	Date
Prepared By:	Jorge C. Troncoso	9/12/99
Checked By:	Donald J. Montgomery	12/6/99
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

MONTGOMERY WATSON
Mining Group

Project Name: TRIASSIC PARK HAZARDOUS WASTE LANDFILL
Project Number: 1342602.02190200
Sheet 1 of
Prepared By: JCT
Date 10/11/99
Checked By: DJM
Date 12/06/99

PURPOSE: STABILITY ANALYSIS OF EXTERIOR SLOPE ON SOUTH-WEST CORNER OF LANDFILL

METHOD: USE BISHOP'S ANALYSIS METHOD IMPLEMENTED IN PROGRAM SLOPE W

ASSUMPTIONS: - NATURAL SOILS CONSIST OF UPPER DOCKUM USE SAME PROPERTIES INDICATED IN APPENDIX E-1.

- SLOPES ARE UNSATURATED.

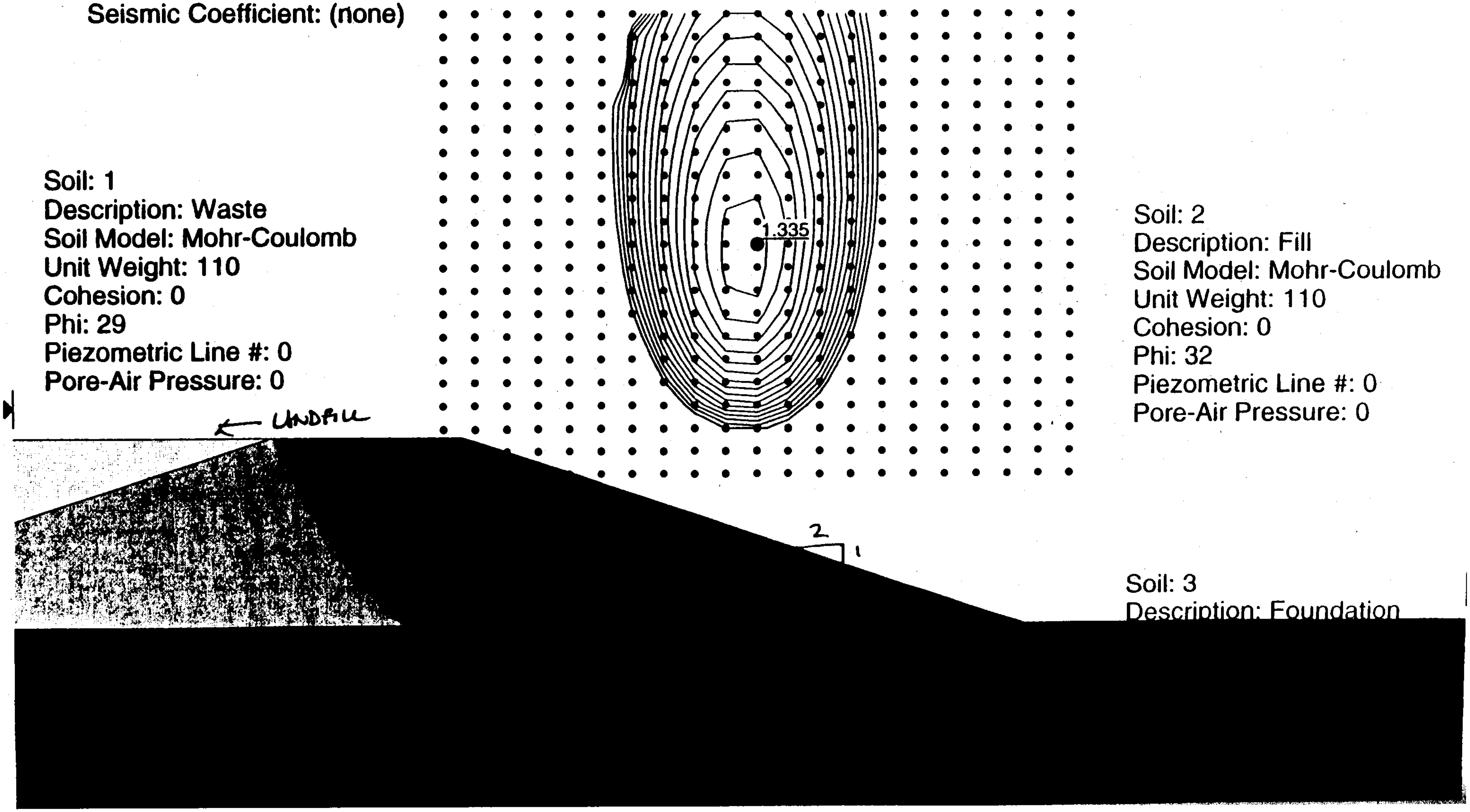
- GROUND ACCELERATION OF 0.04g (SEE APPENDIX E-1).

- WASTE PROPERTIES FROM APPENDIX E-3.

- COMPACTED SILTY SAND PLACED AS FILL → $\phi = 32°$.

CALCULATION: - STATIC FOS = 1.3
- DYNAMIC FOS = ~~1.2~~ 1.1 DJM.

Description: Triassic Park
Comments: Outside Slopes of Landfill (south west corner).
File Name: Triassic.slp
Last Saved Date: 11/12/99
Last Saved Time: 10:24:30 AM
Analysis Method: Bishop
Direction of Slip Movement: Left to Right
Slip Surface Option: Grid and Radius
Seismic Coefficient: (none)

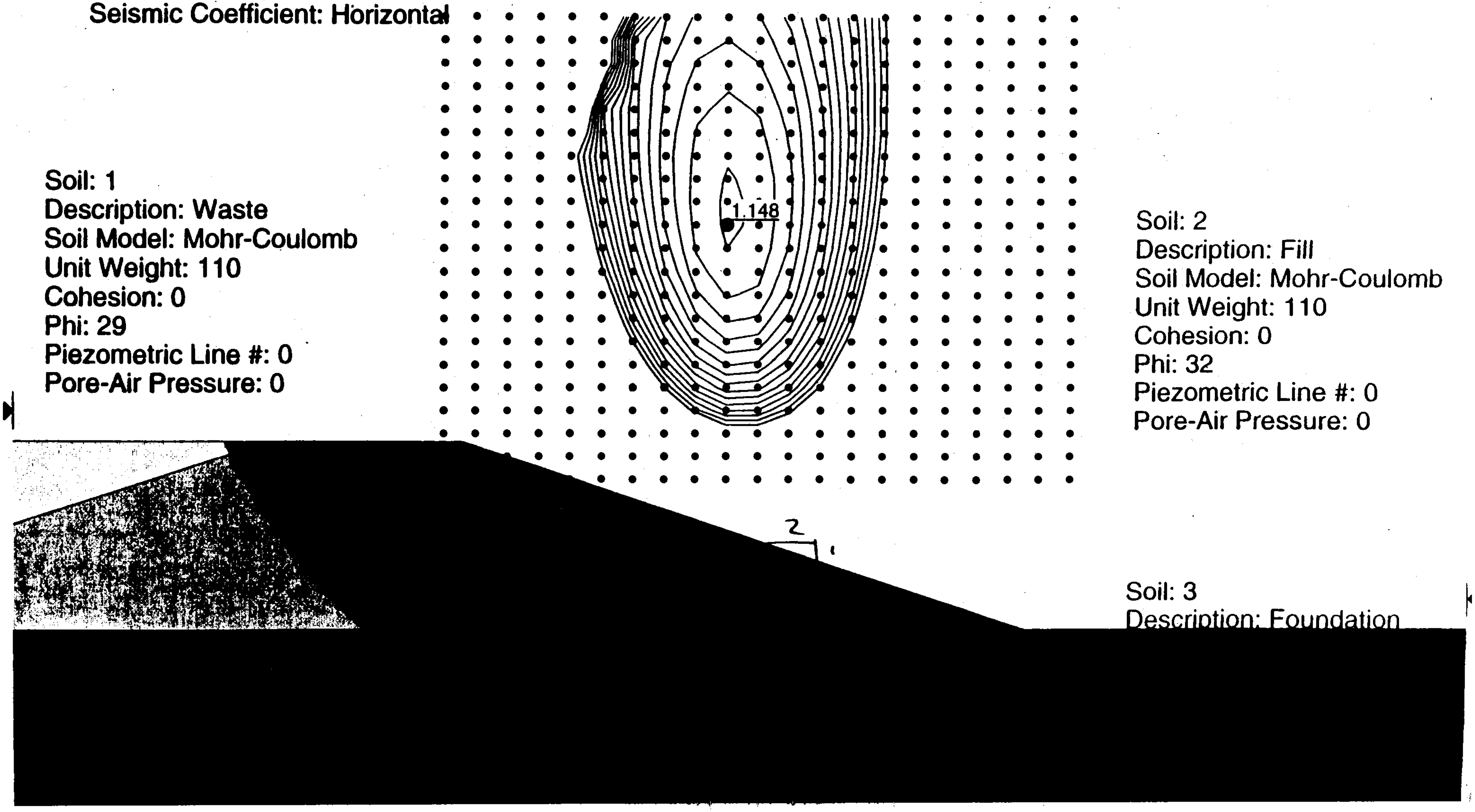


Soil: 1
Description: Waste
Soil Model: Mohr-Coulomb
Unit Weight: 110
Cohesion: 0
Phi: 29
Piezometric Line #: 0
Pore-Air Pressure: 0

Soil: 2
Description: Fill
Soil Model: Mohr-Coulomb
Unit Weight: 110
Cohesion: 0
Phi: 32
Piezometric Line #: 0
Pore-Air Pressure: 0

Soil: 3
Description: Foundation

Description: Triassic Park
Comments: Outside Slopes of Landfill
File Name: Triassic.slp
Last Saved Date: 11/12/99
Last Saved Time: 10:22:46 AM
Analysis Method: Bishop
Direction of Slip Movement: Left to Right
Slip Surface Option: Grid and Radius
Seismic Coefficient: Horizontal



Soil: 1
Description: Waste
Soil Model: Mohr-Coulomb
Unit Weight: 110
Cohesion: 0
Phi: 29
Piezometric Line #: 0
Pore-Air Pressure: 0

Soil: 2
Description: Fill
Soil Model: Mohr-Coulomb
Unit Weight: 110
Cohesion: 0
Phi: 32
Piezometric Line #: 0
Pore-Air Pressure: 0

Soil: 3
Description: Foundation

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-35

Project Title: Triassic Park Waste Disposal Facility

Project No.: 602-0200

Calculation Title: Stability of Landfill Cover System Under Saturated Conditions

	Name	Date
Prepared By:	Jorge C. Troncoso	9/26/99
Checked By:	Donald J. Montgomery	11/24/99
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

Project Name TRIASSIC PARK
Project Number 602 1
Prepared By J. Monroy Date 10/26/99
Checked By D. Montgomery Date 11/24/99

OBJECTIVE: ANALYZE THE STABILITY OF COVER SYSTEM UNDER SATURATED CONDITIONS.

METHOD: USE INFINITE SLOPE ANALYSIS. FAILURE ALONG WEAK INTERFACES, GCL-GEOMEMBRANE AND VEGETATIVE COVER

ASSUMPTIONS: USE PROPERTIES FROM APPENDIX E-5 AND FOR VEGETATIVE COVER => $\phi = 15°$.

CALCULATIONS:

$$FOS = \frac{c + h(\gamma_{sat} - \gamma_w)\cdot\cos^2\beta\cdot\tan\phi}{\gamma_{sat}\cdot h\cdot\sin\beta\cdot\cos\beta}$$

WITH: $h = 2.5\ ft$
$\gamma_{sat} = 110\ pcf$
$\beta = 3.4°$
$\gamma_w = 62.4\ pcf$

$$\Rightarrow FOS = \frac{2.5(110 - 62.4)\cdot\cos^2 3.4\cdot\tan 15}{110\cdot 2.5\cdot\sin 3.4\cdot\cos 3.4}$$

$$= 1.95$$ ✓ ok

FOR: $\gamma_{sat} = 150\ pcf \Rightarrow FOS = 2.63$ ✓

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-36

Project Title: Triassic Park Waste Disposal Facility

Project No.: 602-0200

Calculation Title: Concrete Bearing Capacity Beneath Tanks

	Name	Date
Prepared By:	Jorge C. Troncoso	8/27/99
Checked By:	Donald J. Montgomery	11/24/99
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

MONTGOMERY WATSON
Mining Group

Project Name: TRIASSIC PARK
Project Number: 1342602 0219.0200
Sheet 1 of 2
Prepared By: JCT
Date 8/11/99
Checked By: D.J.M. Duff
Date 11/2/99

CONCRETE BEARING CAPACITY BENEATH TANKS

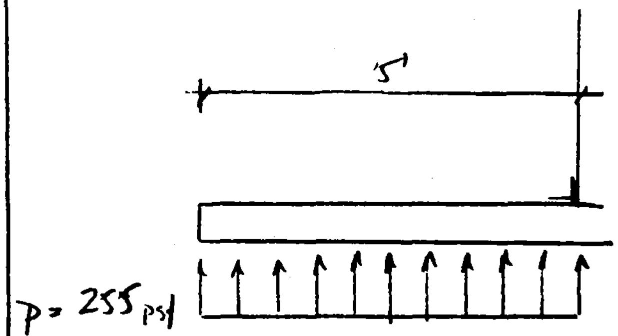
OBJECTIVE: DETERMINE IF CONCRETE PAD CAN TAKE PRESSURE OF TANK.

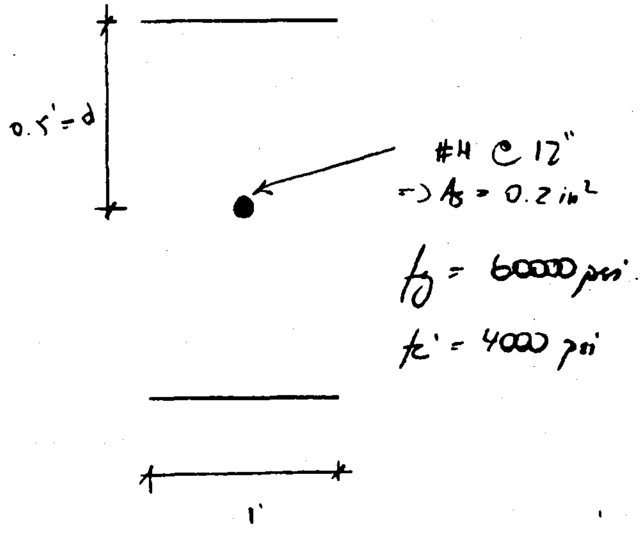
METHOD: CALCULATE PRESSURES THAT SOIL PRODUCES ON CONCRETE SLAB AND VERIFY THAT MOMENTS AND SHEAR FORCES ARE LESS THAN THE ALLOWABLE ACCORDING TO ACI.

ASSUMPTIONS: - TANKS HOLD 9000 gal OF LIQUID WITH A DENS. OF 62 pcf. => TOTAL WEIGHT OF LIQUID = 34t. EACH TANK WEIGHS: 17t -> TOTAL WEIGHT = 51t = DIMENSIONS OF SLAB = 21 × 21 ft^2 -> $p = 255$ psf.

CALCULATION:

- MAXIMUM DISTANCE BETWEEN EDGE OF SLAB AND TANK = 5'





$$\rho = \frac{A_s}{b \cdot d} = \frac{0.2}{12 \cdot 6} = 0.0028$$

$$\rightarrow a = \frac{0.2 \cdot 60000}{0.85 \cdot 4000 \cdot 12}$$

$$= 0.3 \text{ in.}$$

MOMENT RESISTANCE

$$\Rightarrow \phi \cdot M_n = 0.7 \cdot 0.2 \cdot 60000 \cdot \left(6 - 0.3/2\right) =$$

$$= 49140 \text{ lb} \cdot \text{in}$$

$$M_u = 255 \cdot 1 \cdot 5 \cdot 5/2 = 3188 \text{ lb} \cdot \text{ft} = 38250 \text{ lb} \cdot \text{in} < 49140 \text{ lb} \cdot \text{in}$$

MONTGOMERY WATSON
Mining Group

Project Name: TRIASSIC PARK
Project Number: 1342602.0290207
Sheet: 2 of 2
Prepared By: JCF
Date: 8/11/99
Checked By: C.H.M.
Date: 11/21/99

SHEAR RESISTANCE:

$V_c = 2 \cdot \sqrt{f'_c} \; b_w \cdot d$

$= 2 \cdot \sqrt{4000} \cdot 12 \cdot 6$

$= 9107$ lb

$V_u = 255 \cdot 5 \cdot 1 = 1275$ lb

$V_u < \phi V_c = 0.85 \cdot 9107 = 7741 \leftarrow$ OK

$\Rightarrow$ NO STIRRUPS NECESSARY.

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-37

Project Title: Triassic Park Waste Disposal Facility

Project No.: 602-0200

Calculation Title: Stability Analysis of South Cut Slope of Landfill

	Name	Date
Prepared By:	Jorge C. Troncoso	9/12/99
Checked By:	Donald J. Montgomery	12/6/99
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

MONTGOMERY WATSON
Mining Group

Project Name: TRIASSIC PARK HAZARDOUS WASTE LANDF.
Project Number: 1342602.02190200
Sheet: 1 of
Prepared By: JCT
Date: 10/12/99
Checked By: D.M.
Date: 12/06/99

Deep Failure Surface

PURPOSE: STABILITY ANALYSIS OF SOUTH CUT SLOPE OF LANDFILL (for a deep failure surface)

METHOD USE BISHOP'S ANALYSIS METHOD IMPLEMENTED IN PROGRAM SLOPE-W.

ASSUMPTIONS: SAME ASSUMPTIONS AS APPENDIX Z-1.

CALCULATION: STATIC FOS = ~~1.1~~ ~~1.4~~ 1.45 D.M.

THE LOAD OF EQUIPMENT PLACED AT THE TOP OF THE SLOPE ~~REDUCES~~ THE FOS ~~TO 1~~ MAINTAINS AT ~~1.1~~. 1.45 D.M.

Shallow Failure Surface

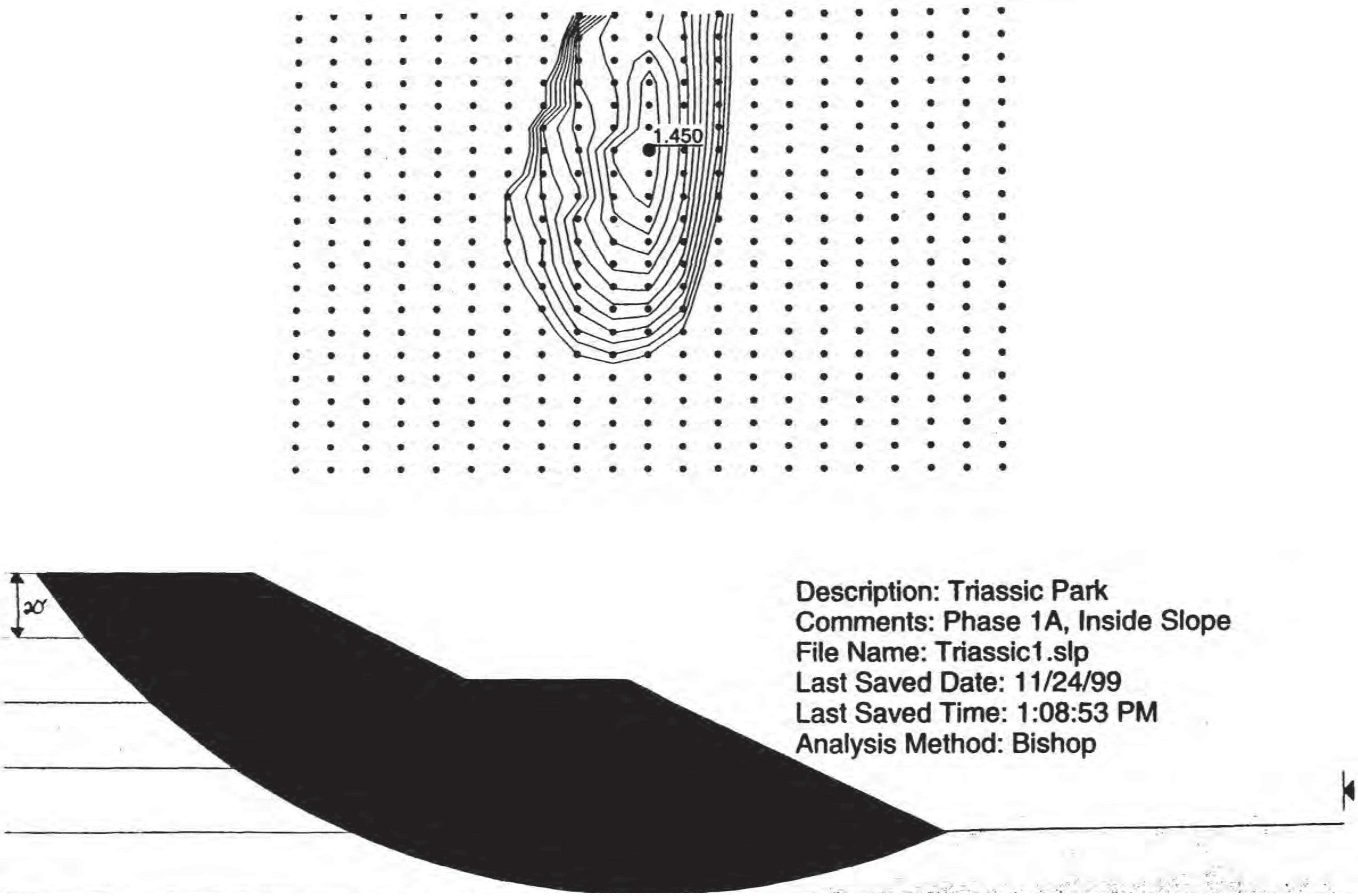
Purpose: Stability analysis for shallow surface failure on south cut slope of Landfill.

Method: Use Bishop's Analysis Method implemented in slope/W program.

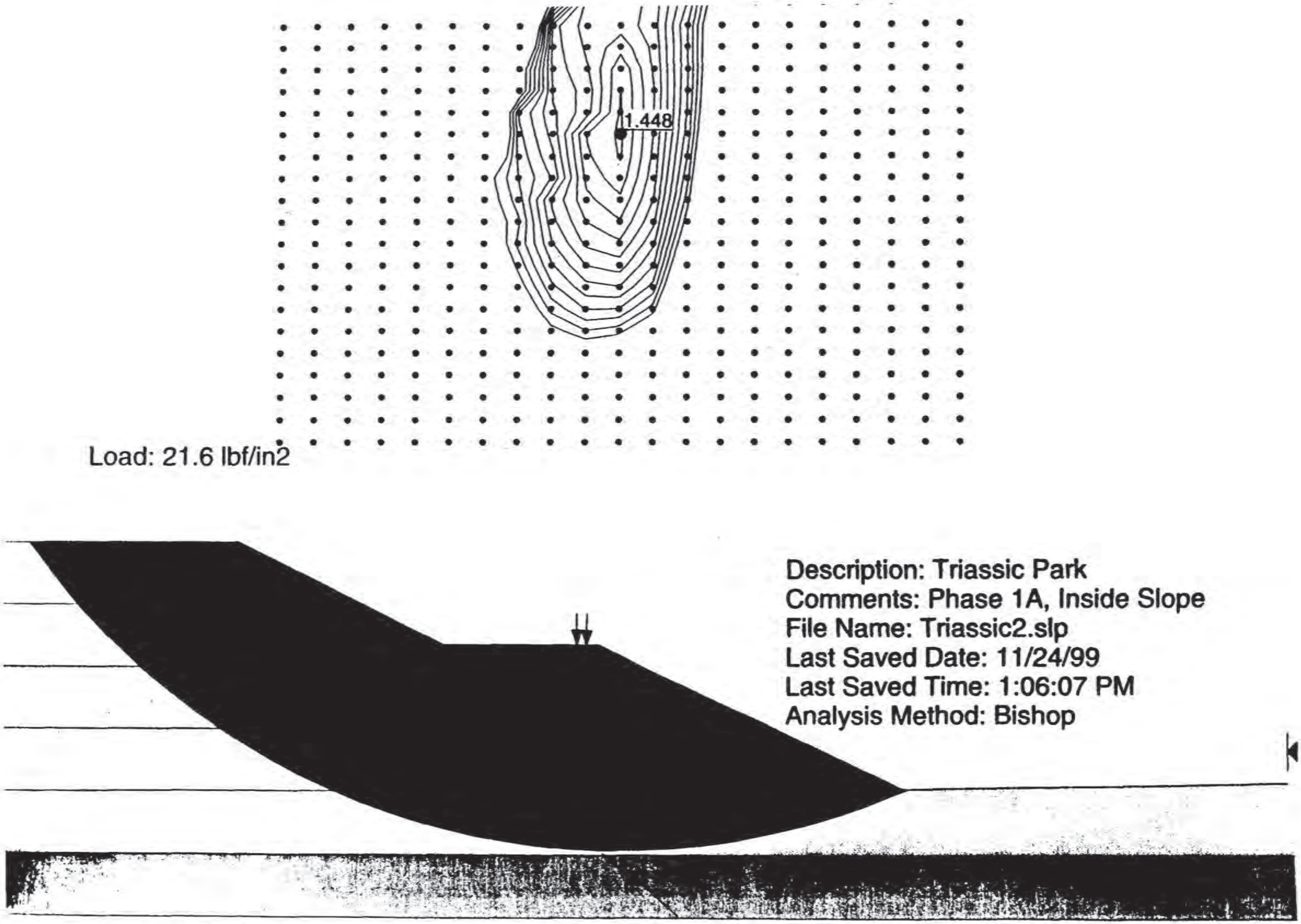
Assumptions: Same assumptions as above. $S/p = 0.2$ applied in 20' layers

Calculation:

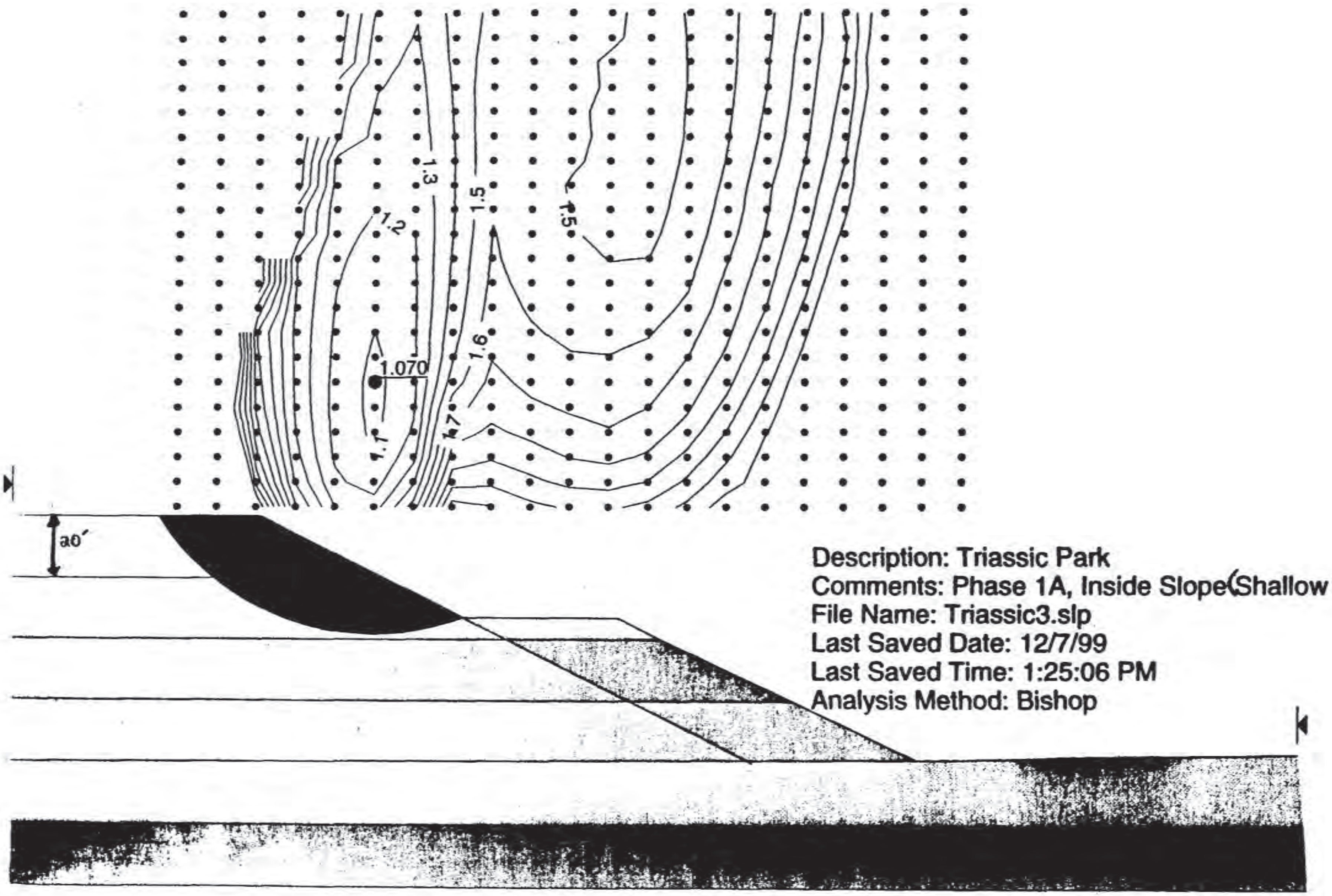
Static FOS = 1.1



Description: Triassic Park
Comments: Phase 1A, Inside Slope
File Name: Triassic1.slp
Last Saved Date: 11/24/99
Last Saved Time: 1:08:53 PM
Analysis Method: Bishop



Description: Triassic Park
Comments: Phase 1A, Inside Slope
File Name: Triassic2.slp
Last Saved Date: 11/24/99
Last Saved Time: 1:06:07 PM
Analysis Method: Bishop



Description: Triassic Park
Comments: Phase 1A, Inside Slope(Shallow Failure)
File Name: Triassic3.slp
Last Saved Date: 12/7/99
Last Saved Time: 1:25:06 PM
Analysis Method: Bishop

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-39

Project Title: Triassic Park Waste Disposal Facility

Project No.: 602-0200

Calculation Title: Capacity and Volume Calculations

	Name	Date
Prepared By:	John Pellicer	8/14/99
Checked By:	Patrick Corser	8/16/99
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

MONTGOMERY WATSON
Mining Group

Project Name TRIASSIC PARK / Waste Disposal Facility
Project Number 1742602
Sheet 1 of 2
Prepared By J. Pellicer
Date 14-Aug-99
Checked By
Date 16 Aug 99

OBJECTIVE: Determine volume of Drum Handling Unit
(for July 1999 RSI)

- 7 drum storage cells (see pg 2)
- Each cell can contain 160 drums (see pg 2)
- Drum size: 55 gallons (see pg 2)

Storage Volume: $(7\ \text{cells})\left(160\ \frac{\text{drums}}{\text{cell}}\right)\left(55\ \frac{\text{gal}}{\text{drum}}\right) = 61{,}600\ \text{gal}$

Unit Process Code: 501

21.

1342602
14-Aug-99
Triassic Park

7.0 DRUM HANDLING UNIT

7.1 DRUM HANDLING UNIT DESIGN

7.1.1 General

The purpose of the drum handling unit is to provide storage capacity for drummed waste streams which will either be processed in the stabilization unit, placed in the landfill, or shipped to other waste processing centers such as incinerators or solvent recovery plants.

Drum handling unit design elements include drum handling unit layout, subgrade design; liner design; concrete floor design, and drainage sump design. This section describes each of these design elements.

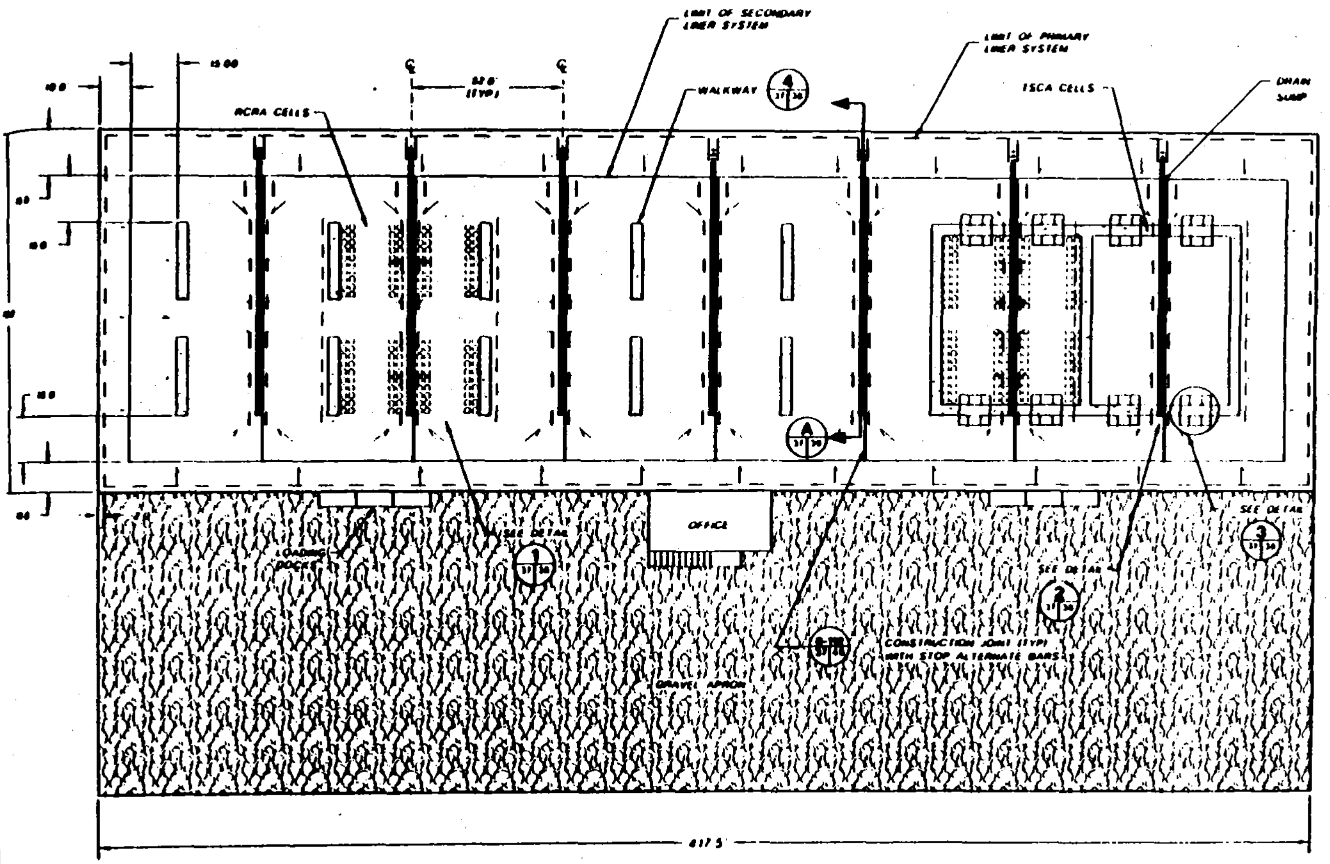
7.1.2 Drum Handling Layout

Drawing No. 37 (Volume III) shows the layout of the drum handling unit floor plan and surrounding area. Additional details for the floor and floor drains are illustrated on Drawing Nos. 38 and 39 (Volume III).

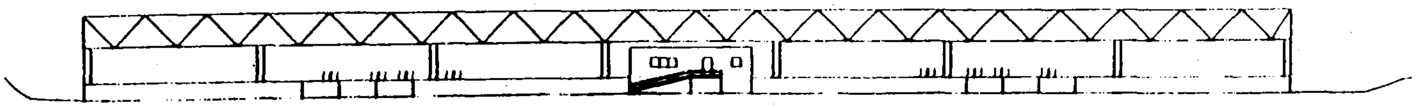
As previously discussed, the drum handling unit entrance faces the north access road. Incoming trucks will enter the gravel lined apron and will back up to the loading dock areas. Once the truck unloading (or loading) operation is complete, the trucks will exit the unit via the same north access road. Parking areas for site personnel vehicles will be designated near the drum handling unit office. The gravel apron in front of the unit will not be used to stage waste haul trucks.

The drum handling building will be an open walled building with a roof which extends over the entire floor and truck docking areas. The roof structure will eliminate rainwater from entering the drum handling area. The open walls will provide ample ventilation inside the building, however, personnel involved with drum sampling and decanting activities will still be required to use supplied air respiratory systems. As discussed in Section 1.5, during winter months the site will experience temperatures as low as 14°F, with average daily temperatures of 36°F. Under the most severe conditions, freezing of liquids in the drums may be possible. Therefore, during periods of extended low temperatures, drums will be monitored for any sign of leakage or damage due to freezing. Damaged drums will be immediately placed in over pack units to ensure containment.

The 49,265 sf total floor area is divided into 7 drum storage cells with each cell having a separate drain, collection sump, and leak detection sump. Each 63-ft long by 52-ft wide cell is capable of storing 160 drums. Two of the cells are designated as TSCA cells and as such are required to be isolated from other drum storage cells. The 0.5 ft high by 3.5 ft wide walkway which surrounds the TSCA cell provides the necessary isolation. The remaining five cells are also separated by walkways. As shown on Drawing No. 38, (Volume III) drums will be placed in four rows, two drums deep. Two 12-ft wide aisles will provide access for the forklift to place and remove drums. Any drum spills or leakage will flow to the deep drain located along the centerline of the cell. The drain bottom slopes at 2 percent to the sumps located on the south side (rear) of the building. Any fluids in the sump will be removed through the LCRS and



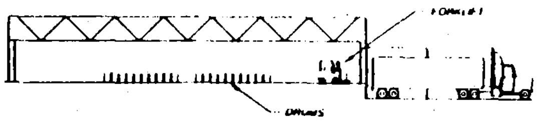
TYPICAL DRUM FLOOR LAYOUT



TYPICAL FRONT ELEVATION

LEGEND

- DRAINAGE FLOW DIRECTION ON TOP OF CONCRETE
- — — — EXTENT OF PRIMARY GEOMEMBRANE
- — — — EXTENT OF SECONDARY GEOMEMBRANE
- ⁞⁞ DRUMS



TYPICAL SIDE ELEVATION

SCALE
20 0 20 40

Show Drum Off Set
From Walk ways
1 Ft - Min

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

4/4/96 Patrick G. Corser

Date Patrick G. Corser, NM PE [illegible]

Not For Construction

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TRIASSIC PARK

WASTE DISPOSAL FACILITY

DRAWING TITLE

DRUM HANDLING UNIT
GENERAL ARRANGEMENT

MONTGOMERY WATSON
Mining Group

Project Name TRIASSIC PARK/ Waste Disposal Facility
Project Number 1342602
Sheet 1 of 3
Prepared By J. Pellicer
Date 16-Aug-99
Checked By
Date 16AUG99

OBJECTIVE: Determine volume of Roll-Off Unit. (for July 1999 RS

Roll-Off Container Size: 22 ft long x 8 ft wide x 8 ft tall (sup

Number of Roll Containers: 132 containers

Roll-Off Container Volume: (22 ft)(8 ft)(8 ft) = 1408 ft^3 ⇒ 52 cy
RATED CAPACITY = 40 CY. ⇒ Used 40 CY

Roll-Off Unit Waste Volume: (132 containers)$\left(40 \frac{cy}{container}\right)$ = 5,280 cy

Use 202 GALLONS/CY

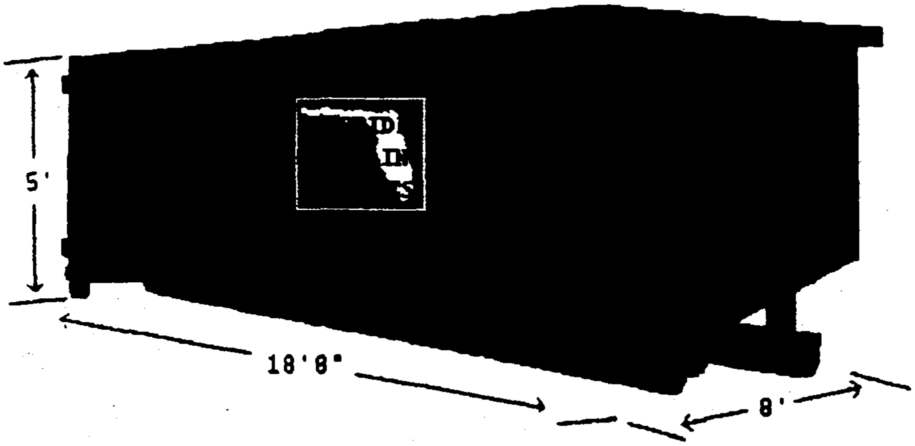
≈ 1,066,560 gal

SAY 1,000,000

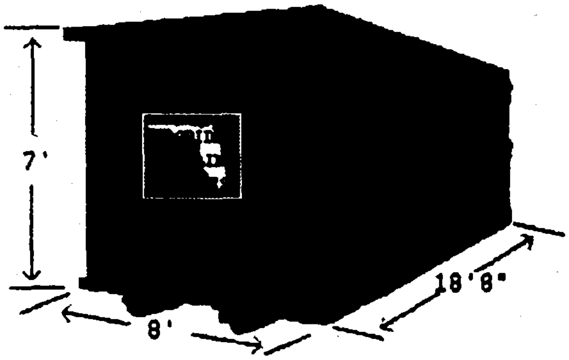
Unit Process Code: 501

16-Aug-99
1342 W2
Transit Park

2/



30 Yard



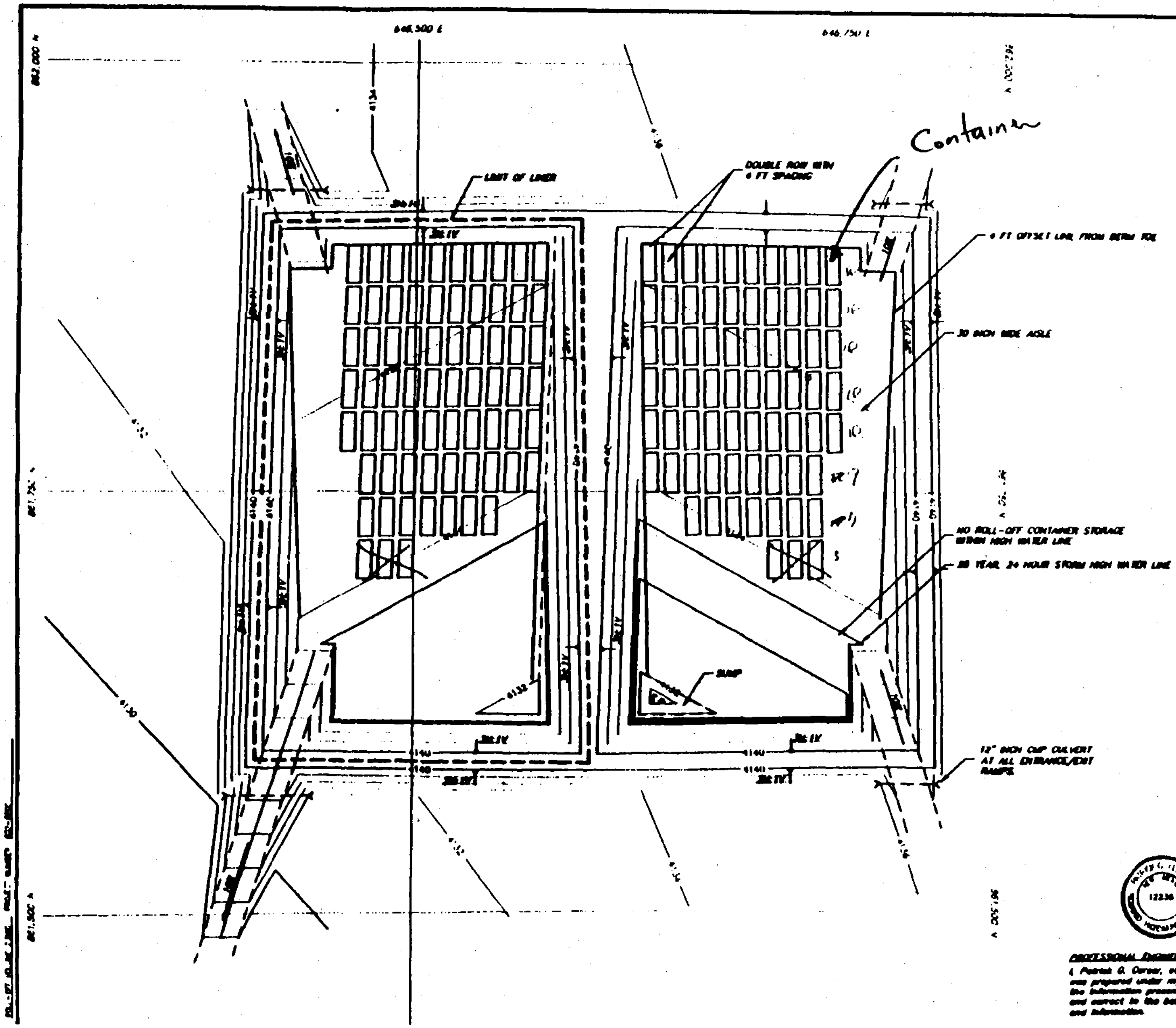
Other Roll-Off Container Sizes and Dimensions:

10 Yard: Length 14' Width 6' Height 3'

* **40 Yard: Length 22' Width 8' Height 8'**

Compactor Containers

Self-Contained



NOTE
FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2
"INDEX, LEGEND AND GENERAL NOTES"

J1'
16-Aug-99
1342602
Triassic Park

SCALE
CONTOUR INTERVAL 2 FT

Not For Construction

12236

PROFESSIONAL ENGINEER'S STATEMENT
I, Patrick G. Corser, state that this map was prepared under my supervision and all the information presented herein is true and correct to the best of my knowledge and information.

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE
TRUCK ROLL-OFF AREA
DRAINAGE SURFACE CONTOURS

MONTGOMERY WATSON
Mining Group

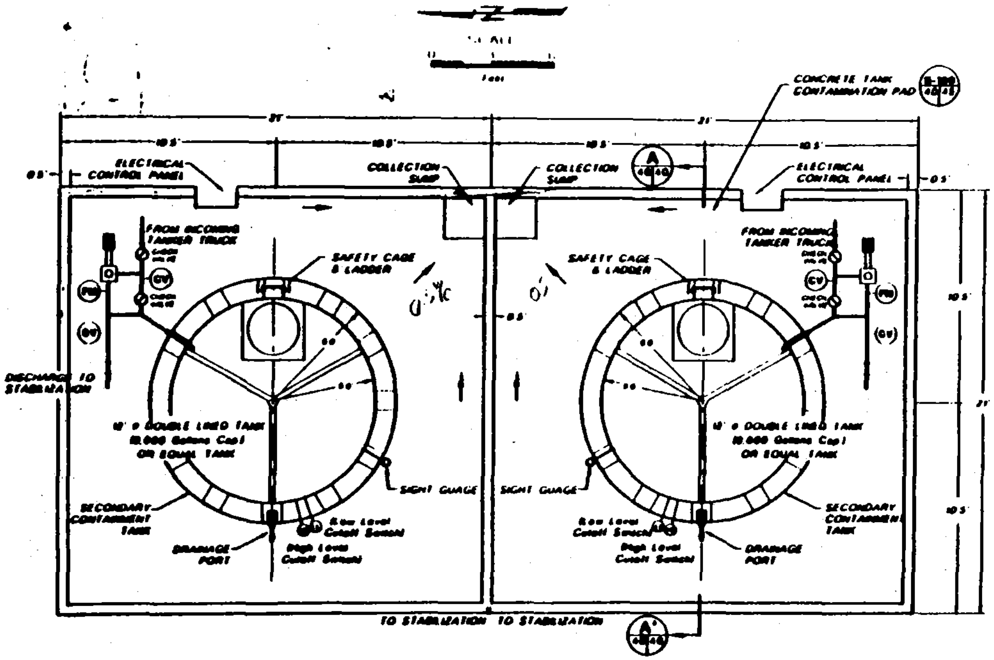
Project Name TRIASSIC PARK / Waste Disposal Facility
Project Number 1342602
Sheet 1 of
Prepared By J. Pellicer
Date 16-Aug-99
Checked By
Date [illegible] 99

OBJECTIVE: Determine Volume of Liquid Waste Storage Unit.

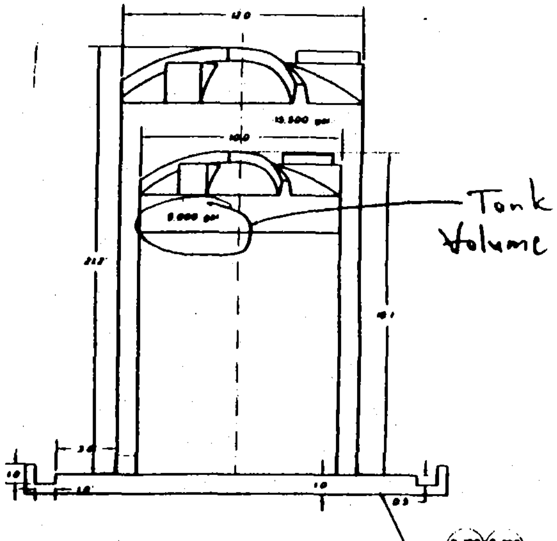
Tank Volume: 9,000 gal (see pg 2)
Number of Tanks: 4 (see pg. 2)

Waste Volume: $(4 \text{ tanks})\left(9{,}000 \frac{\text{gal}}{\text{tank}}\right) = 36{,}000 \text{ gal}$

Unit Process Code: S02



LIQUID WASTE RECEIVING & STORAGE AREA



Tank Volume

SECTION A-A'

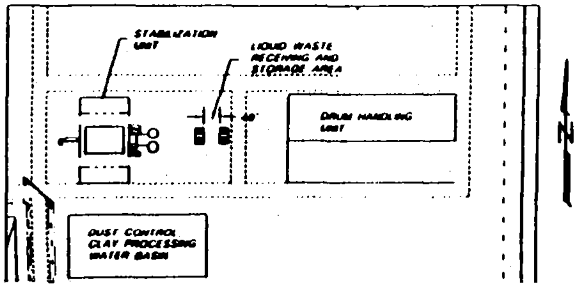
[illegible]

Number of Tanks - 4

PROFESSIONAL ENGINEER'S STATEMENT

I, [illegible] G. Corker, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and [illegible]

NOTES
1 FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No 2.



Not For Construction

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE
LIQUID WASTE RECEIVING
AND STORAGE UNIT LAYOUT

MONTGOMERY WATSON
Mining Group

Project Name TRIASSIC PARK Waste Disposal Fac
Project Number 1342602 Sheet 1 of 2
Prepared By J. Pellicer Date 13-Aug-99
Checked By Date

OBJECTIVE: Determine volume of Evaporation Pond 1A and 1B. (For July 1999 RSI)

Pond 1A

Dimensions @ Elev 4121 ft: 285 ft by 138 ft

Dimensions @ Elev 4111 ft: 225 ft by 85 ft

Area @ 4121 ft = (285 ft) (138 ft) = 39,330 ft^2

Area @ 4111 ft = (225 ft) (85 ft) = 19,125 ft^2

Pond Depth = 12 ft (conservative maximum)

Pond 1A Volume = $\left(\frac{39330 + 19,125}{2}\right) * 12\ ft = 350,730\ ft^3$

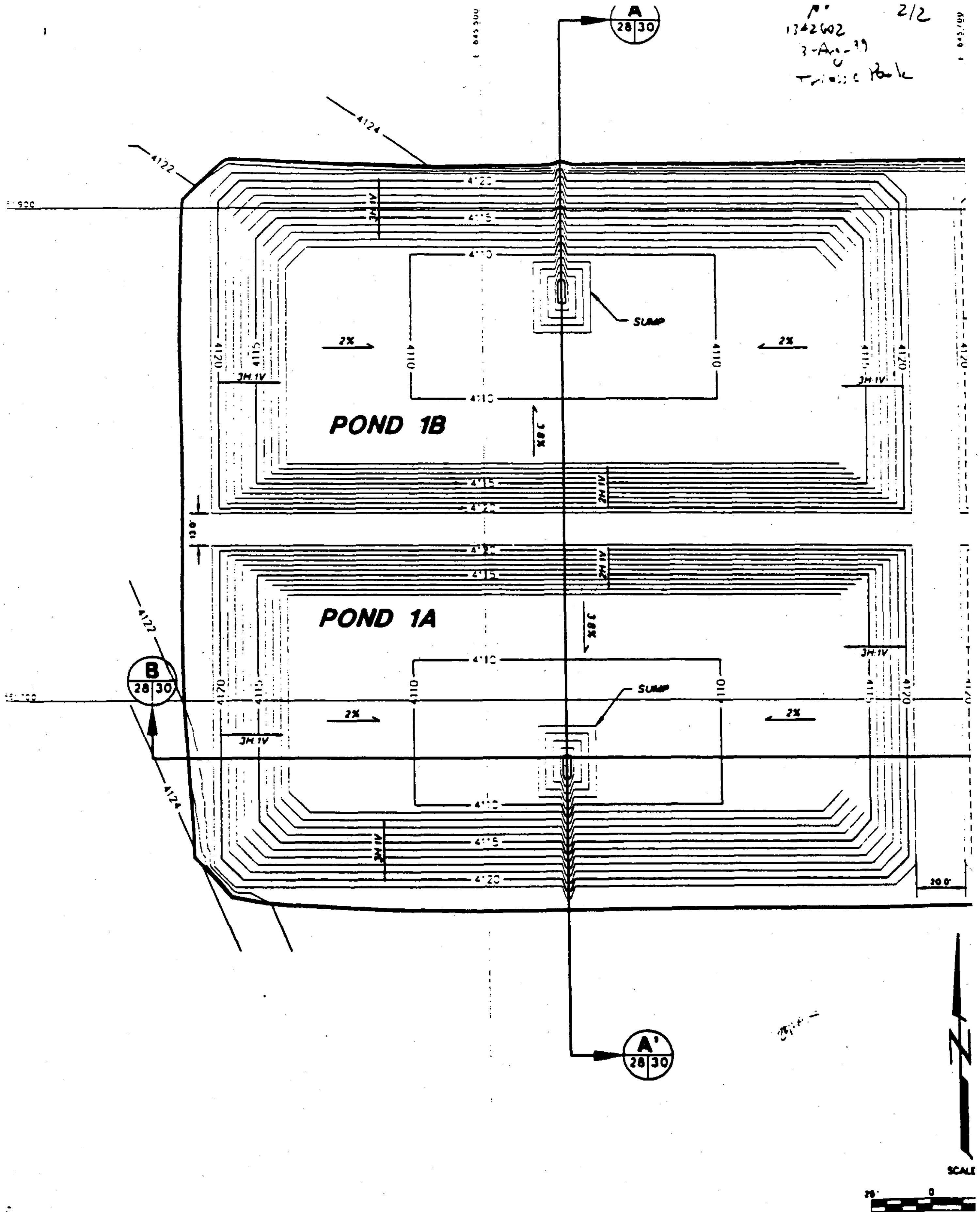
Pond 1A Volume = $350,730\ ft^3 * 7.48 \frac{gal}{ft^3}$ - 2,623,460 gal

Pond 1B Volume = 2,623,460 gal since it has identical

Total Volume = (2)(2,623,460 gal) = 5,246,920 gal ≈ 5,250,000 g

Unit Process Code: T02

2/2
1342602
3-Aug-99
Triassic Park



R GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2.
DEX, LEGEND AND GENERAL NOTES".

CONTOUR INTERVAL 1 FT.
CONTOUR INTERVAL 2 FT.

MONTGOMERY WATSON
Mining Group

Project Name TRIASSIC PARK Waste Disposal Facility
Project Number 342602 Sheet 1 of 2
Prepared By J. Pellicer Date 14-Aug-99
Checked By Date 16 Aug 99

OBJECTIVE: Determine volume of waste to be stored in permitted part of landfill (for July 1999 RSI)

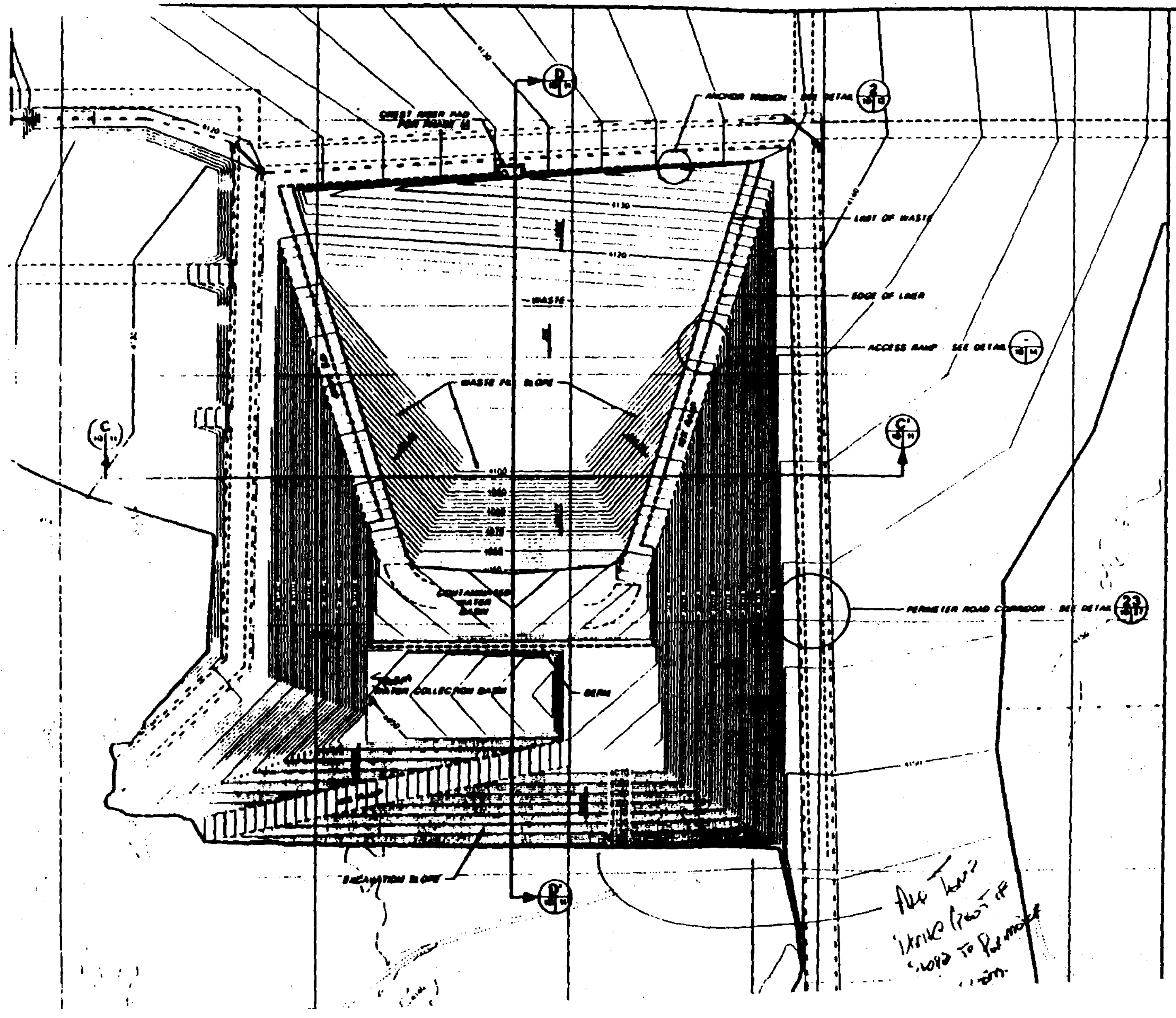
METHOD: Civil Soft Software

Volume: 553,200 cy (see pg 2)

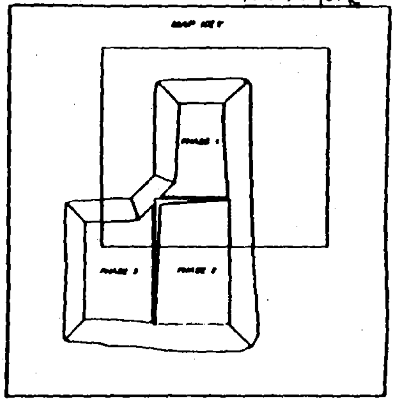
Unit Process Code: D80

14 Aug 99 [illegible] 2/2

134262
Triassic Park



Are these 'inside' (part of 'slope' to perimeter [illegible]



NOTES
1 FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No 2 "INDEX LEGEND AND GENERAL NOTES"
2 TOPOGRAPHY FROM AERIAL SURVEYS PERFORMED AUGUST 1997 BY KOOGLE AND POULS ENGINEERING
3 WASTE FILL VOLUME FOR PHASE IA 583,200 CY

PROFESSIONAL ENGINEER'S STATEMENT

[illegible]

SCALE

CONTOUR INTERVAL 2 FT

Not For Construction

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE
FILLING PLAN -

MONTGOMERY WATSON
Mining Group

Project Name: TRIASSIC PARK | Waste Disposal Facility
Project Number: 1342602
Prepared By: J. Pellicer
Checked By: [illegible]
Sheet 1 of 3
Date: 16-Aug-99
Date: [illegible]

OBJECTIVE: Determine volume of waste stabilization mixing bins.

Number of Mixing Bins: 4 (see pg. 2)

Bin Volume: (23 ft)(6 ft)(10 ft) = 1380 ft^3 ≈ 51 cy
(see pg 3)

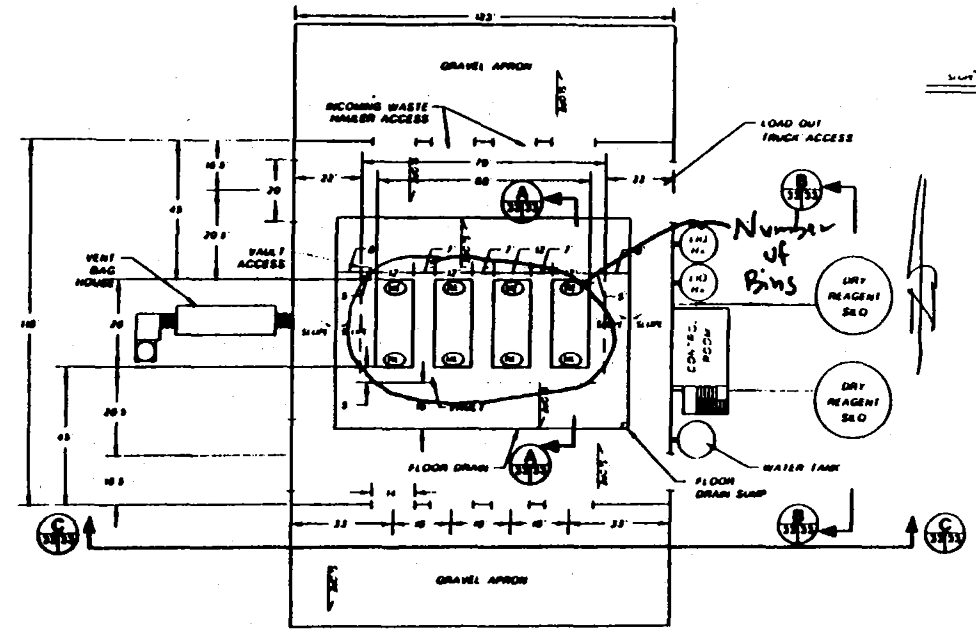
Assume: $15 \frac{\text{bins}}{\text{day}}$

Volume of Processed Waste: $15 \frac{\text{bins}}{\text{day}} \cdot 51 \frac{\text{cy}}{\text{bin}} = 765$ cy

$$\text{Volume} = 765\,\text{cy} \cdot \frac{27\,ft^3}{\text{cy}} \cdot \frac{7.48\,\text{gal}}{ft^3} = 154{,}499\ \text{gal/dy}$$

$$\approx 150{,}000\ \text{gal/day}$$

Unit Process Code: T01

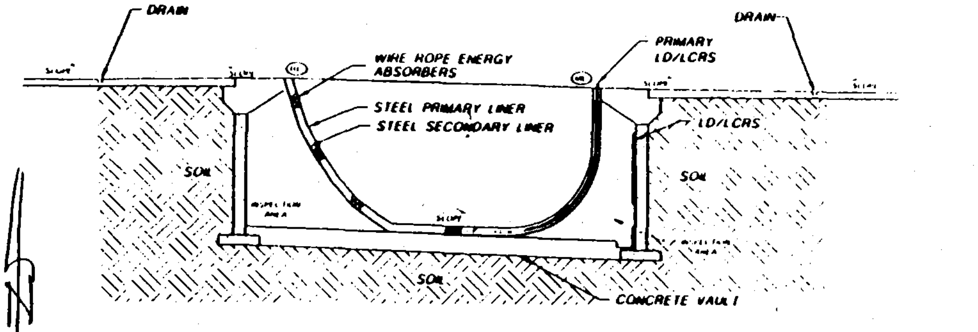


LEGEND

- RECEIVING END
- MIXING END

STABILIZATION BUILDING FLOOR PLAN

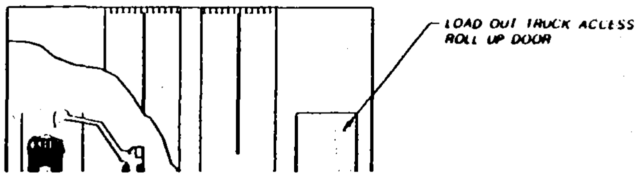
SCALE



A 33/35 TYPICAL BIN & VAULT SECTION

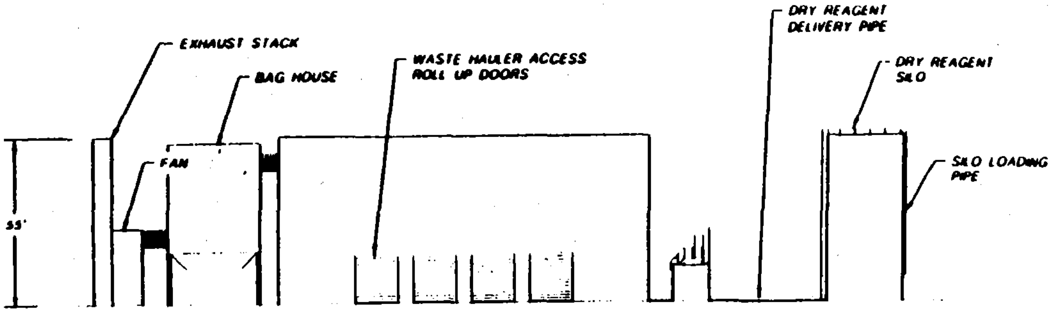
SCALE

NOTE
SEE DRAWING 35 FOR BIN DETAILS



B 33/35 TYPICAL END ELEVATION

Not To Scale



C 33/35 TYPICAL FRONT ELEVATION

Not To Scale

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this map was prepared under my supervision and all the information described hereon is true and correct to the best of my knowledge and information.

Not For Construction

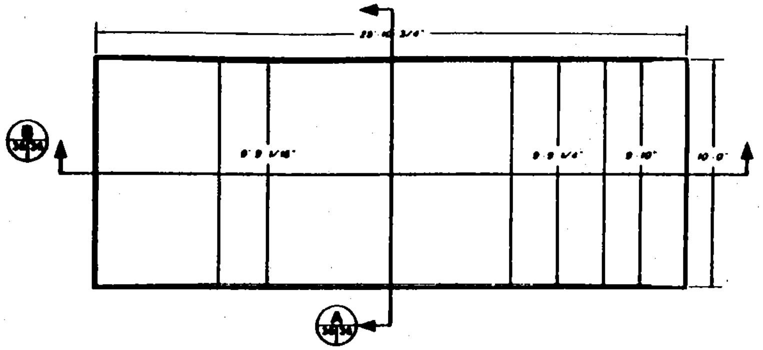
TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE
STABILIZATION UNIT
GENERAL ARRANGEMENT

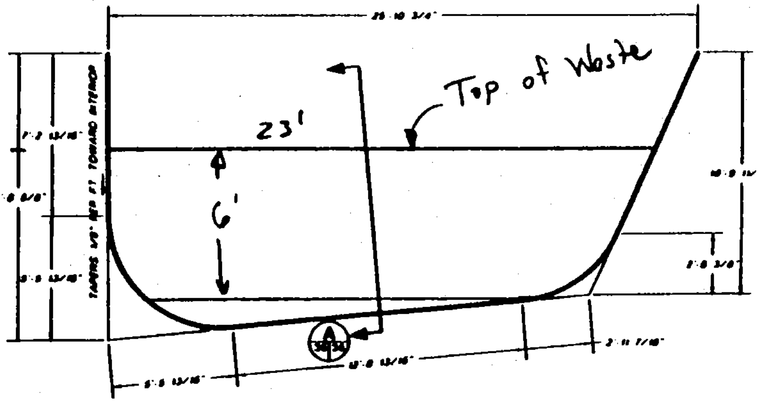
JTP
1742602
16-Aug-99
Triassic Park

2/3

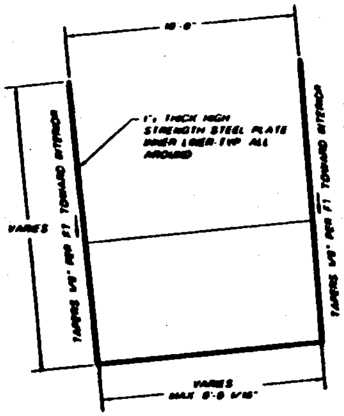
JSF 5/3
1342602
16-Aug-99
Triassic Park



PLAN VIEW - INNER LINER



B LONGITUDINAL SECTION - INNER LINER



A CROSS SECTION - INNER LINER

SCALE

TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE
STABILIZATION UNIT
BIN DESIGN

FRED H. SCHOTT & ASSOCIATES

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-40

Project Title: Triassic Park Waste Disposal Facility

Project No.: 602-0200

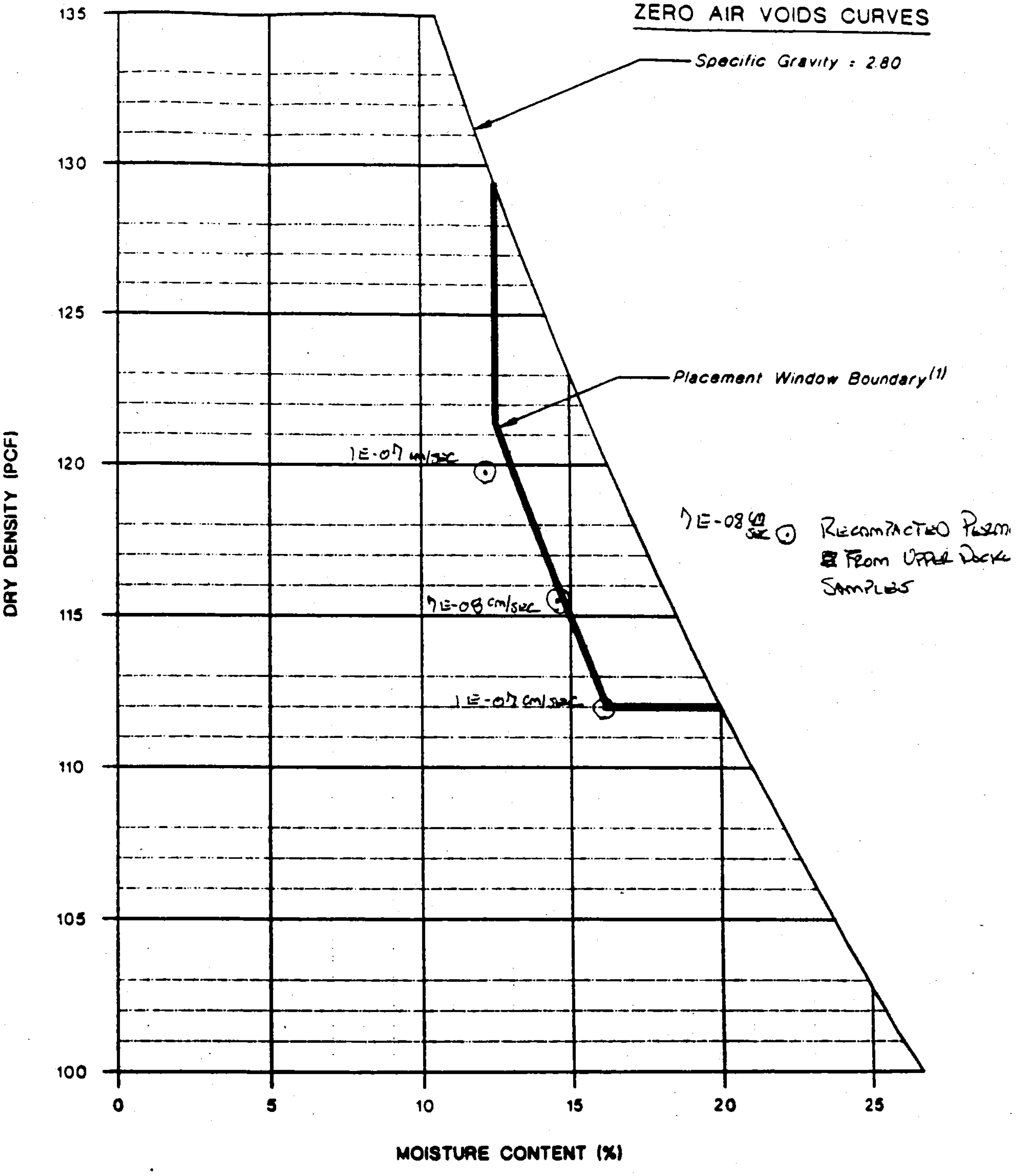
Calculation Title: Permeability Tests of Compacted Clay Liner

	Name	Date
Prepared By:	John Pellicer	11/17/97
Checked By:		
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

TERRAMATRIX/LAB TEST/CO - #602-200
953-2903
TABLE 2
SUMMARY OF FLEXIBLE WALL PERMEABILITY TEST RESULTS

SAMPLE NUMBER	SAMPLE LENGTH (cm)	SAMPLE DIA. (cm)	SAMPLE DRY DEN. (pcf)	TARGET DRY DEN. (pcf)	COMPACTION (%)	INITIAL MOISTURE (%)	TARGET MOISTURE (%)	EFFECT. STRESS (psi)	BACK PRESSURE (psi)	GRADIENT	AVERAGE PERM. (cm/sec)
602 #1	9.65	7.27	119.8	120.6	(99.3)	12.3	(12.5)	5	95	20	1.4×10^{-7}
602 #1	9.62	7.27	115.5	116.6	(99.1)	14.1	(14.0)	5	95	20	6.6×10^{-8}
602 #1	9.55	7.27	112.1	111.7	(100.4)	16.1	(16.0)	5	95	20	1.1×10^{-7}



(1) PLACEMENT WINDOW BOUNDARY MAY BE MODIFIED BASED ON RESULTS OF TEST FILL.

0	Part B Permit	[illegible]	[illegible]	K.Conrad	[illegible]	
REV No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY	

TerraMatrix
MONTGOMERY WATSON
Mining Group

PROJECT No. [illegible]
AutoCAD FILE: [illegible]
SCALE: —
FIGURE No. 02221-1

Triassic Park Waste Disposal Facility

RECOMPACTED PERMEABILITY DATA AND PROPOSED
CLAY LINER PLACEMENT WINDO

TERRAMATRIX/LAB TEST/CO - #602-200
953-2903
TABLE 2
SUMMARY OF FLEXIBLE WALL PERMEABILITY TEST RESULTS

SAMPLE NUMBER	SAMPLE LENGTH (cm)	SAMPLE DIA. (cm)	SAMPLE DRY DEN. (pcf)	TARGET DRY DEN. (pcf)	COMPACTION (%)	INITIAL MOISTURE (%)	TARGET MOISTURE (%)	EFFECT. STRESS (psi)	BACK PRESSURE (psi)	GRADIENT	AVERAGE PERM. (cm/sec)
602 #1	9.65	7.27	119.8	120.6	(99.3)	12.3	(12.5)	5	95	20	1.4×10^{-7}
602 #1	9.62	7.27	115.5	116.6	(99.1)	14.1	(14.0)	5	95	20	6.6×10^{-8}
602 #1	9.55	7.27	112.1	111.7	(100.4)	16.1	(16.0)	5	95	20	1.1×10^{-7}

~~FLOW PUMP~~ PERMEABILITY TEST
Mercury Manometer

JOB NUMBER: 993-2903

PROJECT: Terramatrix/Labtest/CO

DATE: 10/1/97

BORING:

SAMPLE: SP1/F1

DEPTH: 116.6 pcf @ 14.0 % MC

SAMPLE SPECIFICS

Length (L)(cm):	9.62	9.83
Diameter (cm):	7.27	7.41
Wet Weight (g):	846.5	890.3

MOISTURE CONTENTS

	INITIAL	FINAL	
Wet Weight + Tare (g)	210.75	1050.6	
Dry Weight + Tare (g)	188.89	907.0	
Tare (g) PT 19	33.64	160.8	Z-12
Moisture Content (%)	14.1	19.2	

READINGS

Cell Pressure (psi):

Back Pressure (psi):

Effective Stress (psi):

Motor Speed (1-12):

% Max:

H (cm):
(high setting, ignore decimal point)

PERMEABILITY CALCULATIONS

Flow Rate Q (cm/sec)
(from flow rate chart)

Area (cm²):

Apparent Velocity (v) = $\frac{Q}{A}$ =
(cm/s) [SEE NOTE]

Gradient (i) = $\frac{H}{L}$ = 20

Permeability (K) = $\frac{v}{i}$ = 6.6×10^{-8}
(cm/sec)

DENSITY CALCULATIONS

Area (cm²): 41.51

Volume (cm³): 399.3

Wet Density (pcf): 131.8

Dry Density (pcf): 115.5

NOTE: Can use column 4 of the chart only if the sample is 2.8" diameter.

REMARKS Remold @ 116.6 & 14 % MC

397.8 X 116.6 X 1.14 ÷ 62.4 = 847.4

(99.1 % of requested density)

GOLDER ASSOCIATES INC.

1200 @ 6.4
1285.7 @ 14
+85.7

847.4
281.8
1129.2

CONSTANT VOLUME PERMEABILITY / ASTM D 5084

(For use with Manometer Board)

PROJECT TITLE: TERRA MATRIX/LAB TEST/CO
PROJECT NO.: 953-2903 602
SAMPLE ID: Spl 1 remold at 116.6pcf 14.0%mc

Cell Pressure 100 psi
Sample Pressure = 95 psi
Run # = 1

Sample Data, Initial

Height, cm	9.62
Diameter, cm	7.27
Area, cm^2	41.51
Volume, cm^3	399.33
Wet Mass, g	846.5
Moisture Content, %	14.1%
Dry Density, pcf	115.9
Spec. Gravity	~~2.66~~
Void Ratio	~~0.45~~
Saturation, %	~~0.0~~
Effective stress, psi	5

Initial Manometer Readings

Pipette = 24.85
Annulus = 9.3

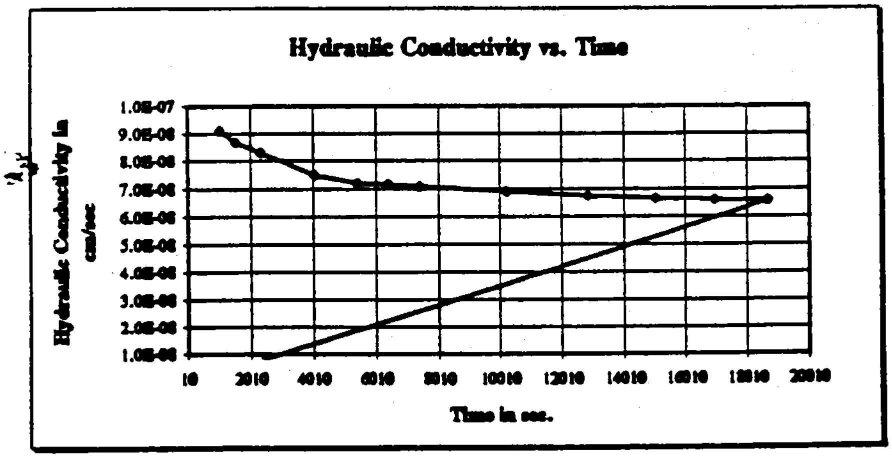
Gradient 20

12.5%mc

Manometer Constants:
M1 = 0.06 cm^2
M2 = 1.48
Sample Constants:
S = 0.23 cm^-1
Specific Gravity Constant:
G = 12.61
Test Constant:
C = 0.0011
Trial Constant:
T = 0.09

Minutes	Seconds	Δt, cum. (sec)	T-B (cm)	Delta Zo (cm)	C/t	(1-delta Zo*T)	PERMEABILITY (cm/sec)
16	50	1010	24	0.85	1.1E-06	0.919	9.1E-08
25	25	1525	23.65	1.2	7.2E-07	0.886	8.7E-08
38	40	2320	23.15	1.7	4.7E-07	0.839	8.3E-08
67	20	4040	22.3	2.55	2.7E-07	0.758	7.5E-08
90	0	5400	21.7	3.15	2.0E-07	0.701	7.2E-08
106	30	6390	21.25	3.6	1.7E-07	0.658	7.2E-08
123	0	7380	20.85	4	1.5E-07	0.620	7.1E-08
170	0	10200	19.85	5	1.1E-07	0.525	6.9E-08
213	30	12810	19.1	5.75	8.5E-08	0.454	6.8E-08
250	0	15000	18.55	6.3	7.3E-08	0.402	6.7E-08
282	20	16940	18.11	6.74	6.5E-08	0.360	6.6E-08
311	0	18660	17.75	7.1	5.9E-08	0.326	6.6E-08
0	0	0	0	24.85	#DIV/0!	-1.360	#DIV/0!
0	0	0	0	24.85	#DIV/0!	-1.360	#DIV/0!
0	0	0	0	24.85	#DIV/0!	-1.360	#DIV/0!
0	0	0	0	24.85	#DIV/0!	-1.360	#DIV/0!
0	0	0	0	24.85	#DIV/0!	-1.360	#DIV/0!

PERMEABILITY REPORTED AS = #DIV/0! cm/sec =



TECH: BDM
DATE: 10/6/97

CHECKED:
DATE:

GEOTECHNICAL TESTING LABORATORY
GOLDER ASSOCIATES INC.
DENVER, CO

RIDGED WALL PERMEABILITY
ASTM D 5084

PROJECT TITLE: [illegible]
PROJECT NO.: 953-2403
SAMPLE ID: 1 116.5@14.0

~~Piston Pressure~~ = 100 psi
~~Sample Pressure~~ = 95 psi
Run # = 1

Sample Data, Initial

Height, cm 9.62
Diameter, cm ~~7.095~~ 7.27
Area, cm^2 39.54
Volume, cm^3 0.00
Wet Mass, g 846.5
Moisture Content, % 14.1
Dry Density, pcf #DIV/0!
Spec. Gravity —
Void Ratio #DIV/0!
Saturation, % #DIV/0!

Calculation Constants:

Manometer Constants:
M1 = 0.03 cm^2
M2 = 1.041
Sample Constants:
S = 0.00 cm^-1
Specific Gravity Constant:
G = 12.56
Test Constant:
C = 0.0000
Trial Constant:
T = #DIV/0!

Initial Manometer Readings

Pipette = 24.75
Annulus = 9.3

Minutes	Seconds	Δt, cum. (sec)	Tail (cm)	Delta Zo (cm)	C/t	delta Zo^	MEABILITY (cm/sec)
16	00	0	24.0	0	#DIV/0!	#DIV/0!	#DIV/0!
25	25	0	23.65	0	#DIV/0!	#DIV/0!	#DIV/0!
38	40	0	23.15	0	#DIV/0!	#DIV/0!	#DIV/0!
67	20	0	22.30	0	#DIV/0!	#DIV/0!	#DIV/0!
90	20	0	21.70	0	#DIV/0!	#DIV/0!	#DIV/0!
106	30	0	21.25	0	#DIV/0!	#DIV/0!	#DIV/0!
123	00	0	20.85	0	#DIV/0!	#DIV/0!	#DIV/0!
170	20	0	19.25	0	#DIV/0!	#DIV/0!	#DIV/0!
213	00	0	19.10	0	#DIV/0!	#DIV/0!	#DIV/0!
250	00	0	18.55	0	#DIV/0!	#DIV/0!	#DIV/0!
282	20	0	18.10	0	#DIV/0!	#DIV/0!	#DIV/0!
311	00	0	17.75	0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!

PERMEABILITY REPORTED AS ** #DIV/0!
cm/sec **

Gradient = 20

$$R_p = R_{eq} + \frac{iL}{18.62}$$

$$= 14.35 + \frac{9.62 \times 2}{18.62}$$

$$= 24.7$$

TECH:
DATE:

CHECKED:
DATE:

GEOTECHNICAL TESTING LABORATORY
GOLDER ASSOCIATES INC.
DENVER, CO

ERMEABILITY TESTING
BACK PRESSURE SATURATION

PROJECT Terramatrix/Lahtet JOB NO. 953-2903 DATE [illegible]

BORING NO. SAMPLE NUMBER 602 022 DEPTH

SOIL DESCIPTION 116.6 @ 14.0 TESTED BY APPROVED BY

Cell 7 3

5PSI

DATE	TIME	MEASURE B		PRESSURE (PSI)			BURETTS (cm)$^{-3}$			COMMENTS
		BOTTOM	TOP	CELL (LEFT)	BOTTOM (MIDDLE)	TOP (RIGHT)	TOP (LEFT)	BOTTOM (MIDDLE)	CELL (RIGHT)	
10/1				7	5					De Air
				12	10			9.5	10.4	
				22	20			10.6	14.5	
				52	50					
10/2				62	60					
				72	70			7.2	2.0	
				82	80			7.4	4.0	
				92	90			7.4	5.2	
			98.9 98.6	100 92						B=978
				100	95					

~~FLOW PU~~MP PERMEABILITY TEST

Mercury Manometer

JOB NUMBER: 953-2403

BORING:

PROJECT: Terramatrix/Labtest/C

SAMPLE: 602.022 Spl #1

DATE: 10/1/97

DEPTH: 111.7 @ 16.0% mc

SAMPLE SPECIFICS

Length (L)(cm):	9.55	9.65
Diameter (cm):	7.27	7.33
Wet Weight (g):	826.7	863.5

MOISTURE CONTENTS

		INITIAL	FINAL	
Wet Weight + Tare (g)		257.62	947.9	
Dry Weight + Tare (g)		226.59	800.28	
Tare (g)	X 12	33.29	84.91	✓ /
Moisture Content (%)		16.1	20.6	

READINGS

Cell Pressure (psi): 100

Back Pressure (psi): 95

Effective Stress (psi): 5

Motor Speed (1-12):

% Max:

H (cm):
(high setting, ignore decimal point)

PERMEABILITY CALCULATIONS

Flow Rate Q (cm/sec)
(from flow rate chart)

Area (cm²):

Apparent Velocity (v) = $\frac{Q}{A}$ =
(cm/s) (SEE NOTE)

Gradient (i) = $\frac{H}{L}$ = 20

Permeability (K) = $\frac{v}{i}$ = 1.1×10^{-7}
(cm/sec)

DENSITY CALCULATIONS

Area (cm²): 41.51

Volume (cm³): 196.4

Wet Density (pcf): 130.1

Dry Density (pcf): 112.1

NOTE: Can use column 4 of the chart only if the sample is 2.8" diameter.

REMARKS Remold @ 111.7 & 16% MC

397.8 × 111.7 × 1.16 ÷ 62.4 = 826.0

100.4

GOLDER ASSOCIATES INC.

1200 @ 6.4
1308.3 16.0
+108.3

826.0
281.97
1108.0

CONSTANT VOLUME PERMEABILITY / ASTM D 5084
(For use with Manometer Board)

PROJECT TITLE: TERRA MATRIX/LAB TEST/CO
PROJECT NO.: 953-2903 602
SAMPLE ID: Spl 1 remold at 111.7pcf 16.0%mc

Cell Pressure 100 psi
Sample Pressure = 95 psi
Run # = 1

Sample Data, Initial

Height, cm	9.55
Diameter, cm	7.27
Area, cm^2	41.51
Volume, cm^3	396.43
Wet Mass, g	826.7
Moisture Content, %	16.1%
Dry Density, pcf	112.1
Spec. Gravity	~~0~~
Void Ratio	~~#DIV/0!~~
Saturation, %	~~#DIV/0!~~
Effective stress, psi	5

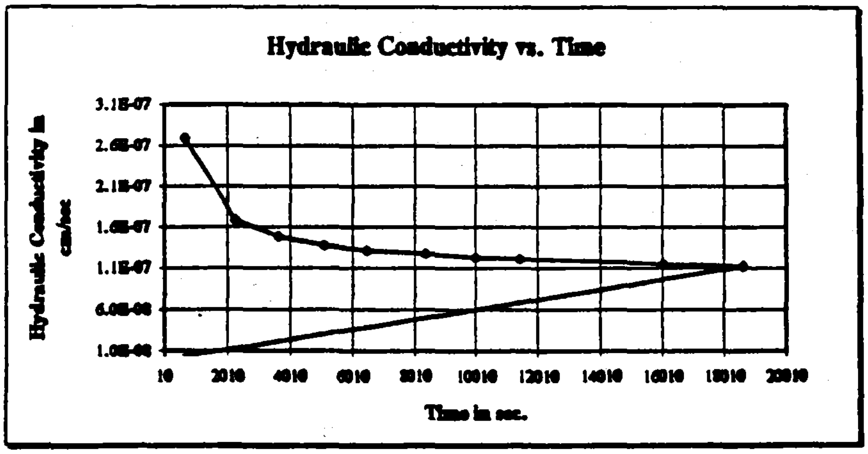
Initial Manometer Readings
Pipette = 24.7
Annulus = 9.4

Manometer Constants
M1 = 0.06 cm^2
M2 = 1.48
Sample Constants
S = 0.23 cm^-1
Specific Gravity Constant:
G = 12.61
Test Constant:
C = 0.0011
Trial Constant:
T = 0.10

Gradient 20

Minutes	Seconds	[illegible] (sec)	Tail (cm)	Delta Za (cm)	CA	[illegible]	PERMEABILITY (cm/sec)
10	55	655	23.15	1.55	1.7E-06	0.850	2.7E-07
37	35	2255	21.65	3.05	4.8E-07	0.706	1.7E-07
60	30	3630	20.65	4.05	3.0E-07	0.609	1.5E-07
84	30	5070	19.8	4.9	2.1E-07	0.527	1.4E-07
107	15	6435	19.1	5.6	1.7E-07	0.459	1.3E-07
139	0	8340	18.25	6.45	1.3E-07	0.377	1.3E-07
166	10	9970	17.7	7	1.1E-07	0.324	1.2E-07
190	15	11415	17.25	7.45	9.5E-08	0.281	1.2E-07
266	45	16005	16.25	8.45	6.8E-08	0.184	1.1E-07
310	0	18600	15.85	8.85	5.8E-08	0.146	1.1E-07
0	0	0	0	24.7	#DIV/0!	-1.384	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.384	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.384	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.384	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.384	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.384	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.384	#DIV/0!

PERMEABILITY REPORTED AS == #DIV/0!
cm/sec ==



TECH: BDM
DATE: 10/7/97
CHECKED:
DATE:

GEOTECHNICAL TESTING LABORATORY
GOLDER ASSOCIATES INC.
DENVER, CO

RIDGED WALL PERMEABILITY
ASTM D 5084

PROJECT TITLE: [illegible]
PROJECT NO.:
SAMPLE ID: 372 1 [illegible]

Piston Pressure = psi
Sample Pressure = psi
Run # = 1

Sample Data, Initial

Height, cm 9.55
Diameter, cm ~~7.095~~ 7.27
Area, cm^2 39.54
Volume, cm^3 0.00
Wet Mass, g [illegible]
Moisture Content, % 16.1
Dry Density, pcf #DIV/0!
Spec. Gravity
Void Ratio #DIV/0!
Saturation, % #DIV/0!

Calculation Constants:

Manometer Constants:
M1 = 0.03 cm^2
M2 = 1.041
Sample Constants:
S = 0.00 cm^-1
Specific Gravity Constant:
G = 12.56
Test Constant:
C = 0.0000
Trial Constant:
T = #DIV/0!

Initial Manometer Readings

Pipette = 24.85
Annulus = 9.35

Minutes	Seconds	Δt, cum. (sec)	Tail (cm)	Delta Zo (cm)	C/t	delta Zo*	MEABILITY (cm/sec)
10	55	0	23.15	0	#DIV/0!	#DIV/0!	#DIV/0!
37	35	0	21.65	0	#DIV/0!	#DIV/0!	#DIV/0!
60	30	0	20.65	0	#DIV/0!	#DIV/0!	#DIV/0!
84	30	0	19.80	0	#DIV/0!	#DIV/0!	#DIV/0!
107	15	0	19.10	0	#DIV/0!	#DIV/0!	#DIV/0!
139	00	0	18.25	0	#DIV/0!	#DIV/0!	#DIV/0!
166	10	0	17.70	0	#DIV/0!	#DIV/0!	#DIV/0!
190	15	0	17.25	0	#DIV/0!	#DIV/0!	#DIV/0!
266	45	0	16.25	0	#DIV/0!	#DIV/0!	#DIV/0!
310	00	0	15.85	0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!

PERMEABILITY REPORTED AS ** #DIV/0!
cm/sec **

Gradient = 20

$$Rp = Req + \frac{iL}{18.62}$$

$$= 14.35 + \frac{20 \times 9.5}{18.62}$$

$$= 24.6$$

TECH:
DATE:

CHECKED:
DATE:

GEOTECHNICAL TESTING LABORATORY
GOLDER ASSOCIATES INC.
DENVER, CO

ERMEABILITY TESTING
BACK PRESSURE SATURATION

PROJECT Teramatrix/Labtest/Co JOB NO. ______ DATE ______

JORING NO. ______ SAMPLE NUMBER 602 022 Soil DEPTH ______

SOIL DESCIPTION 111.7 pcf @ 16.0% MC TESTED BY ______ APPROVED BY ______

Cell C

DATE	TIME	MEASURE B		PRESSURE (PSI)			BURETTS (cm)$^{-3}$			5 PS
		BOTTOM	TOP	CELL (LEFT)	BOTTOM (MIDDLE)	TOP (RIGHT)	TOP (LEFT)	BOTTOM (MIDDLE)	CELL (RIGHT)	COMMENTS
10/1				7	5			~~7.5~~	~~6~~	Re A
				12	10			7.5	6.0	
				22	20			10.4	10.6	
				52	50			3.6	5.0	
10/2				62	60			6.4	2.0	
				72	70			6.6	3.5	
				82	80			/	/	
			99.2 / 89.3	92	90			6.5	5.0	" "
				102 / 92						B 97%
				100	95					

Mercury Manometer

~~FLOW PUMP~~ PERMEABILITY TEST

767

JOB NUMBER: 953-2903
PROJECT: Terramatrix
DATE: 10/1/97

BORING:
SAMPLE: 602 · 0200 spl # 1
DEPTH: 120.6 pcf & 12.5% MC

SAMPLE SPECIFICS

Length (L)(cm):	9.65	9.89
Diameter (cm):	7.27	7.42
Wet Weight (g):	864.0	917.9

MOISTURE CONTENTS

	INITIAL	FINAL	
Wet Weight + Tare (g)	220.24	1073.0	
Dry Weight + Tare (g)	19967	925.4	
Tare (g) X-22	32.93	155.2	CC-1
Moisture Content (%)	12.3	19.2	

READINGS

Cell Pressure (psi): 100
Back Pressure (psi): 95
Effective Stress (psi): 5
Motor Speed (1-12):
% Max:
H (cm):
(high setting, ignore decimal point)

PERMEABILITY CALCULATIONS

Flow Rate Q (cm/sec)
(from flow rate chart)
Area (cm²):
Apparent Velocity (v) = $\frac{Q}{A}$ =
(cm/s) (SEE NOTE)
Gradient (i) = $\frac{H}{L}$ = 20
Permeability (K) = $\frac{v}{i}$ = 1.4×10^{-7}
(cm/sec)

DENSITY CALCULATIONS

Area (cm²): 41.51
Volume (cm³): 400.6
Wet Density (pcf): 134.6
Dry Density (pcf): 119.8

NOTE: Can use column 4 of the chart only if the sample is 2.8" diameter.

REMARKS Remold @ 120.6 & 12.5 % MC

397.8 X 120.6 X 1.125 ÷ 62.4 = 864.9 g

~~99.0~~ (99.3% of requested comp)

GOLDER ASSOCIATES INC.

1200 @ 6.4
1268.8 @ 12.5
+68.8

864.9
241.9
1116.8

CONSTANT VOLUME PERMEABILITY / ASTM D 5084
(For use with Manometer Board)

PROJECT TITLE:	TERRA MATRIX/LAB TEST/CO		
PROJECT NO.:	953-2903	602	
SAMPLE ID:	Spl 1	remold at 120.6pcf 12.5%mc	

Cell Pressure = 100 psi
Sample Pressure = 95 psi
Run # = 1

Sample Data, Initial

Height, cm	9.65
Diameter, cm	7.27
Area, cm^2	41.51
Volume, cm^3	400.58
Wet Mass, g	864
Moisture Content, %	12.3%
Dry Density, pcf	119.8
Spec. Gravity	~~2.66~~
Void Ratio	~~0.58~~
Saturation, %	~~0.0~~
Effective stress, psi	5

Initial Manometer Readings

Pipette = 24.7
Annulus = 9.4

Gradient 20

12.5%mc

Manometer Constants:
M1 = 0.06 cm^2
M2 = 1.48

Sample Constants:
S = 0.23 cm^-1

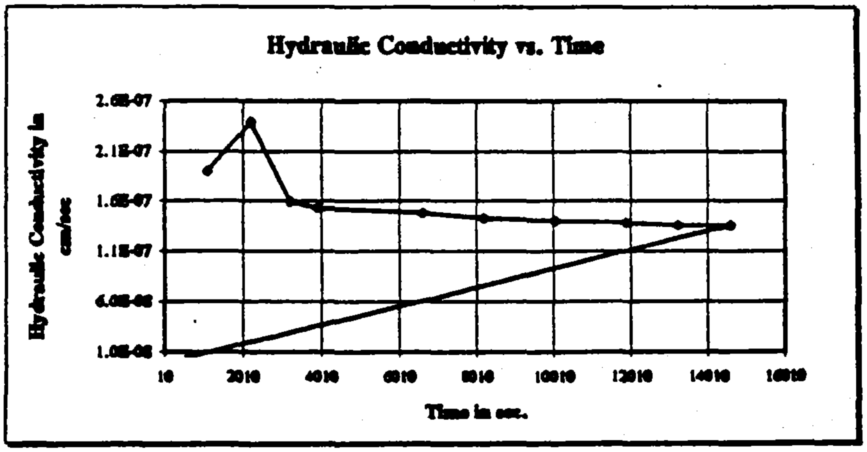
Specific Gravity Constant:
G = 12.61

Test Constant:
C = 0.0011

Trial Constant:
T = 0.10

Minutes	Seconds	Δt, cum. (sec)	Tail (cm)	Delta Zo (cm)	C/t	(1-delta Zo)^T	PERMEABILITY (cm/sec)
17	50	1070	22.95	1.75	1.0E-06	0.831	1.9E-07
36	45	2205	20.75	3.95	5.0E-07	0.619	2.4E-07
53	20	3200	20.85	3.85	3.4E-07	0.628	1.6E-07
65	0	3900	20.35	4.35	2.8E-07	0.580	1.5E-07
110	0	6600	18.6	6.1	1.7E-07	0.411	1.5E-07
136	30	8190	17.9	6.8	1.3E-07	0.344	1.4E-07
167	30	10050	17.2	7.5	1.1E-07	0.276	1.4E-07
198	0	11880	16.65	8.05	9.2E-08	0.223	1.4E-07
220	30	13230	16.35	8.35	8.3E-08	0.194	1.4E-07
243	0	14580	16.05	8.65	7.5E-08	0.165	1.4E-07
0	0	0	0	24.7	#DIV/0!	-1.384	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.384	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.384	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.384	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.384	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.384	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.384	#DIV/0!

PERMEABILITY REPORTED AS == #DIV/0!
cm/sec ==



TECH:	BDM	CHECKED:	
DATE:	10/3/97	DATE:	

GEOTECHNICAL TESTING LABORATORY
GOLDER ASSOCIATES INC.
DENVER, CO

RIDGED WALL PERMEABILITY
ASTM D 5084

PROJECT TITLE: Terramatrix
PROJECT NO.: 953-2703
SAMPLE ID: #1

Piston Pressure = 100 psi
Sample Pressure = 95 psi
Run # = 1

Sample Data, Initial

Height, cm 9.65
Diameter, cm ~~7.095~~ 7.27
Area, cm^2 39.54
Volume, cm^3 0.00
Wet Mass, g 864.0
Moisture Content, % 12.3
Dry Density, pcf #DIV/0!
Spec. Gravity
Void Ratio #DIV/0!
Saturation, % #DIV/0!

Initial Manometer Readings

Pipette = 24.5
Annulus = 9.5

Calculation Constants:

Manometer Constants:
M1 = 0.03 cm^2
M2 = 1.041
Sample Constants:
S = 0.00 cm^-1
Specific Gravity Constant:
G = 12.56
Test Constant:
C = 0.0000
Trial Constant:
T = #DIV/0!

Minutes	Seconds	Δt, cum. (sec)	Tail (cm)	Delta Zo (cm)	C/t	delta Zo*	MEABILITY (cm/sec)
17	50	0	22.95	0	#DIV/0!	#DIV/0!	#DIV/0!
36	45	0	21.75	0	#DIV/0!	#DIV/0!	#DIV/0!
53	20	0	20.85	0	#DIV/0!	#DIV/0!	#DIV/0!
65	00	0	20.35	0	#DIV/0!	#DIV/0!	#DIV/0!
110	00	0	18.60	0	#DIV/0!	#DIV/0!	#DIV/0!
136	30	0	17.90	0	#DIV/0!	#DIV/0!	#DIV/0!
167	30	0	17.20	0	#DIV/0!	#DIV/0!	#DIV/0!
198	00	0	16.65	0	#DIV/0!	#DIV/0!	#DIV/0!
220	30	0	16.35	0	#DIV/0!	#DIV/0!	#DIV/0!
243	00	0	16.05	0	#DIV/0!	#DIV/0!	#DIV/0!
284	30	0	15.65	0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!

PERMEABILITY REPORTED AS ** #DIV/0!
cm/sec **

$$R_p = R_{eq} + \frac{iL}{18.62}$$

$$= 14.35 + \frac{20 \times 9.65}{18.62}$$

$$= 24.7$$

TECH:
DATE:

CHECKED:
DATE:

GEOTECHNICAL TESTING LABORATORY
GOLDER ASSOCIATES INC.
DENVER, CO

RMEABILITY TESTING
BACK PRESSURE SATURATION

PROJECT Terramatrix/Lariat HCo JOB NO. 953-2703 DATE 10/1/97

ORING NO. SAMPLE NUMBER 502-322 1 DEPTH

SOIL DESCIPTION 120.6 pcf @ 12.5% MC TESTED BY APPROVED BY

Cell A

5 PSI

DATE	TIME	MEASURE B		PRESSURE (PSI)			BURETTS (cm)^{3}			COMMENTS
		BOTTOM	TOP	CELL (LEFT)	BOTTOM (MIDDLE)	TOP (RIGHT)	TOP (LEFT)	BOTTOM (MIDDLE)	CELL (RIGHT)	
10/1				7	5					De Air
				12	10			9.6	8.2	
				22	20			10.9	12.3	
				52	50			10.4	5.2	
10/2				62	60					
				72	70			5.6	1.7	
				82	80			5.7	3.4	
				92	90			5.9	4.5	
			~~96%~~ 89	~~102~~ 102						B=96%
				100	95					

2

Golder Associates
CONSULTING GEOTECHNICAL ENGINEERS

TerraMatrix/Labte

WATER CONTENT DETERMINATION

PROJECT NO. 953-290
DATE:

LAB NUMBER						
BOREHOLE NUMBER						
SAMPLE NUMBER	1					
DEPTH OF SAMPLE						
CONTAINER NUMBER	X 3					
WT. WET SOIL + TARE	260.73					
WT. DRY SOIL + TARE	247.03					
WEIGHT OF WATER						
TARE WT.	32.82					
WT. OF DRY SOIL						
WATER CONTENT W%	6.4					

LAB NUMBER						
BOREHOLE NUMBER						
SAMPLE NUMBER						
DEPTH OF SAMPLE						
CONTAINER NUMBER						
WT. WET SOIL AND TARE						
WT. DRY SOIL AND TARE						
WEIGHT OF WATER						
TARE WT.						
WT. OF DRY SOIL						
WATER CONTENT W%						

LAB NUMBER						
BOREHOLE NUMBER						
SAMPLE NUMBER						
DEPTH OF SAMPLE						
CONTAINER NUMBER						
WT. WET SOIL + TARE						
WT. DRY SOIL + TARE						
WEIGHT OF WATER						
TARE WT.						
WT. OF DRY SOIL						
WATER CONTENT W%						

PROJECT NO. ______

Golder Associates Fax

To: PAUL PELLICER **Fax Number:** 970-879-9048

Company: TERRAMATRIX **Date:** 4-21-99

From: DAVE DIX **Our Ref:**

RE:

Total pages (including cover): 14 **Hard copy to follow** ☒

Golder
Associat

Golder Associates Inc
Soils Laboratory
12860 W. Cedar Dr., S
206
Lakewood, Colorado 8
Telephone (303) 969-9
Fax (303) 969-0468

MESSAGE

PAUL,

WILL DROP HARD COPY IN MAIL.

Dave

Comprehensive Consul
Services in Geotechnic
Engineering, Environm
Remediation and Wast
Management

Environmental Remedia
Waste Management
Landfill Siting & Design
Civil Engineering & Cons
Mining & Quarrying
Oil and Gas Waste Management
Soil and Rock Mechanic
Nuclear Waste Manage
Risk Assessment
Energy Projects
Transportation
Water Resources

Offices in Australia, C
Finland, Germany, Ho
Hungary, Indonesia
Sweden, United Kin
United States

~~FLOW PUMP~~ PERMEABILITY TEST

Mercury Manometer

JOB NUMBER: 953-2403
BORING:
PROJECT: Tensumatrix/Labtest
SAMPLE: Spl #1
DATE: 10/1/97
DEPTH: 116.6 pcf @ 14.0 % MC

SAMPLE SPECIFICS

Length (L)(cm):	9.62	9.83
Diameter (cm):	7.27	7.41
Wet Weight (g):	846.5	890.3

MOISTURE CONTENTS

	INITIAL	FINAL	
Wet Weight + Tare (g)	210.75	1050.6	
Dry Weight + Tare (g)	188.89	907.0	
Tare (g) PT19	33.64	160.8	Z-12
Moisture Content (%)	14.1	19.2	

READINGS

Cell Pressure (psi):
Back Pressure (psi):
Effective Stress (psi):
Motor Speed (1-12):
% Max:
H (cm):
(high setting, ignore decimal point)

PERMEABILITY CALCULATIONS

Flow Rate Q (cm/sec)
(from flow rate chart)
Area (cm²):
Apparent Velocity (v) = $\frac{Q}{A}$ =
(cm/s) (SEE NOTE)
Gradient (i) = $\frac{H}{L}$ = 20
Permeability (K) = $\frac{v}{i}$ = 6.6×10^{-8}
(cm/sec)

NOTE: Can use column 4 of the chart only if the sample is 2.8" diameter.

DENSITY CALCULATIONS

Area (cm²): 41.51
Volume (cm³): 399.3
Wet Density (pcf): 131.8
Dry Density (pcf): 115.5

REMARKS Remold @ 116.6 & 14 % MC
397.8 X 116.6 X 1.14 ÷ 62.4 = 847.4

(99.1 % of required density)

GOLDER ASSOCIATES INC.

1200 @ 6.4
1285.7 @ 14
+85.7

847.4
281.8
1129.2

CONSTANT VOLUME PERMEABILITY / ASTM D 5084

(For use with Manometer Board)

PROJECT TITLE: TERRA MATRIX/LAB TEST/CO
PROJECT NO.: 953-2983 602
SAMPLE ID: Spl 1 | remold at 116.6pcf 14.0%mc

Cell Pressure = 100 psi
Sample Pressure = 95 psi
Run # = 1

Sample Data, Initial

Height, cm 9.62
Diameter, cm 7.27
Area, cm^2 41.51
Volume, cm^3 399.33
Wet Mass, g 846.5
Moisture Content, % 14.1%
Dry Density, pcf 115.9
Spec. Gravity ~~2.60~~
Void Ratio ~~0.40~~
Saturation, % ~~0.0~~
Effective stress, psi 5

Initial Manometer Readings

Pipette = 24.85
Annulus = 9.3

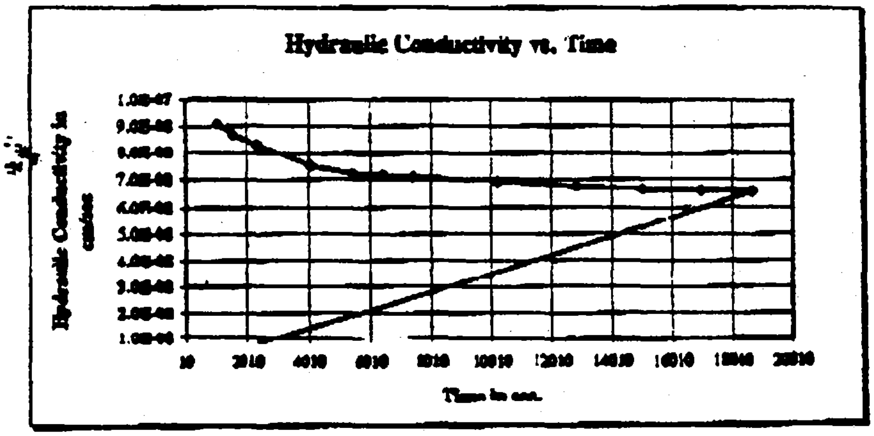
Gradient 20

12.5%mc

Manometer Constants
M1 = 0.06 cm^2
M2 = 1.48
Sample Constants
S = 0.23 cm^-1
Specific Gravity Constants
G = 2.61
Test Constants
C = 0.0011
Trial Constants
T = 0.09

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	50	1010	24	0.85	1.1E-06	0.919	9.1E-08
25	25	1525	23.65	1.2	7.2E-07	0.886	8.7E-08
38	40	2320	23.15	1.7	4.7E-07	0.839	8.3E-08
67	20	4040	22.5	2.35	2.7E-07	0.754	7.5E-08
90	0	5400	21.7	3.15	2.0E-07	0.701	7.2E-08
108	30	[illegible]	21.25	3.6	1.7E-07	0.668	7.2E-08
129	0	[illegible]	20.85	4	1.5E-07	0.639	7.1E-08
170	0	10200	19.85	5	1.1E-07	0.575	6.9E-08
213	30	12810	19.1	5.75	8.5E-08	0.454	6.8E-08
[illegible]	0	[illegible]	18.55	6.3	7.1E-08	0.407	6.7E-08
[illegible]	20	[illegible]	18.11	6.74	6.5E-08	0.369	6.6E-08
311	0	18660	17.75	7.1	5.9E-08	0.324	6.6E-08
0	0	0	0	24.85	#DIV/0!	-1.349	#DIV/0!
0	0	0	0	24.85	#DIV/0!	-1.349	#DIV/0!
0	0	0	0	24.85	#DIV/0!	-1.349	#DIV/0!
0	0	0	0	24.85	#DIV/0!	-1.349	#DIV/0!
0	0	0	0	24.85	#DIV/0!	-1.349	#DIV/0!

PERMEABILITY REPORTED AS ** #DIV/0!
cm/sec **



TECH: [illegible]
DATE: 10/6/97
CHECKED:
DATE:

GEOTECHNICAL TESTING LABORATORY
GOLDER ASSOCIATES INC.
DENVER, CO

RIDGED WALL PERMEABILITY
ASTM D 5084

PROJECT TITLE: [illegible]
PROJECT NO.: 953-2405
SAMPLE ID: 1 116.6@14.0

Piston Pressure = 100 psi
Sample Pressure = 95 psi
Run # = 1

Sample Data, Initial

Height, cm 9.62
Diameter, cm ~~7.095~~ 7.27
Area, cm^2 39.54
Volume, cm^3 0.00
Wet Mass, g 846.5
Moisture Content, % 14.1
Dry Density, pcf #DIV/0!
Spec. Gravity
Void Ratio #DIV/0!
Saturation, % #DIV/0!

Calculation Constants:

Manometer Constants:
M1 = 0.03 cm^2
M2 = 1.041
Sample Constants:
S = 0.00 cm^-1
Specific Gravity Constants:
G = 12.56
Test Constants:
C = 0.0000
Trial Constant:
T = #DIV/0!

Initial Manometer Readings

Pipette = 24.85
Annulus = 9.3

[illegible]	[illegible]	[illegible]	[illegible]	Delta Z [illegible]	C [illegible]	Delta Z [illegible]	PERMEABILITY
16	00	0	24.0	0	#DIV/0!	#DIV/0!	#DIV/0!
27	25	0	23.65	0	#DIV/0!	#DIV/0!	#DIV/0!
38	40	0	23.15	0	#DIV/0!	#DIV/0!	#DIV/0!
67	20	0	22.30	0	#DIV/0!	#DIV/0!	#DIV/0!
90	20	0	21.70	0	#DIV/0!	#DIV/0!	#DIV/0!
106	30	0	21.35	0	#DIV/0!	#DIV/0!	#DIV/0!
123	[illegible]	0	20.85	0	#DIV/0!	#DIV/0!	#DIV/0!
170	[illegible]	0	19.85	0	#DIV/0!	#DIV/0!	#DIV/0!
213	00	0	19.10	0	#DIV/0!	#DIV/0!	#DIV/0!
250	00	0	18.95	0	#DIV/0!	#DIV/0!	#DIV/0!
282	20	0	18.70	0	#DIV/0!	#DIV/0!	#DIV/0!
311	00	0	17.75	0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!

PERMEABILITY REPORTED AS ** #DIV/0! cm/sec **

Gradient = 20

$$Rp = Req + \frac{i\,L}{18.62}$$

$$= 14.35 + \frac{9.62 \times 20}{18.62}$$

$$= 24.7$$

TECH:
DATE:
CHECKED:
DATE:

GEOTECHNICAL TESTING LABORATORY
GOLDER ASSOCIATES INC.
DENVER, CO

PERMEABILITY TESTING
BACK PRESSURE SATURATION

PROJECT Terramatrix/Habitat JOB NO. 953-2903 DATE Oct 1

BORING NO. SAMPLE NUMBER 602 022 1 DEPTH

SOIL DESCIPTION 116.6 @ 14.0 TESTED BY APPROVED BY

cell 4 2

DATE	TIME	MEASURE B		PRESSURE (PSI)			BURETTS (cm)$^{-3}$			5 PSI
		BOTTOM	TOP	CELL (LEFT)	BOTTOM (MIDDLE)	TOP (RIGHT)	TOP (LEFT)	BOTTOM (MIDDLE)	CELL (RIGHT)	COMMENTS
10/1				7	5					De Air
				12	10			9.5	10.4	
				22	20			10.6	14.9	
				52	50					
10/2				62	60					
				72	70			7.2	2.0	
				82	80			7.4	4.0	
				92	90			7.4	5.2	
			98.9 / 98.6	100 / 92						B=.978
				100	95					

~~FLOW PUMP~~ PERMEABILITY TEST

Mercury Manometer

JOB NUMBER: 953-2403

PROJECT: Terramatrix/Labtests

DATE: 10/1/97

BORING:

SAMPLE: 602.022 spl #1

DEPTH: 111.7 @ 16.0% mc

SAMPLE SPECIFICS

Length (L)(cm):	9.55	9.65
Diameter (cm):	7.27	7.33
Wet Weight (g):	826.7	863.5

MOISTURE CONTENTS

	INITIAL	FINAL	
Wet Weight + Tare (g)	257.62	947.9	
Dry Weight + Tare (g)	226.59	800.28	
Tare (g) X12	33.29	84.91	V1
Moisture Content (%)	16.1	20.6	

READINGS

Cell Pressure (psi): 100

Back Pressure (psi): 95

Effective Stress (psi): 5

Motor Speed (1-12):

% Max:

H (cm):
(high setting, ignore decimal point)

PERMEABILITY CALCULATIONS

Flow Rate Q (cm/sec)
(from flow rate chart)

Area (cm²):

Apparent Velocity (v) = $\frac{Q}{A}$ =
(cm/sec) (SEE NOTE)

Gradient (I) = $\frac{H}{L}$ = 20

Permeability (K) = $\frac{v}{I}$ = 1.1×10^{-7}
(cm/sec)

DENSITY CALCULATIONS

Area (cm²): 41.51

Volume (cm³): 196.4

Wet Density (pcf): 130.1

Dry Density (pcf): 112.1

NOTE: Can use column 4 of the chart only if the sample is 2.8" diameter.

REMARKS: Remold @ 111.7 & 16% MC.

347.8 X 111.7 X 1.16 ÷ 62.4 = 826.0

100.4

GOLDER ASSOCIATES INC.

1200 @ 6.4
1308.3 16.0
+ 108.3

826.0
281.97
1108.0

CONSTANT VOLUME PERMEABILITY / ASTM D 5084
(For use with Manometer Board)

PROJECT TITLE: TERRA MATRIX/LAB TEST/CO
PROJECT NO.: 953-2903 602
SAMPLE ID: Spl 1 remold at 111.7pcf 16.0%mc

Cell Pressure = 100 psi
Sample Pressure = 95 psi
Run # = 1

Sample Data, Initial

Height, cm	9.55
Diameter, cm	7.27
Area, cm^2	41.51
Volume, cm^3	396.43
Wet Mass, g	826.7
Moisture Content, %	16.1%
Dry Density, pcf	112.1
Spec. Gravity	---0---
Void Ratio	#DIV/0!
Saturation, %	#DIV/0!
Effective stress, psi	5

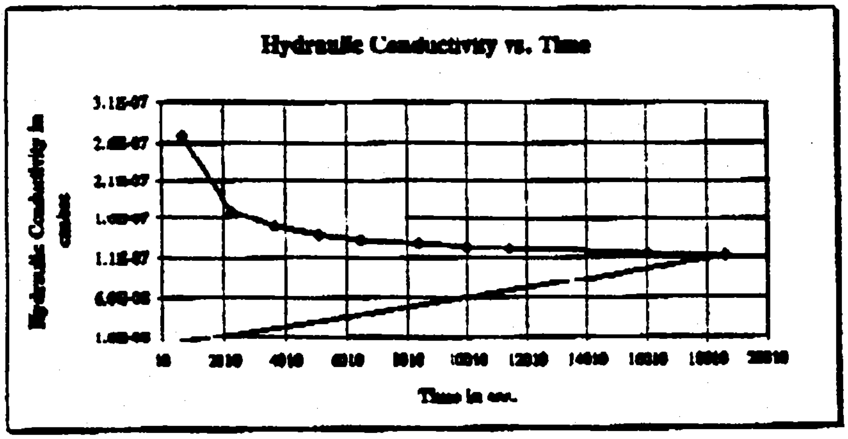
Initial Manometer Readings
Pipette = 24.7
Annulus = 9.4

Gradient 20

Manometer Constants
M1 = 0.06 cm^2
M2 = 1.48
Sample Constants
S = 0.25 cm^-1
Specific Gravity Constants
G = 12.61
Test Constants
C = 0.0011
Total Constants
T = 0.10

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	55	655	23.15	1.55	1.77E-06	0.859	2.77E-07
37	35	2255	21.65	3.05	4.85E-07	0.768	1.77E-07
60	30	3630	20.65	4.05	3.05E-07	0.609	1.58E-07
84	30	5070	19.8	4.9	2.15E-07	0.527	1.45E-07
107	15	6435	19.1	5.6	1.73E-07	0.459	1.35E-07
139	0	8340	18.25	6.45	1.38E-07	0.377	1.38E-07
166	10	9970	17.7	7	1.15E-07	0.326	1.29E-07
190	15	11415	17.25	7.45	9.56E-08	0.281	1.25E-07
268	46	16126	16.25	8.45	6.85E-08	0.186	1.15E-07
318	0	19080	15.85	8.85	5.85E-08	0.166	1.15E-07
0	0	0	0	24.7	#DIV/0!	-1.396	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.396	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.396	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.396	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.396	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.396	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.396	#DIV/0!

PERMEABILITY REPORTED AS == #DIV/0!
cm/sec ==



TECH: RCM
DATE: 10/7/97
CHECKED:
DATE:

GEOTECHNICAL TESTING LABORATORY
GOLDER ASSOCIATES INC.
DENVER, CO

RIDGED WALL PERMEABILITY
ASTM D 5084

PROJECT TITLE: [illegible]
PROJECT NO.:
SAMPLE ID: 502 1 111.7 16.0

Piston Pressure = psi
Sample Pressure = psi
Run # = 1

Sample Data, Initial

Height, cm 9.66
Diameter, cm ~~7.096~~ 7.27
Area, cm^2 39.54
Volume, cm^3 0.00
Wet Mass, g 826.7
Moisture Content, % 16.1
Dry Density, pcf #DIV/0!
Spec. Gravity ——
Void Ratio #DIV/0!
Saturation, % #DIV/0!

Initial Manometer Readings

Pipette = 24.85
Annulus = 9.35

Calculation Constants:

Manometer Constants:
M1 = 0.03 cm^2
M2 = 1.041
Sample Constants:
S = 0.00 cm^-1
Specific Gravity Constant:
G = 12.56
Test Constant:
C = 0.0000
Trial Constant:
T = #DIV/0!

Minutes	Seconds	[illegible]	[illegible]	DeltaZp	[illegible]	deltaZa	PERMEABILITY
10	55	0	23.15	0	#DIV/0!	#DIV/0!	#DIV/0!
37	35	0	21.65	0	#DIV/0!	#DIV/0!	#DIV/0!
60	30	0	20.65	0	#DIV/0!	#DIV/0!	#DIV/0!
84	30	0	19.80	0	#DIV/0!	#DIV/0!	#DIV/0!
107	15	0	19.10	0	#DIV/0!	#DIV/0!	#DIV/0!
139	00	0	18.25	0	#DIV/0!	#DIV/0!	#DIV/0!
166	10	0	17.70	0	#DIV/0!	#DIV/0!	#DIV/0!
190	15	0	17.25	0	#DIV/0!	#DIV/0!	#DIV/0!
266	45	0	16.25	0	#DIV/0!	#DIV/0!	#DIV/0!
310	00	0	15.85	0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!

PERMEABILITY REPORTED AS => #DIV/0!
cm/sec <=

Gradient = 20

$$R_p = R_{eq} + \frac{iL}{18.62}$$

$$= 14.35 + \frac{20 \times 9.5}{18.62}$$

$$= 24.6$$

TECH:
DATE:

CHECKED:
DATE:

GEOTECHNICAL TESTING LABORATORY
GOLDER ASSOCIATES INC.
DENVER, CO

PERMEABILITY TESTING
BACK PRESSURE SATURATION

PROJECT Terramatrix/Labtest/Co JOB NO. DATE

BORING NO. SAMPLE NUMBER 602 022 Soil DEPTH

SOIL DESCIPTION 111.7pcf @ 16.0%MC TESTED BY APPROVED BY

Cell C

5 PS

DATE	TIME	MEASURE B		PRESSURE (PSI)			BURETTS (cm)^{3}			COMMENTS
		BOTTOM	TOP	CELL (LEFT)	BOTTOM (MIDDLE)	TOP (RIGHT)	TOP (LEFT)	BOTTOM (MIDDLE)	CELL (RIGHT)	
10/1				7	5			~~7.5~~	6	Re A
				12	10			7.5	6.0	
				22	20			10.4	10.6	
				52	50			7.6	5.0	
10/2				62	60			6.4	2.0	
				72	70			6.6	3.5	
				82	80			/	/	
				92	90			6.5	5.0	" "
			99.7/ 89.7	102/ 97						B 97%
				100	95					

Mercury Manometer

~~FLOW PUMP~~ PERMEABILITY TEST

767-

JOB NUMBER: 953-2903
PROJECT: Terramatrix
DATE: 10/1/97
BORING:
SAMPLE: 602-020 spl # 1
DEPTH: 120.6 pcf & 12.5 % MC

SAMPLE SPECIFICS

Length (L)(cm):	9.65	9.89
Diameter (cm):	7.27	7.42
Wet Weight (g):	864.0	917.9

MOISTURE CONTENTS

		INITIAL	FINAL	
Wet Weight + Tare (g)		220.24	1073.0	
Dry Weight + Tare (g)		196.67	925.4	
Tare (g)	X-22	32.93	155.2	CC-1
Moisture Content (%)		12.3	19.2	

READINGS

Cell Pressure (psi): 100
Back Pressure (psi): 95
Effective Stress (psi): 5
Motor Speed (1-12):
% Max:
H (cm):
(high setting, ignore decimal point)

PERMEABILITY CALCULATIONS

Flow Rate Q (cm/sec)
(from flow rate chart)
Area (cm²):
Apparent Velocity (v) = $\frac{Q}{A}$ =
(cm/s) (SEE NOTE)
Gradient (I) = $\frac{H}{L}$ = 20
Permeability (K) = $\frac{v}{i}$ = 1.4×10^{-7}
(cm/sec)

DENSITY CALCULATIONS

Area (cm²): 41.51
Volume (cm³): 400.6
Wet Density (pcf): 134.6
Dry Density (pcf): 119.8

NOTE: Can use column 4 of the chart only it the sample is 2.8" diameter.

REMARKS Remold @ 120.6 & 12.5 % MC
397.8X120.6X1.125 ÷ 62.4 = 864.9g

~~[illegible]~~ 99.3% of requested dry

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1200@6.4
1268.8@12.5
+68.8

864.9
281.9
1146.8

CONSTANT VOLUME PERMEABILITY / ASTM D 5084

(For use with Manometer Board)

PROJECT TITLE: TERRA MATRIX/LAB TEST/CO
PROJECT NO.: 933-2909 601
SAMPLE ID: Spl. 1 | remold on 120.4pcf 12.5%mc

Cell Pressure = 100 psi
Sample Pressure = 95 psi
Run # = 1

Sample Data, Initial

Height, cm	9.48
Diameter, cm	7.27
Area, cm^2	41.51
Volume, cm^3	408.58
Wet Mass, g	864
Moisture Content, %	12.3%
Dry Density, pcf	119.8
Spec. Gravity	~~[illegible]~~
Void Ratio	~~[illegible]~~
Saturation, %	~~[illegible]~~
Effective stress, psi	5

Initial Manometer Readings

Pipette = 24.7
Annulus = 9.4

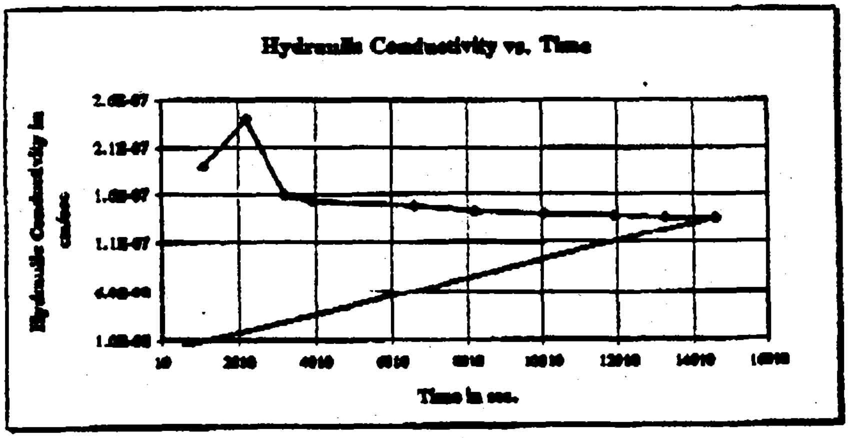
Gradient 20

12.5%mc

Manometer Constants
M1 = 0.06 cm^2
M2 = 1.48
Sample Constants
S = 0.23 cm^-1
Specific Gravity Constant:
G = 12.61
Test Constant:
C = 0.0011
Trial Constant:
T = 0.10

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17	50	1070	22.95	1.75	1.0E-06	0.831	1.9E-07
34	45	2085	20.75	3.95	5.0E-07	0.619	2.4E-07
55	30	3330	20.85	3.85	3.4E-07	0.628	1.6E-07
65	0	3900	20.35	4.35	2.8E-07	0.580	1.5E-07
110	0	6600	18.6	6.1	1.7E-07	0.411	1.5E-07
136	30	8190	17.9	6.8	1.3E-07	0.344	1.4E-07
167	30	10050	17.2	7.5	1.1E-07	0.276	1.4E-07
193	0	11580	16.65	8.05	9.2E-08	0.229	1.4E-07
220	30	13230	16.15	8.55	8.5E-08	0.194	1.4E-07
243	0	14580	16.05	8.65	7.5E-08	0.165	1.4E-07
0	0	0	0	24.7	#DIV/0!	-1.386	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.386	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.386	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.386	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.386	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.386	#DIV/0!
0	0	0	0	24.7	#DIV/0!	-1.386	#DIV/0!

PERMEABILITY REPORTED AS => #DIV/0!
cm/sec <=



TECH: JDM
DATE: 10/2/97

CHECKED:
DATE:

GEOTECHNICAL TESTING LABORATORY
GOLDER ASSOCIATES INC.
DENVER, CO

RIDGED WALL PERMEABILITY
ASTM D 5084

PROJECT TITLE:: Terra/McCrie
PROJECT NO.: 953 2403
SAMPLE ID: #1

Piston Pressure = 100 psi
Sample Pressure = 95 psi
Run # = 1

Sample Data, Initial

Height, cm: 9.65
Diameter, cm: ~~7.095~~ 7.27
Area, cm^2: 39.54
Volume, cm^3: 0.00
Wet Mass, g: 864.0
Moisture Content, %: 12.3
Dry Density, pcf: #DIV/0!
Spec. Gravity:
Void Ratio: #DIV/0!
Saturation, %: #DIV/0!

Calculation Constants:

Manometer Constants:
M1 = 0.03 cm^2
M2 = 1.041
Sample Constants:
S = 0.00 cm^-1
Specific Gravity Constant:
G = 12.56
Test Constant:
C = 0.0000
Trial Constant:
T = #DIV/0!

Initial Manometer Readings

Pipette = 24.7
Annulus = 9.0

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]TY
17	50	0	22.95	0	#DIV/0!	#DIV/0!	#DIV/0!
36	45	0	21.79	0	#DIV/0!	#DIV/0!	#DIV/0!
53	20	0	20.85	0	#DIV/0!	#DIV/0!	#DIV/0!
65	00	0	20.35	0	#DIV/0!	#DIV/0!	#DIV/0!
110	00	0	18.60	0	#DIV/0!	#DIV/0!	#DIV/0!
136	30	0	17.90	0	#DIV/0!	#DIV/0!	#DIV/0!
167	30	0	17.20	0	#DIV/0!	#DIV/0!	#DIV/0!
198	00	0	16.65	0	#DIV/0!	#DIV/0!	#DIV/0!
220	30	0	16.35	0	#DIV/0!	#DIV/0!	#DIV/0!
243	00	0	16.05	0	#DIV/0!	#DIV/0!	#DIV/0!
284	30	0	15.65	0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!
		0		0	#DIV/0!	#DIV/0!	#DIV/0!

PERMEABILITY REPORTED AS = #DIV/0!
cm/sec **

$$R_P = R_{eq} + \frac{\bar{I}L}{18.62}$$

$$= 14.35 + \frac{209.65}{18.62}$$

$$= 24.7$$

TECH:
DATE:

CHECKED:
DATE:

GEOTECHNICAL TESTING LABORATORY
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DENVER, CO

PERMEABILITY TESTING
BACK PRESSURE SATURATION

PROJECT Terramatrix/[illegible] JOB NO. 953-2903 DATE 10/1/97
BORING NO. SAMPLE NUMBER 602-022 1 DEPTH
SOIL DESCRIPTION 120.6 pcf @ 12.5% MC TESTED BY APPROVED BY

DATE	TIME	MEASURE B		PRESSURE (PSI)			BURETTS (cm)$^{-3}$			5 PSI
		BOTTOM	TOP	CELL (LEFT)	BOTTOM (MIDDLE)	TOP (RIGHT)	TOP (LEFT)	BOTTOM (MIDDLE)	CELL (RIGHT)	COMMENTS
10/1				7	5					De Air
				12	10			9.4	8.2	
				22	20			10.9	12.3	
				52	50			10.4	5.2	
10/2				62	60					
				72	70			5.6	1.7	
				82	80			5.7	3.4	
				92	90			5.9	4.5	
			98.6 89	102 92						B=96%
				100	95					

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TerraMatrix/Labtest/

WATER CONTENT DETERMINATION

PROJECT NO. 953-2903
DATE:

LAB NUMBER					
BOREHOLE NUMBER					
SAMPLE NUMBER	1				
DEPTH OF SAMPLE					
CONTAINER NUMBER	X 3				
WT. WET SOIL + TARE	260.73				
WT. DRY SOIL + TARE	247.03				
WEIGHT OF WATER					
TARE WT.	32.82				
WT. OF DRY SOIL					
WATER CONTENT W %	6.4				

LAB NUMBER					
BOREHOLE NUMBER					
SAMPLE NUMBER					
DEPTH OF SAMPLE					
CONTAINER NUMBER					
WT. WET SOIL AND TARE					
WT. DRY SOIL AND TARE					
WEIGHT OF WATER					
TARE WT.					
WT. OF DRY SOIL					
WATER CONTENT W %					

LAB NUMBER					
BOREHOLE NUMBER					
SAMPLE NUMBER					
DEPTH OF SAMPLE					
CONTAINER NUMBER					
WT. WET SOIL + TARE					
WT. DRY SOIL + TARE					
WEIGHT OF WATER					
TARE WT.					
WT. OF DRY SOIL					
WATER CONTENT W %					

PROJECT NO.

MONTGOMERY WATSON

Calculation Cover Sheet Appendix E-41

Project Title: Triassic Park Waste Disposal Facility

Project No.: 602-0200

Calculation Title: Clay Liner Compatibility References

	Name	Date
Prepared By:	Jorge Troncoso	8/25/99
Checked By:		
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

A. Gwen Eklund[1]

A Laboratory Comparison of the Effects of Water and Waste Leachate on the Performance of Soil Liners

REFERENCE: Eklund, A. G., **"A Laboratory Comparison of the Effects of Water and Waste Leachate on the Performance of Soil Liners,"** ***Hydraulic Barriers in Soil and Rock, ASTM STP 874***, A. I. Johnson, R. K. Frobel, N. J. Cavalli, and C. B. Pettersson, Eds., American Society for Testing and Materials, Philadelphia, 1985, pp. 188–202.

ABSTRACT: A study was conducted to determine the performance of two compacted native soils and the soils plus a commercial additive when exposed to specific paper mill waste leachates. Fluids produced from actual paper mill wastes were used in accelerated (high-pressure), anaerobic permeability tests with two disposal site soils and the soils with a beneficient added. Comparison tests measuring hydraulic conductivity were performed to determine behavioral differences of the candidate soil liners with the waste leachate and water. Test results were used to evaluate waste impacts on soil and on the soil plus a commercial additive. Emphasis was placed on identifying fatal flaws in expected field liner performance.

Test results indicated that the two soils tested were effective in containing the paper mill waste leachates. One soil physically contained the waste leachates by providing an impermeable barrier ($K = << 10^{-7}$ cm/s). The other soil, while not providing as strong a physical barrier, ($K = 10^{-7}$ cm/s), did contain the leachate through chemical attenuation of the trace contaminants in the leachate. While the commercial additive improved the impervious barrier characteristics of this soil, it was determined to be optional. Both mechanisms of containment will be effective in providing protection of groundwater resources below a nonhazardous waste landfill.

KEY WORDS: permeability, soil liners, liner compatibility

The use of compacted soils is frequently used to retard leachate and waste liquid components from leakage and subsequent pollution of groundwater. In this study two soils and the soils plus a commercial additive were tested for permeability performance with water and leachate from paper mill wastes.

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[1] Senior scientist, geochemistry and waste characterization, Physical Chemistry Div., Radian Corp., Austin, TX 78766.

The major objectives of this study were to (1) provide an approach for evaluating in the laboratory a soil liner's performance expected in the field, and (2) to determine if a soil additive was necessary for good liner performance. The approach was comprised of tests allowing rapid identification of liner failure mechanisms.

Background

The purpose of lining a waste disposal facility is to retard waste contaminants from leaving the site and entering natural groundwater systems near the site. In their performance, liners function by two mechanisms: (1) impedance of flow of the pollutant carrier (usually water) into the subsoil, or (2) attenuation of suspended or dissolved pollutants so that the exiting leachate contains contaminants within acceptable ranges for groundwater [*1*], or both (1) and (2).

The first liner function is attained by constructing a material with low permeability. The sorptive or attenuative capability relies on the chemical composition and mass of the liner. Soil liners generally function by both mechanisms. Soils generally have a large capacity to sorb materials of different types, but some soils do not provide an impermeable boundary. These properties can sometimes be enhanced by the use of soil additives. A greater thickness of a soil layer beneath the disposal impoundment also can result in a lower flux of a contaminant through the liner. A good soil liner will contain a minimum of 25 to 28% clay-size particles by weight [*1*]. The clay-size fraction (<0.002 mm) has a relatively large surface area, and the mechanical behavior of a clayey soil is dependent on the physiochemical interactions between soil particle surfaces.

Soils used as liners also must have acceptable engineering properties. The soil consistency differs with moisture content, and the degree of hydration of clayey soils has a direct effect upon the liner's compressive strength. The plastic limit and the liquid limit are also valuable in assessing the engineering characteristics of soils [*2*].

The mechanical soil properties can be altered by mechanical compaction, which affects the permeability. (The mechanical behavior is also controlled by the stresses that act on soil, for example, overburden pressure.) For a given method of compaction and compactive effort, each soil has a unique laboratory moisture/density relation, that is, Proctor compaction curve, which defines optimum moisture and maximum dry density for design considerations. Soil permeability is a numerical measure of the ability of the soil to transmit a fluid. The permeability is dependent on both the soil properties and leachate properties. A good liner will usually possess a hydraulic conductivity coefficient (K) of 1×10^{-7} cm/s or less when it is tested with a simulated (or ac-

Stanley R. Peterson[1] *and Glendon W. Gee*[1]

Interactions Between Acidic Solutions and Clay Liners: Permeability and Neutralization

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REFERENCE: Peterson, S. R. and Gee, G. W., "**Interactions Between Acidic Solutions and Clay Liners: Permeability and Neutralization,**" *Hydraulic Barriers in Soil and Rock, ASTM STP 874*, A. I. Johnson, R. K. Frobel, N. J. Cavalli, and C. B. Pettersson, Eds., American Society for Testing and Materials, Philadelphia, 1985, pp. 229-245.

ABSTRACT: Liner failure, defined as an increase in liner permeability, was not found to be a problem when acidic uranium mill tailings solutions percolated through clay liner materials for periods extending up to three years. Liner materials taken from mill sites in Wyoming decreased in permeability with time in the laboratory columns when permeated with tailings solution. One clay liner decreased in permeability from one half to over two orders of magnitude, depending on the given clay sample and contacting solution. These decreases in permeability were attributed to pore plugging resulting from the precipitation of minerals and solids and to soil particle dispersion.

The clay liner material from Morton Ranch, Wyoming, exhibited a residual buffering capacity that was able to maintain column effluent pH values at higher levels than the influent pH values for extended time (in excess of 30 pore volumes). A likely cause for the elevated pH is the redissolution of iron and aluminum hydrous oxides. Redissolution of iron and aluminum hydrous oxides consumes hydrogen ions.

KEY WORDS: buffering capacity, hydraulic conductivity, particle-size analysis, permeameter, precipitation

Clay materials have been proposed as liners in uranium mill tailings impoundments. However, long-term response of clay to contact with acidic tailings solution is not well understood. Crim et al [*1*] found measurable increases in permeability in montmorillonite clays subjected to extended contact with an acidic (pH < 1) tailings solution. These increases in permeability varied by more than two orders of magnitude, but tended to increase most dramatically after the pH of the effluent dropped below 4 (from an initial value near 8). Gee et al [*2,3*] studied the effects of extended contact of

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Ann Arbor, MI, June 14-17, 1987.

DRAFT

Chemical Effects on Clay Hydraulic Conductivity

James K. Mitchell, F.ASCE[1] and Fritz T. Madsen[2]

ABSTRACT: Hydraulic conductivity and its susceptibility to changes with time or exposure to chemicals are major factors in selection of clay for use in waste containment barriers. Available concepts of clay-chemical interactions and data permit development of conclusions useful for prediction of clay barrier performance in waste containment applications.

Among the most important conclusions are that (1) the influences of the many factors that can cause changes in hydraulic conductivity can be understood from the perspective of their effects on the soil fabric, (2) the influences of chemicals on high water content clays such as in slurry walls are likely to be much greater than on lower water content compacted clays, (3) the effects of inorganic chemicals are consistent with their effects on particle surface double layers, their effects on surface and edge charges, and on pH, and (4) the effects of organic chemicals are influenced primarily by their water solubility, their dielectric constant, their polarity, and whether the clay is exposed to the pure chemical or a dilute solution. The type of test used may have a very large effect on the values of hydraulic conductivity that are measured. In almost all cases pure organic liquids will interact adversely with clays by causing some shrinking and cracking, with concurrent large conductivity increases; however, dilute solutions of organics have essentially no effect.

INTRODUCTION

The hydraulic conductivity and its susceptibility to changes with time or exposure to chemicals are the major factors in the selection of clay for use in waste containment barriers. Such barriers are usually in the form of landfill liners and covers, lagoon liners, and slurry walls. Much has been written about the influences of chemicals in permeants on the hydraulic conductivity of the permeated clay. There has also been much debate about the most suitable tests for measurement of the hydraulic conductivity for use in hazardous waste problems.

The purpose of this paper is to synthesize the available information so as to permit the development of conclusions about chemicals and clay hydraulic conductivity that may be useful for evaluation and prediction of clay barrier performance in waste containment applications. The following subjects are addressed:

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[2] Swiss Federal Institute of Technology, Zurich.

CLAY LINER COMPATIBILITY IN WASTE DISPOSAL PRACTICE

By Richard J. Finno,[1] M. ASCE, and William R. Schubert,[2]
A. M. ASCE

ABSTRACT: Waste permeants can affect the value of fluid conductivity of cla
soils used as liner material in disposal containment systems in a number c
ways. Varying chemical constitutents found in permeants encountered in di
posal practice may have different effects on the value of fluid conductivity c
clay. To provide information concerning field performance, undisturbed sam
ples of natural clay liner material that were exposed to either landfill leachat
or acidic wastes in the field were subjected to physical and chemical testing i
the laboratory. Index properties and values of fluid conductivity of exposed cla
samples, as well as unexposed control samples, were measured. Chemical anal
ysis of both waste permeants and clays were performed to evaluate chemica
interactions between the soils and permeants. The results of the testing pro
gram indicate that the laboratory values of fluid conductivity of the clay sam
ples did not significantly increase due to field exposure to the various wastes

INTRODUCTION

Soils are often used in parts of containment systems in waste dis
practice to inhibit the flow of liquid contaminants into the environ
Because of their low fluid conductivity, in situ and recompacted c
soils are used as "impervious" liners for landfills and waste storag
face impoundments. The liners are incorporated into an overall d
philosophy of containment in which leachate is removed from a la
for treatment to reduce static fluid pressure on a liner. In many c
the fluid conductivity of a saturated soil is the controlling factor in
surface migration of waste leachates. Predictions of leachate flow thr
a liner can only be as accurate as the assigned values of fluid cor
tivity.

Research has been conducted to study effects of various chemical
stituents on physical properties of clay. Much of it has been perfo
in the laboratory under varying simulations of liner exposure to che
constituents. Laboratory testing techniques used in some of the st
have been questioned in regard to proper simulation of the expo
conditions. For example, review of a number of case studies indi
that values of fluid conductivity have variations of two or three o
of magnitude when one soil type was tested using different meth
In addition, laboratory measured values of conductivity may be se
orders of magnitude lower than those which exist in situ. Olson
Daniel (20) and, more recently, Dunn and Mitchell (7) have prese
excellent summaries of different testing procedures and state of the
tice for measuring fluid conductivity of soils. In addition to the

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[2] District Engr., Waste Management, Inc., Oak Brook, IL 60521.

Note.—Discussion open until May 1, 1987. To extend the closing date one m
a written request must be filed with the ASCE Manager of Journals. The m
script for this paper was submitted for review and possible publication on M
6, 1985. This paper is part of the *Journal of Environmental Engineering*, Vol.
No. 6, December, 1986. ©ASCE, ISSN 0733-9372/86/0006-1070/$01.00. Pape
21095.

Irene M.-C. Lo,[1] Howard M. Liljestrand,[2] and David E. Daniel[2]

HYDRAULIC CONDUCTIVITY AND ADSORPTION PARAMETERS FOR POLLUTANT TRANSPORT THROUGH MONTMORILLONITE AND MODIFIED MONTMORILLONITE CLAY LINER MATERIALS

REFERENCE: Lo, I. M.-C., Liljestrand, H. M., and Daniel, D. E., "Hydraulic Conductivity and Adsorption Parameters for Pollutant Transport through Montmorillonite and Modified Montmorillonite Clay Liner Materials," Hydraulic Conductivity and Waste Contaminant Transport in Soil, ASTM STP 1142, David E. Daniel and Stephen J. Trautwein, Eds., American Society for Testing and Materials, Philadelphia, 1994.

ABSTRACT: Montmorillonite clay has been modified by the addition of humic acid (HA) and aluminum hydroxide (AlOH) coatings to enhance the sorption of organics, attenuate their transport, and minimize changes in hydraulic conductivity. Batch sorption experiments and hydraulic conductivity tests have been performed to compare this HA-AlOH-Clay with commercially available Claymax®. Claymax® has an approximately 6.8-19 times greater Langmuir adsorption maximum for Pb^{2+} than that of HA-AlOH-Clay, but the partition coefficients of chlorobenzenes to the HA-AlOH-Clay are 14-25 times greater than that to Claymax®. Hydraulic conductivity tests for Claymax® with and without HA-AlOH-Clay have been performed using tap water, a synthetic leachate, and pure methanol. Synthetic leachate increased the hydraulic conductivity of the HA-AlOH-Clay together with Claymax® to $1.2 \cdot 10^{-9}$ cm/s or about 3 times over that for tap water. The hydraulic conductivity of HA-AlOH-Clay alone is greater than the minimum required value ($k = 1 \cdot 10^{-7}$ cm/s) but can be used together with Claymax® to control chemical fluxes.

KEYWORDS: montmorillonite, humic acid, organically modified clay, sorption, lead, partition, chlorobenzenes, hydraulic conductivity.

The present design philosophy for liner systems is to minimize the rate of contaminant transport by reducing the hydraulic transport of leachate and thus the advective flux of contaminants through the liner. However even when advection is minimal, contaminants can migrate through clays by Fickian diffusion at rates that can be significant (Shackelford, et al. 1989). Moreover, the hydraulic conductivity of natural clay barriers can increase upon reaction with organic contaminants (Mitchell and Madsen 1987, Fernandez and Quigley 1988).

A new liner system design (Figure 1) is proposed to maximize the retardation of pollutants, minimize diffusive fluxes, and minimize hydraulic conductivity. A bentonite clay layer (Claymax®) provides cation exchange for the sorption of heavy metal cations and an organically modified clay (clay coated with aluminum hydroxide to form a bridge to a layer of humic acid) for the sorption of the hydrophobic organics. Claymax® is a three layer geotextile clay liner manufactured by James Clem Corp. consisting of an open weave polypropylene geotextile, bentonite with swelling additives affixed with water soluble glue, and open weave polyester geotextile support fabric. The current design for liner systems consists of a permeable material for collection of leachate, a synthetic geomembrane, and 3 m of clay as the primary liner and a redundant set of these three layers as the secondary liner. In Figure 1, the Claymax® plus organically modified clay layers replace the 3 m of clay that is currently recommended to be used in combination with the a geomembrane in a double liner leachate collection system.

The introduction of a new type of clay material coated with humic acid is based on three factors. First, humic coatings are thermodynamically stable (Greenland, 1971, Stevenson, 1982). Second, the material cost is low. Third, dissolved humics generated in disposal sites facilitate the transport of metal ion and neutral hydrophobic organic pollutants. A clay material designed to sorb humics will control this facilitated transport mechanism and, therefore, mitigate the flux of pollutants (Liljestrand et al., 1992).

In this study, column permeameter tests and batch adsorption experiments were used to evaluate the hydraulic conductivity and pollutant attenuation of montmorillonite (as the control case) and the humic acid-aluminum hydroxide-clay (HA-AlOH-Clay). The contaminants chosen were lead, a representative inorganic cation, and a homologous series of chlorobenzenes with a range of octanol-water partition coefficient (K_{OW}). The hydraulic conductivities of the liner materials were determined using flexible wall permeameters permeated with three fluids: tap water, synthetic leachate, and pure methanol.

MATERIALS AND EXPERIMENTAL METHODS

Laboratory Preparation of HA-AlOH-Clay

Synthesis of AlOH-Clay

Hydroxide-aluminum interlayers in expanding layers of Wyoming Montmorillonite SWy-1 obtained from the Source Clay Repository of the Clay Minerals Society available through the University of Missouri were prepared by the cation exchange method (Rengasamy and Oades, 1978, Oades, 1984, Srinivansan, and Fogler, 1990). The cross-linking agents between the expanding layers were hydroxide ions and aluminum ions with OH/Al molar ratios of 1.5, 1.85 and 2.6. The aluminum hydroxide polymers attach to the clay units with a uniform spacing to a pillar

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[1] Lecturer, Civil and Structural Engineering, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong.

[2] Professor, Civil Engineering, The University of Texas at Austin, Austin, TX 78712.

Steven R. Day[1]

THE COMPATIBILITY OF SLURRY CUTOFF WALL MATERIALS WITH CONTAMINATED GROUNDWATER

REFERENCE: Day, S. R., "The Compatibility of Slurry Cutoff Wall Materials with Contaminated Groundwater," Hydraulic Conductivity and Waste Contaminant Transport in Soils, ASTM STP 1142, David E. Daniel and Stephen J. Trautwein, Eds., American Society for Testing and Materials, Philadelphia, 1994.

ABSTRACT: Slurry cutoff walls are frequently relied upon to block groundwater flows from toxic waste sites and landfills. The long-term effectiveness of slurry cutoff wall materials is critical to the successful containment of these facilities and the protection of groundwater resources. A variety of laboratory indicator tests have been attempted by engineers and academia to make compatibility determinations but at present there has been little published experience to show which tests produce meaningful results and how these tests can be used to demonstrate compatibility.

Hydraulic conductivity is a useful measure of chemical/soil compatibility but permeability tests alone cannot assure the long-term stability of a slurry cutoff wall. A suite of indicator tests are used where the leachate and the proposed materials are combined and tested in immersion, desiccation, sedimentation, and other modes. Each indicator test attempts to model a different scenario of the slurry cutoff wall installation and operation.

This paper presents the experience of a specialty contractor from a number of projects, where an incompatibility was discovered and alternate materials were used to find a successful solution. Monitoring results from these sites has proven the effectiveness of the chosen solution. The laboratory test methods described are relatively simple and rely on worst-case scenarios, performed in a step-by-step process, that culminates with flexible wall permeability tests. Based on the methods described and the results from successful projects where these methods were used, engineers, owners and the public may better rely on long-term slurry cutoff wall performance with an increased level of confidence.

KEYWORDS: attapulgite, bentonite, compatibility, containment, deep soil mixing, hydraulic conductivity, slurry cutoff wall

INTRODUCTION

Slurry cutoff walls are permanent subsurface structures used to direct and control groundwater flow. Since the inception of this technique in the 1940's, slurry cutoff walls have been used where relatively unpolluted groundwater was diverted for civil works such as dams, dikes and dewatering structural excavations (Rossi di Cervia 1992). With the beginnings of CERCLA legislation and the environmental movement in the 1970's, more and more slurry cutoff walls are built to contain contaminated groundwater at landfills, hazardous waste and industrial facilities (Ryan 1987). The hydraulic conductivity or permeability of slurry cutoff walls is usually the performance criterion relied upon in the design, construction and contracting of these structures. For projects with an environmental function, the lowest practical hydraulic conductivity is typically specified for the maximum protection of the public and groundwater resources.

Hydraulic conductivity (permeability) testing has significantly improved over the last decade but is of limited use in determining incompatibility. The time and expense required for hydraulic conductivity tests limit the user in formulating compatible mixtures and complicates feasibility estimates. Furthermore, the flexible wall permeability test, the industry standard, requires the imposition of a confining stress, which can mask certain incompatibilities (Evans 1993).

In this paper, compatibility is defined as when two materials, i.e., contaminated groundwater (or leachate) and soil-bentonite, can be mixed together or coexist without reacting chemically or interfering with the performance of the soil-bentonite. An incompatible result is an increase in permeability in the soil-bentonite or chemical reaction which produces a degradation in the physical properties of the soil-bentonite.

Predetermining the compatibility of slurry wall materials with contaminated groundwater is generally recognized as good engineering practice (Ryan 1987; D'Appolonia 1980; Grube 1992; Millet and Perez 1981; Tallard 1984). Some methods, other than hydraulic conductivity testing, have been proposed to determine compatibility (McCandless and Bodocsi 1988; Khera and Thilliyar 1990; Wu and Khera 1990) but these have had limited experience and the results of some test are poorly understood. This paper presents a suite of relatively simple and quick indicator-type tests which can be used in concert with hydraulic conductivity tests to more quickly and better determine the most applicable materials for the containment of contaminated groundwater with slurry cutoff walls.

PURPOSE OF COMPATIBILITY TESTING

Compatibility tests should simulate the long-term, worst-case performance of slurry walls in a contaminated groundwater environment. As yet, no standards exist which can guide the user to determine compatibility.

The primary reason for performing compatibility tests is to ensure that the slurry cutoff wall performs as intended. Compatibility testing also makes the planning and construction effort more efficient and results in a higher

---

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Charles D. Shackelford[1]

WASTE-SOIL INTERACTIONS THAT ALTER HYDRAULIC CONDUCTIVITY

REFERENCE: Shackelford, C. D., "Waste-Soil Interactions that Alter Hydraulic Conductivity," Hydraulic Conductivity and Waste Contaminant Transport in Soil, ASTM STP 1142, David E. Daniel and Stephen J. Trautwein, Eds., American Society for Testing and Materials, Philadelphia, 1994.

ABSTRACT: Liquid-soil compatibility of soil hydraulic conductivity is reviewed with respect to the materials and methods used in evaluating waste-soil interactions, factors influencing interpretation of test results, and the interactions that are thought to alter significantly the hydraulic conductivity of clay soils. Significant increases in hydraulic conductivity may result from flocculation of clay particles due to interactions with electrolyte solutions, shrinkage of the soil matrix in the presence of concentrated organic solvents, and acid-base dissolution of the soil. Observed effects typically are greater in rigid-wall permeameters than flexible-wall permeameters.

Considerable evidence supports the use of the Gouy-Chapman theory for describing the influence of aqueous solutions on the fabric and, therefore, the hydraulic conductivity of clay soils. However, swelling test results suggest that the Gouy-Chapman theory does not account properly for shrinkage effects which have been observed to result in large increases in hydraulic conductivity upon permeation with concentrated organic solvents.

Three mechanisms may contribute to an increase in the hydraulic conductivity of clay soils upon permeation with acid permeants: (1) flocculation of the clay, (2) dissolution of the clay minerals (aluminosilicates), and (3) dissolution of other minerals (e.g., $CaCO_3$) in the clay soil. Dissolution and piping of clay minerals leads to increases in hydraulic conductivity. Dissolution of carbonates initially leads to buffering, re-precipitation, pore clogging, and a decrease in hydraulic conductivity. Depletion of the buffering capacity leads to a decrease in pH, dissolution of constituents, and a possible increase in hydraulic conductivity.

The measured hydraulic conductivity of a compacted sand-bentonite mixture is shown to be significantly affected by the sequence of permeation to a saturated calcium solution. The effect, termed "first exposure", has important implications with respect to the application of laboratory test results for evaluation of the suitability of a material for a waste containment barrier.

KEYWORDS: permeability, hydraulic conductivity, compatibility, laboratory testing, waste disposal, clay liners, soil fabric, diffuse double layer, volume change, inorganic chemicals, organic chemicals

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Attachment CC

Surface Water Control Plan

APPENDIX F

SURFACE WATER CONTROL SYSTEM DESIGN

1.0 INTRODUCTION

This appendix contains the methodology, assumptions, and calculation for the proposed channels, culverts and ponds.

METHODOLOGIES AND ASSUMPTIONS

2.0 HYDROLOGY

The hydrologic calculations used to evaluate the Triassic Park Landfill surface water control system were performed utilizing the SEDCAD+ computer model developed by Civil Software Design.

SEDCAD+ is a hydrologic, hydraulic, and sediment calculation model designed for use on computer systems. The SEDCAD+ hydrologic model calculates runoff volume, and peak flow via a numerical modeling technique based on user inputs of a design storm event, (i.e., precipitation frequency data, selection of rainfall distribution, and convolution increment). Hydrographs are developed on a subwatershed basis with the input of area, time of concentration, SCS curve number, and the selection of a hydrograph shape. Routing of hydrographs is accomplished by the Muskingum Method.

Inputs to the hydrology component of the SEDCAD+ computer model include:

- Precipitation Distribution
- Storm Duration
- Return Period/Precipitation
- Hydrograph Response Shape
- Drainage Basin Area
- Time of Concentration
- Muskingum Routing Parameters
- Curve Number

Input values used in this model, are shown on the SEDCAD+ printouts in Attachment 1, and are explained in the following text.

2.1 Precipitation Distribution

A precipitation distribution is input to model the runoff hydrograph. SEDCAD+ allows the user to choose between the SCS Type I and Type II Storms. The SCS Type II distribution was input as a geographical estimation of the area storms.

2.2 Storm Duration

A storm duration of 24 hours was used for the design and evaluation of the stormwater control system and represents the largest peak flow condition.

2.3 Return Period/Precipitation

A precipitation amount is required for the appropriate return period. As required by current regulations for the Triassic Park Landfill, the following precipitation amount was used for the design and evaluation of the stormwater control system (National Oceanic and Atmospheric Administration, 1973)

2-year, 24-hour event	2.1 inches
25-year, 24-hour event	4.3 inches
100-year, 24-hour event	5.3 inches

2.4 Hydrograph Response Shape

A unit hydrograph is chosen for each drainage area or sub-area model to predict the runoff response. The hydrograph responses available in the SEDCAD+ model are slow, medium, and fast. A slow response corresponds to a forested area or an area with a number of obstructions. A fast response corresponds to an unvegetated or poorly protected area. Medium hydrograph responses were chosen for disturbed and undisturbed areas.

The internal convolution increment is 0.05 hours and values are saved at the user specified interval of 0.1 hours or greater. A convolution increment of 0.1 was specified for the Triassic Park Landfill Area.

2.5 Drainage Basin Area

The drainage areas were determined by direct measurement from the U.S. Geological Survey, Mescalero Point quadrangle map, and a 1"=100' scale ariel survey topography map of the site. All basin areas are shown on the SEDCAD+ computer printouts in Attachment 1.

2.6 Time of Concentration, T_c

The time of concentration was calculated using the SCS upland method (a utility of SEDCAD+). All hydraulic lengths, drainage heights and slopes were measured directly from the above mentioned map and drawing. The calculated values for each structure are shown on the SEDCAD+ printouts in Attachment 1.

2.7 Muskingum Routing Parameters, K, X

The Muskingum Routing Parameters were also calculated using the SCS upland method. All hydraulic lengths, drainage heights and slopes were measured directly from the appropriate maps and drawings. The values calculated between each junction and/or subwatershed are shown on the SEDCAD+ printouts in Attachment 1.

2.8 Curve Number, CN

The run-off curve number is a factor relating the amount of rainfall to the amount of run-off for a given area. Curve numbers (CN) were evaluated based on vegetation and soil type for the given watershed. Vegetation was assumed based on anticipated cover vegetation. Indigenous surface soils types were obtained from the county Soil Conservation Service. The following curve numbers, presented in Table A-1, were assigned to area watersheds (U.S. Department of Commerce, 1986):

TABLE A-1
CURVE NUMBERS

Area Type	Hydrologic Soil Group	Vegetation	Curve Number
Final Cover	B	Herbaceous (Fair)	71
Facilities Disturbed	B	Newly Graded	86
Waste	C	Newly Graded	91
Landfill Disturbed	D	Newly Graded	94
Undisturbed	B	Herbaceous (Fair)	71

3.0 CHANNEL DESIGNS

The surface water diversion dimensions were determined using Mannings Equation for open channel flow Channels with flow velocities less than 5 fps from a 25-year event will not require erosion protection. Channels with peak flow velocities greater than 5 fps from a 25-year event but less than 5 fps from and average storm (2-year event) will also not utilize erosion protection. During average storm events these channels should be stable, however, during major storm events the channels may show signs of erosion in some areas. These areas will be repaired as required following all major storm events. Channels with peak flow velocities greater than 5 fps from and average storm will be lined with gravel or riprap size particles if required. To minimize sediment transport to receiving streams the East Channel and Final Cover Roadside Ditch will be lined with gravel.

Riprap and gravel sizes were determined using the SEDCAD+ subroutine for designing riprap lined channels, utilizing the PADER Method

All inputs and results are shown on the SEDCAD channel design computer printouts in Attachment 2.

A riprap apron will be constructed at the end of the East channel to dissipate the flow before entering the natural channel to help reduces erosion. The apron size and riprap requirement was designed using design curves relating culvert size, peak flow and taiwater conditions. The design calculations are shown in Attachment 3

All inputs and results are shown on the SEDCAD channel design computer printouts

4.0 CULVERT DESIGNS

The culverts were sized using the U.S. Bureau of Public Roads nomograph using a headwater/ diameter ratio of 1.5. The culvert design inputs and results are shown in Attachment 4 along with the nomographs.

5.0 PONDS

All three surface water detention basins are designed to contain the storm water discharge from the entire active site area given flows from a 25-year, 24-hour storm event. The total run-off for each basin was determined using SEDCAD+. All inputs and results are shown on the SEDCAD+ computer printouts in Attachment 1. The pond volumes were determine by determining the areas of the stages for every two foot elevation and developing a stage storage table. The stage storage tables for each pond are shown in Attachment 5.

6.0 REFERENCES

Barfield, B.J., Warner, R.C., Haan, C.T., 1981, *Applied Hydrology and Sedimentology for Disturbed Areas.*

Warner, R.C., Schwab, P.J, 1992, *SEDCAD + Version 3.*

Urban Hydrology For Small Watersheds, TR-55, 1986, Soil Conservation Service, USDA

TRIASSIC PARK LANDFILL

CHANNEL DESIGNS

Ditch	25-yr,24-hr Flow Q (cfs)	Slope (%)	Bottom Width (ft)	Side Slope (H:1V)	Depth of Flow (ft)	Velocity (fps)	Freeboard (ft)	Maximum ~~Minimum~~ Total Depth (ft)	Erosion Protection	2 -yr,24-hr Flow Q (cfs)	Velocity (fps)
1	34.2	0.5-2.0	0	2	2.1	6.7	~~0.3~~ 1	~~2.4~~ 3.1	None	4.8	~~4.3~~ 4.1
2	62.2	0.5-1.0	0	2	2.6	6.0	~~0.3~~ 1	~~2.9~~ 3.6	None	8.3	3.6
3	126.6	0.5-1	5	3	2.4	5.75	~~0.3~~ 1	~~2.7~~ 3.4	None	40	4.8
		1.1-2	5	3	2.1	6.6	~~0.3~~ 1	~~2.3~~ 3.1	Riprap D50=6"	(4)	(4)
4	6.8	0.5-1.0	0	2	1.1	3.5	~~0.3~~ 1	~~1.4~~ 2.1	None	(4) ~~[illegible]~~	~~[illegible]~~ (4)
5	217.3	0.5-1.0	10	~~2~~ 3	2.3	7.3	~~0.3~~ 1	~~2.6~~ 3.3	None	53.6	~~5.0~~ 4.8
6	30.1	0.5-1	0	2	2.0	5.0	~~0.3~~ 1	~~2.3~~ 3	None	(4) ~~[illegible]~~	(4) ~~[illegible]~~
7 Lower	7.3	1	0	1.5	0.9	6.0	~~0.3~~ 1	~~1.2~~ 1.9	HDPE	(4)	(4)
7 Upper	7.3	10	0	1.5	0.6	14.2	~~0.3~~ 1	~~0.9~~ 1.6	HDPE	(4)	(4)
8 Lower	19.3	1	0	1.5	1.3	7.6	~~0.3~~ 1	~~1.6~~ 2.3	HDPE	(4)	(4)
8 Upper	19.3	10	0	1.5	0.8	18	~~0.3~~ 1	~~1.1~~ 1.8	HDPE	(4)	(4)
East	272.8	0.5-0.8	16	3	~~2.3~~ 2.5	~~6.05~~ 5.5	~~0.3~~ 1	~~2.6~~ 2.5	Gravel D50=3"	(4)	(4)
Final Cover Road Side	31.5	0.5-2.4	0	3	1.8	~~5.7~~ 5	~~0.3~~ 1	~~2.1~~ 2.8	Gravel D50=3"	(4)	(4)
Spillway	358	0.5	20	3	~~2.4~~ 2.4	5.4	1.0	~~3.4~~ 3.6	Gravel D50=3"	(4)	(4)
9	40.1	6.5	3	3	2.1	4.7	1	3.1	None	(4)	(4)
10	90.4	0.5	3	3	2.1	4.7	1	3.1	None	(4)	(4)

Notes:

(1) Maximum allowable velocity for channels without erosion protection 5 fps.

(2) Channels with velocities greater than 5 fps for the 25-year event and less than 5 fps for the 2 year storm will not be lined. These channels will be repaired after major storm events.

(3) Maximum allowable velocity for gravel lined channels is 6 fps

(4)

* THE VELOCITY CALCULATIONS WERE NOT REQUIRED FOR THE 2-YEAR STORM BECAUSE THE 25-YEAR ~~STORM~~ RAIN EVENT FLOW VELOCITY WAS LESS THAN 5 fps, SO THE 2-YEAR, 24-HOUR RAIN EVENT FLOW VELOCITY WOULD ~~[illegible]~~ BE LESS THAN 5 fps, OR [illegible] THAT IT WAS NEEDED IS UNNECESSARY.

ATTACHMENT 1
SEDCAD+ COMPUTER PRINTOUTS

ATTACHMENT 1
SEDCAD+ COMPUTER PRINTOUTS

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

TRIASSIC PARK LANDFILL: FACILITIES DITCHES AND POND

by

Name: TEL

Company Name: ACZ, INC.
File Name: J:\602\SEDCAD\FACPOND

Date: 11-13-1997

```
              Civil Software Design -- SEDCAD+ Version 3.1
     Copyright (C) 1987-1992.  Pamela J. Schwab.  All rights reserved.

                          Company Name:  ACZ, INC.
     Filename: J:\602\SEDCAD\FACPOND                 User:  TEL
                       Date:  11-13-1997 Time:  16:28:43
            TRIASSIC PARK LANDFILL: FACILITIES DITCHES AND POND
   Storm:  4.30 inches,  25 year-24 hour, SCS Type II
                  Hydrograph Convolution Interval:  0.1 hr

                =============================================
                SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE
                =============================================

                              -Hydrology-

                                                               Base-   Runoff    Pea
BS SWS                Area    CN UHS    Tc       K       X      Flow    Volume  Disch
                      (ac)             (hrs)   (hrs)           (cfs)   (ac-ft)   (cf
=====================================================================================
11  1                 32.80   71  M    0.348   0.000 0.000     0.0     4.38     34
                             Type: Null    Label: DITCH 1
111 Structure         32.80                                            4.38
-------------------------------------------------------------------------------------
111 Total IN/OUT      32.80                                            4.38     34
=====================================================================================
121  1                77.80   71  M    0.595   0.000 0.000     0.0    10.39     62
                             Type: Null    Label: DITCH 2
121 Structure         77.80                                           10.39
-------------------------------------------------------------------------------------
21 Total IN/OUT       77.80                                           10.39     62
=====================================================================================
211  1               104.10   86  M    0.852   0.000 0.000     0.0    24.46    126
                             Type: Null    Label: DITCH 3
211 Structure        104.10                                           39.24
-------------------------------------------------------------------------------------
211 Total IN/OUT     214.70                                           39.24    210
=====================================================================================
111 to 211 Routing                             0.009 0.277
=====================================================================================
221  1                 4.40   86  M    0.563   0.000 0.000     0.0    -1.03      6
                             Type: Null    Label: DITCH 4
221 Structure          4.40                                            1.03
-------------------------------------------------------------------------------------
221 Total IN/OUT       4.40                                            1.03      6
=====================================================================================
311  1                 4.50   86  M    0.099   0.000 0.000     0.0     1.06     12
                             Type: Null    Label: DITCH 5
311 Structure          4.50                                           41.33
-------------------------------------------------------------------------------------
311 Total IN/OUT     223.60                                           41.33    21
=====================================================================================
211 to 311 Routing                             0.078 0.277
=====================================================================================
321  1                15.60   86  M    0.330   0.000 0.000     0.0     3.67     3
                             Type: Null    Label: DITCH 6
21 Structure          15.60                                            3.67
-------------------------------------------------------------------------------------
321 Total IN/OUT      15.60                                            3.67     3
=====================================================================================
```

```
411  1          8.30   86  M   0.166  0.000 0.000   0.0   1.95    19.
411  2          8.20   71  M   0.561  0.000 0.000   0.0   1.10     6.
411  3          9.80   98  F   0.001  0.000 0.000   0.0   3.32    32.
               Type: Null   Label: STORMWATER POND
'11 Structure   26.30                                     51.36
---------------------------------------------------------------------
.11 Total IN/OUT  265.50                                  51.36   254.
=====================================================================
311 to 411 Routing                   0.000 0.486
=====================================================================
```

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

TRIASSIC PARK LANDFILL: FACILITIES DITCHES AND POND

by

Name: TEL

Company Name: ACZ, INC.
File Name: J:\602\SEDCAD\FACPOND

Date: 11-13-1997

```
              Civil Software Design -- SEDCAD+ Version 3.1
    Copyright (C) 1987-1992.  Pamela J. Schwab.  All rights reserved.

                    Company Name:  ACZ, INC.
    Filename: J:\602\SEDCAD\FACPOND            User:  TEL
                  Date:  11-13-1997 Time:  16:28:50
           TRIASSIC PARK LANDFILL: FACILITIES DITCHES AND POND
   Storm:  5.30 inches, 100 year-24 hour, SCS Type II
               Hydrograph Convolution Interval:  0.1 hr

             ============================================
              SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE
             ============================================

                          -Hydrology-

                                                          Base-  Runoff    Pe
JBS SWS             Area   CN UHS   Tc      K      X      Flow   Volume  Disc
                    (ac)           (hrs)  (hrs)           (cfs)  (ac-ft)  (c
=============================================================================
111  1             32.80   71  M   0.348  0.000 0.000     0.0     6.41     5
                        Type: Null   Label: DITCH 1
111 Structure      32.80                                          6.41
-----------------------------------------------------------------------------
111 Total IN/OUT   32.80                                          6.41     5
=============================================================================
121  1             77.80   71  M   0.595  0.000 0.000     0.0    15.21     9
                        Type: Null   Label: DITCH 2
121 Structure      77.80                                         15.21
-----------------------------------------------------------------------------
121 Total IN/OUT   77.80                                         15.21     9
=============================================================================
211  1            104.10   86  M   0.852  0.000 0.000     0.0    32.51    16
                        Type: Null   Label: DITCH 3
211 Structure     104.10                                         54.13
-----------------------------------------------------------------------------
211 Total IN/OUT  214.70                                         54.13    29
=============================================================================
111 to 211 Routing                        0.009 0.277
=============================================================================
221  1              4.40   86  M   0.563  0.000 0.000     0.0     1.37
                        Type: Null   Label: DITCH 4
221 Structure       4.40                                          1.37
-----------------------------------------------------------------------------
221 Total IN/OUT    4.40                                          1.37
=============================================================================
311  1              4.50   86  M   0.099  0.000 0.000     0.0     1.41     1
                        Type: Null   Label: DITCH 5
311 Structure       4.50                                         56.91
-----------------------------------------------------------------------------
311 Total IN/OUT  223.60                                         56.91    30
=============================================================================
211 to 311 Routing                        0.078 0.277
=============================================================================
321  1             15.60   86  M   0.330  0.000 0.000     0.0     4.87     3
                        Type: Null   Label: DITCH 6
 21 Structure      15.60                                          4.87
-----------------------------------------------------------------------------
321 Total IN/OUT   15.60                                          4.87     3
=============================================================================
```

```
411  1                8.30   86  M   0.166  0.000 0.000    0.0    2.59    25
411  2                8.20   71  M   0.561  0.000 0.000    0.0    1.60    10
411  3                9.80   98  F   0.001  0.000 0.000    0.0    4.13    39
                      Type: Null   Label: STORMWATER POND
'11 Structure        26.30                                        70.12
--------------------------------------------------------------------------
-11 Total IN/OUT    265.50                                        70.12   357
==========================================================================
311 to 411 Routing                          0.000 0.486
==========================================================================
```

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

TRIASSIC PARK LANDFILL: FACILITIES DITCHES AND POND

by

Name: TEL

Company Name: ACZ, INC.
File Name: J:\602\SEDCAD\FACPOND

Date: 11-14-1997

```
                 Civil Software Design -- SEDCAD+ Version 3.1
         Copyright (C) 1987-1992.  Pamela J. Schwab.  All rights reserved.

                       Company Name:  ACZ, INC.
         Filename: J:\602\SEDCAD\FACPOND              User:  TEL
                      Date:  11-14-1997 Time:  09:55:46
              TRIASSIC PARK LANDFILL: FACILITIES DITCHES AND POND
       Storm:  2.10 inches,   2 year-24 hour, SCS Type II
                       Hydrograph Convolution Interval:  0.1 hr

                     ==========================================
                      SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE
                     ==========================================

                                   -Hydrology-

                                                              Base-  Runoff    Pea
JBS SWS                 Area   CN UHS   Tc      K       X     Flow   Volume  Disch
                        (ac)           (hrs)  (hrs)          (cfs)  (ac-ft)   (cf
==================================================================================
111  1                 32.80   71  M   0.348  0.000 0.000     0.0     0.84       4
                            Type: Null   Label: DITCH 1
111 Structure          32.80                                          0.84
----------------------------------------------------------------------------------
111 Total IN/OUT       32.80                                          0.84       4
==================================================================================
121  1                 77.80   71  M   0.595  0.000 0.000     0.0     1.99       8
                            Type: Null   Label: DITCH 2 _
121 Structure          77.80                                          1.99
----------------------------------------------------------------------------------
 21 Total IN/OUT       77.80                                          1.99       8
==================================================================================
211  1                104.10   86  M   0.852  0.000 0.000     0.0     8.03      40
                            Type: Null   Label: DITCH 3
211 Structure         104.10                                         10.85
----------------------------------------------------------------------------------
211 Total IN/OUT      214.70                                         10.85      51
==================================================================================
111 to 211 Routing                            0.009 0.277
==================================================================================
221  1                  4.40   86  M   0.563  0.000 0.000     0.0     0.34       2
                            Type: Null   Label: DITCH 4
221 Structure           4.40                                          0.34
----------------------------------------------------------------------------------
221 Total IN/OUT        4.40                                          0.34       2
==================================================================================
311  1                  4.50   86  M   0.099  0.000 0.000     0.0     0.35       4
                            Type: Null   Label: DITCH 5
311 Structure           4.50                                         11.54
----------------------------------------------------------------------------------
311 Total IN/OUT      223.60                                         11.54      53
==================================================================================
211 to 311 Routing                            0.078 0.277
==================================================================================
321  1                 15.60   86  M   0.330  0.000 0.000     0.0     1.20       9
                            Type: Null   Label: DITCH 6
 21 Structure          15.60                                          1.20
----------------------------------------------------------------------------------
321 Total IN/OUT       15.60                                          1.20       9
==================================================================================
```

```
411  1                 8.30   86  M    0.166  0.000 0.000     0.0     0.64     6
411  2                 8.20   71  M    0.561  0.000 0.000     0.0     0.21     0
411  3                 9.80   98  F    0.001  0.000 0.000     0.0     1.53    15
                       Type: Null   Label: STORMWATER POND
411 Structure         26.30                                          15.12
--------------------------------------------------------------------------------
411 Total IN/OUT     265.50                                          15.12    64
================================================================================
311 to 411 Routing                            0.000 0.486
================================================================================
```

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

TRIASSIC PARK LANDFILL: RAMP DITCHES & CLAENWATER COLLECTION POND

by

Name: TEL

Company Name: ACZ, INC.
File Name: J:\602\SEDCAD\COLBASIN

Date: 11-14-1997

```
              Civil Software Design -- SEDCAD+ Version 3.1
       Copyright (C) 1987-1992.  Pamela J. Schwab.  All rights reserved.

                       Company Name:  ACZ, INC.
       Filename: J:\602\SEDCAD\COLBASIN           User:  TEL
                    Date:  11-14-1997 Time:  13:22:41
      TRIASSIC PARK LANDFILL: RAMP DITCHES & CLAENWATER COLLECTION POND
     Storm:  4.30 inches,  25 year-24 hour, SCS Type II
                 Hydrograph Convolution Interval:  0.1 hr

                 ==========================================
                  SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE
                 ==========================================

                               -Hydrology-

                                                         Base-  Runoff    Pea
JBS SWS               Area   CN UHS   Tc      K      X   Flow   Volume  Disch
                      (ac)           (hrs)  (hrs)        (cfs)  (ac-ft)   (cf
=============================================================================
111  1                2.30   94  F   0.026  0.000 0.000    0.0     0.69     7
                          Type: Null   Label: DITCH 7
111 Structure         2.30                                         0.69
-----------------------------------------------------------------------------
111 Total IN/OUT      2.30                                         0.69     7
=============================================================================
121  1                6.10   94  F   0.071  0.000 0.000    0.0     1.84    19
                          Type: Null   Label: DITCH 8
121 Structure         6.10                                         1.84
-----------------------------------------------------------------------------
  1 Total IN/OUT      6.10                                         1.84    19
=============================================================================
211  1                6.60   94  F   0.046  0.000 0.000    0.0     1.99    20
                      Type: Null   Label: COLLECTION POND
211 Structure         6.60                                         4.52
-----------------------------------------------------------------------------
211 Total IN/OUT     15.00                                         4.52    47
=============================================================================
111 to 211 Routing                          0.000 0.486
=============================================================================
```

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

GANDY TRIASSIC PARK LANDFILL : SITE PERIMETER DITCH

by

Name: DGG

Company Name: ACZ, INC.
File Name: J:\602\SEDCAD\OFFSITE

Date: 11-08-1997

```
                  Civil Software Design -- SEDCAD+ Version 3.1
          Copyright (C) 1987-1992.  Pamela J. Schwab.  All rights reserved.

                         Company Name:  ACZ, INC.
          Filename: J:\602\SEDCAD\OFFSITE          User:  DGG
                      Date:  11-08-1997 Time:  13:07:58
               GANDY TRIASSIC PARK LANDFILL : SITE PERIMETER DITCH
        Storm:  4.30 inches,  25 year-24 hour, SCS Type II
                        Hydrograph Convolution Interval:  0.1 hr

                 ==============================================
                  SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE
                 ==============================================

                                   -Hydrology-

                                                       Base-  Runoff    Pea
JBS SWS              Area  CN UHS  Tc       K     X    Flow   Volume  Disch
                     (ac)          (hrs)  (hrs)        (cfs)  (ac-ft)   (cf
===========================================================================
111  1             377.80  71  M   0.709  0.000 0.000    0.0    50.47   272
                        Type: Null   Label: EAST DITCH
111 Structure      377.80                                       50.47
---------------------------------------------------------------------------
111 Total IN/OUT   377.80                                       50.47   272
===========================================================================
```

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

GANDY TRIASSIC PARK LANDFILL : FINAL COVER ROADSIDE DITCH

by

Name: DGG

Company Name: ACZ, INC.
File Name: J:\602\SEDCAD\ROADSIDE

Date: 11-07-1997

```
                Civil Software Design -- SEDCAD+ Version 3.1
     Copyright (C) 1987-1992.  Pamela J. Schwab.  All rights reserved.

                      Company Name:  ACZ, INC.
     Filename: J:\602\SEDCAD\ROADSIDE            User:  DGG
                    Date:  11-07-1997 Time:  15:14:00
        GANDY TRIASSIC PARK LANDFILL : FINAL COVER ROADSIDE DITCH
   Storm:  4.30 inches,  25 year-24 hour, SCS Type II
                  Hydrograph Convolution Interval:  0.1 hr

                 ============================================
                  SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE
                 ============================================

                              -Hydrology-

                                                       Base-  Runoff    Pea
JBS SWS               Area   CN UHS   Tc      K      X   Flow   Volume  Disch
                      (ac)            (hrs)  (hrs)       (cfs)  (ac-ft)  (cf
===========================================================================
111  1               27.00   71  M   0.258  0.000 0.000   0.0     3.61    31
                       Type: Null   Label: ROADSIDE DITCH
111 Structure        27.00                                        3.61
---------------------------------------------------------------------------
111 Total IN/OUT     27.00                                        3.61    31
===========================================================================
```

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

GANDY : LANDFILL PHASE 1 RUN-OFF

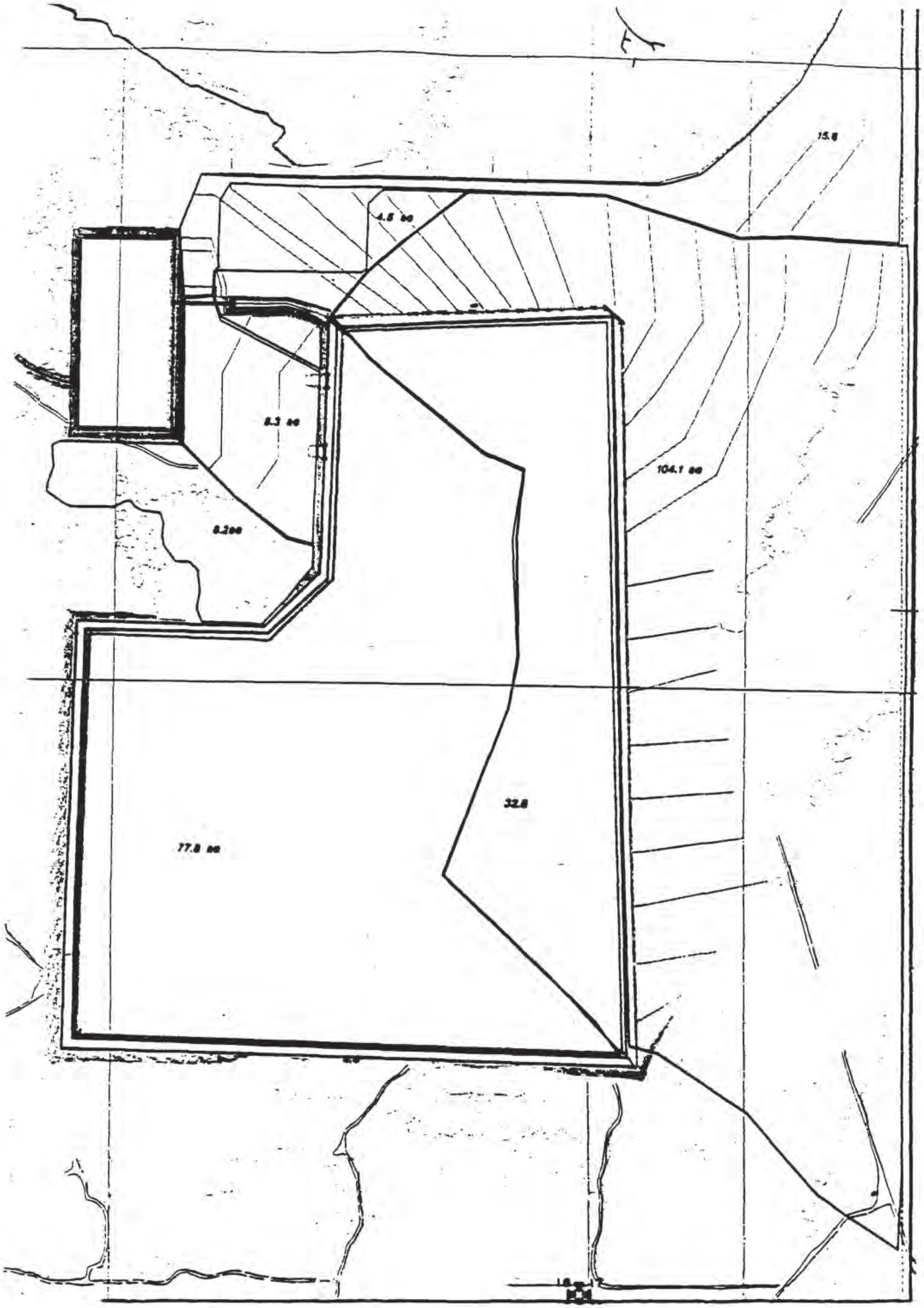
by

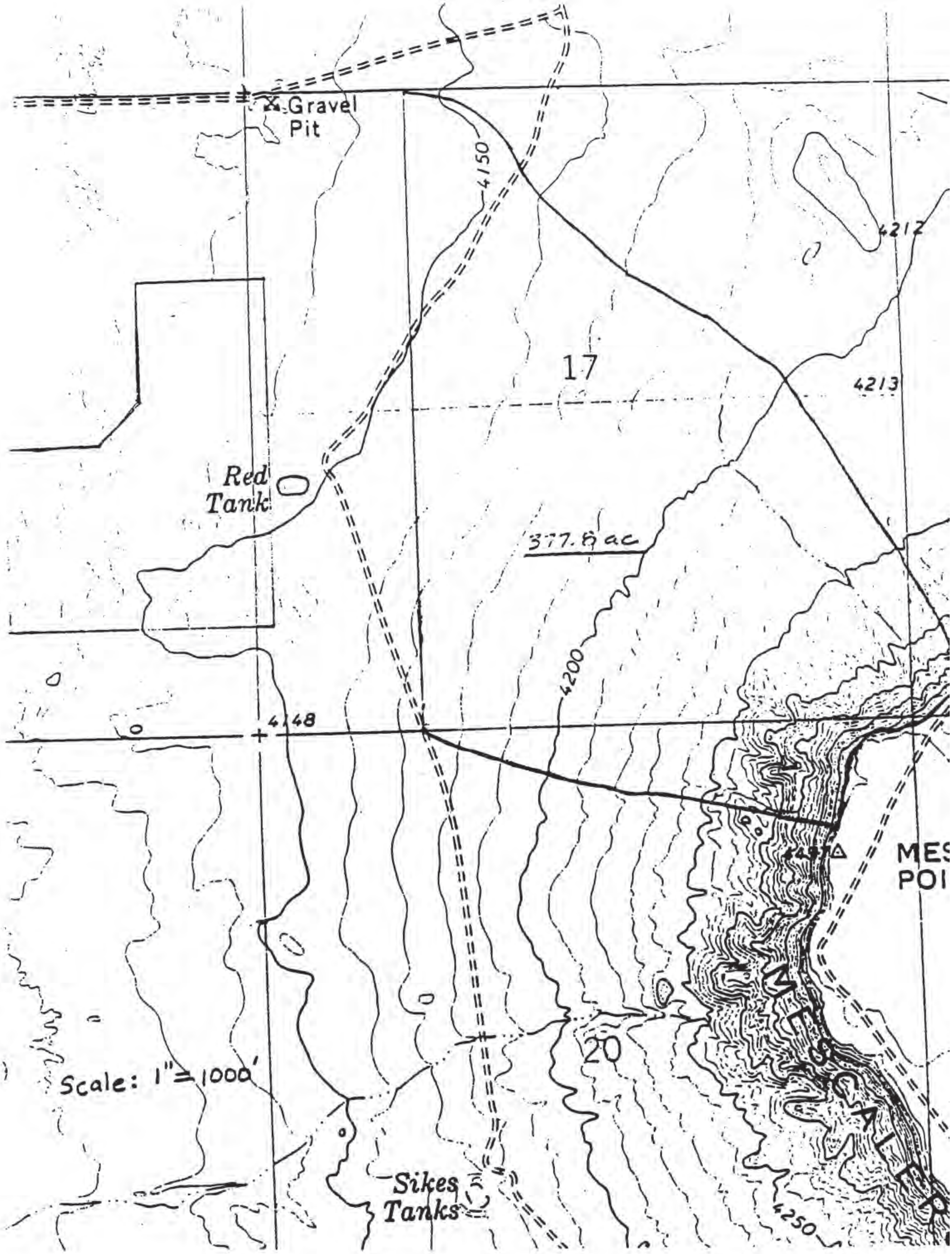
Name: TEL

Company Name: ACZ, INC.
File Name: J:\602\SEDCAD\LANDFILL

Date: 11-08-1997

```
                Civil Software Design -- SEDCAD+ Version 3.1
      Copyright (C) 1987-1992.  Pamela J. Schwab.  All rights reserved.

                      Company Name:  ACZ, INC.
      Filename: J:\602\SEDCAD\LANDFILL          User:  TEL
                     Date:  11-08-1997 Time:  16:23:38
                     GANDY : LANDFILL PHASE 1 RUN-OFF
    Storm:  4.30 inches,  25 year-24 hour, SCS Type II
                 Hydrograph Convolution Interval:  0.1 hr

                ============================================
                 SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE
                ============================================

                              -Hydrology-

                                                        Base-  Runoff    Pea
JBS SWS                  Area   CN UHS   Tc     K     X   Flow  Volume  Disch
                         (ac)            (hrs)  (hrs)     (cfs)  (ac-ft)  (cf
==========================================================================
111  1                   15.60   91  M   0.070  0.000 0.000   0.0    4.30    47
                         Type: Null   Label: PHASE 1 LANDFILL
111 Structure            15.60                                       4.30
--------------------------------------------------------------------------
111 Total IN/OUT         15.60                                       4.30    47
==========================================================================
```


15.8
4.8 ac
8.3 ac
8.2ac
104.1 ac
32.8
77.8 ac



Gravel Pit
4150
4212
17
4213
Red Tank
377.8 ac
4200
4148
MES
POI
MESCALER
20
Scale: 1"=1000'
Sikes Tanks
4250

ATTACHMENT 2
CHANNEL DESIGNS

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------

             DITCH 1

          INPUT VALUES:

  Shape                 TRIANGULAR
  Discharge                34.20 cfs
  Slope                     0.50 %
  Sideslopes             2.00:1 (L)    2.00:1 (R)
  Manning's n               0.025
  Material         STIFF CLAY
  Freeboard             .3 ft

             RESULTS:

  Depth                     2.07 ft
     with Freeboard         2.37 ft
  Top Width                 8.27 ft
     with Freeboard         9.47 ft
  Velocity                  4.00 fps
  Cross Sectional Area      8.55 sq ft
  Hydraulic Radius          0.92 ft
  Froude Number             0.69
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------


             DITCH 1

          INPUT VALUES:

  Shape                   TRIANGULAR
  Discharge                  34.20 cfs
  Slope                       2.00 %
  Sideslopes               2.00:1 (L)    2.00:1 (R)
  Manning's n                 0.025
  Material           STIFF CLAY
  Freeboard               .3 ft


             RESULTS:

  Depth                       1.59 ft
     with Freeboard           1.89 ft
  Top Width                   6.38 ft
     with Freeboard           7.58 ft
  Velocity                    6.73 fps
  Cross Sectional Area        5.08 sq ft
  Hydraulic Radius            0.71 ft
  Froude Number               1.33
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------


             DITCH 1

          INPUT VALUES:

  Shape                 TRIANGULAR
  Discharge                 4.80 cfs
  Slope                     2.00 %
  Sideslopes             2.00:1 (L)    2.00:1 (R)
  Manning's n               0.025
  Material           STIFF CLAY
  Freeboard             .3 ft


             RESULTS:

  Depth                     0.76 ft
     with Freeboard         1.06 ft
  Top Width                 3.05 ft
     with Freeboard         4.25 ft
  Velocity                  4.12 fps
  Cross Sectional Area      1.17 sq ft
  Hydraulic Radius          0.34 ft
  Froude Number             1.17
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------


            DITCH 2

         INPUT VALUES:

  Shape                     TRIANGULAR
  Discharge                    62.20 cfs
  Slope                         0.50 %
  Sideslopes                 2.00:1 (L)    2.00:1 (R)
  Manning's n                  0.025
  Material             STIFF CLAY
  Freeboard                  .3 ft


            RESULTS:

  Depth                          2.59 ft
     with Freeboard              2.89 ft
  Top Width                     10.35 ft
     with Freeboard             11.55 ft
  Velocity                       4.65 fps
  Cross Sectional Area          13.39 sq ft
  Hydraulic Radius               1.16 ft
  Froude Number                  0.72
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------

             DITCH 2

          INPUT VALUES:

  Shape                   TRIANGULAR
  Discharge                  62.20 cfs
  Slope                       1.00 %
  Sideslopes               2.00:1 (L)    2.00:1 (R)
  Manning's n                 0.025
  Material           STIFF CLAY
  Freeboard               .3 ft

             RESULTS:

  Depth                       2.27 ft
     with Freeboard           2.57 ft
  Top Width                   9.09 ft
     with Freeboard          10.29 ft
  Velocity                    6.02 fps
  Cross Sectional Area       10.33 sq ft
  Hydraulic Radius            1.02 ft
  Froude Number               1.00
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------

             DITCH 2

          INPUT VALUES:

  Shape                 TRIANGULAR
  Discharge                 8.30 cfs
  Slope                     1.00 %
  Sideslopes             2.00:1 (L)    2.00:1 (R)
  Manning's n               0.025
  Material         STIFF CLAY
  Freeboard             .3 ft

             RESULTS:

  Depth                     1.07 ft
     with Freeboard         1.37 ft
  Top Width                 4.27 ft
     with Freeboard         5.47 ft
  Velocity                  3.64 fps
  Cross Sectional Area      2.28 sq ft
  Hydraulic Radius          0.48 ft
  Froude Number             0.88
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------


             DITCH 3

          INPUT VALUES:

  Shape                   TRAPEZOIDAL
  Discharge                 126.60 cfs
  Slope                       0.50 %
  Sideslopes               3.00:1 (L)    3.00:1 (R)
  Bottom Width                5.00 ft
  Manning's n                 0.030
  Material          STIFF CLAY
  Freeboard                .3 ft


             RESULTS:

  Depth                       2.36 ft
     with Freeboard           2.66 ft
  Top Width                  19.13 ft
     with Freeboard          20.93 ft
  Velocity                    4.45 fps
  Cross Sectional Area       28.42 sq ft
  Hydraulic Radius            1.43 ft
  Froude Number               0.64
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------


             DITCH 3

          INPUT VALUES:

  Shape                   TRAPEZOIDAL
  Discharge                 126.60 cfs
  Slope                       1.00 %
  Sideslopes               3.00:1 (L)     3.00:1 (R)
  Bottom Width                5.00 ft
  Manning's n                 0.030
  Material             STIFF CLAY
  Freeboard                  .3 ft


             RESULTS:

  Depth                       2.00 ft
     with Freeboard           2.30 ft
  Top Width                  17.00 ft
     with Freeboard          18.80 ft
  Velocity                    5.75 fps
  Cross Sectional Area       22.01 sq ft
  Hydraulic Radius            1.25 ft
  Froude Number               0.89
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------


             DITCH 3

          INPUT VALUES:

  Shape                 TRAPEZOIDAL
  Discharge                40.00 cfs
  Slope                     1.00 %
  Sideslopes             3.00:1 (L)    3.00:1 (R)
  Bottom Width              5.00 ft
  Manning's n               0.025
  Material         STIFF CLAY
  Freeboard              .3 ft

             RESULTS:

  Depth                     1.03 ft
     with Freeboard         1.33 ft
  Top Width                11.18 ft
     with Freeboard        12.98 ft
  Velocity                  4.80 fps
  Cross Sectional Area      8.33 sq ft
  Hydraulic Radius          0.72 ft
  Froude Number             0.98
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------
```

DITCH 3

```
INPUT VALUES:

Shape                   TRAPEZOIDAL
Discharge                 126.60 cfs
Slope                       1.10 %
Sideslopes               3.00:1 (L)    3.00:1 (R)
Bottom Width                5.00 ft
Manning's n                 0.035
Material             6" RIPRAP
Freeboard                .3 ft

            RESULTS:

Depth                       2.10 ft
   with Freeboard           2.40 ft
Top Width                  17.62 ft
   with Freeboard          19.42 ft
Velocity                    5.32 fps
Cross Sectional Area       23.80 sq ft
Hydraulic Radius            1.30 ft
Froude Number               0.81
```

```
SEDCAD+ RIPRAP CHANNEL DESIGN
-----------------------------
        DITCH 3
        INPUT VALUES:

Shape                    TRAPEZOIDAL
Discharge                  126.60 cfs
Slope                        2.00 %
Sideslopes (L and R)     3.00:1          3.00:1
Bottom Width                 5.00 feet
Freeboard                 .3 ft

            RESULTS:

Steep Slope Design - PADER Method

Depth                        1.82 ft
   with Freeboard            2.12 ft
Top Width                   15.94 ft
   with Freeboard           17.74 ft
Velocity                     6.63 fps
Cross Sectional Area        19.10 sq ft
Hydraulic Radius             1.16 ft
Manning's n                 0.035
Froude Number                1.07
Dmax                         0.625 ft ( 7.50 in)
D50                          0.500 ft ( 6.00 in)
D10                          0.167 ft ( 2.00 in)
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------


             DITCH 4

          INPUT VALUES:

  Shape                 TRIANGULAR
  Discharge                 6.80 cfs
  Slope                     0.50 %
  Sideslopes             2.00:1 (L)    2.00:1 (R)
  Manning's n               0.025
  Material         STIFF CLAY
  Freeboard             .3 ft

             RESULTS:

  Depth                     1.13 ft
     with Freeboard         1.43 ft
  Top Width                 4.51 ft
     with Freeboard         5.71 ft
  Velocity                  2.67 fps
  Cross Sectional Area      2.55 sq ft
  Hydraulic Radius          0.50 ft
  Froude Number             0.63
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------

             DITCH 4

          INPUT VALUES:

  Shape                 TRIANGULAR
  Discharge                 6.80 cfs
  Slope                     1.00 %
  Sideslopes             2.00:1 (L)    2.00:1 (R)
  Manning's n               0.025
  Material          .STIFF CLAY
  Freeboard             .3 ft

             RESULTS:

  Depth                     0.99 ft
     with Freeboard         1.29 ft
  Top Width                 3.96 ft
     with Freeboard         5.16 ft
  Velocity                  3.46 fps
  Cross Sectional Area      1.96 sq ft
  Hydraulic Radius          0.44 ft
  Froude Number             0.87
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------


             DITCH 5

          INPUT VALUES:

  Shape                 TRAPEZOIDAL
  Discharge               217.30 cfs
  Slope                     0.50 %
  Sideslopes             3.00:1 (L)    3.00:1 (R)
  Bottom Width             10.00 ft
  Manning's n               0.025
  Material         .STIFF CLAY
  Freeboard             .3 ft

             RESULTS:

  Depth                     2.27 ft
     with Freeboard         2.57 ft
  Top Width                23.63 ft
     with Freeboard        25.43 ft
  Velocity                  5.69 fps
  Cross Sectional Area     38.21 sq ft
  Hydraulic Radius          1.57 ft
  Froude Number             0.79
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------


          DITCH 5

       INPUT VALUES:

  Shape                  TRAPEZOIDAL
  Discharge                217.30 cfs
  Slope                      1.00 %
  Sideslopes              3.00:1 (L)    3.00:1 (R)
  Bottom Width              10.00 ft
  Manning's n                0.025
  Material             .STIFF CLAY
  Freeboard                 .3 ft

          RESULTS:

  Depth                       1.90 ft
     with Freeboard           2.20 ft
  Top Width                  21.39 ft
     with Freeboard          23.19 ft
  Velocity                    7.29 fps
  Cross Sectional Area       29.79 sq ft
  Hydraulic Radius            1.35 ft
  Froude Number               1.09
```

Material:

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
10.00	3.0:1	3.0:1	1.0	0.0250			

	w/o Freeboard	w/ Freeboard
Design Discharge:	53.60 cfs	
Depth:	0.89 ft	
Top Width:	15.31 ft	
Velocity:	4.78 fps	
X-Section Area:	11.21 sq ft	
Hydraulic Radius:	0.719	
Froude Number:	0.98	

```
           SEDCAD+ NONERODIBLE CHANNEL DESIGN
           ----------------------------------

                       DITCH 6

                    INPUT VALUES:

            Shape                  TRIANGULAR
            Discharge                 30.10 cfs
            Slope                      0.50 %
            Sideslopes              2.00:1 (L)    2.00:1 (R)
            Manning's n                0.025
            Material             STIFF CLAY
            Freeboard                .3 ft

                       RESULTS:

            Depth                      1.97 ft
               with Freeboard          2.27 ft
            Top Width                  7.88 ft
               with Freeboard          9.08 ft
            Velocity                   3.87 fps
            Cross Sectional Area       7.77 sq ft
            Hydraulic Radius           0.88 ft
            Froude Number              0.69
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------


            DITCH 6

         INPUT VALUES:

  Shape                 TRIANGULAR
  Discharge                30.10 cfs
  Slope                     1.00 %
  Sideslopes              2.00:1 (L)     2.00:1 (R)
  Manning's n               0.025
  Material            STIFF CLAY
  Freeboard                .3 ft

            RESULTS:

  Depth                      1.73 ft
     with Freeboard          2.03 ft
  Top Width                  6.92 ft
     with Freeboard          8.12 ft
  Velocity                   5.02 fps
  Cross Sectional Area       5.99 sq ft
  Hydraulic Radius           0.77 ft
  Froude Number              0.95
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------


         DITCH 7 LOWER

         INPUT VALUES:

  Shape                     TRIANGULAR
  Discharge                     7.30 cfs
  Slope                         1.00 %
  Sideslopes                 1.50:1 (L)    1.50:1 (R)
  Manning's n                   0.013
  Material          HDPE
  Freeboard                  .3 ft


            RESULTS:

  Depth                         0.90 ft
     with Freeboard             1.20 ft
  Top Width                     2.71 ft
     with Freeboard             3.61 ft
  Velocity                      5.97 fps
  Cross Sectional Area          1.22 sq ft
  Hydraulic Radius              0.38 ft
  Froude Number                 1.57
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------


          DITCH 7 UPPER

          INPUT VALUES:

  Shape                      TRIANGULAR
  Discharge                      7.30 cfs
  Slope                         10.00 %
  Sideslopes                  1.50:1 (L)     1.50:1 (R)
  Manning's n                    0.013
  Material           HDPE
  Freeboard                   .3 ft


             RESULTS:

  Depth                          0.59 ft
     with Freeboard              0.89 ft
  Top Width                      1.76 ft
     with Freeboard              2.66 ft
  Velocity                      14.15 fps
  Cross Sectional Area           0.52 sq ft
  Hydraulic Radius               0.24 ft
  Froude Number                  4.61
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------


          DITCH 8 LOWER

          INPUT VALUES:

  Shape                 TRIANGULAR
  Discharge                19.30 cfs
  Slope                     1.00 %
  Sideslopes             1.50:1 (L)    1.50:1 (R)
  Manning's n               0.013
  Material          HDPE
  Freeboard              .3 ft


             RESULTS:

  Depth                     1.30 ft
     with Freeboard         1.60 ft
  Top Width                 3.90 ft
     with Freeboard         4.80 ft
  Velocity                  7.61 fps
  Cross Sectional Area      2.54 sq ft
  Hydraulic Radius          0.54 ft
  Froude Number             1.66
```

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------

          DITCH 8 UPPER

          INPUT VALUES:

  Shape                 TRIANGULAR
  Discharge                19.30 cfs
  Slope                    10.00 %
  Sideslopes             1.50:1 (L)    1.50:1 (R)
  Manning's n               0.013
  Material         HDPE
  Freeboard              .3 ft

             RESULTS:

  Depth                     0.84 ft
     with Freeboard         1.14 ft
  Top Width                 2.53 ft
     with Freeboard         3.43 ft
  Velocity                 18.04 fps
  Cross Sectional Area      1.07 sq ft
  Hydraulic Radius          0.35 ft
  Froude Number             4.89
```

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
16.00	3.0:1	3.0:1	0.8			

PADER Method - Mild Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	272.80 cfs	
Depth:	2.20 ft	
Top Width:	29.18 ft	
Velocity:	5.50 fps	
X-Section Area:	49.64 sq ft	
Hydraulic Radius:	1.660	
Froude Number:	0.74	
Manning's n:	0.0340	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

EAST
CHANNEL

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
16.00	3.0:1	3.0:1	0.5			

PADER Method - Mild Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	272.80 cfs	
Depth:	2.49 ft	
Top Width:	30.96 ft	
Velocity:	4.66 fps	
X-Section Area:	58.56 sq ft	
Hydraulic Radius:	1.843	
Froude Number:	0.60	
Manning's n:	0.0340	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

```
SEDCAD+ NONERODIBLE CHANNEL DESIGN
----------------------------------


   FINAL COVER ROAD SIDE DITCH

          INPUT VALUES:

  Shape                     TRIANGULAR
  Discharge                    31.50 cfs
  Slope                         0.50 %
  Sideslopes                 3.00:1 (L)    3.00:1 (R)
  Manning's n                   0.030
  Material             GRAVEL
  Freeboard                  .3 ft


             RESULTS:

  Depth                         1.82 ft
     with Freeboard             2.12 ft
  Top Width                    10.90 ft
     with Freeboard            12.70 ft
  Velocity                      3.18 fps
  Cross Sectional Area          9.90 sq ft
  Hydraulic Radius              0.86 ft
  Froude Number                 0.59
```

Material: Riprap

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	2.4			

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	31.50 cfs	
Depth:	1.45 ft	
Top Width:	8.70 ft	
Velocity:	5.00 fps	
X-Section Area:	6.31 sq ft	
Hydraulic Radius:	0.688	
Froude Number:	1.03	
Manning's n:	0.0360	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
20.00	3.0:1	3.0:1	0.5			

PADER Method - Mild Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	358.00 cfs	
Depth:	2.62 ft	
Top Width:	35.71 ft	
Velocity:	4.91 fps	
X-Section Area:	72.91 sq ft	
Hydraulic Radius:	1.995	
Froude Number:	0.61	
Manning's n:	0.0340	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Triassic Park

Evaporation Pond
Diversion Ditch Design

Jorge C. Troncoso

Montgomery Watson Americas, Inc.
165 S. Union Blvd.
Suite 410
Lakewood, CO 80228

Phone: (303) 763-5140
Email: jorge.t.troncoso@mw.com

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	25 yr - 24 hr
Rainfall Depth:	4.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Diversion Ditch

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	35.700	35.700	90.44	7.32

Structure Detail:

Structure #1 (Null)

Diversion Ditch

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)
#1	1	35.700	0.373	0.000	0.000	82.000	TR55	90.44	7.323
	Σ	**35.700**						**90.44**	**7.323**

Subwatershed Time of Concentration Details:

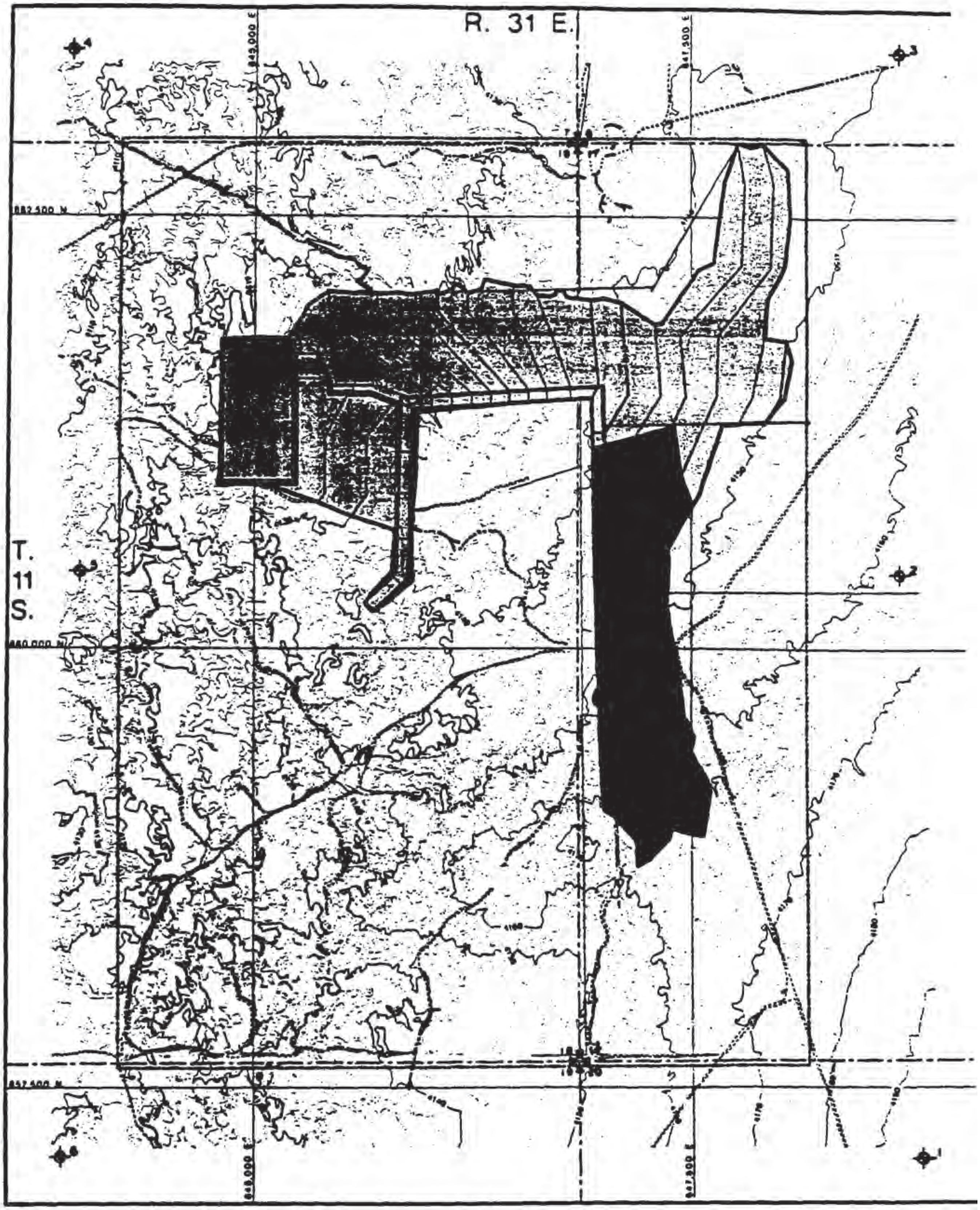
Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	7. Paved area and small upland gullies	1.25	26.00	2,080.00	2.250	0.256
		7. Paved area and small upland gullies	0.50	3.00	600.00	1.420	0.117
#1	**1**	**Time of Concentration:**					**0.373**

Material: Stiff clay very colloidal

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.00	3.0:1	3.0:1	0.5	0.0250				3.8

	w/o Freeboard	w/ Freeboard
Design Discharge:	90.44 cfs	
Depth:	2.07 ft	
Top Width:	15.45 ft	
Velocity:	4.73 fps	
X-Section Area:	19.14 sq ft	
Hydraulic Radius:	1.187	
Froude Number:	0.75	


R. 31 E.
T. 11 S.
4
3
2
5
6
1
7
8
18
17
18
17
19
20
882,500 N
880,000 N
647,500 E

ATTACHMENT 3
APRON DESIGN

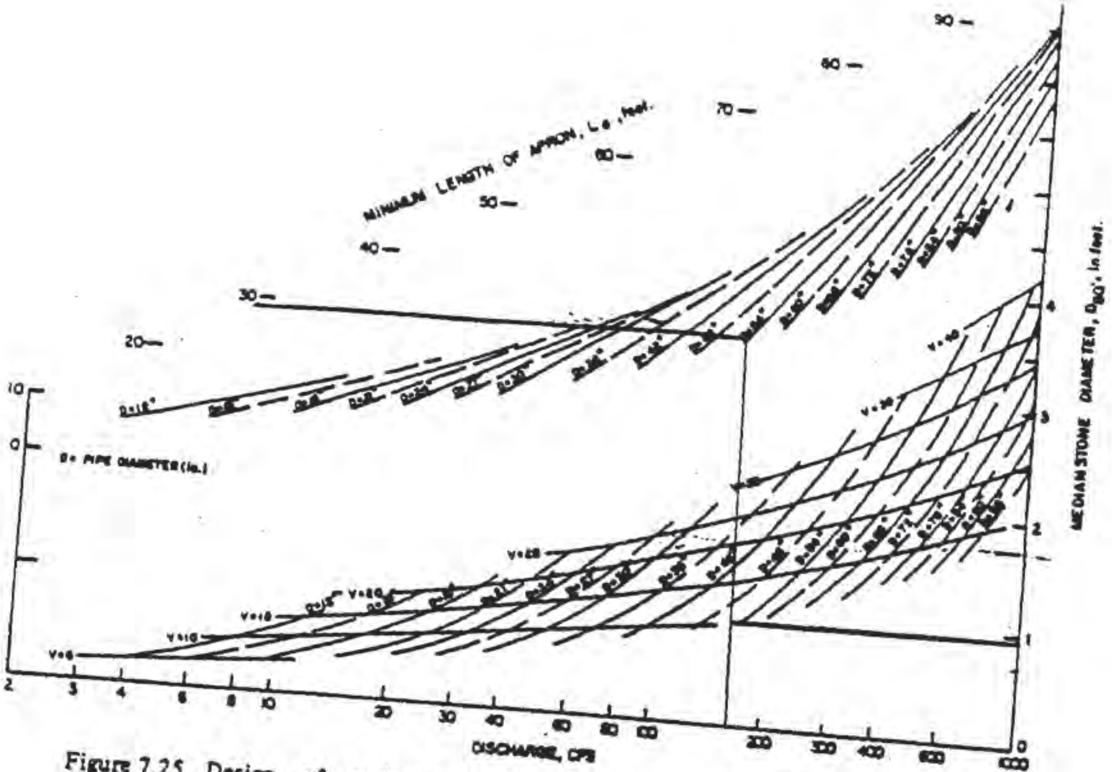


Figure 7.25. Design of outlet protection - minimum tailwater condition, $T_w < 0.5D$. (U.S. EPA, 1976)

Apron Calculation East Ditch

Flow 272 cfs (136 cfs per culvert)

Culverts 2 - 54 "φ

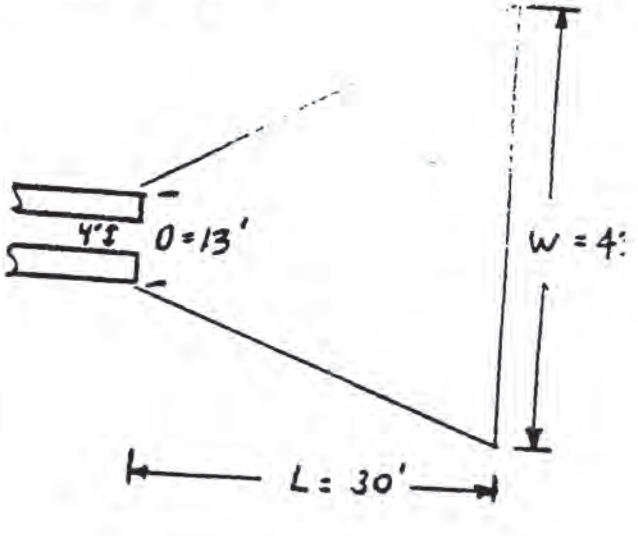
D_{50} = 1'

Apron Length L = 30'

Apron Width = W = D + L

= 13 + 30

= 43'



FROM BARFIELD ET AL. (1981)

ATTACHMENT 4
CULVERT DESIGNS

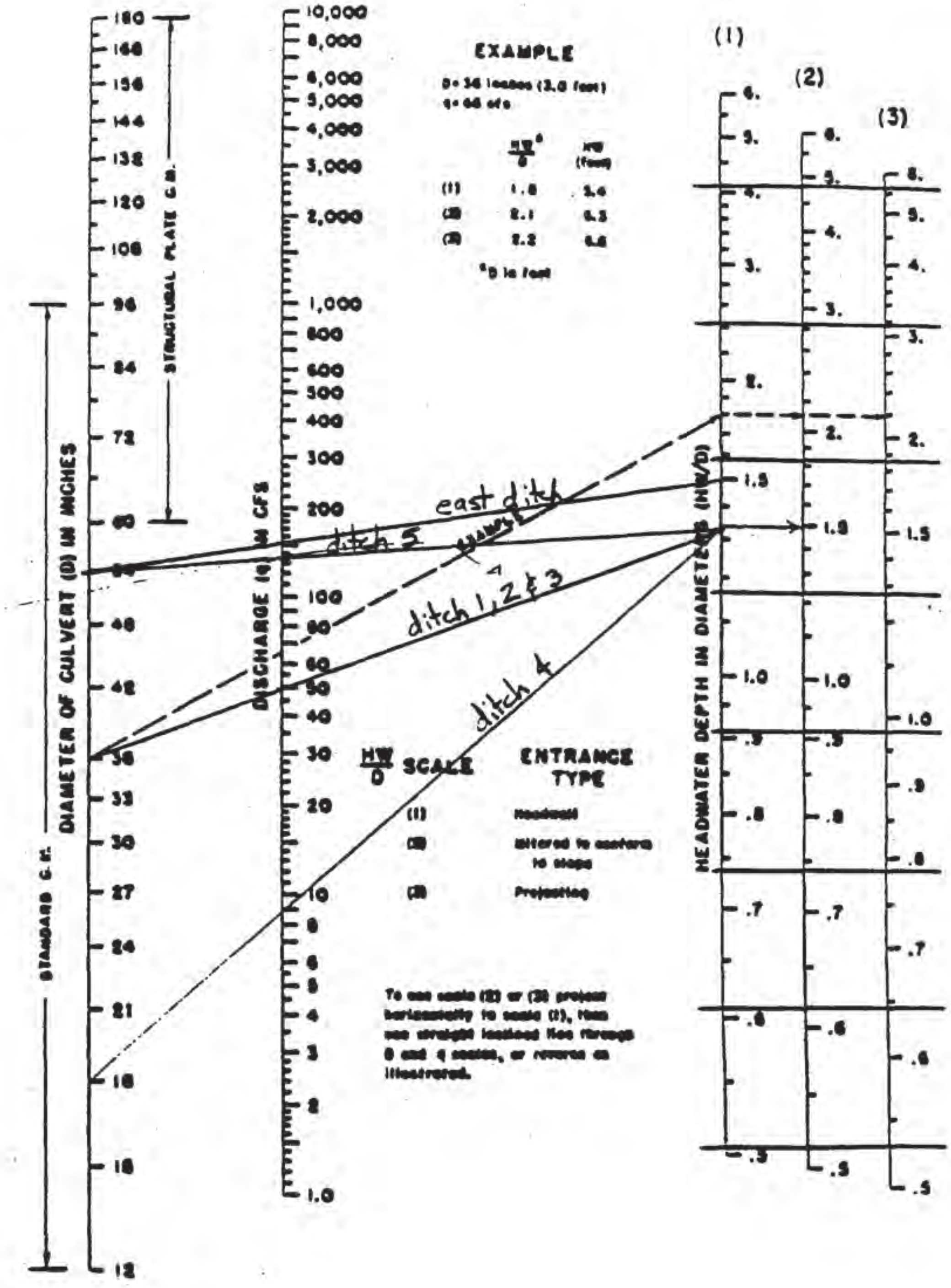
CULVERT SUMMARY

Project: Triassic Park Landfill
Project Number: 602
Prepared by: D. Gleason

Channel	Flow Q (cfs)	Culvert Capacity (cfs)	No. of Culverts (1)	Culvert Dia. (in.)	Total Capacity (cfs)
East Ditch	272.8	155	2	54	310
Ditch 1 and 2	96.4	50	2	36	100
Ditch 3	126.6	50	3	36	150
Ditch 4	6.8	9	1	18	9
Ditch 5	217.3	135	2	54	270

Note:
(1) Represents the number of culverts needed at each road crossing.

Ditch 8	19.3	50	1	36	50
Ditch 9 and 10	90.4	50	2	36	100



BUREAU OF PUBLIC ROADS JAN. 1963

Exhibit 14-9. Headwater depth for C. M. pipe culverts with inlet control.

ATTACHMENT 5
POND STAGE STORAGE TABLES

Facilities Retention Basin

Elev.	Area	Area	Avg.Area	Depth	Volume	Cul. Vol.
4106	254327	5.8385				
4108	267492	6.1408	5.9897	2	11.9793	11.9793
4110	280944	6.4496	6.2952	2	12.5904	24.5697
4112	294685	6.7650	6.6073	2	13.2146	37.7843
4114	308713	7.0871	6.9261	2	13.8521	51.6364
4116	323030	7.4157	7.2514	2	14.5028	66.1392

Phase 1 Liner Basin

Elev.	Area	Area	Avg.Area	Depth	Volume	Cul. Vol.
4050	7000	0.1607				
4052	31400	0.7208	0.4408	2	0.8815	0.8815
4054	59500	1.3659	1.0434	2	2.0868	2.9683
4056	83300	1.9123	1.6391	2	3.2782	6.2466
4058	96096	2.2061	2.0592	2	4.1184	10.3649
4060	106300	2.4403	2.3232	2	4.6464	15.0113

Collection Basin

Elev.	Area	Area	Avg.Area	Depth	Volume	Cul. Vol.
4050	125	0.0029				
4052	13787	0.3165	0.1597	2	0.3194	0.3194
4054	27405	0.6291	0.4728	2	0.9456	1.2650
4056	42342	0.9720	0.8006	2	1.6012	2.8662
4058	58600	1.3453	1.1587	2	2.3173	5.1835
4060	69100	1.5863	1.4658	2	2.9316	8.1151

MONTGOMERY WATSON

Calculation Cover Sheet Appendix F1

Project Title: Triassic Park Waste Disposal Facility

Project No.: 602-0200

Calculation Title: Sediment Demonstration

	Name	Date
Prepared By:	Dan Gleason	11/15/97
Checked By:	Tom Leidich	11/15/97
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

SOIL LOSS CALCULATIONS FOR TRIASSIC PARK LANDFILL COVER

1.0 EROSION CALCULATIONS

In order to evaluate the cover effectiveness for the Triassic Park Landfill an erosion analysis was performed. Calculated gross erosion effects on the existing surface slope were evaluated in comparison to State regulations. The equations and input parameters used to determine the gross annual sediment yield for the Triassic Park Landfill are presented in the following sections.

The Revised Universal Soil Loss Equation (RUSLE) was used to estimate the annual sediment yield (Barfield et al, 1981):

$$Y = R \bullet K \bullet L \bullet S \bullet C \bullet P$$

Where:
Y = Sediment yield (tons per acre-year)
R = Rainfall factor
K = Soil erodibility factor
L = Length factor
S = Slope factor
C = Control factor
P = Practice factor

1.1 AVERAGE ANNUAL RAINFALL FACTOR, R_{annual}

The average annual rainfall factor was obtained for the following equation: $R = 27(P_{2,6})^{2.2}$ (Barfield et al, 1981). A value of 98 was used for the Triassic Park Landfill Cover Analysis.

1.2 SOIL ERODIBILITY FACTOR, K

The soil erodibility factor for the subject site was assumed based on site specific Soil Conservation data. The following soil erodibility factor was used for the Triassic Park Landfill analysis.

TABLE 1
SOIL ERODIBILITY FACTOR

Dominant Soil Type	Soil Texture	Soil Erodibility Factor (K)
Roswell - Faskin- Jalmer Association	Sand to sandy loam	0.30

1.3 LENGTH FACTOR, L

The length factor for the sediment yield equation was determined based on the following equation (Renard et al, 1996):

$$L = \left(\frac{\lambda}{72.6}\right)^m$$

Where:
λ = Representative slope length (ft)
m = Variable slope length exponent

The representative slope length was measured directly from topographic maps of the subject site. The slope length is defined as the distance from the point of origin of overland flow to the point where the slope decreases such that significant deposition occurs or the flow enters a defined channel.

The slope length exponent is related to the ratio β of rill erosion (caused by flow) to interill erosion (principally caused by raindrop impact) by the following equation (Renard et al, 1996):

$$m = \frac{\beta}{(1+\beta)}$$

$$\beta = \frac{\frac{\sin\ \theta}{0.0896}}{(3.0 \bullet (\sin\theta)^{0.8} + 0.56)}$$

Where: $\theta =$ Slope angle

1.4 SLOPE FACTOR, S

The slope factor is representative of the typical slope length found on the subject site and calculated as follows:

$S = 10.8 \bullet \sin(\theta) + 0.03$ for slopes < 9%

$S = 16.8 \bullet \sin(\theta) - 0.50$ for slopes ≥ 9%

Slope angles were determined from topographic maps or from design slope information.

1.5 CONTROL FACTOR, C

The control factor is used to account for vegetative or mulch cover. The following values were utilized:

TABLE 2
CONTROL FACTOR

Surface	Vegetation	Control Factor (C)
Vegetated Conditions	No appreciable canopy, 60 % herbaceous cover	0.042

1.6 PRACTICE FACTOR, P

The practice factor is used to account for soil surface conditions, such as contour furrow ditches. The following values were utilized:

TABLE 3
PRACTICE FACTOR

Surface	Practice	Practice Factor (P)
Vegetated Conditions	None	0.80

2.0 RESULTS

Based on the attached spreadsheet calculations a maximum slop length of 650 feet adequately meets the maximum allowable gross erosion rate of 2 tons per acre-year for 6 % slope and 30 feet.

3.0 REFERENCES

Barfield, Warner, and Haan, 1981. *Applied Hydrology and Sedimentology for Disturbed Areas.* Oklahoma Technical Press, Stillwater, Oklahoma

Renard, K.G., Foster, G.R. Weesies G.A., McCool D.K., Yoder D.C., coordinators, 1996. *Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal soil Loss Equation (RUSLE).* Agriculture Handbook No. 703. U.S. Department of Agriculture

CALCULATED SEDIMENTOLOGY DATA

FINAL COVER

SOIL ERODIBILITY FACTOR:

Soil Type	Soil Group	Erodibility Factor, K
Final Cover	B	0.3

SLOPE FACTOR:

Length (ft)	Elevation Change (ft)	Slope (%)	m	Slope Angle (deg)	LS Factor
30	7.5	25.0%	0.6	14.0	2.10

The LS Factor was calculated by:

LS = (Slope Length/72.6)^m(10.8*sin(slope angle) + 0.03) for Slopes < 9%*

LS = (Slope Length/72.6)^m(16.8*sin(slope angle) - 0.5) for Slopes > or = 9%*

Where:

Slope < or = 3%	*m = 0.3*
Slope = 4%	*m = 0.4*
5% > Slope < 10%	*m = 0.5*
Slope > 10%	*m = 0.6*

COVER AND PRACTICE FACTORS:

Cover Type	Cover (%)	Canopy (%)	Control Factor, C	Practice Factor, P
Final Cover	60%	0%	0.042	0.80

RAINFALL FACTOR:

R = 98

TRIASSIC PARK LANDFILL
CALCULATED SEDIMENT YIELD

The following spreadsheet calculates the predicted sediment yield for the project area. The gross sediment yield is determined according to the Revised Universal Soil Loss Equation.

PARAMETER DESCRIPTION	VALUE	
Annual Rainfall Factor	98.00	
Soil Erodibility Factor	0.30	
Length Slope Factor	2.10	
Control Factor	0.04	
Practice Factor	0.80	
Gross Annual Sediment Yield	2.08	tons/acre/year
Sediment Density	94.00	pcf
Gross Annual Sediment Yield	0.0010	acre-feet/acre/year
Sediment Delivery Ratio	90%	
Estimated Annual Sediment Yield	0.0009	acre-feet/acre/year
Watershed Area	0	acres
Watershed Annual Sediment Yield	0.0000	acre-feet/year
Number of years	1	years
Required Pond Sediment Storage	0.000	acre-feet

TRIASSIC PARK LANDFILL
CALCULATED SEDIMENTOLOGY DATA

FINAL COVER

SOIL ERODIBILITY FACTOR:

Soil Type	Soil Group	Erodibility Factor, K
Final Cover	B	0.3

SLOPE FACTOR:

Length (ft)	Elevation Change (ft)	Slope (%)	m	Slope Angle (deg)	LS Factor
650	39	6.0%	0.5	3.4	2.03

The LS Factor was calculated by:

LS = (Slope Length/72.6)^m(10.8*sin(slope angle) + 0.03) for Slopes < 9%*

LS = (Slope Length/72.6)^m(16.8*sin(slope angle) - 0.5) for Slopes > or = 9%*

Where:

Slope < or = 3%	*m = 0.3*
Slope = 4%	*m = 0.4*
5% > Slope < 10%	*m = 0.5*
Slope > 10%	*m = 0.6*

COVER AND PRACTICE FACTORS:

Cover Type	Cover (%)	Canopy (%)	Control Factor, C	Practice Factor, P
Final Cover	60%	0%	0.042	0.80

RAINFALL FACTOR: R = 98

CALCULATED SEDIMENT YIELD

The following spreadsheet calculates the predicted sediment yield for the project area. The gross sediment yield is determined according to the Revised Universal Soil Loss Equation.

PARAMETER DESCRIPTION	VALUE	
Annual Rainfall Factor	98.00	
Soil Erodibility Factor	0.30	
Length Slope Factor	2.03	
Control Factor	0.04	
Practice Factor	0.80	
Gross Annual Sediment Yield	2.00	tons/acre/year
Sediment Density	94.00	pcf
Gross Annual Sediment Yield	0.0010	acre-feet/acre/year
Sediment Delivery Ratio	90%	
Estimated Annual Sediment Yield	0.0009	acre-feet/acre/year
Watershed Area	0	acres
Watershed Annual Sediment Yield	0.0000	acre-feet/year
Number of years	1	years
Required Pond Sediment Storage	0.000	acre-feet

MONTGOMERY WATSON

Calculation Cover Sheet Appendix F-3

Project Title: Triassic Park Waste Disposal Facility

Project No.: 1342602

Calculation Title: Calculate Flood Plain

	Name	Date
Prepared By:	Jorge Troncoso	9/11/99
Checked By:		
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

MONTGOMERY WATSON
Mining Group

Project Name: TRIASSIC PARK HAZARDOUS WASTE [illegible]
Project Number: 1342602.021.0200
Sheet: 1 of
Prepared By: JCT
Date: 10/11/99
Checked By:
Date:

PURPOSE: CALCULATE FLOOD AREA

METHOD: RATIONAL METHOD TO CALCULATE PEAK FLOW AND MANNING EQUATION TO CALCULATE INUNDATED AREA.

ASSUMPTIONS: USE CONSERVATIVE VALUES.

* RATIONAL EQUATION: $q_p = C \cdot i \cdot A \cdot 1.008$

A: MEASURED FROM ATTACHED MAP = 1937.6 acres.
$C = 1$ (MAXIMUM RUN-OFF)
i: RAINFALL INTENSITY = 5.3 in in 24 HR $\Rightarrow i = 0.22$

$\Rightarrow q_p = 1.008 \cdot 1 \; 0.22 \cdot 1937.6$
$= 429.7$ cfs.

DIFFERENCE IN ELEVATION: 4500 TO 4150
LENGTH OF DRAINAGE: 10500 ft.

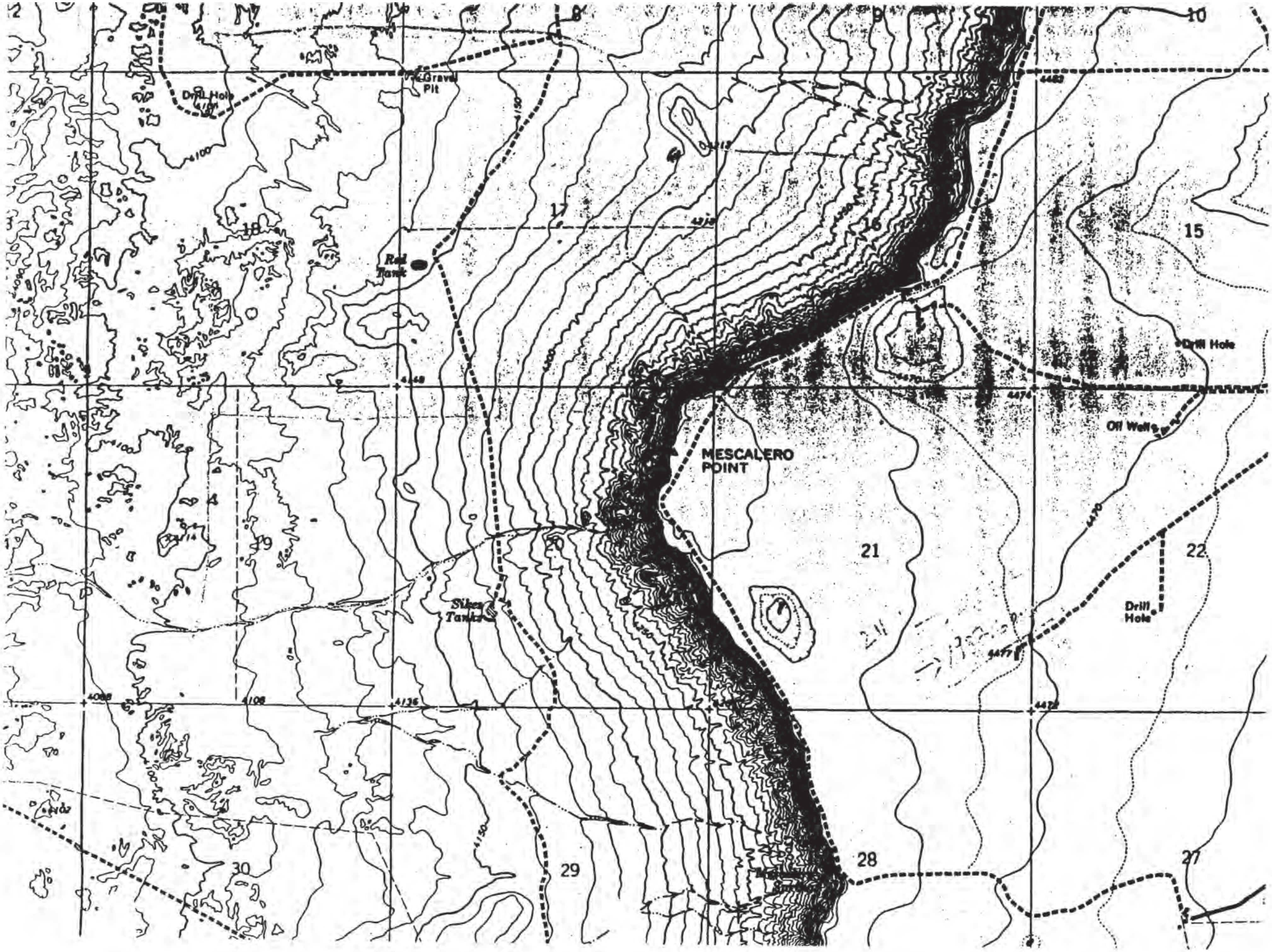
MINIMUM SLOPE = 0.03 → WIDTH = 119 ft.

FOR: C = 0.3 (FLAT PASTURE, CLAY AND SILT LOAM)

q_p = 128.9 cfs. ⇒ WIDTH = 75.8 ft. → NO FLOOD PLAIN.

FLOOD MAY BE CONTROLLED BY 2FT DITCH.

REFERENCE: HAAN ET AL 1994. DESIGN HYDROLOGY AND SEDIMENTOLOGY FOR SMALL CATCHMENTS, ACADEMIC PRESS, CALIFORNIA


MESCALERO POINT
Red Tank
Gravel Pit
Drill Hole
Sikes Tanks
Oil Wells
Drill Hole
Drill Hole
4100
4150
4200
4250
4470
4448
4477
4474
4482
4478
4068
4106
4136
2
7
8
9
10
17
16
15
18
19
20
21
22
30
29
28
27

Flood Plain
Worksheet for Triangular Channel

Project Description	
Project File	c:\flood pl.fm2
Worksheet	Gandy Flood Plain
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.030000	ft/ft
Left Side Slope	33.000000	H : V
Right Side Slope	33.000000	H : V
Discharge	429.70	cfs

Results		
Depth	1.80	ft
Flow Area	107.35	ft²
Wetted Perimeter	119.09	ft
Top Width	119.04	ft
Critical Depth	1.60	ft
Critical Slope	0.056526	ft/ft
Velocity	4.00	ft/s
Velocity Head	0.25	ft
Specific Energy	2.05	ft
Froude Number	0.74	
Flow is subcritical.		

Flood Plain
Worksheet for Triangular Channel

Project Description	
Project File	c:\flood pl.fm2
Worksheet	Gandy Flood Plain
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.030000	ft/ft
Left Side Slope	33.000000	H : V
Right Side Slope	33.000000	H : V
Discharge	128.90	cfs

Results		
Depth	1.15	ft
Flow Area	43.51	ft²
Wetted Perimeter	75.82	ft
Top Width	75.79	ft
Critical Depth	0.99	ft
Critical Slope	0.066366	ft/ft
Velocity	2.96	ft/s
Velocity Head	0.14	ft
Specific Energy	1.28	ft
Froude Number	0.69	
Flow is subcritical.		

Flood Plain
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\flood pl.fm2
Worksheet	Flood Plain
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.005000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	16.00	ft
Discharge	128.90	cfs

Results		
Depth	2.26	ft
Flow Area	51.63	ft²
Wetted Perimeter	30.32	ft
Top Width	29.59	ft
Critical Depth	1.17	ft
Critical Slope	0.053768	ft/ft
Velocity	2.50	ft/s
Velocity Head	0.10	ft
Specific Energy	2.36	ft
Froude Number	0.33	
Flow is subcritical.		

Attachment DD

Manufacturer Information

MONTGOMERY WATSON

Calculation Cover Sheet Appendix H-1

Project Title: Triassic Park Waste Disposal Facility

Project No.: 1342602

Calculation Title: Performance Curves of Grundfos Pumps

	Name	Date
Prepared By:	Jorge Troncoso	8/25/99
Checked By:		
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

SUN-BELT
Pump & Supply, Inc.

FAX COVER SHEET

SUN-BELT PUMP & SUPPLY, INC.
3710 SANBORN
BOX 30577
AMARILLO, TEXAS 79107
USA
Phone number 806/381-1199
Fax number 806/381-1202

SEND TO	
Montgomery Watson	**From** Steve Gray
Attention Jorge Troncosa	**Date** 10-26-99
Office location	**Office location** AMARILLO www.sunbeltpump.com
Fax number	**Phone number** email: sunbelt@arn.net

☐ Urgent ☐ Reply ASAP ☐ Please comment ☑ Please review ☐ For your information

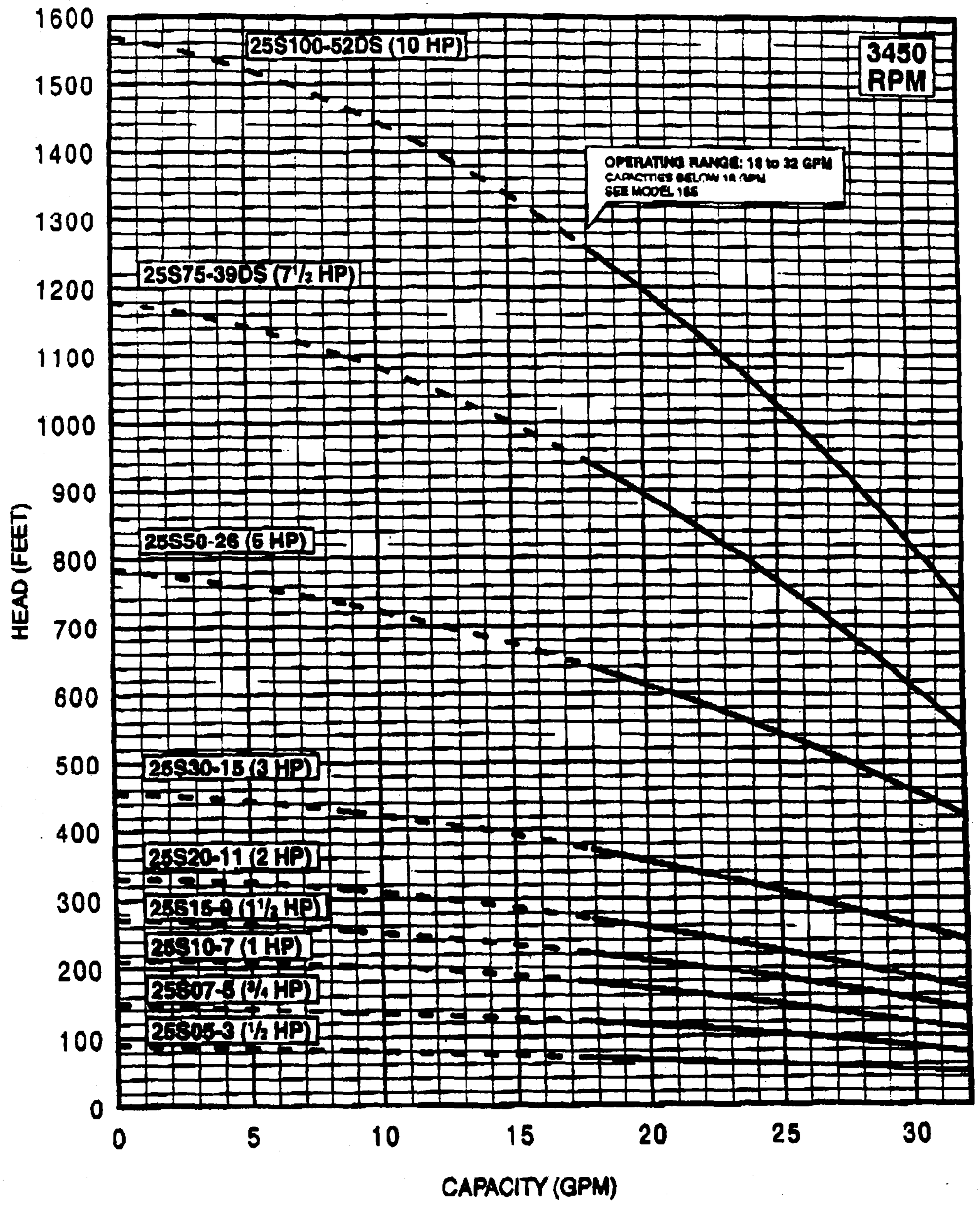
Total pages, including cover: 5

COMMENTS

Any Question please call

Performance Curves 25 GPM Model 25S

FLOW RANGE: 18 -32 GPM **OUTLET SIZE: 1½ " NPT** **NOMINAL DIA. 4"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, .5-5 HP/3450 RPM.
6" MOTOR STANDARD,7.5-10HP/3450 RPM.
Alternate motor sizes available.

Performance conforms to ISO 2548 Annex B
@ 2 ft. min. submergence.

Model 25S 25 GPM Technical Data

DIMENSIONS AND WEIGHTS

MODEL NO.	FIG.	HP	MOTOR SIZE	DISCH. SIZE	DIMENSIONS IN INCHES A	B	C	D	E	APPROX. SHIP WT.
25S05-3	A	1/2	4"	1 1/2" NPT	18.1	9.5	8.6	3.8	3.9	26
25S07-5	A	3/4	4"	1 1/2" NPT	20.9	10.7	10.2	3.8	3.9	28
25S10-7	A	1	4"	1 1/2" NPT	23.7	11.8	11.9	3.8	3.9	29
25S15-9	A	1 1/2	4"	1 1/2" NPT	27.1	13.6	13.5	3.8	3.9	34
25S20-11	A	2	4"	1 1/2" NPT	30.3	15.1	15.2	3.8	3.9	37
25S30-15	A	3	4"	1 1/2" NPT	39.1	20.6	18.5	3.8	3.9	59
25S50-26	A	5	4"	1 1/2" NPT	51.2	23.6	27.6	3.8	3.9	76
25S75-39DS	A	7 1/2	6"	1 1/2" NPT	66.8	24.2	42.6	5.4	4.6	168
25S100-52DS*	B	10	6"	1 1/2" NPT	90.9	25.4	65.5	5.4	5.4	228

NOTES: All models suitable for use in 4" wells, unless otherwise noted.
Weights include pump end with motor in lbs.
* Built into sleeve 1½" NPT discharge, 6" min. well dia.

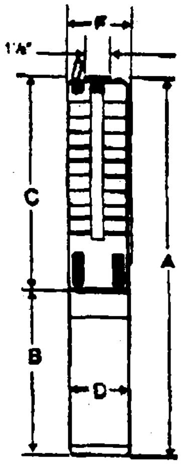


Fig. A

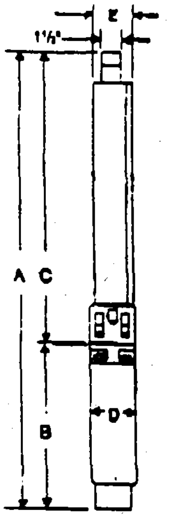


Fig. B

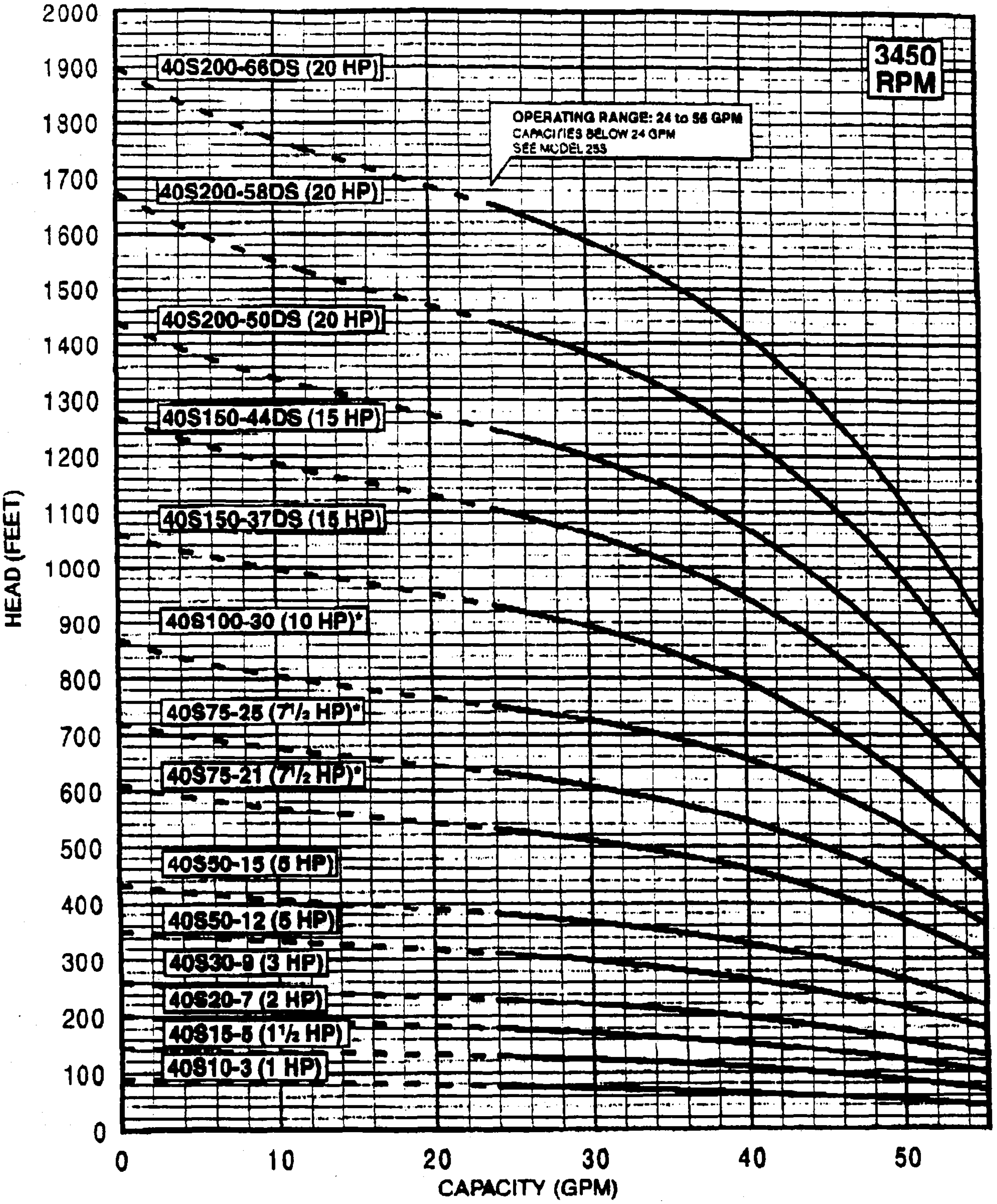
MATERIALS OF CONSTRUCTION

COMPONENT	SPLINED SHAFT (3-26 Stgs.)	CYLINDRICAL SHAFT (39 Stgs.)	DEEP SET (52 Stgs)
Check Valve Housing	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Check Valve	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Impeller	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Suction Interconnector	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Inlet Screen	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Pump Shaft	304 Stainless Steel	431 Stainless Steel	431 Stainless Steel
Straps	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Cable Guard	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Priming Inducer	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Coupling	316/431 Stainless Steel	316/431 Stainless Steel	329/416 Stainless Steel**
Check Valve Seat	NBR/304 Stainless Steel	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Top Bearing	NBR	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Impeller Seal Ring	NBR/PBT (Valox®)	NBR/PPS (Ryton®)	NBR/PPS (Ryton®)
Intermediate Bearings	NBR	304 Stainless Steel	NBR/316 Stainless Steel
Shaft Washer	Not Required	LCP (Vectra®)	LCP (Vectra®)
Split Cone	Not Required	304 Stainless Steel	304 Stainless Steel
Split Cone Nut	Not Required	316 Stainless Steel	304 Stainless Steel
Sleeve	Not Required	Not Required	316 Stainless Steel
Sleeve Flange	Not Required	Not Required	304 Stainless Steel
Coupling Key	Not Required	Not Required	302/304 Stainless Steel**

NOTES: Specifications are subject to change without notice.
Valox ® is a registered trademark of General Electric Co.
Vectra ® is a registered trademark of Hoechast Calanese Corporation.
Ryton ® is a registered trademark of Phillips 66.
** If using 4" non-standard motors, refer to 329/420/431 Stainless Steel for coupling.
A coupling key is not required.

Performance Curves 40 GPM Model 40S

FLOW RANGE: 24 - 55 GPM **OUTLET SIZE: 2 " NPT** **NOMINAL DIA. 4"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, 1-10 HP/3450 RPM.
6" MOTOR STANDARD,15-20 HP/3450 RPM.
* Also available with 6" motor.

Performance conforms to ISO 2548 Annex B
@ 5 ft. min. submergence.

GRUNDFOS

Model 40S 40 GPM Technical Data

DIMENSIONS AND WEIGHTS

MODEL NO.	FIG.	HP	MOTOR SIZE	DISCH. SIZE	DIMENSIONS IN INCHES A	B	C	D	E	APPROX. SHIP WT.
40S10-3	A	1	4"	2" NPT	24.0	11.8	12.8	3.8	3.9	32
40S15-5	A	1 1/2	4"	2" NPT	29.7	13.6	16.1	3.8	3.9	37
40S20-7	A	2	4"	2" NPT	34.5	15.1	19.4	3.8	3.9	41
40S30-9	A	3	4"	2" NPT	43.3	20.6	22.7	3.8	3.9	65
40S50-12	A	5	4"	2" NPT	51.3	23.6	27.7	3.8	3.9	78
40S50-15	A	5	4"	2" NPT	56.2	23.6	32.6	3.8	3.9	84
40S75-21*	A	7 1/2	4"	2" NPT	74.6	29.6	45.0	3.8	5.4	120
40S75-25*	A	7 1/2	4"	2" NPT	81.2	29.6	51.6	3.8	5.4	124
40S100-30*	A	10	4"	2" NPT	103.7	43.9	59.8	3.8	5.4	181
40S150-37DS	A	15	6"	2" NPT	99.5	28.0	71.5	5.4	5.4	244
40S150-44DS	A	15	6"	2" NPT	111.0	28.0	83.0	5.4	5.4	340
40S200-50DS**	B	20	6"	2" NPT	136.0	30.6	105.4	5.4	5.5	319
40S200-58DS**	B	20	6"	2" NPT	149.2	30.6	118.8	5.4	5.5	334
40S200-68DS**	B	20	6"	2" NPT	162.4	30.6	131.8	5.4	5.5	394

NOTES: All models suitable for use in 4" wells, unless otherwise noted.
Weights include pump end with motor in lbs.
* Also available with 6" motor.
** Built into sleeve 2" NPT discharge, 6" min. well dia.

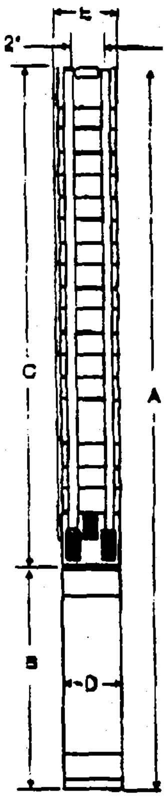


Fig. A

MATERIALS OF CONSTRUCTION

COMPONENT	CYLINDRICAL SHAFT (3-44 Stgs.)	DEEP SET (50-68 Stgs.)
Check Valve Housing	304 Stainless Steel	304 Stainless Steel
Check Valve	304 Stainless Steel	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel	304 Stainless Steel
Impeller	304 Stainless Steel	304 Stainless Steel
Suction Interconnector	304 Stainless Steel	304 Stainless Steel
Inlet Screen	304 Stainless Steel	304 Stainless Steel
Pump Shaft	431 Stainless Steel	431 Stainless Steel
Straps	304 Stainless Steel	304 Stainless Steel
Cable Guard	304 Stainless Steel	304 Stainless Steel
Priming Inducer	304 Stainless Steel	304 Stainless Steel
Coupling	316/431 Stainless Steel **	329/ 416 Stainless Steel
Check Valve Seat	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Top Bearing	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Impeller Seal Ring	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Intermediate Bearings	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Shaft Washer	LCP (Vectra®)	LCP (Vectra®)
Split Cone	304 Stainless Steel	304 Stainless Steel
Split Cone Nut	304 Stainless Steel	304 Stainless Steel
Sleeve	Not Required	316 Stainless Steel
Sleeve Flange	Not Required	304 Stainless Steel
Coupling Key	Not Required **	302/304 Stainless Steel

NOTES: Specifications are subject to change without notice.
Vectra ® is a registered trademark of Hoechst Calanese Corporation.
** If using 6" non-standard motors, refer to 416 Stainless Steel for coupling and 302/304 for the coupling key.

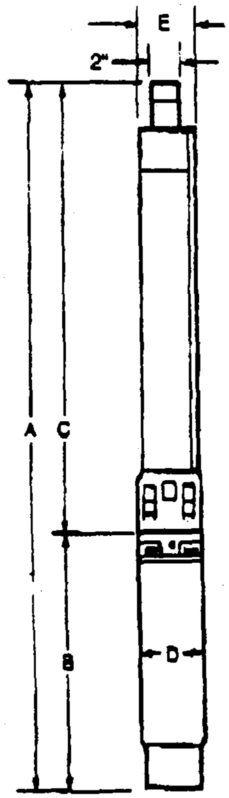


Fig. B

MONTGOMERY WATSON

Calculation Cover Sheet Appendix H-2

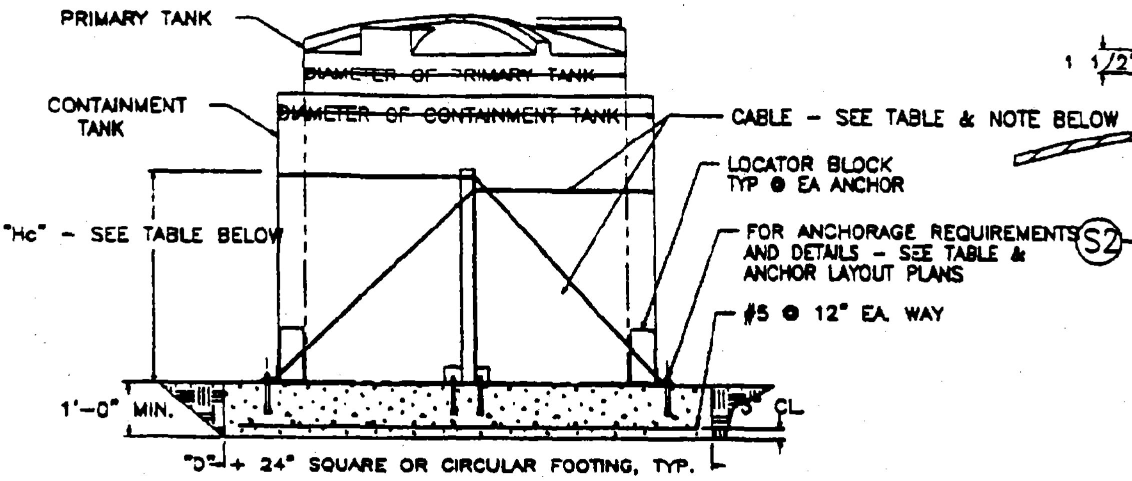
Project Title: Triassic Park Waste Disposal Facility

Project No.: 1342602

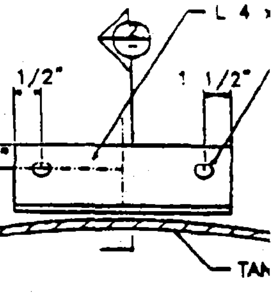
Calculation Title: Calculation of Tie-Ins for Polyethylene Tanks

	Name	Date
Prepared By:	Jorge Troncoso	8/25/99
Checked By:		
Reviewed By:		

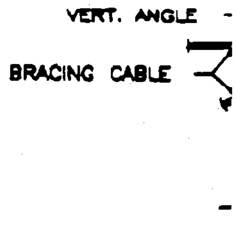
Revisions	Date	By	Checked By	Reviewed By



① ELEVATION



(S2) ANCHOR TYPE S2



④ ELEVAT

TANK DATA						ANCHORAGE REQUIREMENTS		
PRIMARY MODEL NO.	CONTAINMENT MODEL NO.	CAPACITY (GALS.)	DIAMETER	HEIGHT	WEIGHT (LBS.)	ANCHOR LAYOUT	CABLE Hc	CABLE DIAMETER

GENERAL NOTES

1. TANK RESTRAINT ANCHORAGES, CABLES DESIGNED FOR SEISMIC AND WIND FORCES PER THE UNIFORM BUILDING CODE.

2. TANK FOUNDATION PAD DESIGN REQUIRES AN ALLOWABLE BEARING PRESSURE OF 1500 POUNDS PER SQUARE FOOT (PSF). OWNER TO RETAIN GEOTECHNICAL ENGINEER TO VERIFY.

3. MATERIALS SHALL CONFORM TO THE REQUIREMENTS OF THE UBC AND THE FOLLOWING CRITERIA:

   STRUCTURAL STEEL: ASTM A36

   CONCRETE: COMPRESSIVE STRENGTH (f'c) = 2500 PSI, MAX. SLUMP = 4 INCHES

   REINFORCEMENT: ASTM A615. YIELD STRENGTH (Fy) = 40,000 PSI

   ANCHORS: HILTI "KWIK-BOLT" OR WEJ-IT "ANKR-TITE". INSTALL PER MANUFACTURER'S INSTRUCTIONS AND RECOMMENDATIONS.

   CABLE: 7x19 STAINLESS STEEL CABLE. MINIMUM BREAKING STRENGTHS FOR THE CABLE LISTED SHALL BE CERTIFIED BY THE MANUFACTURER TO MEET THE CRITERIA BELOW.

   3/16" DIAMETER = 3,700 LBS.
   1/4" DIAMETER = 6,400 LBS.
   5/16" DIAMETER = 9,000 LBS.
   3/8" DIAMETER = 13,000 LBS.
   7/16" DIAMETER = 17,000 LBS.

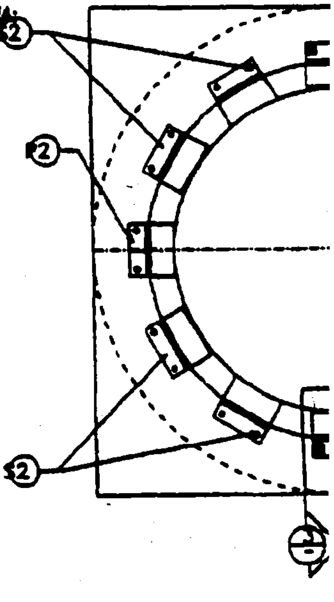
   INSTALLED CABLE SHALL BE PULLED 1/8" PAST SNUG PRIOR TO ANCHORING.

4. FINISH REQUIREMENTS FOR ALL STEEL SHAPES, BOLTS, NUTS, WASHERS, CABLE AND ASSOCIATED HARDWARES SHALL BE PROVIDED BY THE CUSTOMER.

5. REMOVE ALL SHARP EDGES THAT MAY DAMAGE OR CAUSE WEAR TO CABLES.

6. ALL GALLONAGES AND DIMENSIONS ARE NOMINAL.

7. WHERE TANK IS INSTALLED SUCH THAT IT WILL NOT BE EXPOSED TO WIND FORCES (i.e., CONTAINED WITHIN A CLOSED STRUCTURE), THE CABLE BRACING AND ASSOCIATED HARDWARE MAY BE DELETED. IN SUCH CASES, SUBSTITUTE TYPE 'S1' ANCHORS FOR ALL TYPE 'T1' AND 'P1' ANCHORS SHOWN IN LAYOUT PLANS.



Ⓓ ANCH

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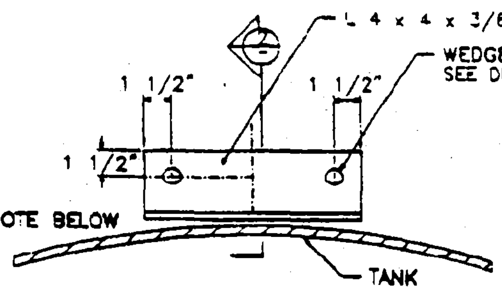
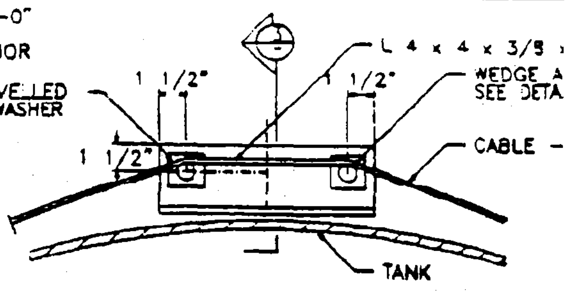
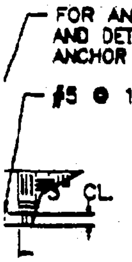


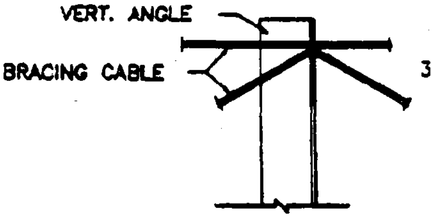
S2 ANCHOR TYPE S2



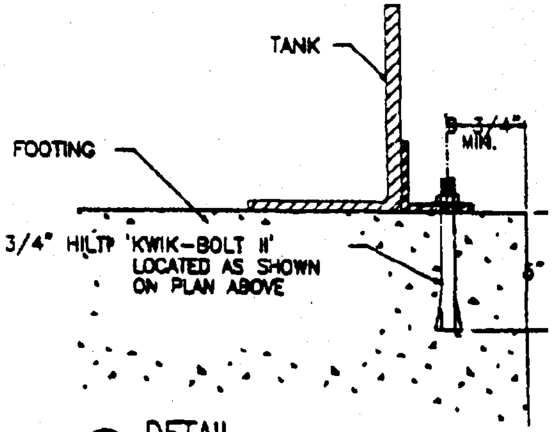
T2 ANCHOR TYPE T2



	ANCHORAGE REQUIREMENTS		
WEIGHT (LBS.)	ANCHOR LAYOUT	CABLE	
		Hc	DIAMETER



4 ELEVATION



2 DETAIL

SEISMIC AND WIND

BEARING PRESSURE
O RETAIN GEOTECHNICAL

THE UBC AND THE FOLLOWING CRITERIA:

PSI, MAX. SLUMP = 4 INCHES

) = 40,000 PSI

E". INSTALL PER

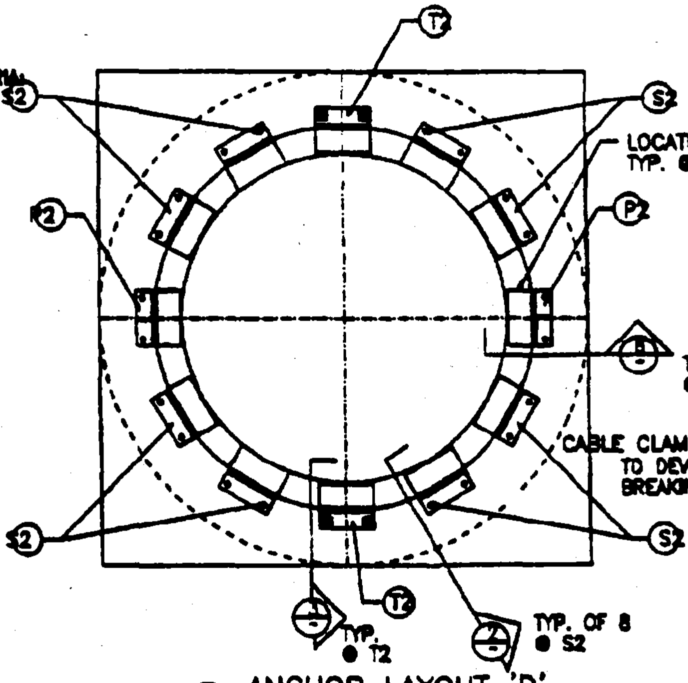
REAKING STRENGTHS FOR THE CABLE
CTURER TO

AST SNUG PRIOR TO ANCHORING.

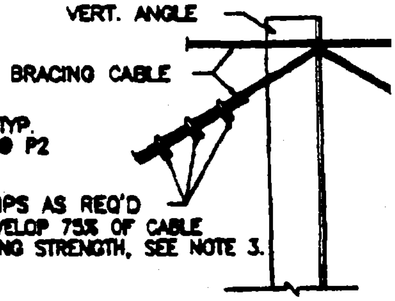
NUTS, WASHERS, CABLE
THE CUSTOMER.

SE WEAR TO CABLES.

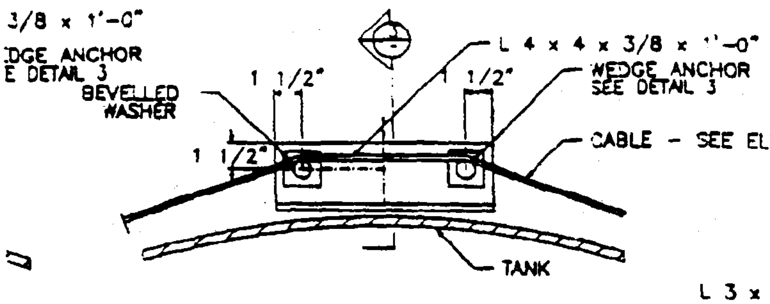
EXPOSED TO WIND FORCES (I.e., CONTAINED WITHIN
ICATED HARDWARE MAY BE DELETED. IN SUCH
'T1' AND 'P1' ANCHORS SHOWN IN LAYOUT PLANS.



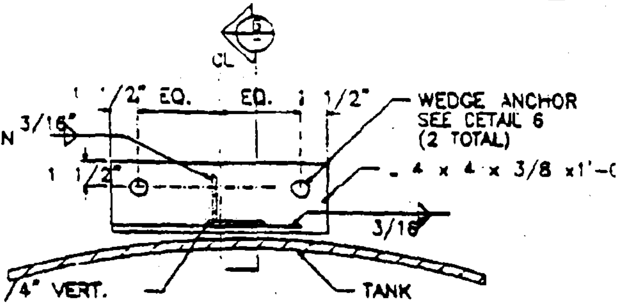
D ANCHOR LAYOUT 'D'



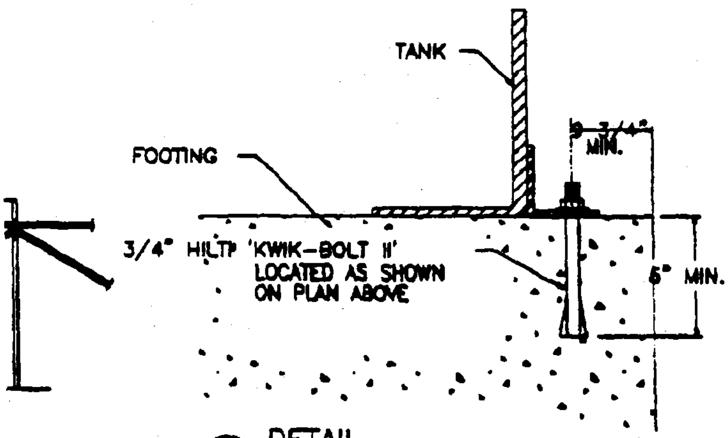
5 CABLE SPLICE



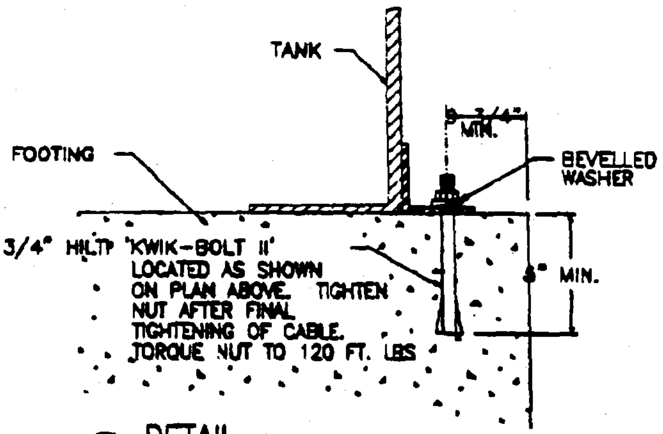
T2 ANCHOR TYPE T2



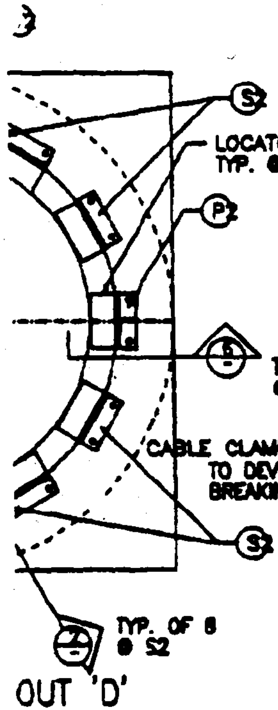
P2 ANCHOR TYPE P2



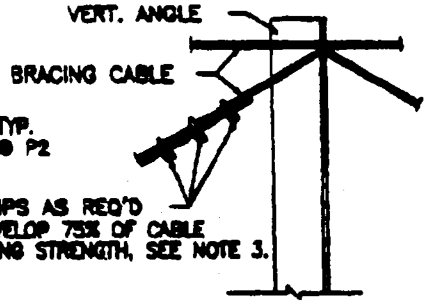
2 DETAIL



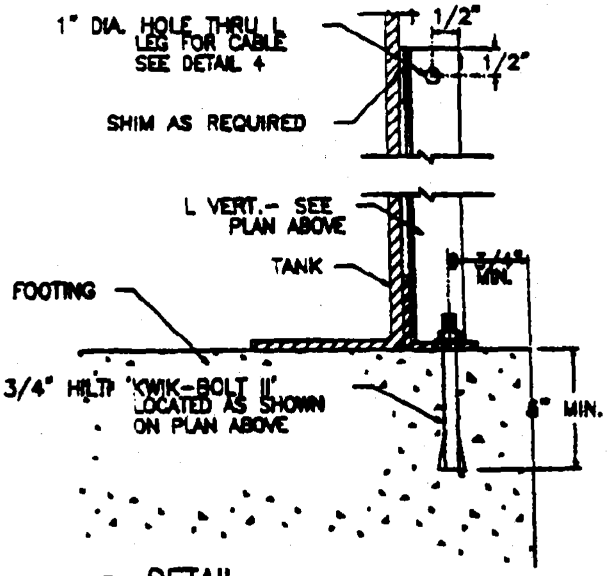
3 DETAIL FOR ANCHOR TYPE T2



OUT 'D'



5 CABLE SPLICE



6 DETAIL

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TANK DATA

Project Name:	Montgomery Watson - Denver, CO
Chemical Stored:	Haz Waste Landfill Leachate
Specific Gravity:	1.1
Primary Tank Model #:	10VCT09K
Containment Model #:	12VOC15E
Containment Type	VOC

SEISMIC CRITERIA

Seismic Zone:	3
Soil Profile Type	SC
Distance to Nearest Fault	N/A
Fault Type	N/A
Importance Factor, I	1.25

Wind Speed in mph	80

Overturning for Seismic	**NO NET SEISMIC OVERTURNING - CHECK FOR WIND**
Overturning for Wind	**NO NET WIND OVERTURNING**

RESTRAINT DESIGN SUMMARY

Layout	C
Cable Height	**N/A**
Cable Diameter	**N/A**
Governing Load Case	**SEISMIC**

Project Name: Montgomery Watson - Denver, CO

Tank Criteria: 1997 UBC - Section 1634.3

Contents: Haz Waste Landfill Leachate
Specific Gravity= 1.1 Density = 68.6 pcf

SECONDARY CONTAIN. TANK MODEL	SEC. CONT. TANK DIAM (FT)	SEC. CONT. TANK HT OVERALL (FT)	SEC. CONT. TANK WEIGHT LBS)	PRIMARY TANK MODEL	PRIMARY TANK CAP (GAL)	PRIMARY TANK DIAM (FT)	PRI. TANK HT OVERALL (FT)	PRI. TANK HT SIDEWALL (FT)	PRI TANK WT (LBS)	CONTENT WEIGHT (LBS)
12VOC15E	12	19.25	4000	10VCT09K	9000	10	16.08	14.92	3000	80328

SEISMIC DESIGN CRITERIA: 1997 UBC, Section 1634.4

			CODE REFERENCE
SEISMIC SHEAR:	Veq = .7Ca I Wp		Section 1634.4
Where: Ca =	0.33	Seismic Coefficient	Table 16-Q
Na =	n/a	Near-Source Factor (Zone 4 locations)	Table 16-S
I =	1.25	(Hazardous Materials)	Table 16-K
Wp =	87328	Weight of Tank + Contents	
Lateral Veq=	0.29	x Wp	

PRIMARY TANK MODEL	PRI. TANK CAP (GAL)	PRI. TANK DIAM (FT)	TANK HT SIDEWALL (FT)	TOTAL TANK WT (LBS)	Lateral Veq (LBS)
10VCT09K	9000	10	14.92	7000	25216

Mot (Ft-LBS)	Mr (Ft-LBS)	Mr:Mot	# BOLT REQ'D	BOLT LAYOUT
188111	296916	1.58	5.97	C

Mot (Ft-LBS)	Mr (Ft-LBS)	Mnet (Ft-LBS)
188111	296916	-108804

Project Name: Montgomery Watson - Denver, CO

WIND DESIGN CRITERIA: 1997 UBC Section 1615 thru 1625				CODE REFERENCE
WIND SHEAR:	Vw = CeCqQsI* Atank			Section 1620
Where: Ce =	1.13	[<20', Exposure C]		Table 16-G
Cq =	0.80	[Round Tank]		Table 16-H
qs =	16.4		80 MPH	Table 16-F
I =	1.15			Table 16-K
p =	17.05	PSF		

Atank = Height of tank * tank diameter

TANK MODEL	TANK CAP GAL)	TANK DIAM (FT)	TANK HT OVERALL (FT)	TANK WT (LBS)	Vw (LBS)	Mot (FT - LBS)	Mr (FT - LBS)	Mnet (FT - LBS)	Hc (Ft)	Ph (LBS)
10VCT09K	9000	12	16.08	7000	3290	26450	28140	-1690	6.50	-260

Notes: Wind shear is calculated based on pressure noted above multiplied by the surface area of the tank (overall ht x diameter). The wind force is applied at midheight to calculate the overturning moment. The resisting moment is based on 67% of the empty weight of the tank acting at the centerline of the tank. In nearly all cases, there is net overturning for wind on an empty tank. The tank has been stabilized for this condition by the addition of cable bracing.

Project Name: Montgomery Watson - Denver, CO

OVERTURNING ANCHORAGE DESIGN

CABLE DESIGN	7 X 19 STEEL AIRCRAFT CABLE
ANCHOR DESIGN:	
ANCHOR TYPE	3/4" Hilti "Kwik-Bolt II"
ALLOWABLE TENSION	1940.00 LBS
ALLOWABLE SHEAR	4225.00 LBS
ICBO No. 4267, 3000 psi concrete	

CABLE DIA. (IN)	BREAK STRENGTH (LBS)	DESIGN STRENGTH (LBS)
3/16	4,200	1,050
1/4	7,000	1,750
5/16	9,300	2,450
3/8	14,400	3,600
7/16	17,000	4,250

TANK MODEL	STAB. FORCE	CABLE FORCE	CABLE SIZE REQ'D (IN)	GOVERNING LOAD CASE	ANCHOR FORCES		ANCHOR STRESS RATIO		
	Ph (LBS)	Pc (LBS)			Rv (LBS)	Rh (LBS)	T	V	TOTAL
10VCT09K	no overturn	no overturn	N/A	SEISMIC	N/A	N/A	N/A	N/A	N/A

NOTES: Where overturning occurs, the tank has been stabilized by the addition of cable bracing. The cable and anchor forces are determined based on the force required at the top of the cable (Ph in Table above) to stabilize the tank.

Where seismic forces govern overturning, the required resisting moment (Mnet) in table above) corresponds to the net seismic overturning moment.

Project Name: Montgomery Watson - Denver, CO

DESIGN LEGENDS AND METHODOLOGY

The tank restraints are designed per 1997 UBC, Section 1634.2 which allows tanks with supported bottoms to be designed using the criteria of Section 1634.3, Formula 34-1. Design methodology and conclusions regarding the design are listed as footnotes in the calculations, pages 1-3. Expanding on that, below is a legend defining each of the terms used in the design tabulations.

SEISMIC DESIGN LEGEND

Veq	Seismic base shear = 0.29 * (tank weight + contents)
Mot	Tank overturning moment = Veq (lateral component)* 1/2 height of tank + Veq (vertical component) * 1/2 tank diameter
Mr	Tank stabilizing moment = (85% of weight of tank + contents) * 80% of tank radius [assumes pivot point inboard edge of tank]
Mnet	Net overturning moment = Mot - Mr. If less than 0, then no overturning.
T/C	Overturning resisting force - Mnet / 80% tank dia. [assumes pivot point inboard of edge of tank]. Where "T/C" < 0, there is no hold down required.
# bolts req'd	Total number of bolts required on each side of tank to restrain from sliding for 1994 UBC seismic forces.

WIND DESIGN LEGEND

Wind shear calculations are based on pressure noted on Page 3 multiplied by the surface area of the tank (height * diameter). The wind force is applied at the midheight to calculate the overturning moment. The resisting moment is based on 67% of the empty weight of the tank acting at the centerline of the tank. In all cases, there is net overturning for wind on an empty tank. The tank has been stabilized for this condition by the addition of cable bracing. The cable and anchor forces are determined based on the force required at the top of the cable (Ph on Page 3) to stabilize the tank for overturning in wind. In all cases, seismic forces govern for design of base shear anchorages.

Dimensions for tanks in wind conditions adjusted for tanks with secondary containment. Height of tank for wind calculations adjusted to account for tank dome

Vw	Wind base shear = design wind pressure (P) * tank height * tank diameter.
Mot	Tank overturning moment = Vw * 1/2 height of tank
Mr	Tank stabilizing moment = (67% of weight of tank) * tank radius
Mnet	Net overturning moment = Mot - Mr. If less than 0, then no overturning.
Hc	Distance from top of foundation to top of cable brace.
Ph	Horizontal restraining force required at top of cable brace to resist net overturning moment = Mnet / Hc.
Pc	Cable force = (Ph / [2* cos(arctan(Hc / tank radius))])/cos(45°)
Rv	Vertical reaction at cable brace anchor bolt = Pc * [sin(arctan(Hc / tank radius))]
Rh	Horizontal reactions at cable brace anchor bolt = Pc * [arctan(Hc / tank radius)]

Project Name: TRW

Cable size required is noted to the left of the "Rh" column and is based on a 4:1 factor of safety for the cable breaking strengths indicated on the drawings and as repeated below.

CABLE DIAM. (IN)	BREAK STRENGTH (LBS)	DESIGN STRENGTH (LBS)
3/16	4,200	1,050
1/4	7,000	1,750
5/16	9,800	2,450
3/8	14,400	3,600
7/16	17,000	4,250

As stated in the footnote to the wind design calculation summary, seismic design criteria governs for the design of base shear anchorage.

MONTGOMERY WATSON

Calculation Cover Sheet — Appendix H-3

Project Title: Triassic Park Waste Disposal Facility

Project No.: 1342602

Calculation Title: Chemical Compatibility of Polyethylene Tanks

	Name	Date
Prepared By:	Jorge Troncoso	8/25/99
Checked By:		
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

HAL MURPHREE & ASSOCIATES, INC. 800-606-8265
Manufacturers' Representatives & Distributors FAX 650-348-4272
e-mail: alburgos@halmurphree.com
website: http://www.halmurphree.com/

- Fax Transmittal -

Date: August 25, 1999
Pages: 10
To: Jorge Troncoso
Montgomery-Watson
Fax Phone: 303-763-8008
From: Al Burgos

www. cencal tanks. com

Subject: Crosslinked Polyethylene Tanks

Jorge-

Following are:

1. Chemical Compatibility Chart
2. Seismic/Wind Restraint Typical Details

Please call me if you have any questions.

P.O. BOX 25144 ◆ SAN MATEO, CA ◆ 94402

HAL MURPHREE & ASSOCIATES, INC.
ABOVE GROUND TANKS FOR LIQUID STORAGE

CHEMICAL RESISTANCE CHART

Substances	% Conc.	Temp.	High Density Crosslink Polyethylene
Acetic Acid			S
Acetone		100°	O
Alum			S
Aluminum Chloride			S
Aluminum Fluoride			S
Aluminum Sulfate			S
Ammonium Acetate			S
Ammonium Chloride			S
Ammonium Fluoride			S
Ammonium Hydoxide			S
Ammonium Nitrate			S
Amyl Alcohol			S
Aniline		70°	O
Antimony Trichloride			S
Aqua Regia			NR
Arsenic Acid	80%		S
Barium Chloride			S
Barium Hydroxide			S
Barium Sulfate			S
Barium Sulfide			S
Benzene		70°	O
Benzene Sulfonic Acid	10%		O
Bismuth Carbonate			S
Boric Acid			S
Brine			S
Bromine			NR
Butane			NR
Butanediol			S
Butyl Alcohol			S
Butyric Acid			O
Calcium Bisulphide			S
Calcium Carbonate			S

S - Satisfactory
O - Some attack
NR - Not recommended

Concentration 100% and temperature allowable to 140° unless otherwise indicated.

HAL MURPHREE & ASSOCIATES, INC.
ABOVE GROUND TANKS FOR LIQUID STORAGE

CHEMICAL RESISTANCE CHART

Substances	% Conc.	Temp.	High Density Crosslink Polyethylene
Calcium Chloride			S
Calcium Hydroxide			S
Calcium Hypochlorite			S
Calcium Nitrate	50%		S
Calcium Sulfate			S
Carbon Disulphide			NR
Carbon Tetrachloride		70°	O
Chlorobenzene		70°	O
Chloroform			NR
Chromic Acid	50%		S
Chromic/Sulfuric Acid			NR
Citric Acid			S
Copper Salts			S
Corn Oil			O
Cottenseed Oil			O
Cyclohexanone		70°	O
Detergents			S
Dextrin			S
Diazo Salts			S
Dibutyl Phthalate		70°	O
Diesel Oil		70°	O
Diethanolamine			S
Diethylene Glycol			S
Dimethyl Formamide			S
Dimethylamine		70°	O
Ethyl Alcohol			S
Ethyl Ether			NR
Ethylene Chlorohydrin		70°	O
Ethylene Dichloride			NR
Ethylene Glycol			S
Ferric Chloride			S
Ferric Nitrate			S

S - Satisfactory
O - Some attack
NR - Not recommended

Concentration 100% and temperature allowable to 140° unless otherwise indicated.

HAL MURPHREE & ASSOCIATES, INC.
ABOVE GROUND TANKS FOR LIQUID STORAGE

CHEMICAL RESISTANCE CHART

Substances	% Conc.	Temp.	High Density Crosslink Polyethylene
Ferric Sulfate			S
Ferrous Chloride			S
Ferrous Sulfate			S
Fish Oil			O
Fluoboric Acid			S
Fluosilicic Acid			S
Formic Acid			S
Fuel Oil		70°	O
Fuming Sulfuric Acid			NR
Furfural		70°	O
Gasoline		70°	O
Gluconic Acid			S
Glucose			S
Glycerol			S
Glycol			S
Glycolic Acid	30%		S
Hexane		70°	O
Hydraulic Oil			O
Hydrazine Hydrate			S
Hydrobromic Acid			S
Hydrochloric Acid			S
Hydrofluoric Acid			S
Hydrofluosilicic Acid	30%		S
Hydrogen Peroxide	30%		S
Hydrogen Phosphide			S
Hydrogen Sulfide			S
Hydroquinone			S
Hypochlorous Acid			S
Jet Fuel		70°	O
Lactic Acid			S
Lactose			S
Lard			O

S - Satisfactory
O - Some attack
NR - Not recommended

Concentration 100% and temperature allowable to 140° unless otherwise indicated.

CHEMICAL RESISTANCE CHART

Substances	% Conc.	Temp.	High Density Crosslink Polyethylene
Latex			S
Lauric Acid			O
Lead Acetate			S
Linseed Oil			O
Lubricating Oils			O
Magnesium Salts			S
Mercury			S
Mercury Salts			S
Methyl Alcohol			S
Methyl Ethyl Ketone			NR
Methyl Sulfuric Acid			S
Methylene Chloride			NR
Mineral Oils			O
Motor Oils			O
Naptha		70°	O
Nickle Salts			S
Nicotinic Acid			S
Nitric Acid	0 - 50%		S
Nitric Acid	over 50%		NR
Nitrobenzene		70°	O
n-Heptane		70°	O
Octyl Cresol		70°	O
Oleic Acid			O
Olive Oil			O
Organic Peroxides			NR
Oxalic Acid			S
Palmitic Acid			O
Peanut Oil			O
Pentane			NR
Perchloric Acid	10%		S
Phenol	10%		S
Phosphoric Acid			S

S - Satisfactory
O - Some attack
NR - Not recommended

Concentration 100% and temperature allowable to 140° unless otherwise indicated.

HAL MURPHREE & ASSOCIATES, INC.
ABOVE GROUND TANKS FOR LIQUID STORAGE

CHEMICAL RESISTANCE CHART

Substances	% Conc.	Temp.	High Density Crosslink Polyethylene
Photographic Solutions			S
Plating Solutions			S
Polymer			S
Potassium Hydroxide			S
Potassium Salts			S
Propane			NR
Propyl Alcohol			S
Propylene Dichloride		70°	O
Propylene Glycol			S
Pyridine			S
Seawater			S
Selenic Acid			S
Silicic Acid			S
Silver Salts			S
Sodium Bisulfite			S
Sodium Carbonate			S
Sodium Chlorate			S
Sodium Cyanide			S
Sodium Ferricyanide			S
Sodium Ferrocyanide			S
Sodium Hydroxide			S
Sodium Hypochlorite	15%		S
Sodium Nitrate			S
Stannic Chloride			S
Stannous Chloride			S
Starch Solutions			S
Stearic Acid			O
Sugar Solutions			S
Sulfuric Acid	98%		S
Sulfurous Acid			S
Tannic Acid			S
Tartaric Acid			S
Thionyl Chloride			NR

S - Satisfactory
O - Some attack
NR - Not recommended

Concentration 100% and temperature allowable to 140° unless otherwise indicated.

HAL MURPHREE & ASSOCIATES, INC.
ABOVE GROUND TANKS FOR LIQUID STORAGE

CHEMICAL RESISTANCE CHART

Substances	% Conc.	Temp.	High Density Crosslink Polyethylene
Toluene		70°	O
Toluene Sulfonic Acid			S
Transformer Oil			O
Trichloroethylene		70°	O
Triethanolamine			S
Urea			S
Vegetable Oils			O
Vinegar			S
Xylene		70°	O
Zinc Orthophosphate			S
Zinc Salts			S

The chemical resistance data provided here and on the preceding pages has been assembled from a wide variety of sources in our industry and is representative of a broad range of chemicals which would be impossible to list fully here. This information is based on practical field experience and actual laboratory testing conducted by the manufacturers of polyethylene resins and finished products.

Keep in mind that this information should only be used as a guideline for recommendations and not a guarantee of chemical resistance. Actual service conditions including temperature, concentration and contaminants will affect variances in chemical resistance.

To the best of our knowledge the information contained in this chart is accurate. However, we do not assume any liability whatsoever for the accuracy or completeness of such information. If questions should arise when using this chart, further research or testing may be necessary.

File:CHEM98.BRO

MONTGOMERY WATSON

Calculation Cover Sheet Appendix H-4

Project Title: Triassic Park Waste Disposal Facility

Project No.: 1342602

Calculation Title: Chemical Compatibility of HDPE Liners

	Name	Date
Prepared By:	Jorge Troncoso	8/25/99
Checked By:		
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

POLY•FLEX Technical Information

CHEMICAL COMPATIBILITY OF POLY-FLEX LINERS

Chemical compatibility or resistance as applied to geomembranes is a relative term. Actually compatibility would mean that one material will dissolve in the other such as alcohol in water or grease in gasoline. An example of incompatibility would be oil and water. In liners it is undesirable to have the chemicals dissolve in the liner hence the term compatibility is the reverse of what is normally meant in the chemical industry. In the strictest sense and from a laboratory prospective, chemical compatibility, as the term applies to this industry, would imply that the chemical has no effect on the liner. On the other hand, from an engineering prospective, chemical compatibility means that a liner will survive the exposure to a given chemical even though the chemical could have some effect on the performance of the liner, but not enough to cause failure. Therefore, one must understand and define chemical compatibility for a specific project.

Generally polyethylene will be effected by chemicals in one of three ways.

1. **No effect-** This means that the chemical in question and the polyethylene do not interact. The polyethylene does not gain (lose) weight, swell, and the physical properties are not significantly altered.
2. **Oxidizes (cross linking)-** Chemicals classed as oxidizing agents will cause the polyethylene molecules to cross link and cause irreversible changes to the physical properties of the liner. Basically it make the liner brittle.
3. **Plasticizes-** Chemicals in this classification are soluble in the polyethylene structure. They do not change the structure of the polyethylene itself but will act as a plasticizer. In doing so, the liner will experience weight gain of 3-15%, may swell by up to 10%, and will have measurable changes in physical properties (i.e. the tensile strength at yield may decrease by up to 20%). Even under these conditions the liner will maintain its integrity and will not be breached by liquids, provided the liner has not been subjected to any stress. These effects are reversible once the chemicals are removed and the liner has time to dry out.

Aside from the effect that chemicals have on a liner is the issue of vapor permeation through the liner. Vapor permeation is molecular diffusion of chemicals through the liner. Vapor transmission for a given chemical is dependent primarily on liner type, contact time, chemical solubility, temperature, thickness, and concentration gradient, but not on hydraulic head or pressure. Transmission through the liner can occur in as little as 1-2 days. Normally, a small amount of chemical is transmitted. Generally HDPE has the lowest permeation rate of the liners that are commercially available.

As stated above chemical compatibility is a relative term. For example, the use of HDPE as a primary containment of chlorinated hydrocarbons at a concentration of 100% may not be recommended, but it may be acceptable at 0.1% concentration for a limited time period or may be acceptable for secondary containment. Factors that go into assessment of chemical compatibility are type of chemical(s), concentration, temperature and the type of application. No hard and fast rules are available to make decisions on chemical compatibility. Even the EPA 9090 test is just a method to generate data so that an opinion on chemical compatibility can be more reliably reached.

A simplified table on chemical resistance is provided to act as a screening process for chemical containment applications.

CHEMICAL CLASS	CHEMICAL EFFECT	PRIMARY CONTAINMENT (LONG TERM CONTACT)		SECONDARY CONTAINMENT (SHORT TERM CONTACT)	
		HDPE	LLDPE	HDPE	LLDPE
CARBOXYLIC ACID	1				
- Unsubstituted (ie. Acetic acid)		B	C	A	C
- Substituted (ie. Lactic acid)		A	B	A	A
- Aromatic (ie. Benzoic Acid)		A	B	A	A
ALDEHYDES	3				
- Aliphatic (ie. Acetaldehyde)		B	C	B	C
- Hetrocyclic (ie. Furfural)		B	C	B	C
AMINE	3				
- Primary (ie. Ethylamine)		B	C	B	C
- Secondary (ie. Diethylamine)		C	C	B	C
- Aromatic (ie. Aniline)		B	C	B	C
CYANIDES (ie. Sodium Cyanide)	1	A	A	A	A
ESTER (ie. Ethyl acetate)	3	B	C	B	C
ETHER (ie. Ethyl ether)		C	C	B	C
HYDROCARBONS	3				
- Aliphatic (ie. Hexane)		C	C	B	C
- Aromatic (ie. Benzene)		C	C	B	C
- Mixed (ie. Crude oil)		C	C	B	C
HALOGENATED HYDROCARBONS	3				
- Aliphatic (ie. Dichloroethane) +A4		C	C	B	C
- Aromatic (ie. Chlorobenzene)		C	C	B	C
ALCOHOLS	1				
- Aliphatic (ie. Ethyl alcohol)		A	A	A	A
- Aromatic (ie. Phenol)		A	C	A	B
INORGANIC ACID					
- Non-oxidizers (ie. Hydrochloric acid)	1	A	A	A	A
- Oxidizers (ie. Nitric Acid)	2	C	C	B	C
INORGANIC BASES (ie. Sodium hydroxide)	1	A	A	A	A
SALTS (ie. Calcium chloride)	1	A	A	A	A

METALS **(ie. Cadmium)**	1	A	A	A	A
KETONES **(ie. Methyl ethyl ketone)**	3	C	C	B	C
OXIDIZERS **(ie. Hydrogen peroxide)**	2	C	C	C	C

Chemical Effect (see discussion on Chemical Resistance)

1. No Effect-Most chemicals of this class have no or minor effect.
2. Oxidizer-Chemicals of this class will cause irreversible degradation.
3. Plasticizer-Chemicals of this class wil cause a reversible change in physical properties.

Chart Rating

1. Most chemicals of this class have little or no effect on the liner.
   Recommended regardless of concentration or temperature (below 150° F)
2. Chemicals of this class will effect the liner to various degrees.
   Recommendation are based on the specific chemical, concentration and temperature.
   Consult with Poly-Flex, Inc.
3. Chemicals of this class at high concentrations will have significant effect on the physical properties of the liner.
   Generally not recommended but may be acceptable at low concentrations and with special design considerations.
   Consult with Poly-Flex, Inc.

The data in this table is provided for informational purposes only and is not intended as a warranty or guarantee. Poly-Flex, Inc. assumes no responsibility in connection with the use of this data. Consult with Poly-Flex, Inc. for specific chemical resistance information and liner selection.

SERROT NATIONAL CORPORATION

Serrot National Corporation
525 Reactor Way
Reno, Nevada 89502

(775) 856-3200
(775) 856-8719 FAX

Date: 10/15/99

Total No. of Pages 5 (including cover)

To: JORGE GRANCOSO Fax No.: 1-303-763-8003

From: CLARK WEST Phone No.:

RE: CHEMICAL RESISTANCE

MESSAGE:

HERE THEY ARE, HOPE THEY HELP.
IF NOT PLEASE CALL!

Thanks
Clark

If any problems arise during transmission, please contact ________ as soon as possible at (775) 856-3200.

Fortiflex® PE Chemical Resistance Chart

[redacted]

Reagent	70°F (21°C)	140°F (60°C)
A		
Acetaldehyde	S	O
Acetic acid (1-10%)	S	S
Acetic acid (10-60%)	S	O
Acetic acid (80-100%)	S	O
Acetic anhydride	S	S
Acetone	S	S
Acids (aromatic)	S	S
Acrylic emulsions	S	S
Adipic acid	S	S
Aluminum chloride concentrated	S	S
Aluminum chloride dilute	S	S
Aluminum fluoride concentrated	S	S
Aluminum sulfate concentrated	S	S
Alums (all types) concentrated	S	S
Amino acetic acid	S	S
Ammonia (100% dry gas)	S	S
Ammonium acetate	S	S
Ammonium bromide	S	S
Ammonium carbonate	S	S
Ammonium chloride saturated	S	S
Ammonium fluoride (20%)	S	S
Ammonium hydroxide	S	S
Ammonium metaphosphate saturated	S	S
Ammonium nitrate saturated	S	S
Ammonium persulfate saturated	S	S
Ammonium phosphate	S	S
Ammonium sulfate saturated	S	S
Ammonium sulfide saturated	S	S
Ammonium thiocyanate saturated	S	S
Amyl acetate (100%)	O	U
Amyl alcohol (100%)	S	S
Amyl chloride (100%)	O	U
Aniline (100%)	S	U
Anise seed oil	O	U
Antimony chloride	S	S
Aqua regia	O	U
Aromatic hydrocarbons	U	U
Arsenic	S	S
Aspirin	S	S
B		
Barium carbonate saturated	S	S
Barium chloride saturated	S	S
Barium hydroxide	S	S
Barium sulfate saturated	S	S
Barium sulfide saturated	S	S
Beer	S	S
Benzaldehyde	S	O
Benzene	O	U
Benzene sulfonic acid	S	S
Benzoic acid crystals	S	S
Benzoic acid saturated	S	S
Bismuth carbonate saturated	S	S
Black liquor	S	S
Bleach lye (10%)	S	S
Borax cold saturated	S	S
Boric acid concentrated	S	S
Boric acid dilute	S	S
Brine	S	S
Bromic acid (10%)	S	S
Bromine liquid (100%)	O	U
Bromochloromethane	U	U
Butadiene	U	U
Butanediol (10%)	S	S
Butanediol (60%)	S	S
Butanediol (100%)	S	S
Butter	S	S
Butyl acetate (100%)	O	U
Butyl alcohol (100%)	S	S
Butylene glycol	S	S
Butyric acid (100%)	S	S
C		
Caffeine citrate saturated	S	S
Calcium bisulfide	S	S
Calcium bromide	S	S
Calcium carbonate saturated	S	S
Calcium chlorate saturated	S	S
Calcium chloride saturated	S	S
Calcium hydroxide	S	S
Calcium hypochlorite bleach solution	S	S
Calcium nitrate (50%)	S	S
Calcium sulfate	S	S
Camphor crystals	S	S
Camphor oil	U	U
Carbon dioxide (100% dry)	S	S
Carbon dioxide (100% wet)	S	S
Carbon dioxide cold saturated	S	S
Carbon disulphide	O	U
Carbon monoxide	S	S
Carbon tetrachloride	U	U
Carbonic acid	S	S
Carnauba wax	S	S
Carrot juice	S	S
Castor oil concentrated	S	S
Catsup	S	S
Caustic soda	S	O
Cedar leaf oil	U	U
Cedar wood oil	U	U
Chlorine liquid	O	U
Chlorobenzene	O	U
Chloroform	U	U
Chlorosulfonic acid (100%)	U	U
Chrome alum saturated	S	S
Chromic acid (10-20%)	S	O
Chromic acid (50%)	S	O
Cider	S	S
Cinnamon	S	S
Cinnamon oil	U	U
Citric acid saturated	S	S
Citronella oil	O	U

Legend: S = Satisfactory O = Some attack U = Unsatisfactory

Reagent	70°F (21°C)	140°F (60°C)
Cloves (ground)	S	S
Coconut oil alcohols	S	S
Cod liver oil	S	S
Coffee	S	S
Copper chloride saturated	S	S
Copper cyanide saturated	S	S
Copper fluoride (2%)	S	S
Copper nitrate saturated	S	S
Copper sulfate dilute	S	S
Copper sulfate saturated	S	S
Corn oil	S	S
Cottonseed oil	S	S
Cranberry sauce	S	S
Cresols	S	O
Cuprous chloride saturated	S	S
Cuprous oxide	S	S
Cyclohexane	U	U
Cyclohexanone	U	U
D		
Decalin	S	U
Detergents (synthetic)	S	S
Developers (photographic)	S	S
Dextrin saturated	S	S
Dextrose saturated	S	S
Dibutyl ether	O	U
Dichlorobenzene (ortho and para)	U	U
Diethylene glycol	S	S
Dioxane	S	S
Disodium phosphate	S	S
E		
Emulsions (photographic)	S	S
Ether	O	O
Ethyl acetate (100%)	O	O
Ethyl alcohol (95%)	S	S
Ethyl alcohol (100%)	S	S
Ethylbenzene	O	U
Ethylene glycol	S	S
F		
Ferric chloride saturated	S	S
Ferric nitrate saturated	S	S
Ferrous ammonium citrate	S	S
Ferrous chloride saturated	S	S
Ferrous sulfate	S	S
Fluoboric acid	S	S
Fluorine	S	U
Fluosilicic acid (32%)	S	S
Fluosilicic acid concentrated	S	S
Formaldehyde (10-30%)	S	S
Formaldehyde (30-40%)	S	O
Formic acid (20%)	S	S
Formic acid (50%)	S	S
Formic acid (100%)	S	S
Fructose saturated	S	S
Fuel oil	S	U

Reagent	70°F (21°C)	140°F (60°C)
Furfural (100%)	O	U
Furfuryl alcohol	S	O
G		
Gallic acid saturated	S	S
Gasoline	S	U
Glucose	S	S
Glycerine	S	S
Glycol	S	S
Glycolic acid (30%)	S	S
Grape juice	S	S
Grapefruit juice	S	S
H		
Heptane	O	U
Hexachlorobenzene	S	S
Hexane	U	U
Hydrobromic acid (50%)	S	S
Hydrochloric acid (10%)	S	S
Hydrochloric acid (20%)	S	S
Hydrochloric acid (35%)	S	S
Hydrocyanic acid	S	S
Hydrocyanic acid saturated	S	S
Hydrofluoric acid (40%)	S	S
Hydrofluoric acid (60%)	S	S
Hydrofluoric acid (75%)	S	S
Hydrogen (100%)	S	S
Hydrogen bromide (10%)	S	S
Hydrogen chloride dry gas	S	S
Hydrogen peroxide (30%)	S	S
Hydrogen peroxide (90%)	S	O
Hydrogen sulfide	S	S
Hydroquinone	S	S
Hypochlorous acid concentrated	S	S
I		
Inks	S	S
Iodine crystals	O	O
Isobutyl alcohol	S	S
Isopropyl alcohol	S	S
Isopropyl ether	O	U
K		
Kerosene	O	O
L		
Lactic acid (10%)	S	S
Lactic acid (90%)	S	S
Lanolin	S	S
Lard	S	S
Lead acetate saturated	S	S
Lead nitrate	S	S
Lemon juice	S	S
Lemon oil	O	U
Lime juice	S	S
Linseed oil	S	S

Reagent	70°F (21°C)	140°F (60°C)
M		
Magnesium carbonate saturated	S	S
Magnesium chloride saturated	S	S
Magnesium hydroxide saturated	S	S
Magnesium nitrate saturated	S	S
Magnesium sulfate saturated	S	S
Margarine	S	S
Mercuric chloride	S	S
Mercuric cyanide saturated	S	S
Mercurous nitrate saturated	S	S
Mercury	S	S
Methyl alcohol (100%)	S	S
Methyl ethyl ketone (100%)	U	U
Methylene chloride (100%)	U	U
Methylsulfuric acid	S	S
Milk	S	S
Mineral oils	S	U
Molasses	S	S
Mustard (prepared)	S	S
N		
Naphtha	O	U
Naphthalene	S	U
Natural gas (wet)	S	S
Nickel chloride saturated	S	S
Nickel nitrate concentrated	S	S
Nickel sulfate	S	S
Nicotinic acid	S	S
Nitric acid (0-30%)	S	S
Nitric acid (30-50%)	S	O
Nitric acid (70%)	S	O
Nitric acid (95-98%)	U	U
Nitrobenzene (100%)	U	U
Nitroglycerine	O	U
O		
Octane	S	S
Oleum concentrated	U	U
Olive oil	S	S
Orange juice	S	S
Oxalic acid dilute	S	S
Oxalic acid saturated	S	S
Ozone	O	O
P		
Palm oil	S	S
Paraffin oil	S	O
Peanut butter	S	S
Pepper (fresh ground)	S	S
Peppermint oil	O	U
Perchloric acid (50%)	S	O
Perchloroethylene	U	U
Petroleum ether	U	U
Petroleum jelly	S	S
Phenol	S	S
Phosphoric acid (0-30%)	S	S
Phosphoric acid (30-90%)	S	S
Phosphoric acid (over 90%)	S	S
Photographic solutions	S	S
Phthalic anhydride	S	S
Pickling baths		
Hydrochloric acid	S	S
Sulfuric acid	S	S
Sulfuricnitric	S	U
Pine oil	O	U
Plating solutions		
Brass	S	S
Cadmium	S	S
Chromium	S	S
Copper	S	S
Gold	S	S
Indium	S	S
Lead	S	S
Nickel	S	S
Rhodium	S	S
Silver	S	S
Tin	S	S
Zinc	S	S
Potassium bicarbonate saturated	S	S
Potassium borate (1%)	S	S
Potassium bromate (10%)	S	S
Potassium bromide saturated	S	S
Potassium carbonate	S	S
Potassium chlorate saturated	S	S
Potassium chloride saturated	S	S
Potassium chromate (40%)	S	S
Potassium cyanide saturated	S	S
Potassium dichromate (40%)	S	S
Potassium ferri/ferro cyanide	S	S
Potassium nitrate saturated	S	S
Potassium perborate saturated	S	S
Potassium perchlorate (10%)	S	S
Potassium permanganate (20%)	S	S
Potassium persulfate saturated	S	S
Potassium sulfate concentrated	S	S
Potassium sulfide concentrated	S	S
Potassium sulfite concentrated	S	S
Propane gas	S	S
Propargyl alcohol	S	S
Propyl alcohol	S	S
Propylene glycol	S	S
Pyridine	S	O
R		
Rayon coagulating bath	S	S
Resorcinol	S	S
S		
Salicylic acid	S	S
Seawater	S	S
Shortening	S	S
Silicic acid	S	S

Reagent	70°F (21°C)	140°F (60°C)
Silver nitrate solution	S	S
Soap solution concentrated	S	S
Sodium acetate saturated	S	S
Sodium benzoate (35%)	S	S
Sodium bicarbonate saturated	S	S
Sodium bisulfate saturated	S	S
Sodium bisulfite saturated	S	S
Sodium borate	S	S
Sodium carbonate concentrated	S	S
Sodium chlorate saturated	S	S
Sodium chloride saturated	S	S
Sodium cyanide	S	S
Sodium dichromate saturated	S	S
Sodium ferrocyanide	S	S
Sodium ferricyanide saturated	S	S
Sodium fluoride saturated	S	S
Sodium hydroxide concentrated	S	S
Sodium hypochlorite	S	S
Sodium nitrate	S	S
Sodium nitrite	S	S
Sodium perborate	S	S
Sodium phosphate	S	S
Sodium sulfide (25% to saturated)	S	S
Sodium sulfite saturated	S	S
Sodium thiosulphate	S	S
Soybean oil	S	S
Stannic chloride saturated	S	S
Stannous chloride saturated	S	S
Starch solution saturated	S	S
Stearic acid (100%)	S	S
Sulfuric acid (0-50%)	S	S
Sulfuric acid (70%)	S	O
Sulfuric acid (80%)	S	U
Sulfuric acid (96%)	O	U
Sulfuric acid (98% concentrated)	O	U
Sulfuric acid (fuming)	U	U
Sulfurous acid	S	S

Reagent	70°F (21°C)	140°F (60°C)
T		
Tannic acid (10%)	S	S
Tartaric acid	S	S
Tea	S	S
Tetrahydrofuran	O	O
Toluene	U	U
Tomato juice	S	S
Transformer oil	S	O
Trichloroethylene	U	U
Trisodium phosphate saturated	S	S
Turpentine	O	U
U		
Urea	S	S
Urine	S	S
V		
Vanilla extract	S	S
Vaseline	S	S
Vinegar (commercial)	S	S
W		
Wetting agents	S	S
Whiskey	S	S
Wines	S	S
X		
Xylene	U	U
Y		
Yeast	S	S
Z		
Zinc chloride saturated	S	S
Zinc oxide	S	S
Zinc sulfate saturated	S	S

S = SATISFACTORY

O = SOME ATTACK

U = UNSATISFACTORY

Note:
The preceding information concerns general chemical resistance only. Since other factors such as permeation, ESCR and container design are involved, full compatibility testing is recommended.

Solvay Polymers, Inc., [illegible] Richmond Avenue, Houston, Texas [illegible] 1-800-[illegible]
Fax 713/[illegible] Mailing Address: P.O. Box 27328, Houston, Texas 77227-[illegible]
Technical Service: 1-800-[illegible] Customer Order Service 1-800-[illegible]

SOLVAY POLYMERS

MONTGOMERY WATSON

Calculation Cover Sheet Appendix H-5

Project Title: Triassic Park Waste Disposal Facility

Project No.: 1342602

Calculation Title: Chemical Compatibility of GCL

	Name	Date
Prepared By:	Jorge Troncoso	8/25/99
Checked By:		
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

SERROT INTERNATIONAL, INC.

Serrot International, Inc.
525 Reactor Way
Reno, Nevada 89502

(775) 856-3200
(775) 856-8719 FAX

Date: 11/16/99

Total No. of Pages 7 (including cover)

To: JORGE TRONCOSO Fax No.: 303-763-8003

From: CLARK WEST Phone No.:

RE: GCL/LEACHATE COMPATIBILITY

MESSAGE:

FOR YOUR REVIEW

Thanks
Clark

If any problems arise during transmission, please contact
as soon as possible at (775) 856-3200.

FIX - 125

BENTOFIX®

Thermal Lock
Geosynthetic Clay Liner

• Technical Bulletin •

GCL Leachate Permeability / Compatibility Report

Job #92029

Introduction:

This report documents the results of Geosynthetic Clay Liner (GCL) a permeability test with tap water and subsequently with a municipal solid waste landfill leachate for which the analysis is enclosed as Attachment A. Since no ASTM test procedure exists for determining the permeability of a geosynthetic clay liners with contaminated fluids, ASTM D 5084 Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter was adapted for this study, under an effective confining stress of 10 psi.

Materials:

The material tested was a sample of Bentofix Thermal Lock NS GCL consisting of a woven geotextile, carrier layer, non-woven geotextile cover layer, and approximately 1lb of sodium bentonite per square foot sandwiched in between them. The tap water used was obtained at the Galesburg Technical Center, and the water was de-aired in a vacuum tank used with our transmissivity devices. The municipal solid waste leachate was received from Lakeview Sanitary Landfill in Erie, Pennsylvania. A characterization of the leachate follows. The sample was tested using a Geotest Model #S5426B Flexible Wall Permeameter.

Test Method Summary:

A 10 cm diameter sample was cut from the base sheet with a sharp knife. The thickness of the sample was then measured with a dead weight micrometer fixed with a 1 ounce mass so as to cause minimal disturbance to the sample. After the permeameter had been checked for a system flow, that was at least ten times greater than the expected flow with a sample, the following profile was created from the bottom to the top on the Teflon pedestal base: Porous stone / Filter paper / Specimen / Filter paper / Porous stone / Teflon Cap Piece. To seal off the specimen to side-wall leakage a bentonite paste was applied to the edge, and Teflon tape was wrapped around the profile to prevent any possible damage to the rubber membrane from the msw leachate. This done, the rubber membrane was stretched and placed in position over the outside of the specimen. Then the appropriate hoses were attached and the cell was placed into position. The cell was then filled with de-aired tap water, and the whole unit was placed on top of the control platform.

After attaching the feed lines for the permeant fluid, the sample was saturated under vacuum until air could no longer be observed exiting the permeameter. The final pressures were set and the sample was allowed to consolidate under no flow conditions. When the consolidation appeared complete, the final thickness was checked and the pressures of the cap and pedestal set to provide a gradient of approximately 2000.

Flow was allowed to continue with the tap water until it appeared that no significant change in the permeability was taking place. The pedestal interface was then emptied and refilled with leachate. Flow with the leachate was allowed to continue for another 33 days at which time another project required its termination.

Results:

The results are summarized in the following tables and graphs. The permeability coefficient (k) was calculated using the following equation:

$$k = QL/Ath$$

where:

k = coefficient of permeability, cm/s,
Q = quantity of flow, taken as the average of inflow and outflow, cm^3,
L = length of specimen along path of flow,cm,
A = cross-sectional area of specimen, cm^2
t = time interval, s, over which flow Q occurs, and
h = difference in hydraulic head across the specimen, cm of water.

The permeability was corrected for changes in viscosity due to temperature fluctuations by multiplying the value by a correction factor (R_t) found on a table in ASTM D 5084. These values were determined according to the relationship $R_t = (-0.02452T + 1.495)$ where T is the degrees Celsius. The corrected permeability value was denoted k_{20}.

Test Conditions	
Cell Pressure	**414 kPa**
Cap Interface Pressure	**241 kPa**
Pedestal Interface Pressure	**345 kPa**
Effective Confining Stress	**69 kPa ±**
Head Difference across Sample	**1054 cm**
Hydraulic Gradient	**2000**
Sample Area	**81 sq. cm**

Conclusions:

Permeability testing with the specific influent the GCL will be subjected to during application is generally considered the best method of determining the expected performance that will be obtained.

This permeability test indicates the Bentofix is compatible with the specific leachate utilized for the permeation of the specimen as exposure to the leachate resulted in no increase to the permeability.

FLX -

Leachate Permeability (k)

(effective stress = 69kPa min.; 103kPa max.)

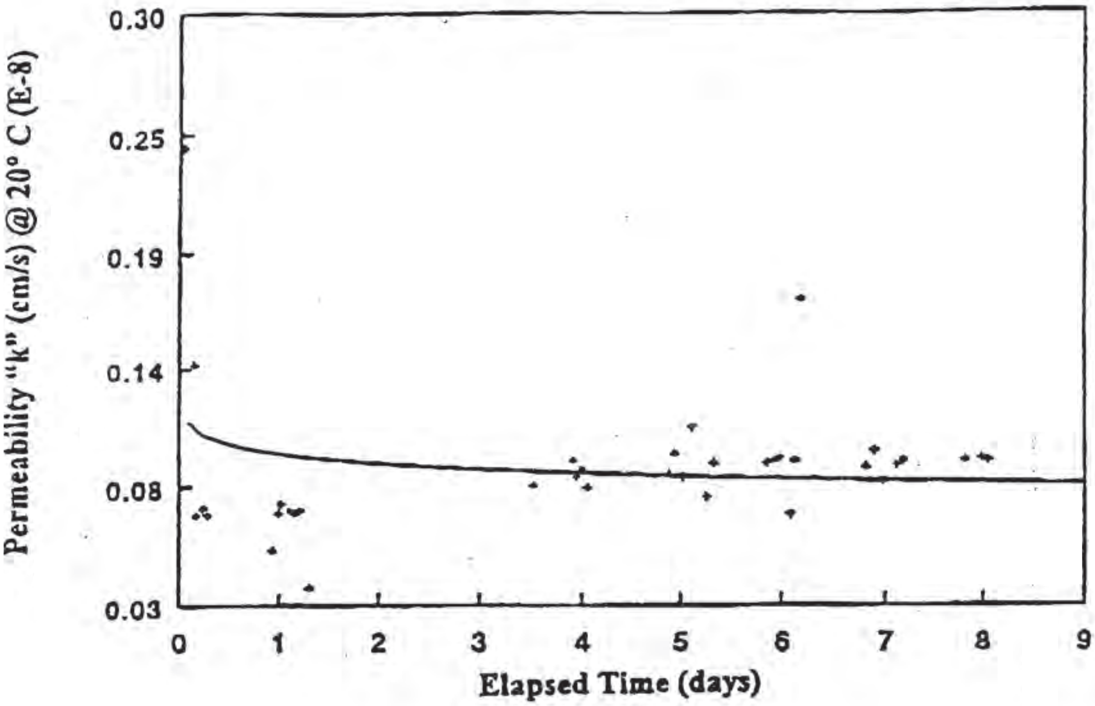
Date	Time	Outflow-Inflow Ratio	$Q_{avg.}$ (cm^3)	Sample Thick. (cm)	Elapsed Time (sec)	Elapsed Time (days)	k (cm/sec)	k_{20} (cm/sec)
5/1	4:02pm	1.47	1.67	0.512	8580	0.10	1.2e-9	1.2e-9
5/2	8:50am	1.10	9.26	0.510	60,480	0.80	9.1e-10	9.4e-10
5/2	1:45pm	0.84	2.31	0.510	17,700	1.00	7.8e-10	9.0e-10
5/4	8:15am	1.11	19.87	0.508	156,600	2.82	7.5e-10	7.9e-10
5/4	10:21am	0.86	0.80	0.508	6840	2.90	7.5e-10	7.7e-10
5/4	2:55pm	1.02	2.10	0.508	16,440	3.09	7.6e-10	7.8e-10
5/4	5:00pm	0.98	0.94	0.508	7500	3.18	7.5e-10	7.5e-10
5/5	8:10am	1.06	6.41	0.507	54,600	3.81	7.0e-10	7.3e-10
5/5	11:53am	0.80	1.86	0.507	13,380	3.97	8.3e-10	8.5e-10
5/5	4:54pm	1.05	2.19	0.507	18,060	4.18	7.2e-10	7.2e-10
5/6	8:15am	1.00	6.40	0.505	55,260	4.82	6.8e-10	7.2e-10
5/6	12:38pm	1.07	1.84	0.505	15,780	5.00	6.9e-10	6.9e-10
5/6	5:15pm	1.05	1.95	0.505	16,620	5.19	6.9e-10	7.1e-10
5/7	8:38am	1.02	6.16	0.503	55,380	5.83	6.5e-10	6.9e-10
5/7	1:09pm	1.07	1.67	0.503	15,180	6.02	6.5e-10	6.3e-10
5/7	4:47pm	1.08	1.51	0.503	13,080	6.17	6.8e-10	6.6e-10
5/8	8:00am	0.98	6.06	0.503	54,780	6.81	6.5e-10	7.0e-10
5/8	1:00pm	1.07	2.09	0.503	18,000	7.01	6.8e-10	6.8e-10
5/8	4:30pm	0.95	1.43	0.503	12,600	7.16	6.7e-10	6.8e-10
5/9	8:03pm	0.97	10.86	0.502	99,180	8.31	6.4e-10	6.8e-10
5/11	8:32am	1.18	13.93	0.500	131,340	9.83	6.3e-10	6.8e-10
5/11	1:07pm	0.77	1.70	0.500	16,500	10.02	6.0e-10	6.2e-10
5/11	4:53pm	1.05	1.62	0.500	13,560	10.18	7.0e-10	7.2e-10
5/12	9:07am	1.00	6.88	0.499	58,440	10.85	6.9e-10	7.2e-10
5/12	1:18pm	1.01	1.82	0.499	15,060	11.03	7.1e-10	7.2e-10
5/12	4:30pm	1.00	1.38	0.499	11,520	11.16	7.0e-10	7.2e-10
5/13	8:17am	0.98	6.68	0.498	56,820	11.83	6.9e-10	7.2e-10
5/13	12:00pm	0.99	1.61	0.498	13,380	11.98	7.0e-10	7.4e-10
5/13	5:40pm	0.98	2.43	0.498	20,400	12.22	6.9e-10	7.3e-10
5/14	8:18am	1.00	6.26	0.498	52,680	12.83	6.9e-10	7.3e-10
5/14	4:44pm	1.06	3.74	0.498	30,360	13.18	7.2e-10	7.2e-10

Leachate Permeability (k) cont.

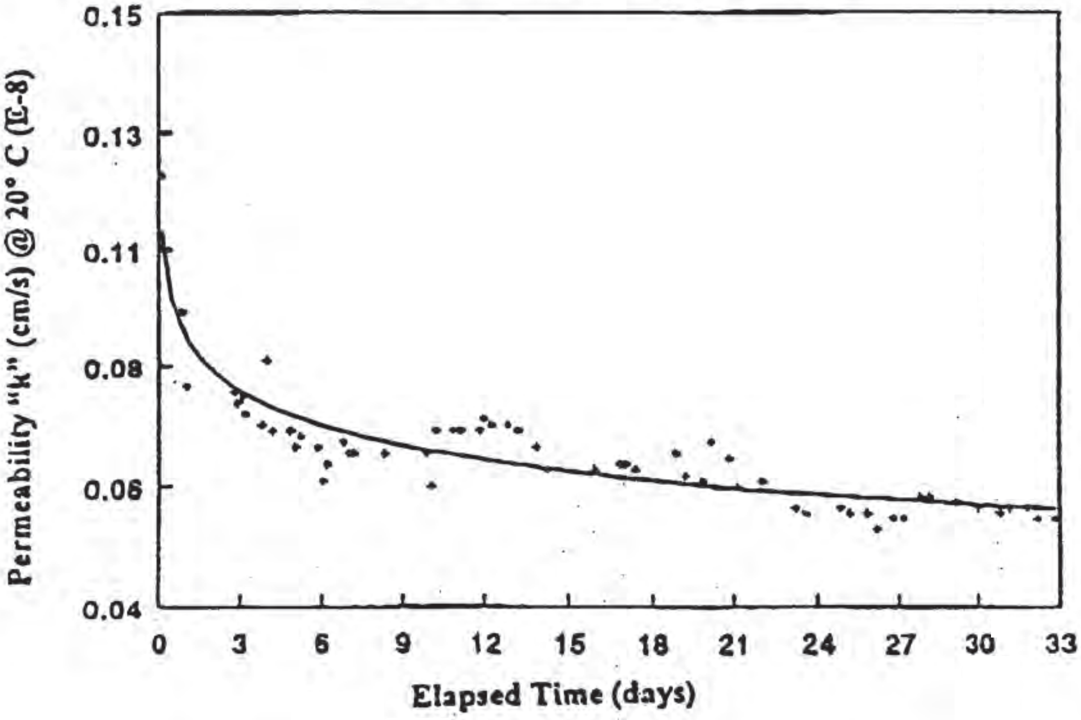
(effective stress =69kPa min.;103kPa max.)

Date	Time	Outflow-Inflow Ratio	$Q_{avg.}$ (cm^3)	Sample Thick. (cm)	Elapsed Time (sec)	Elapsed Time (days)	k (cm/sec)	k_{20} (cm/sec)
5/15	8:40am	1.00	6.83	0.496	57,360	13.84	6.9e-10	6.9e-10
5/15	5:28pm	1.02	2.90	0.495	25,260	14.21	6.7e-10	6.5e-10
5/17	10:35am	1.01	16.55	0.494	143,080	15.92	6.5e-10	6.5e-10
5/18	8:17am	0.99	8.59	0.493	77,520	16.83	6.4e-10	6.6e-10
5/18	1:26pm	1.06	2.12	0.493	18,540	17.04	6.6e-10	6.6e-10
5/18	9:48pm	1.01	3.38	0.493	30,120	17.39	6.5e-10	6.5e-10
5/20	8:18am	0.99	13.63	0.491	124,200	18.83	6.3e-10	6.8e-10
5/20	5:11pm	1.03	2.98	0.491	26,820	19.20	6.4e-10	6.4e-10
5/21	8:08am	1.08	5.59	0.491	53,820	19.82	6.0e-10	6.3e-10
5/21	4:32pm	0.91	3.59	0.491	30,240	20.17	6.8e-10	7.0e-10
5/22	8:50am	1.00	6.26	0.490	56,680	20.83	6.3e-10	6.7e-10
5/22	4:23pm	1.06	2.93	0.490	27,120	21.14	6.2e-10	6.2e-10
5/23	12:56pm	0.98	7.46	0.490	73,740	22.00	5.8e-10	6.3e-10
5/24	6:18pm	0.94	9.94	0.489	104,760	23.22	5.4e-10	5.8e-10
5/26	8:16am	1.01	13.21	0.488	136,680	24.81	5.5e-10	5.8e-10
5/26	4:45pm	1.02	2.98	0.488	30,540	25.16	5.6e-10	5.7e-10
5/27	8:05am	0.98	5.22	0.488	55,200	25.80	5.4e-10	5.7e-10
5/27	4:44pm	1.01	2.96	0.486	31.140	26.15	5.4e-10	5.4e-10
5/28	8:04am	0.99	5.44	0.488	55,200	26.80	5.6e-10	5.6e-10
5/28	4:24pm	1.00	2.99	0.488	30,000	27.15	5.7e-10	5.6e-10
5/29	8:17am	0.98	5.90	0.488	57,180	27.81	5.9e-10	6.0e-10
5/29	4:27pm	1.00	3.02	0.486	29,400	28.15	5.8e-10	6.0e-10
5/30	4:37pm	0.98	8.73	0.486	87,000	29.16	5.7e-10	5.9e-10
5/31	12:25pm	0.99	7.04	0.485	70,740	29.98	5.7e-10	5.8e-10
6/1	8:09am	1.00	7.00	0.485	71,040	30.81	5.6e-10	5.7e-10
6/1	4:52pm	1.03	3.13	0.485	31,380	31.17	5.7e-10	5.8e-10
6/2	8:00am	0.99	5.29	0.485	54,480	31.80	5.5e-10	5.8e-10
6/2	4:46pm	1.02	3.11	0.485	31,560	32.17	5.6e-10	5.6e-10
6/3	8:33am	0.98	5.44	0.484	56,820	32.82	5.4e-10	5.6e-10

FLX - 1



Bentofix Thermal Lock Permeability
(Permeant: Tap Water)



Bentofix Thermal Lock Permeability
(Permeant: MSW Leachate)

FIX - 125

Leachate Analysis
6/29/90

Testing Performed by:

J & L Testing
938 S. Central Ave.
Cannonsburg, PA 15317
Job # 90R825

Lakeview Sanitary Landfill, Erie, PA

Parameter	**mg/L**
pH (SU)	7.0
* Specific Conductance (umhos)	230
Total Suspended Solids	8,400
Total Solids	10,000
Alkalinity	4,700
Biochemical Oxygen Demand	3,000
Bicarbonate	4,700
Carbonate	<1.0
Chemical Oxygen Demand	6,300
Ammonia - N	340
Chloride	1,300
Cyanide	<0.005
Phenol	1.2
Sulfate	12
Total Organic Carbon	2,000
Aluminum	0.45
Arsenic	0.020
Barium	0.68
Cadmium	0.01
Calcium	480
Chromium	0.23
Copper	<0.007
Iron	150
Lead	<0.2
Magnesium	380
Manganese	9.6