AP - 111

EVAPORATION POND REPAIRS REV. 1 (4 of 4)

2017

recommended that the elevation of the water or the elevation of the exterior berms be adjusted such that the high water mark is a minimum of two (2) feet below the exterior containment berm elevation. It is further recommended that the two (2) feet of freeboard be extended to include the interior pond separation dikes as well. Should the interior dikes be breached the most westerly exterior containment dikes could be overtopped.

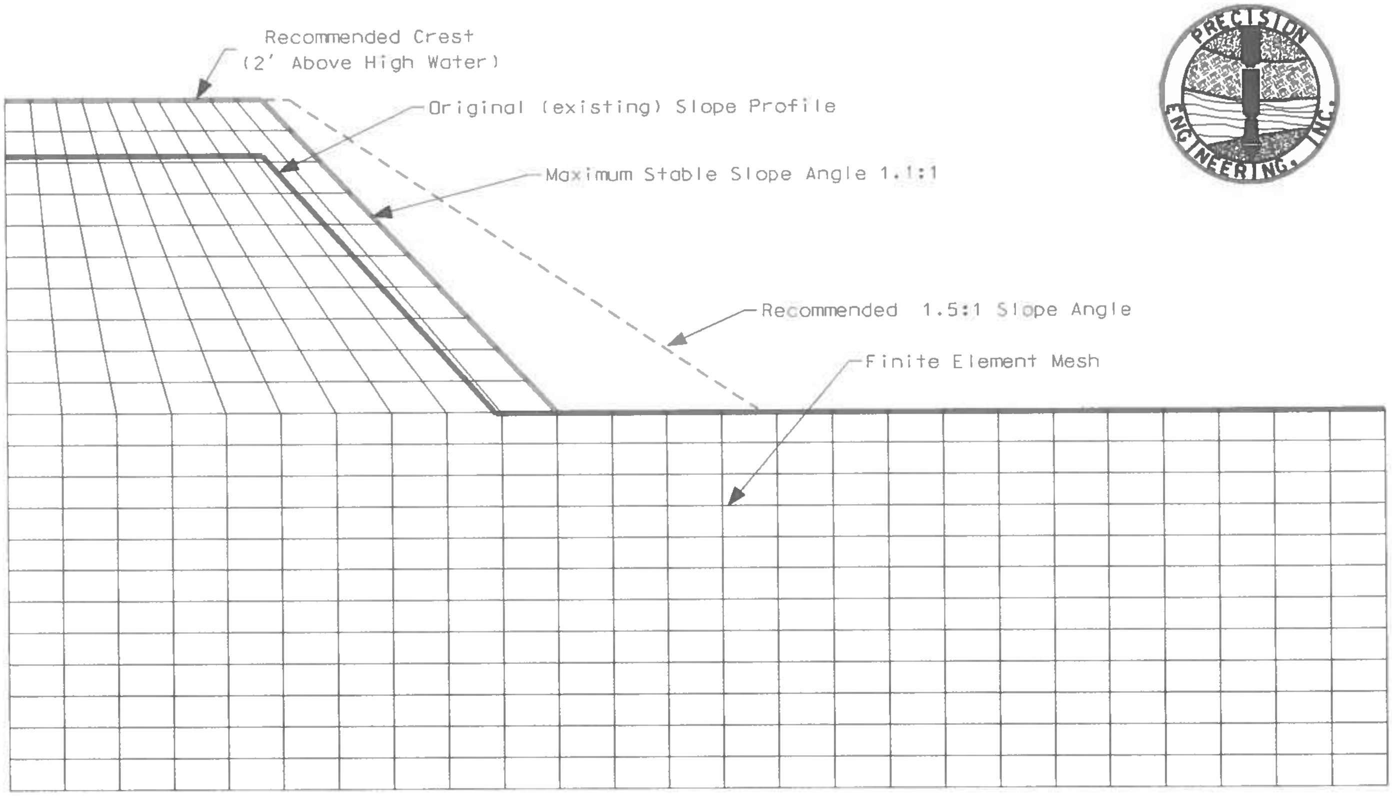
Analysis indicates that when the elevation of the top of the outside containment berms are elevated approximately two (2) feet the minimum factor of safety against failure is 2.1. This minimum critical section is represented by Section 12 on the west side of the ponds (see boring plan). The failure mechanism and associated factor of safety is illustrated in Figure 2.

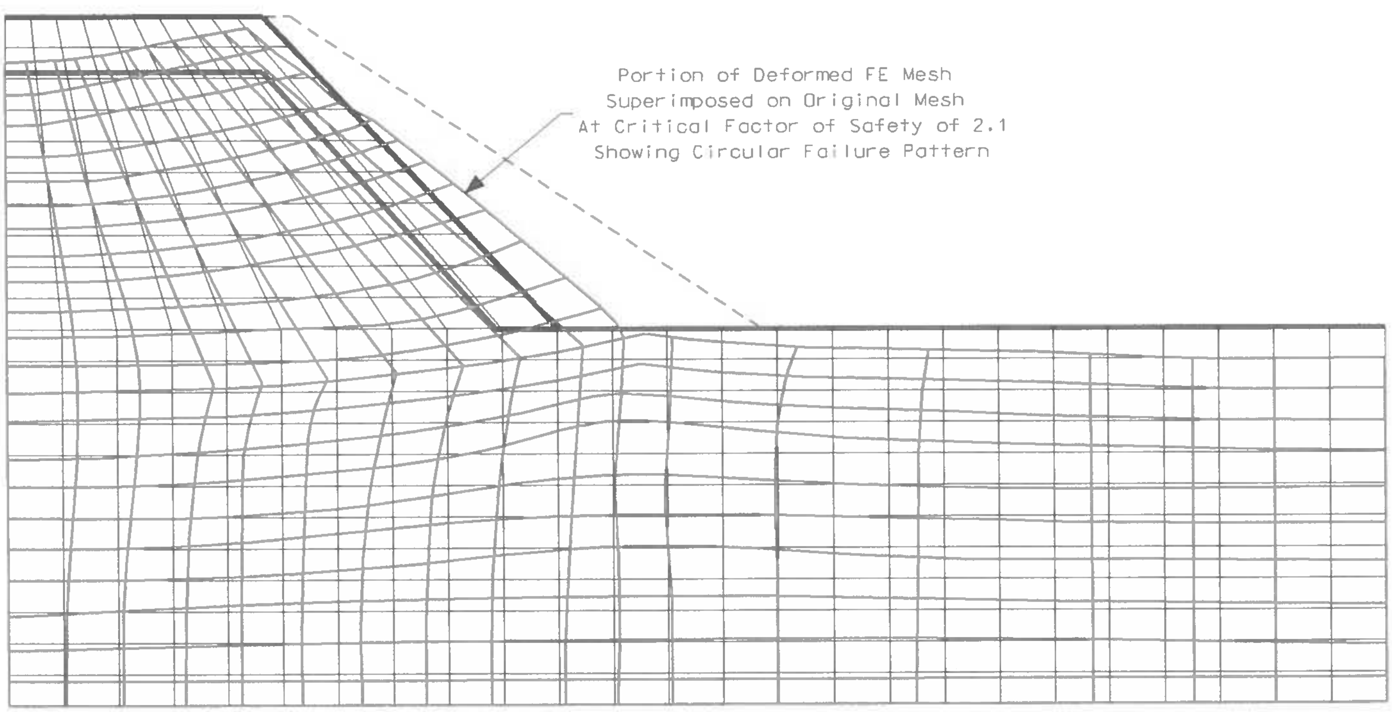
It is recommended that the berm elevations be adjusted to be two (2) feet above the maximum anticipated water level elevation. It is recommended that the minimum width of the top of the containment berms be ten (10) feet. For structural stability, the side slopes of the berms should not exceed their present slope angle after the addition of material to raise the crest elevation. It is recommended, however, that the slope angles not exceed an angle having a horizontal to vertical ratio of 1.5:1. This typically flatter slope angle will resist the development of erosion channels on the exterior face of the berms.

Soils placed to adjust the elevation of the berm crests were analyzed assuming that the material would be taken from the valley floor near the ponds. Based on material properties evaluated on other projects at the site, the soils may be taken from essentially any location on the Ciniza Refinery property. Soils imported to the site should be evaluated for stability. Soils taken from the Ciniza property may be

Figure 2 - Section 12

Critical Section and Failure Mechanism After Elevating and Reshaping Containment Berms





taken from the "Rattlesnake" pit area or the pit used by the NMSH&TD located east of pond 9. It is recommended that material not be taken from an area within twenty feet of the final berm toe points. It is recommended that the proposed borrow material be tested for strength properties by unconsolidated, undrained triaxial shear before being approved as fill material for the containment berms.

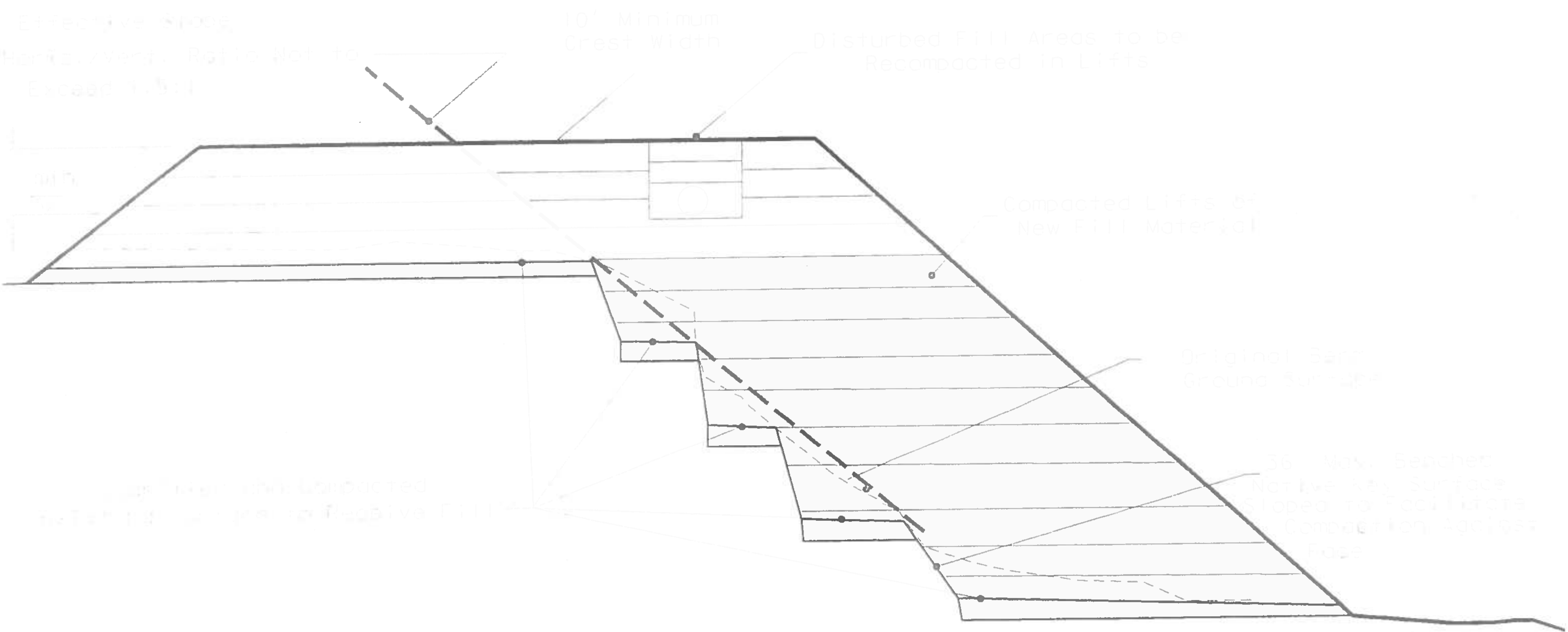
Soil placed on the berms should be keyed into the berms to provide the maximum strength. The side slopes of the existing embankments should be benched to create a horizontal surface for fill construction. This will provide structural interlock with the existing material. All new fill should be placed and compacted in lifts on the benched surfaces. Keys should be cut in the excavated slope to form horizontal benches as nearly level as is reasonable. Each bench should not exceed thirty-six (36) inches in elevation change to avoid stress concentrations within the fill. Bench cut faces may be sloped steeply to facilitate compaction adjacent to the cut face.

Fill should be placed and compacted beginning at the slope toe and progress to the top of the berm to allow for a more homogeneous new fill section. The berm will be more stable if the new slope section is constructed prior to adding height to the berms. The intent of this recommendation is illustrated in Figure 1.

New fill should be placed on existing material that has been properly prepared to receive material. The existing surface should be cleared and grubbed to remove any organic debris and oversized material. Oversized material consists of rocks or soil lumps that exceed six (6) inches in maximum dimension. The standard proctor test (ASTM D-698) should be used as the reference unit weight because the test results provide a more flexible structure that resists cracking during any potential deformation. The prepared surface should be scarified eight (8) inches and compacted to a minimum of 95% of Standard Proctor unit weight.

Figure 1

General Fill Placement on Existing Slopes



New fill soils should be processed to bring them to a moisture content approximately two (2) percent above optimum moisture content. Compaction at this moisture content will minimize the hydraulic conductivity of the lift after compaction. Under no conditions shall fill material contain vegetative or other organic debris. The fill soils should be placed and compacted in uniform lifts not to exceed eight (8) inches in compacted thickness. The soils should be compacted using pad wheeled or sheepsfoot type equipment to provide better lift interlock and minimize the potential for providing a hydraulic conduit between lifts. The new fill soils should be compacted to a minimum of 100% of Standard Proctor (ASTM D-698) unit weight.

6.0 Summary

Analysis as and visual inspection of the exterior containment berms and interior lagoon separation dikes has provided the following conclusions and recommendations:

- The containment berms are structurally stable.
- There is little potential for a piping type failure through the lagoon containment berms.
- No water was detected leaking through or below the containment berms that could cause a stability or surface contamination problem.
- The interior slopes of the containment berms and lagoon separation dikes are susceptible to wave erosion. It is recommended that positive wave energy abatement systems be placed or that a continuous interior lagoon maintenance program be established. The maintenance program will likely cause substantial loss of lagoon life and wave abatement is recommended.
- The containment berms are susceptible to overtopping because of a lack of free board. It has been recommended that the berm heights be adjusted to allow for a minimum of two (2) feet of

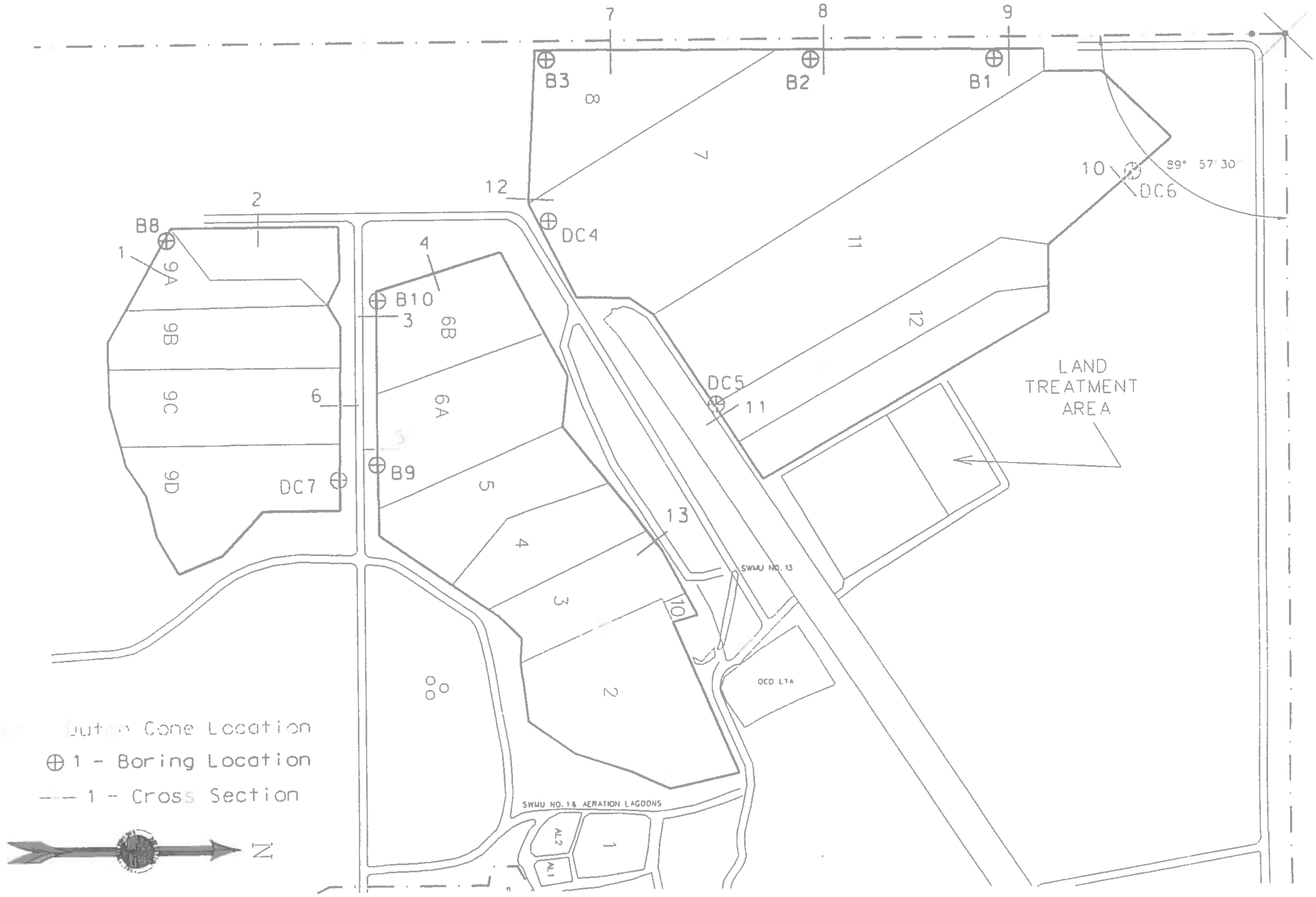
free board above the maximum anticipated water level. Recommendations for fill placement have been provided. The freeboard area should be protected from erosion degradation.

APPENDIX

Giant Refining Company

Ciniza Refinery Evaporation Ponds

Boring Plan



Sheet: 1 OF 10

PRECISION ENGINEERING, INC.

File #: 00-141

Bore Point: SEE SITE PLAN

LOG OF TEST BORINGS

Site: CINIZA

Water Elev: NOT ENCOUNTERED

Elevation: EXISTING

Boring No.: ONE

Date: DECEMBER 06, 2000

LAB #	DEPTH	BLOW COUNT	PLOT	SCALE	SAMPLES	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	%M	L	PI	CLASS.
38625	0.0 - 1.5	4-5-6	//////		SSSS	**CLAY**, REDDISH BROWN, WET, FIRM	25.5		NP	SM/A-2-4
			//////	2.5						
			//////	5.0						
38626	5.0 - 6.5	6-6-6	//////		SSS	STIFF	21.7	47	25	CH/A-7-6
			//////	7.5						
			//////	10						
38627	10.0-11.5	4-5-6	//////		SSS	FIRM	22.5			
	14.5		//////							
			//-///	15		**CLAY**, SLIGHTLY SILTY, REDDISH BROWN, MOIST,				
38628	15.0-16.5	12-16-23	//-///		SSS	HARD	13.2	53	33	CH/A-7-6
			//-///	20						
38629	20.0-21.5	7-15-19	//-///		SSS	SOME SILT LAMANAE	12.0			
	21.5									
	TOTAL DEPTH									

Size & Type of Boring: 8-1/4" ID Hollow Stemmed Auger

Logged By: WHK

Sheet: 2 OF 10

PRECISION ENGINEERING, INC.

File #: 00-141

Bore Point: SEE SITE PLAN
WEST DYKE CENTER

LOG OF TEST BORINGS

Site: CINIZA

Water Elev: NOT ENCOUNTERED

Elevation: EXISTING

Boring No.: TWO

Date: DECEMBER 06, 2000

LAB #	DEPTH	BLOW COUNT	PLOT	SCALE	SAMPLES	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	%M	L	PI	CLASS.
38630	0.0 - 1.5	3-3-3	/*/*/*		S	**CLAY**, VERY SANDY, REDDISH BROWN, WET, SOFT	26.3	30	10	CL/A-4
			/*/*/*		S					
			/*/*/*		S					
			/*/*/*							
			/*/*/*	2.5						
			/*/*/*							
			/*/*/*							
			/*/*/*							
			/*/*/*							
			/*/*/*	5.0						
38631	5.0 - 7.0	SHELBY	/*/*/*							
			/*/*/*							
			/*/*/*							
			/*/*/*							
38632	7.0 -10.0	SHELBY	/*/*/*	7.5						
			//////			NO SAND	33.0			
			//////							
			//////							
			//////							
			//////	10						
			//////							
			//////							
			//////							
			//////							
			//////							
	13.0		//////							
			//*///			**CLAY**, SLIGHTLY SANDY, REDDISH BROWN, MOIST,				
			//*///			HARD				
			//*///							
			//*///	15						
38633	15.0-16.8	SHELBY	//*///							
			//*///							
	16.8		//*///							
	TOTAL DEPTH									
				20						

Size & Type of Boring: 8-1/4" ID Hollow Stemmed Auger

Logged By: WHK

Sheet: 3 OF 10

PRECISION ENGINEERING, INC.

File #: 00-141

LOG OF TEST BORINGS

Bore Point: SOUTHWEST CORNER OF POND 8

Site: CINIZA

Water Elev: NOT ENCOUNTERED

Elevation: EXISTING

Boring No.: THREE

Date: DECEMBER 06, 2000

LAB #	DEPTH	BLOW COUNT	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	%M	L	PI	CLASS.
38634	0.0 - 1.5	3-3-5	//*///		S	**CLAY**, SLIGHTLY SANDY(FINE), REDDISH BROWN,	15.8	50	36	CH/A-7-6
			//*///		S	MOIST, FIRM				
			//*///		S					
			//*///							
			//*///	2.5						
			//*///							
			//*///							
			//*///							
			//*///							
			//*///	5.0						
38635	5.0 - 6.5	3-4-3	//////		S	LITTLE TO NO SAND, WET	30.2			
			//////		S					
			//////		S					
			//////							
			//////	7.5						
			//////							
			//////							
			//////							
			//////							
			//////	10						
38636	10.0-11.5	4-4-6	//////		S		31.1	79	41	CH/A-7-5
			//////		S					
			//////		S					
			//////							
			//////							
			//////							
			//////							
			//////							
			//////							
			//////	15						
38637	15.0-16.5	4-6-9	//////		S		28.4			
			//////		S					
			//////		S					
			//////							
			//////							
			//////							
			//////							
			//////							
			//////							
			//////	20						
38638	20.0-21.5	7-15-21	//*///		S	SLIGHTLY SANDY, HARD	30.8	60	34	CH/A-7-6
			//*///		S					
			//*///		S					
	TOTAL DEPTH									

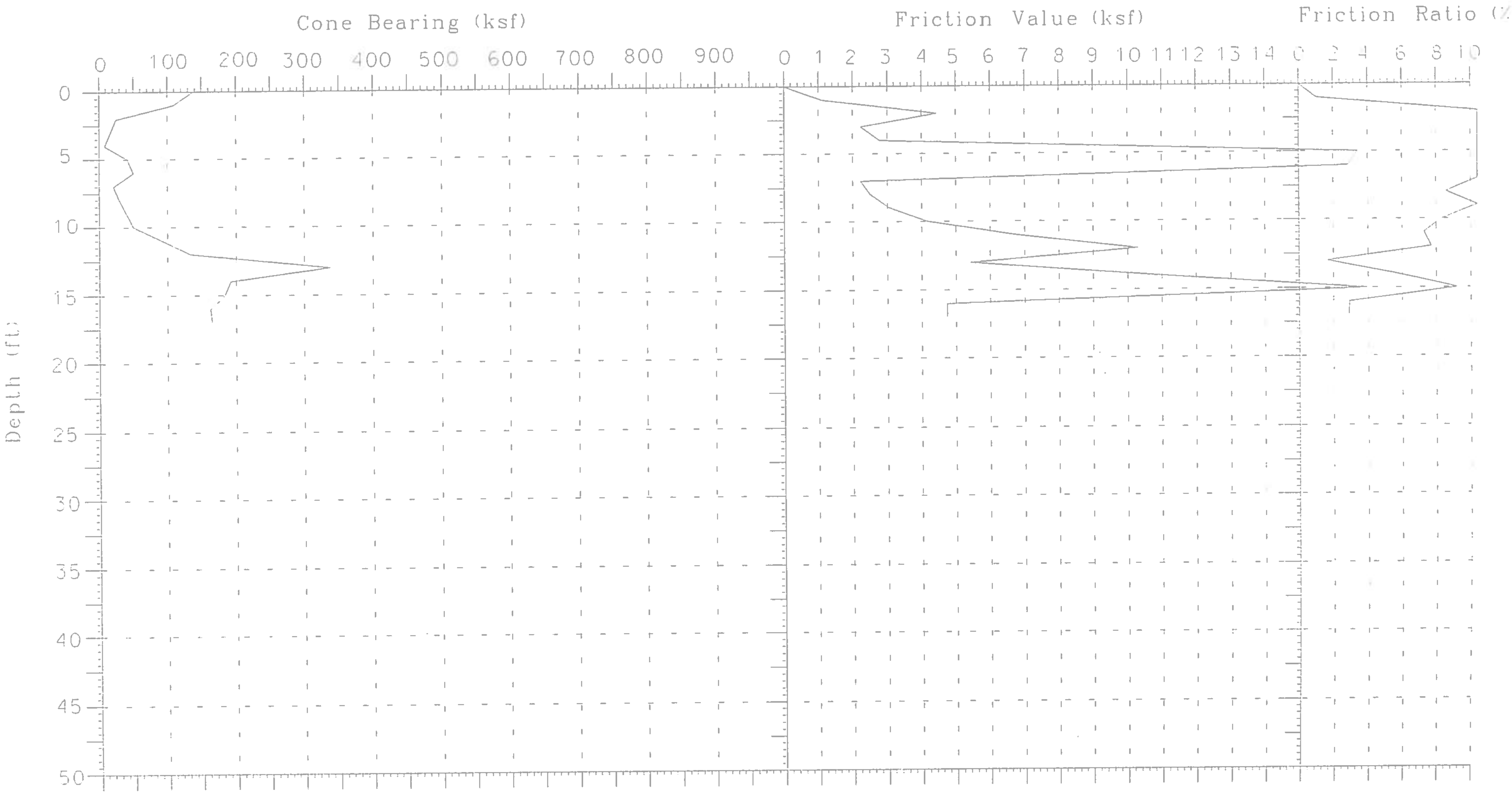
Size & Type of Boring: 8-1/4" ID Hollow Stemmed Auger

Logged By: WHK

Quasi-Static Penetration Sounding Log
ASTM D-3441

Project Location: CINIZA EVAPORATION PONDS
Sounding Date: December 6, 2000
Project Number: 00-141

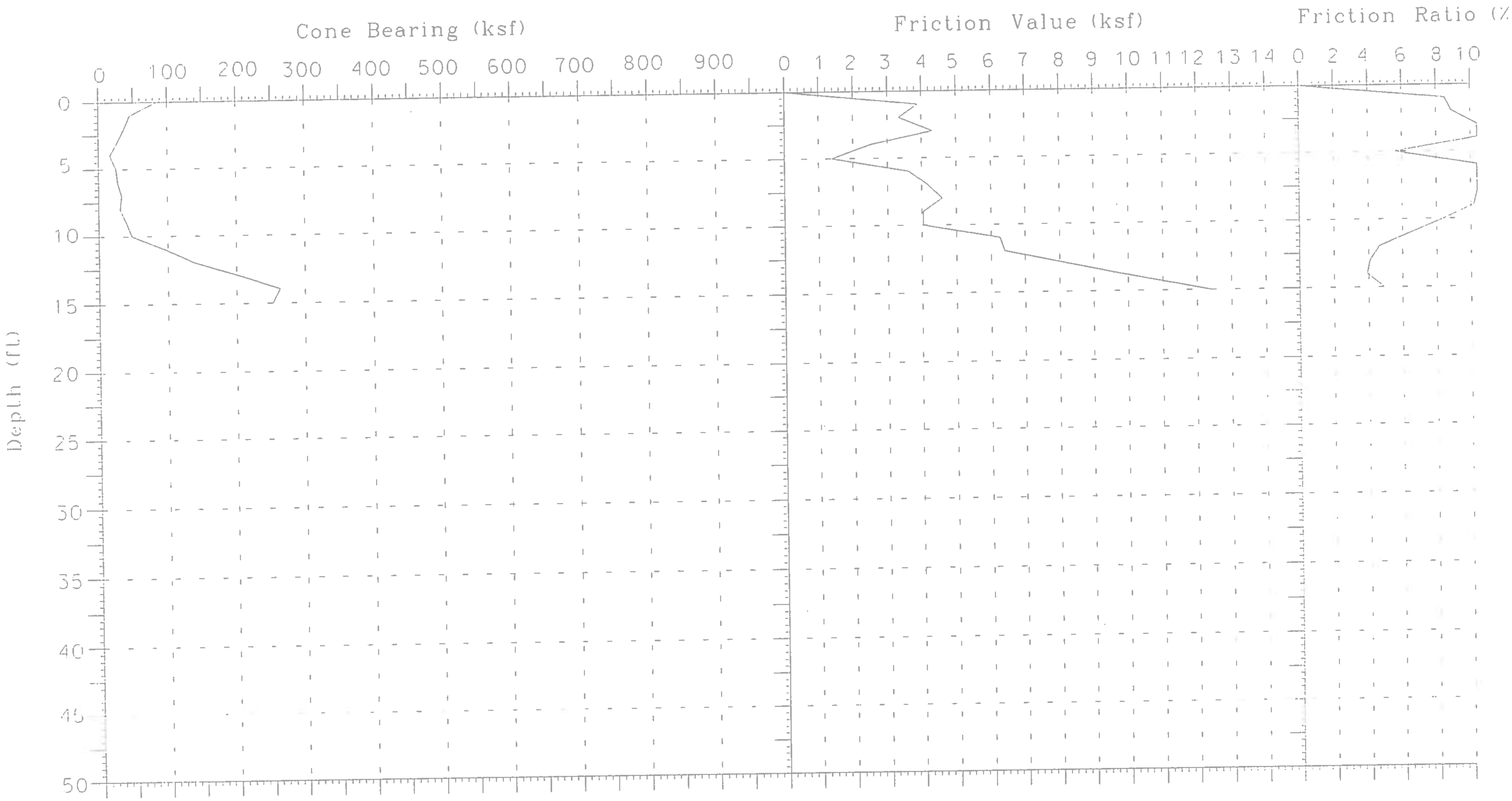
Sounding Number: 4
Sounding Location: see plan



Quasi-Static Penetration Sounding Log
ASTM D-3441

Project Location: CINIZA EVAPORATION PONDS
Sounding Date: December 7, 2000
Project Number: 00-141

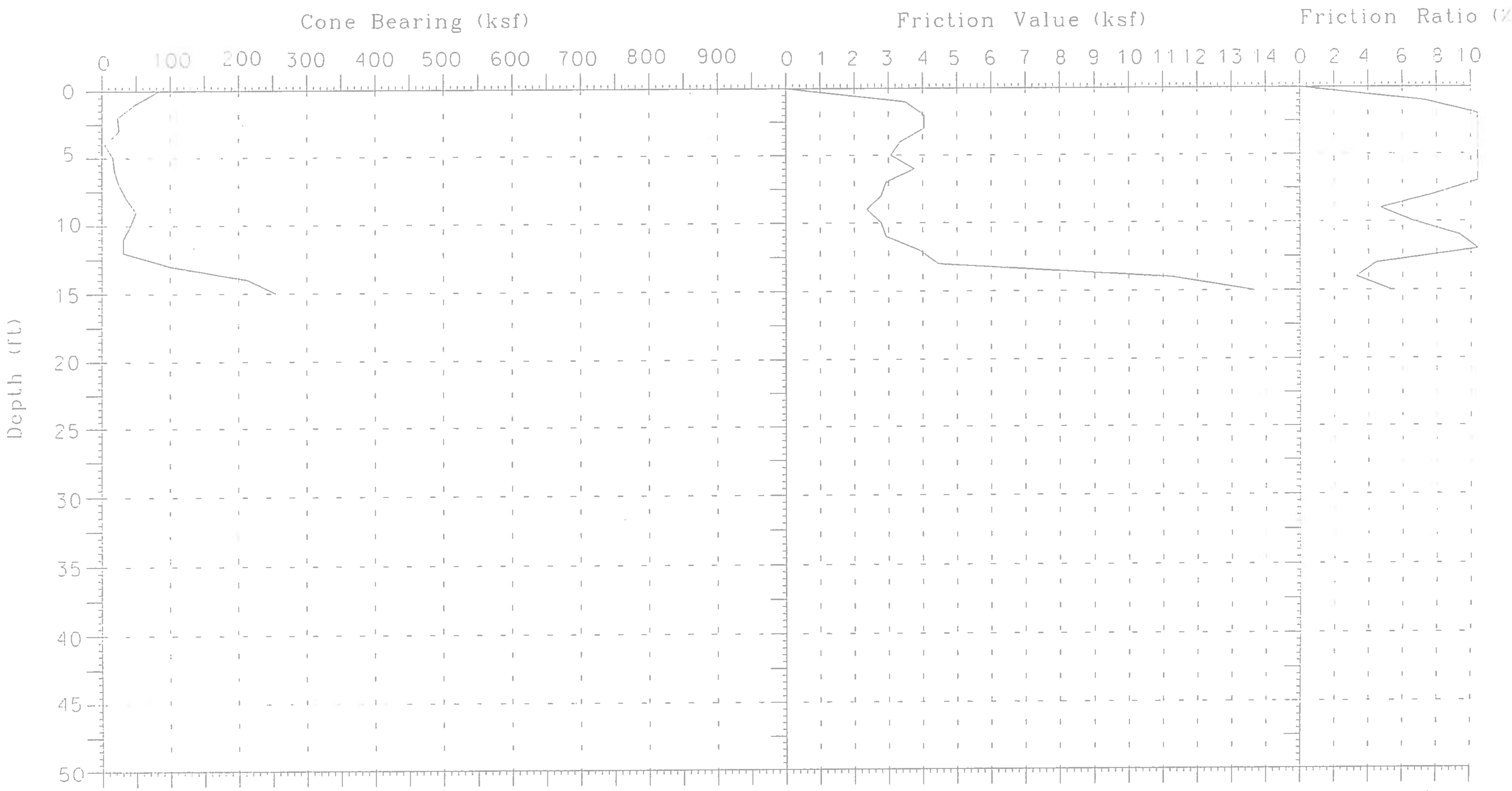
Sounding Number: 5
Sounding Location: see plan



Quasi-Static Penetration Sounding Log
ASTM D-3441

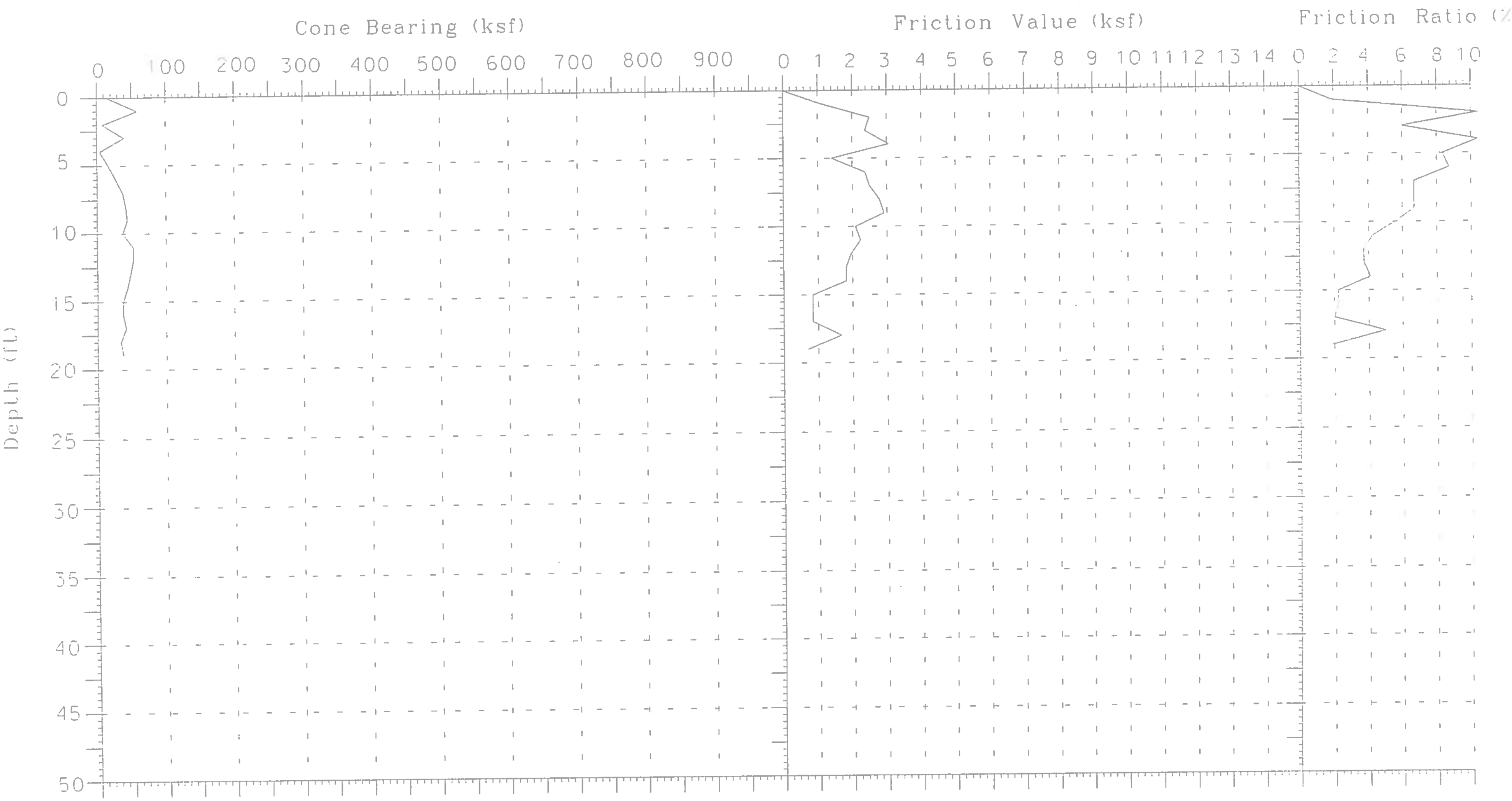
Project Location: CINIZA EVAPORATION PONDS
Sounding Date: December 7, 2000
Project Number: 00-141

Sounding Number: 6
Sounding Location: see plan



Quasi-Static Penetration Sounding Log
ASTM D-3441

Project Location: CINIZA EVAPORATION PONDS
Sounding Date: December 7, 2000
Project Number: 00-141
Sounding Number: 7
Sounding Location: see plan



PRECISION ENGINEERING, INC.

File #: 00-141

LOG OF TEST BORINGS

Bore Point: SOUTHWEST CORNER OF POND 9A

Site: CINIZA

Water Elev: 18'

Elevation: EXISTING

Boring No.: EIGHT

Date: DECEMBER 07, 2000

LAB #	DEPTH	BLOW COUNT	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	%M	L	PI	CLASS.
38639	0.0 - 1.5	4-4-10	/*/*/*		S	CLAY, VERY SANDY(FINE), REDDISH BROWN, WET,	23.1	50	36	CH/A-7-6
			/*/*/*		S	STIFF				
			/*/*/*		S					
			/*/*/*							
			/*/*/*	2.5						
			/*/*/*							
			/*/*/*							
			/*/*/*							
			/*/*/*							
			/*/*/*	5.0						
38640	5.0 - 7.0	SHELBY	//////			LITTLE TO NO SAND SAND, FIRM				
			//////							
			//////							
			//////							
			//////	7.5						
			//////							
			//////							
			//////							
			//////							
			//////	10						
38641	10.0-11.5	3-5-6	//*///		S	SLIGHTLY SANDY	32.2	79	41	CH/A-7-5
			//*///		S					
			//*///		S					
			//*///							
			//*///							
			//*///							
			//*///							
			//*///							
			//*///							
			//*///	15						
38642	15.0-16.5	3-5-5	/*/*/*		S	VERY SANDY	20.1			CH/A-7-6
			/*/*/*		S					
			/*/*/*		S					
			/*/*/*							
			/*/*/*							
			/*/*/*							
			/*/*/*			WATER BEARING AT 18', WATER RISES TO 6'2"				
			/*/*/*			AFTER 24-HOURS AND STABILIZES				
			/*/*/*							
			/*/*/*	20						
38643	20.0-21.2	0-	/*//*/		S	SANDY	24.7	60	34	
		0-	/*//*/		S					
	21.2-21.5	6	/*//*/		S	MUDSTONE, REDDISH BROWN W/SOME GREEN MOTTLING,				
	TOTAL DEPTH					DRY, HARD				

Size & Type of Boring: 8-1/4" ID Hollow Stemmed Auger

Logged By: WHK

PRECISION ENGINEERING, INC.

File #: 00-141

LOG OF TEST BORINGS

Bore Point: CENTER OF SOUTH SIDE OF POND 6A

Site: CINIZA

Water Elev: NOT ENCOUNTERED

Elevation: EXISTING

Boring No.: NINE

Date: DECEMBER 07, 2000

LAB #	DEPTH	BLOW COUNT	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	%M	L	PI	CLASS.
38644	0.0 - 3.0	GRAB	/*/*/*		G	**CLAY**, VERY SANDY, REDDISH BROWN, MOIST, FIRM	14.0	41	25	CL/A-4
			/*/*/*		G					
			/*/*/*		G					
			/*/*/*		G					
			/*/*/*	2.5	G					
			/*/*/*		G					
			/*/*/*							
			/*/*/*							
			/*/*/*							
			/*/*/*	5.0						
38645	5.0 - 7.0	SHELBY	/*/*/*							
			/*/*/*							
			/*/*/*							
			/*/*/*							
			/*/*/*	7.5						
			//////							
			//////							
			//////							
			//////							
			//////	10						
			//////							
			//////							
			//////							
			//////							
38646	12.0-14.0	GRAB	//////		G	WET	27.4			
			//////		G					
			//*///		G					
			//*///		G					
			//*///							
			//*///	15						
38647	15.0-16.0	SHELBY	//*///							
			//*///							
38648	16.0-17.0	SHELBY	//*///			SOFT				
	17.0									
	TOTAL DEPTH									
				20						

Size & Type of Boring: 8-1/4" ID Hollow Stemmed Auger

Logged By: WHK

Sheet: 10 OF 10

PRECISION ENGINEERING, INC.

File #: 00-141

Bore Point: SOUTHWEST CORNER OF POND 6B

LOG OF TEST BORINGS

Site: CINIZA

Water Elev:

Elevation: EXISTING

Boring No.: TEN

Date: DECEMBER 07, 2000

LAB #	DEPTH	BLOW COUNT	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	%M	L	PI	CLASS.
38649	0.0 - 3.0	GRAB	/*//*/		G	**CLAY**, SANDY, REDDISH BROWN, MOIST, FIRM	18.2	52	32	CH/A-7-6
			/*//*/		G					
			/*//*/		G					
			/*//*/		G					
			/*//*/	2.5	G					
			/*//*/		G					
			/*//*/							
			/*//*/							
			/*//*/							
			/*//*/	5.0						
38650	5.0 - 7.0	SHELBY	/*//*/			WET				
			/*//*/							
			/*//*/							
			/*//*/							
38651	7.0 - 10.0	GRAB	//////	7.5	G	LITTLE TO NO SAND, SOFTER AND REDDER 7' TO 10'	37.9	82	40	CH/A-7-5
			//////		G					
			//////		G					
			//////		G					
			//////		G					
			//////	10	G					
	10.0-13.0	GRAB	//////		G					
			//////		G					
			//////		G					
			//////		G					
			//////		G	WET				
			//////		G					
			//////		G					
			//////							
			//////							
			//////	15						
38652	15.0-17.0	SHELBY	//////			**CLAY**, REDDISH BROWN, WET, FIRM, SOME 1/2" ROOT				
			//////			MATTER				
			//////							
	17.0		//////							
	TOTAL DEPTH									
				20						

Size & Type of Boring: 8-1/4" ID Hollow Stemmed Auger

Logged By: WHK

PRECISION ENGINEERING, INC.
P. O. BOX 422,
LAS CRUCES, NEW MEXICO 88004
(505)523-7674

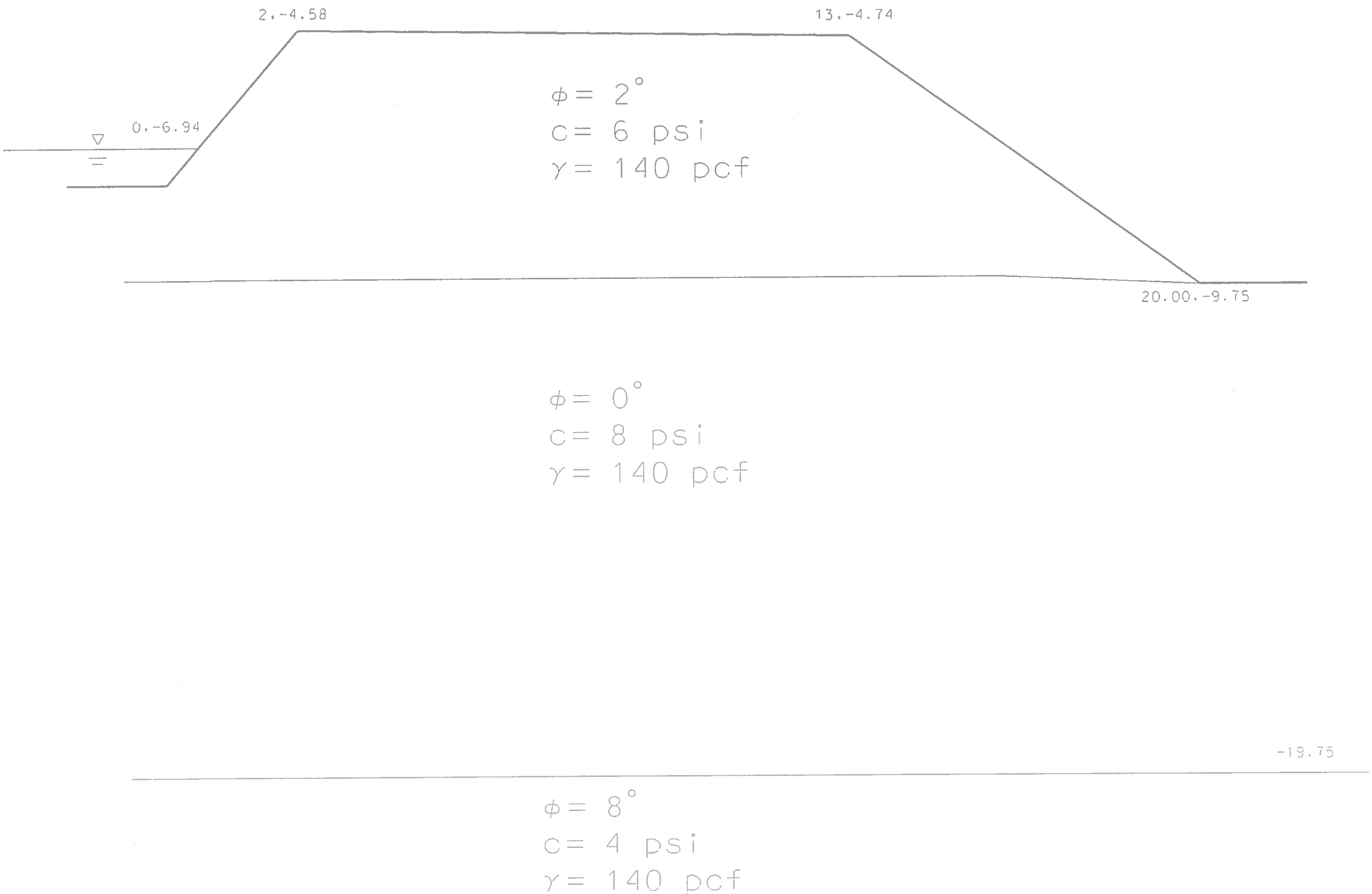
MECHANICAL GRAIN SIZE ANALYSIS SUMMARY

PROJECT: GIANT REFINING
CINIZA EVAPORATION PONDS
LOCATION: CINIZA, NM
FILE NO: 00-141
DATE: DECEMBER 06, 2000

BORING NO.	LAB NO.	DEPTH FEET		SIEVE ANALYSIS % PASSING												ATTERBERG LIMITS		MOIST. CONTENT	USCS CLASS.	AASHTO CLASS.
				1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#20	#40	#60	#140	#200	LL	PI			
1	38625	0.0- 1.5																25.5		
1	38626	5.0- 6.5													92.4	47	25	21.7	CL	A-7-6
1	38627	10.0-11.5																22.5		
1	38628	15.0-16.5													86.6	53	33	13.2	CH	A-7-6
1	38629	20.0-21.5																12.0		
2	38630	0.0- 1.5													59.3	30	10	26.3	CL	A-4
2	38631	5.0- 7.0																		
2	38632	7.0-10.0																33.0		
2	38633	15.0-16.8																		
3	38634	0.0- 1.5													83.2	50	36	15.8	CH	A-7-6
3	38635	5.0- 6.5																30.2		
3	38636	10.0-11.5													97.4	79	41	31.1	CH	A-7-5
3	38637	15.0-16.5																28.4		
3	38638	20.0-21.5													88.1	60	34	30.8	CH	A-7-6
8	38639	0.0- 1.5																23.1		
8	38640	5.0- 7.0																		
8	38641	10.0-11.5													85.2	72	42	32.2	CH	A-7-6
8	38642	15.0-16.5													61.6	42	19	20.1	CL	A-7-6
8	38643	20.0-21.2																24.7		
9	38644	0.0- 3.0													64.0	41	25	14.0	CL	A-7-6
9	38645	5.0- 7.0																		
9	38646	12.0-14.0																27.4		
9	38647	15.0-16.0																		
9	38648	16.0-17.0																		
10	38649	0.0- 1.5													64.7	52	32	18.2	CH	A-7-6
10	38650	2.5- 4.0																		
10	38651	5.0- 6.0													93.7	82	40	37.9	CH	A-7-5
10	38652	6.0- 6.5																		

Section 1

Factor Of Safety = 5.5



Section 1 Profile

```
w1=   11.00
s1=    7.00
w2=   20.00
h1=    7.00
h2=   13.00

nx1=    7
nx2=    7
ny1=    7
ny2=   13
```

Group	phi	c	psi	gamma	e	v
1	2.00	864.00	0.00	140.00	0.1000E+06	0.30
2	0.00	1152.00	0.00	145.00	0.1000E+06	0.30
3	8.00	576.00	0.00	135.00	0.1000E+06	0.30

Property group assigned to each element

```
 1  1  1  1  1  1  1
 1  1  1  1  1  1  1
 1  1  1  1  1  1  1
 1  1  1  1  1  1  1
 1  1  1  1  1  1  1
 2  2  2  2  2  2  2
 2  2  2  2  2  2  2
 2  2  2  2  2  2  2  2  2  2  2  2  2  2
 2  2  2  2  2  2  2  2  2  2  2  2  2  2
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 2  2  2  2  2  2  2  2  2  2  2  2  2  2
 3  3  3  3  3  3  3  3  3  3  3  3  3  3
 3  3  3  3  3  3  3  3  3  3  3  3  3  3
 3  3  3  3  3  3  3  3  3  3  3  3  3  3
 3  3  3  3  3  3  3  3  3  3  3  3  3  3
 3  3  3  3  3  3  3  3  3  3  3  3  3  3
```
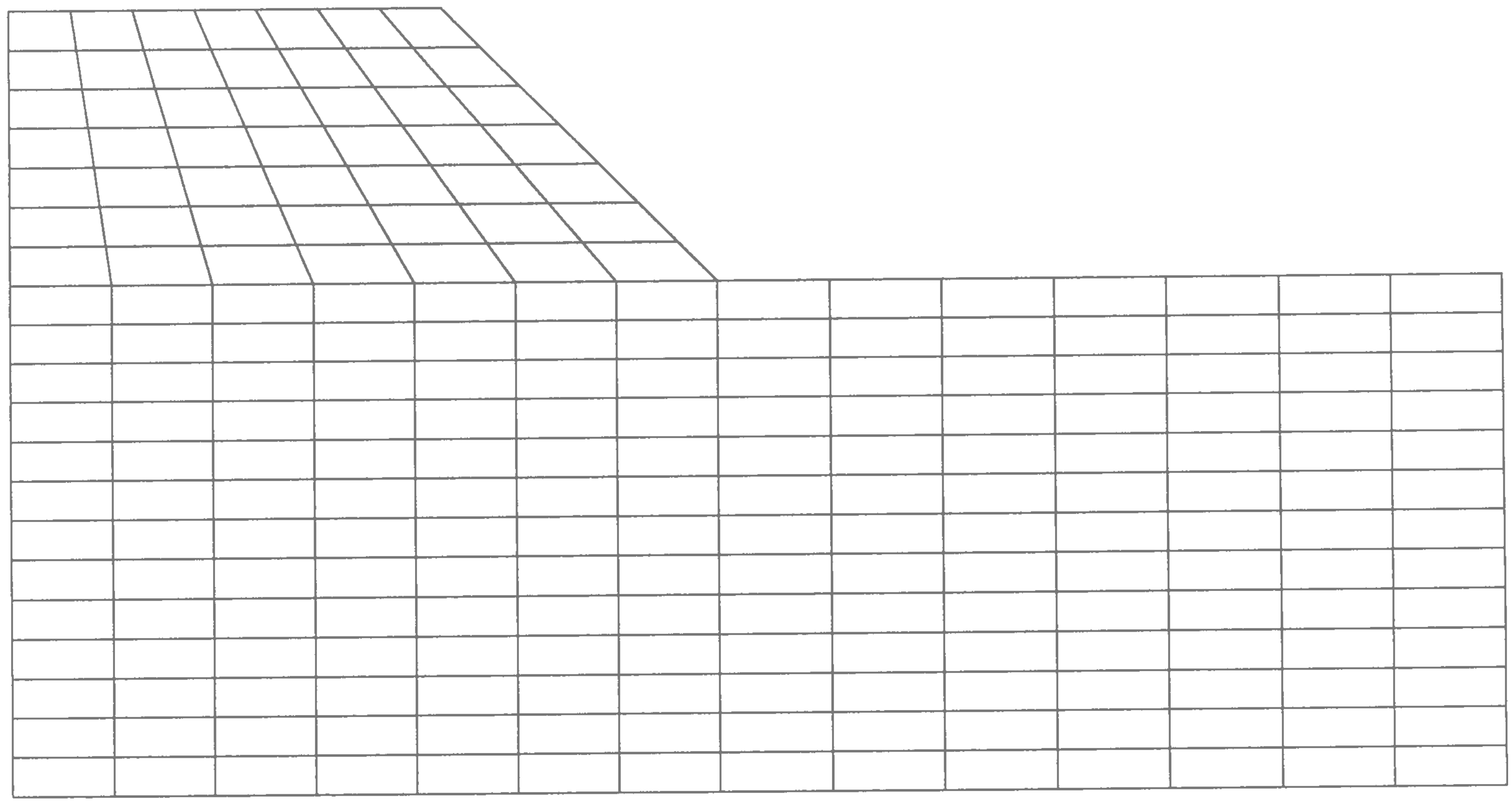
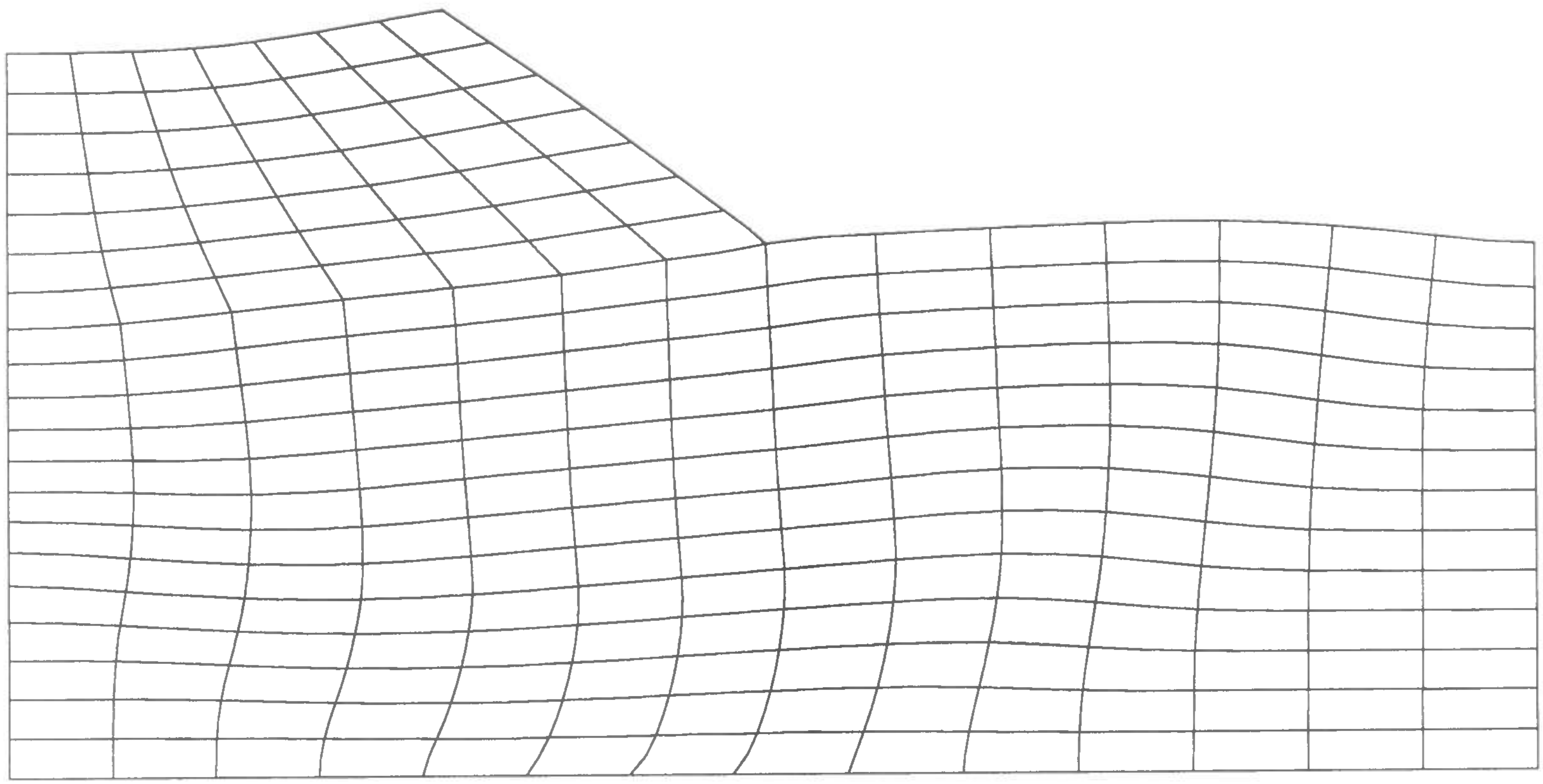

```
tol=  0.000100
limit= 1000
```

trial factor	max displacement	iterations
0.4500E+01	0.4536E+00	51
0.5000E+01	0.4976E+00	74
0.5250E+01	0.5456E+00	162
0.5500E+01	0.2521E+01	1000

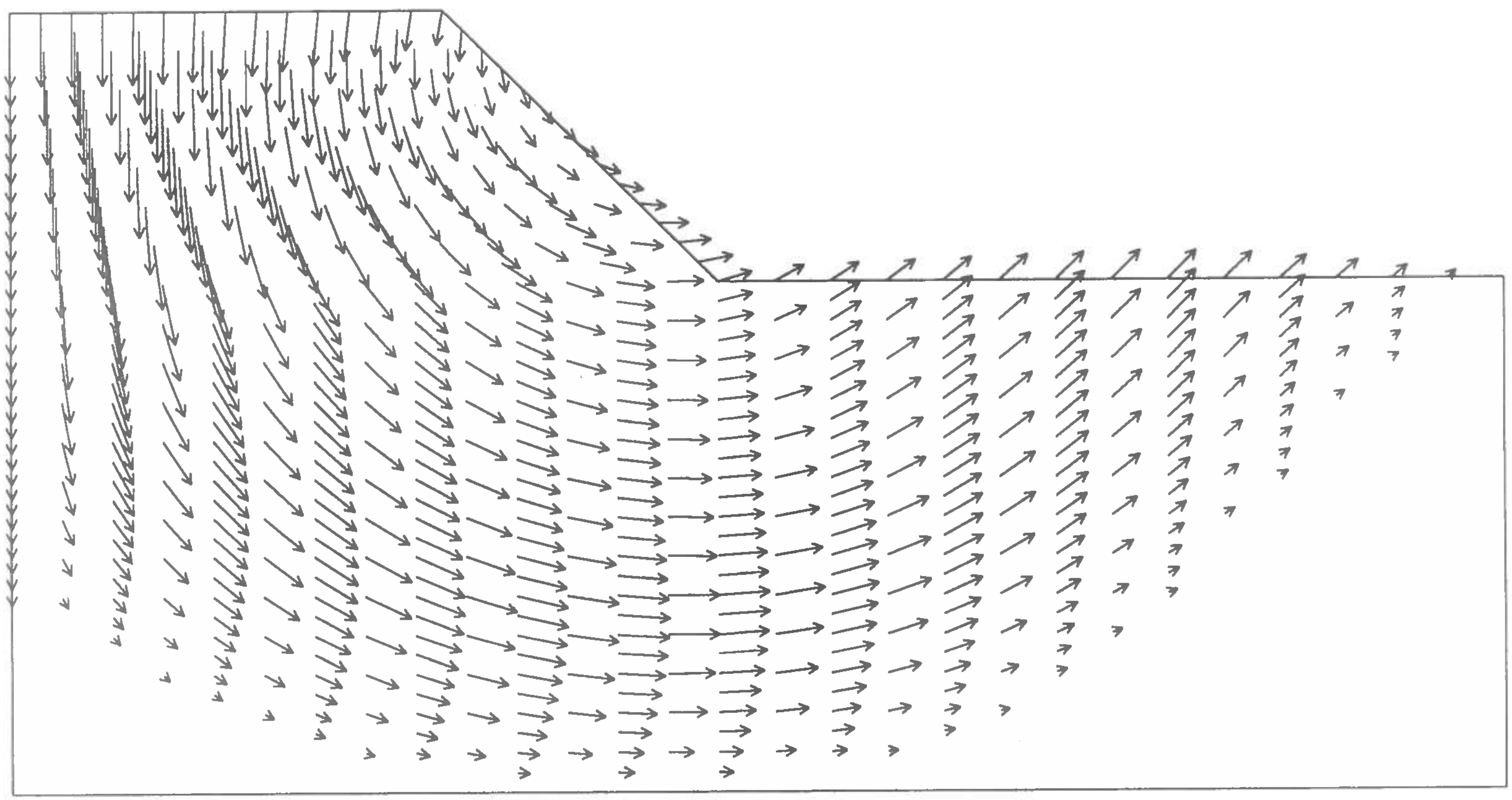
Section 1
Mesh



Section 1
Deformed Mesh

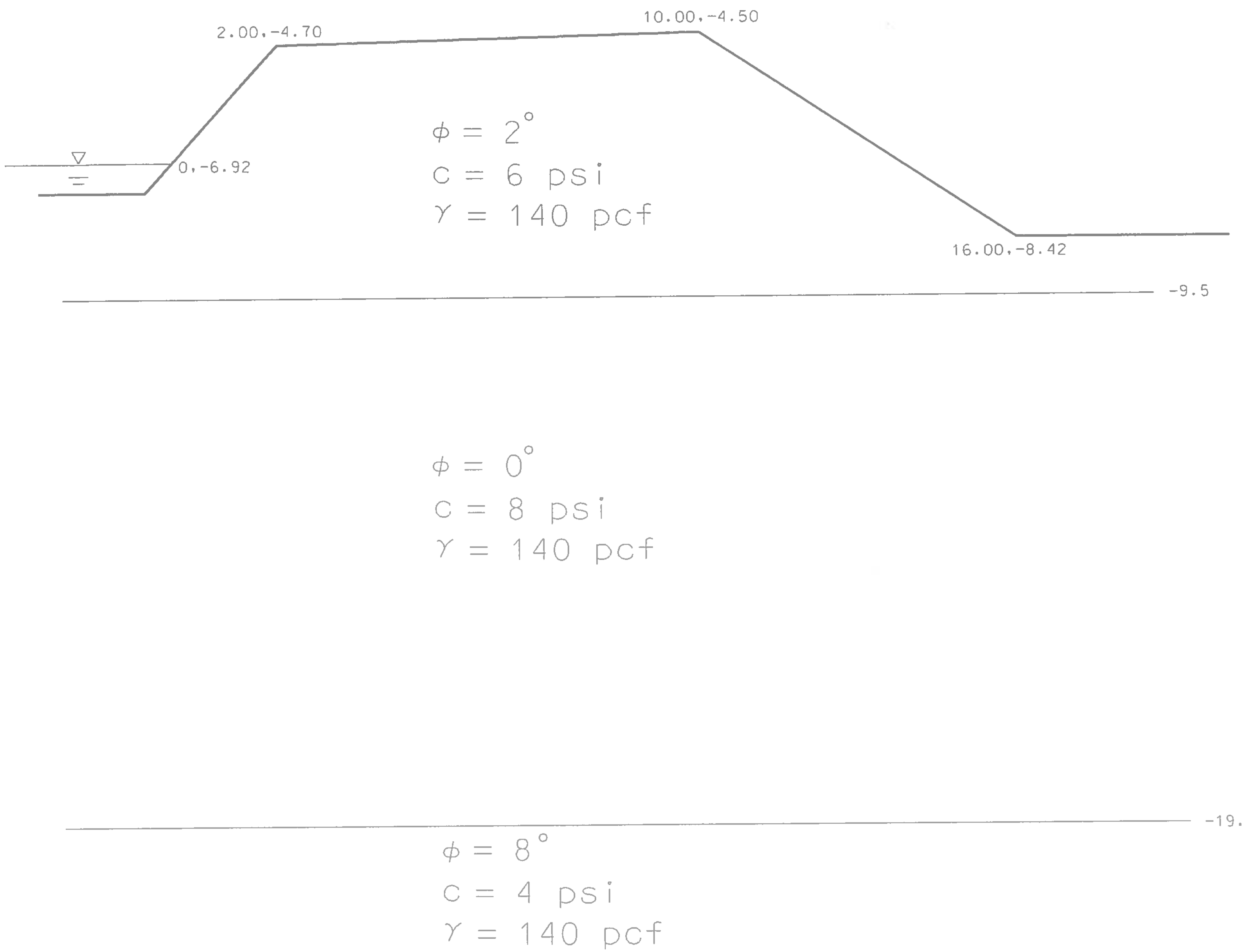


Section 1
Vector Trace



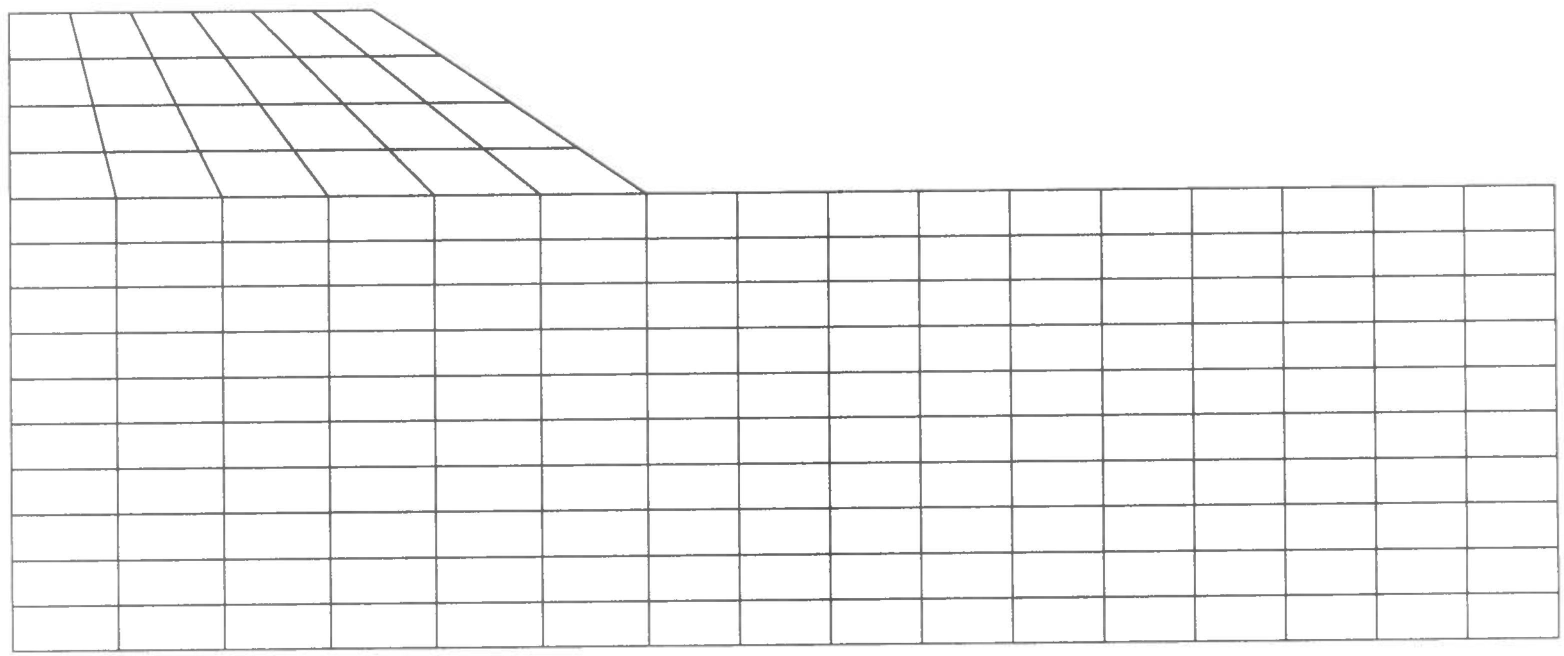
Section 2

Factor Of Safety = 10.0

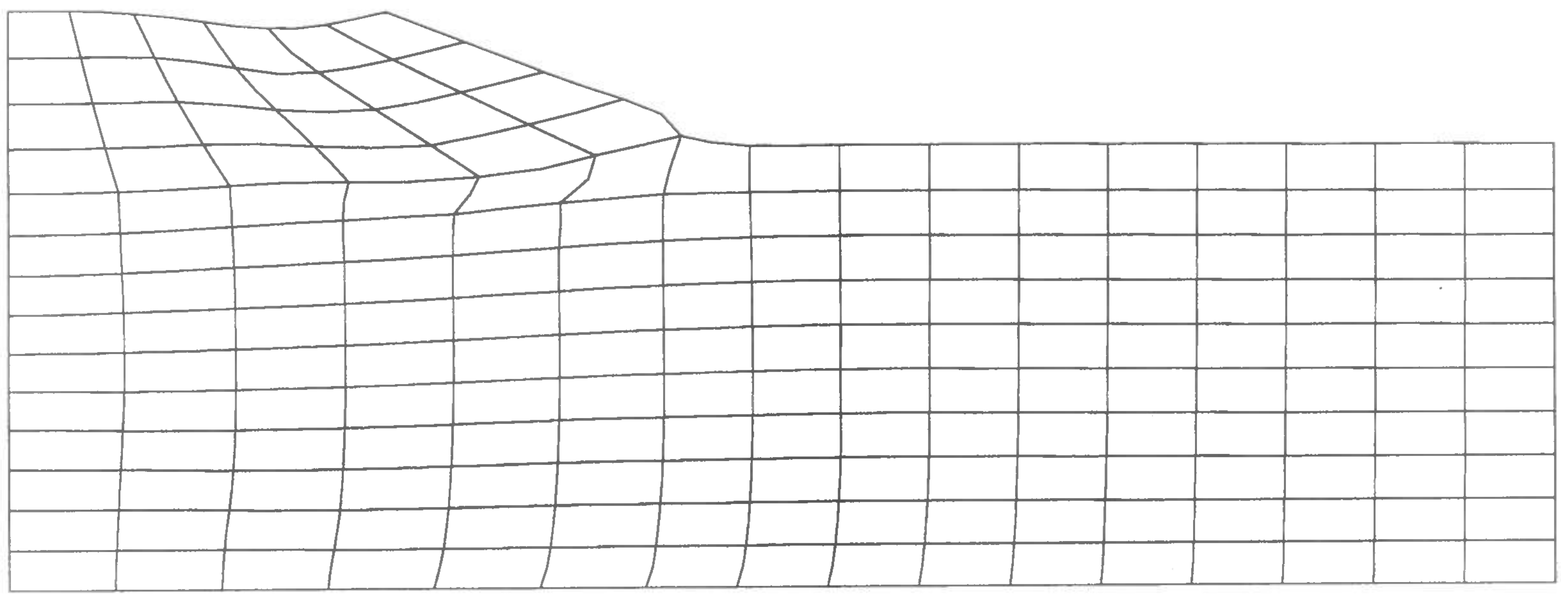


```
Section 2 Profile

w1=    8.00
s1=    6.00
w2=   20.00
h1=    4.10
h2=   10.00

nx1=    6
nx2=   10
ny1=    4
ny2=   10

Group  phi       c      psi    gamma       e          v
  1    2.00   864.00    0.00  140.00  0.1000E+06    0.30
  2    0.00  1152.00    0.00  145.00  0.1000E+06    0.30
  3    8.00   576.00    0.00  135.00  0.1000E+06    0.30

Property group assigned to each element
   1   1   1   1   1   1
   1   1   1   1   1   1
   1   1   1   1   1   1
   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2

tol=  0.000100
limit= 1000

      trial factor    max displacement   iterations
      0.9000E+01      0.2518E+00             83
      0.9500E+01      0.2638E+00            182
      0.1000E+02      0.3798E+00           1000
```

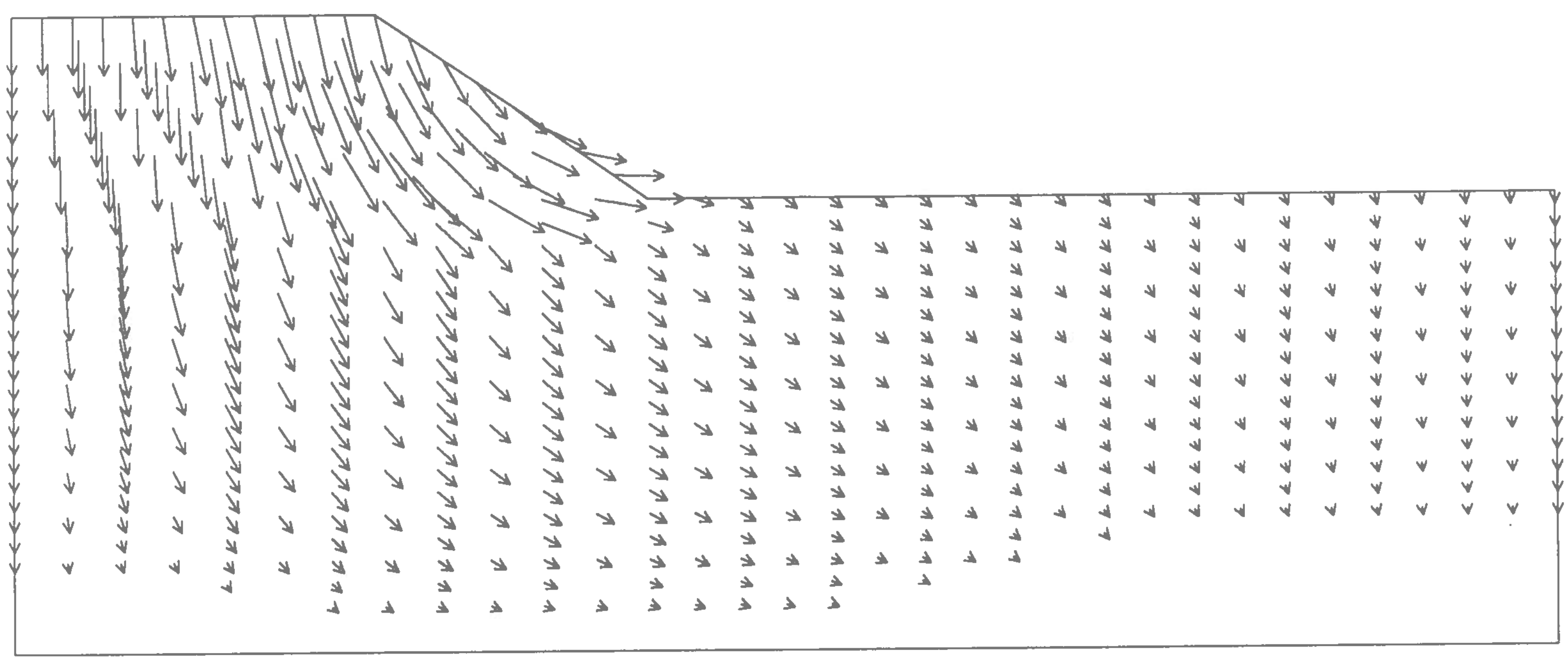
Section 2
Mesh



Section 2
Deformed Mesh

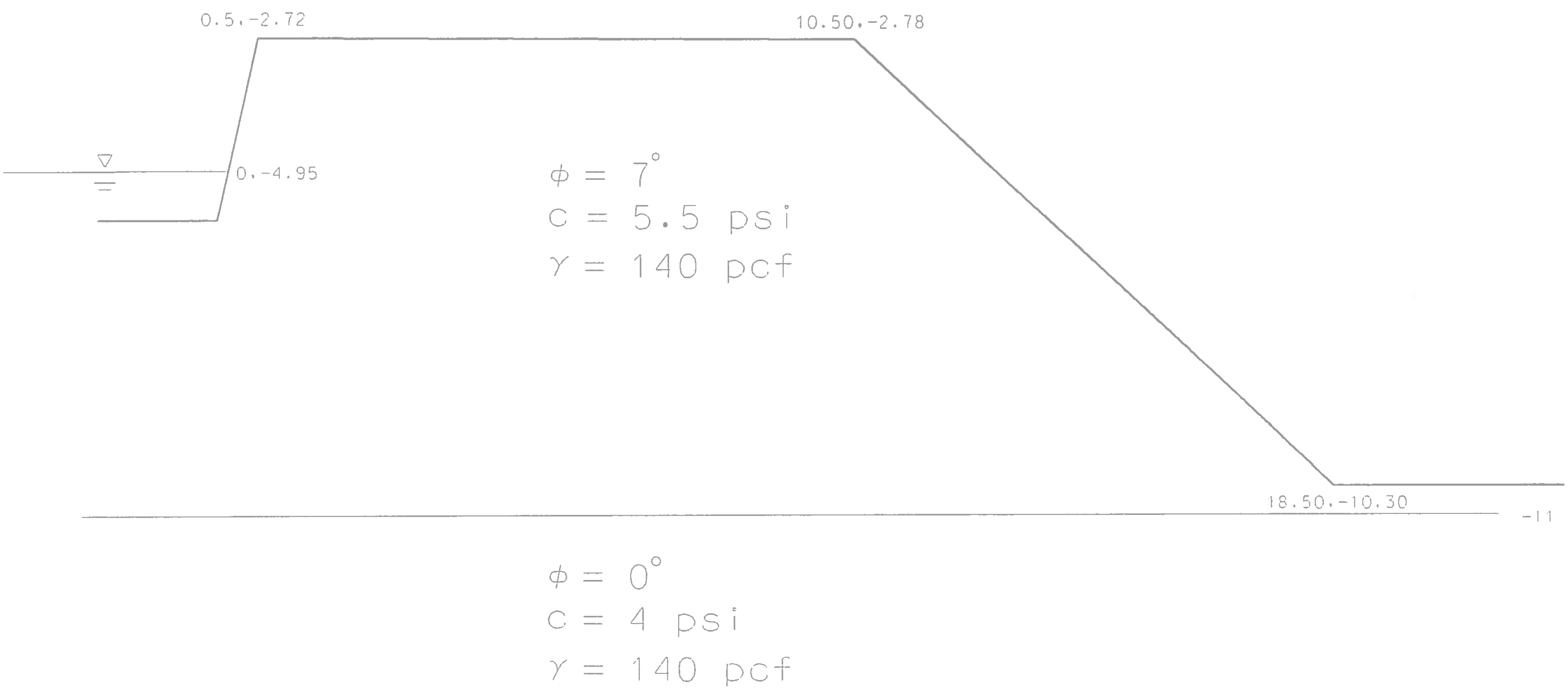


Section 2
Vector Trace



Section 3

Factor Of Safety = 3.0



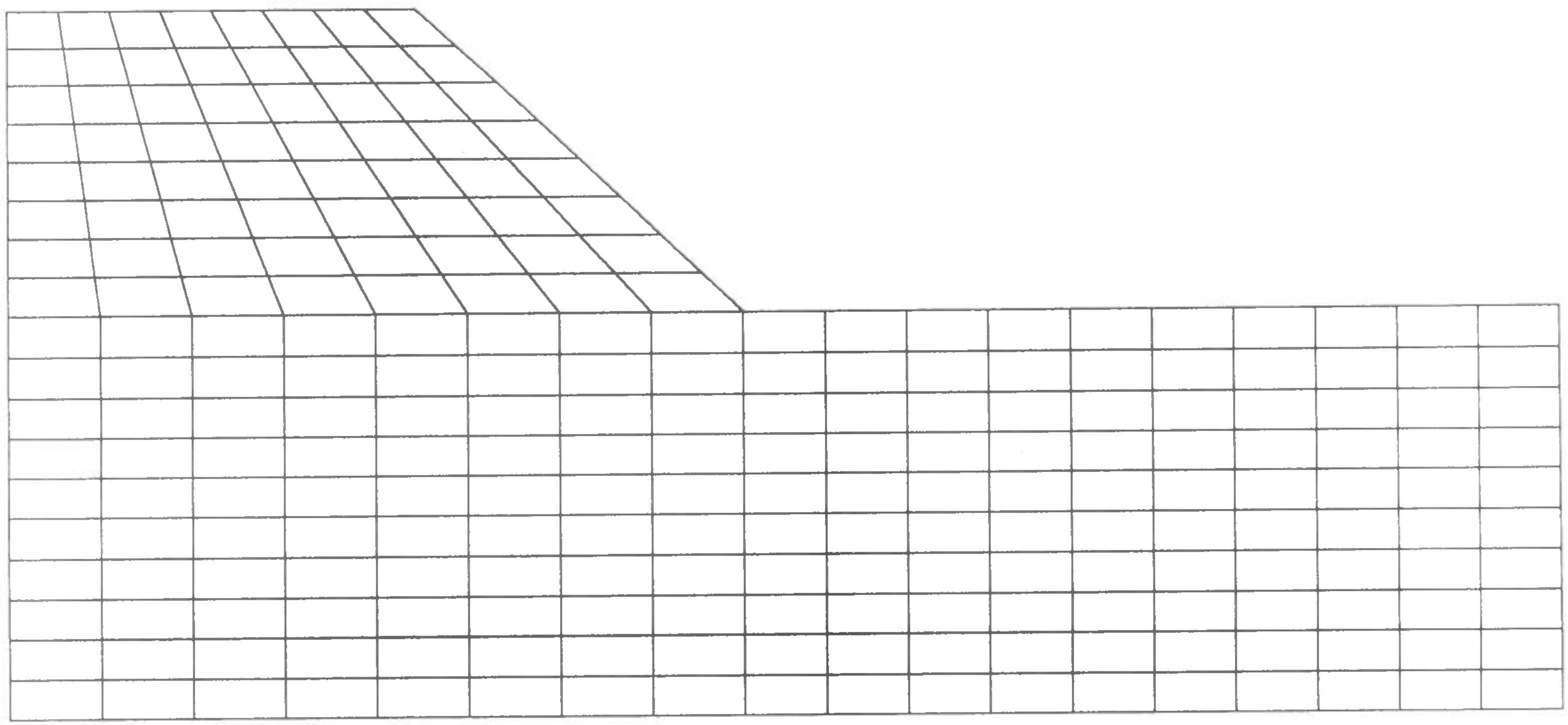
```
Section 3 Profile

w1=   10.00
s1=    8.00
w2=   20.00
h1=    7.50
h2=   10.00

nx1=    8
nx2=   10
ny1=    8
ny2=   10

Group  phi       c      psi    gamma       e          v
  1    7.00  792.00     0.00  140.00  0.1000E+06    0.30
  2    0.00  576.00     0.00  130.00  0.1000E+06    0.30

Property group assigned to each element
   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2

tol=  0.000100
```

limit= 1000

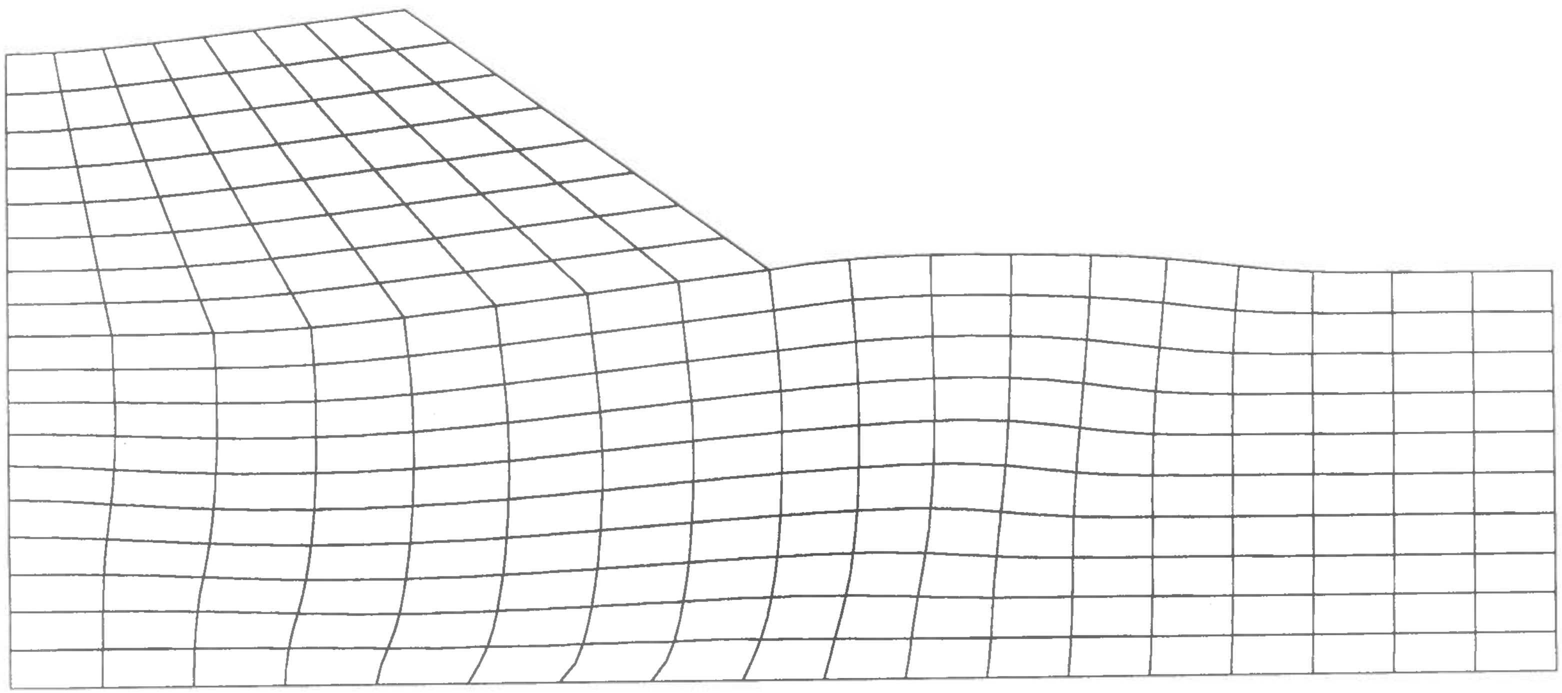
trial factor	max displacement	iterations
0.2000E+01	0.2554E+00	40
0.2500E+01	0.3177E+00	62
0.2750E+01	0.3490E+00	70
0.3000E+01	0.8735E+00	1000

Section 3

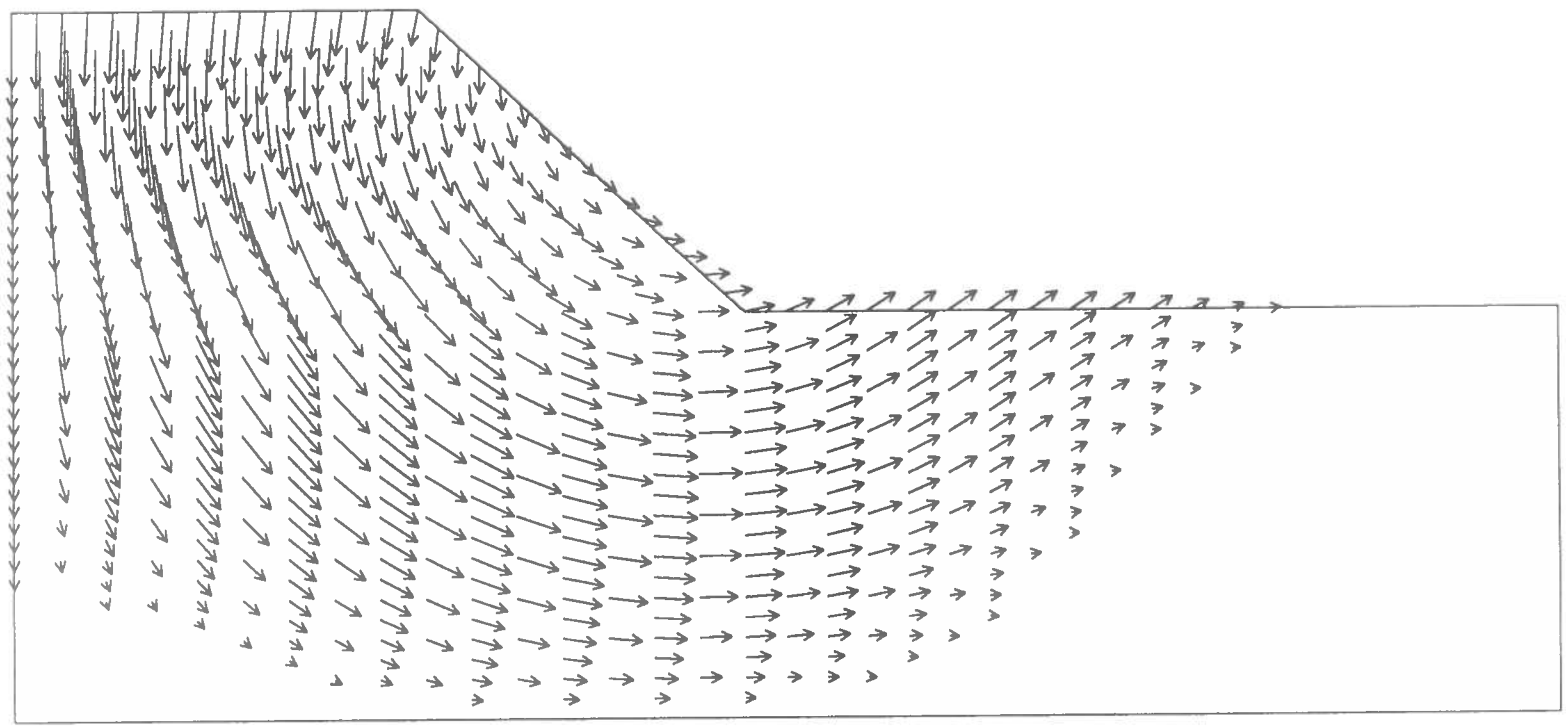
Mesh



Section 3
Deformed Mesh

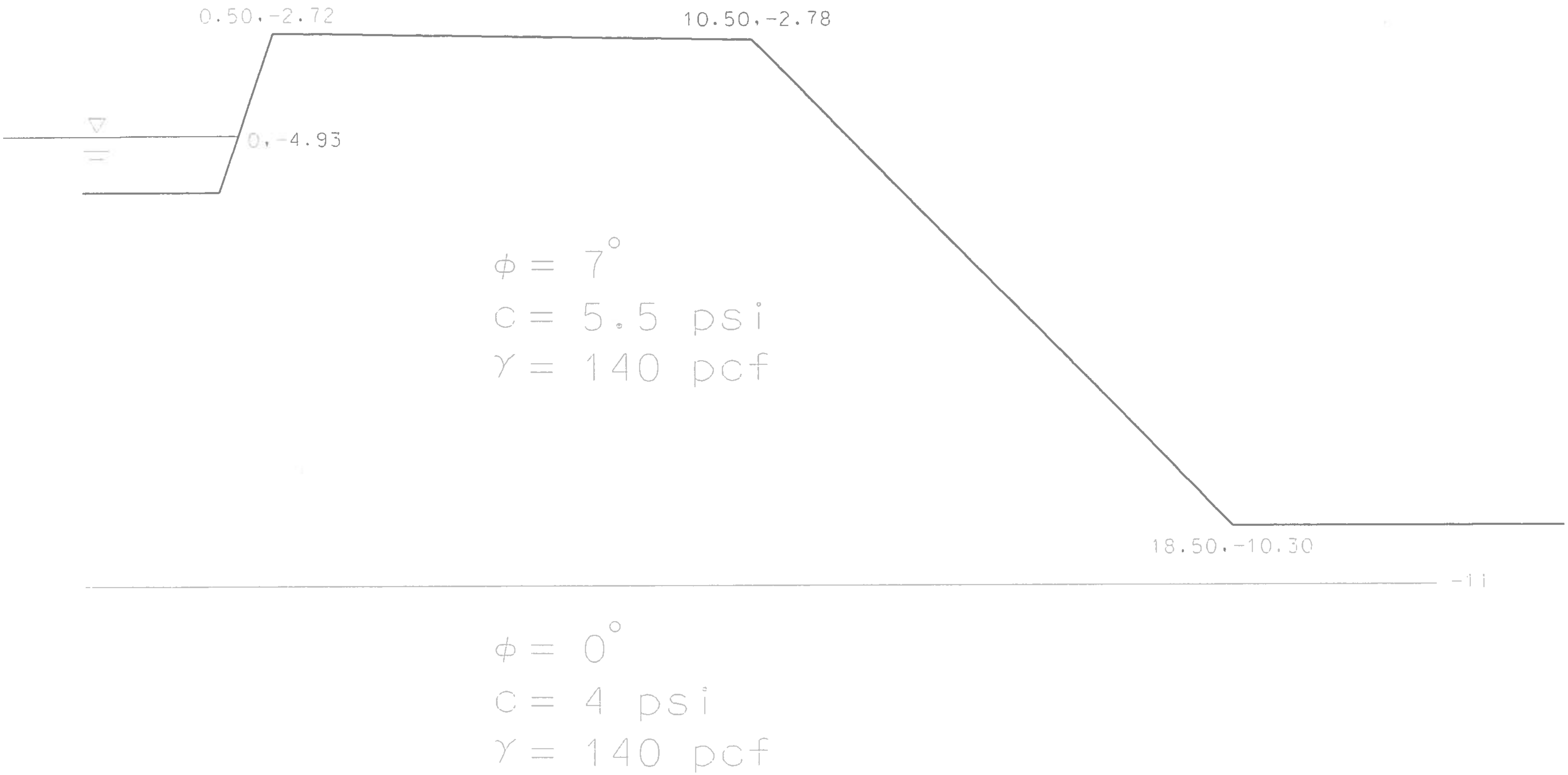


Section 3
Vector Trace



Section 4

Factor Of Safety = 3.0

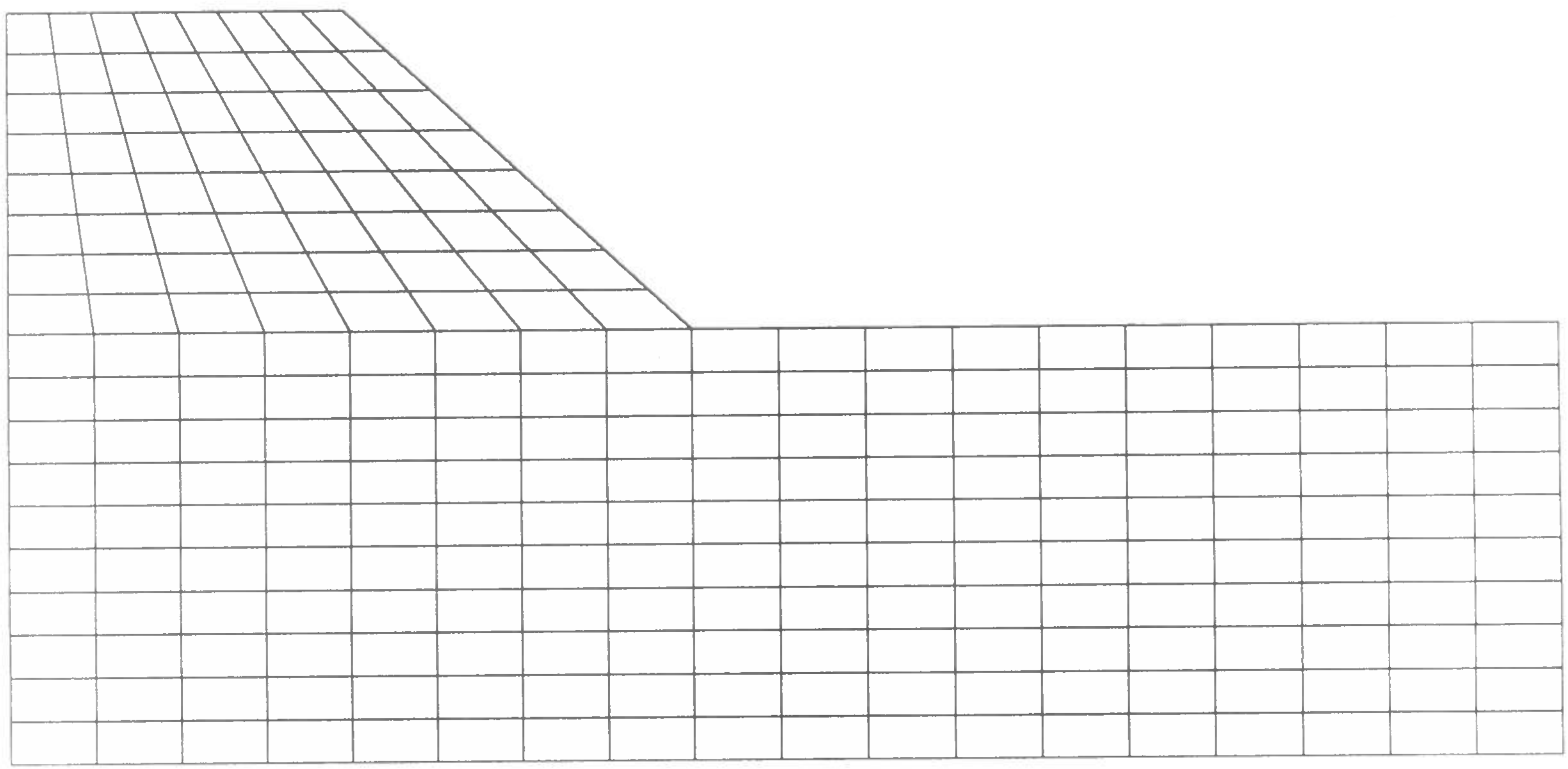


```
Section 4 Profile

w1=    7.75
s1=    8.00
w2=   20.00
h1=    7.50
h2=   10.00

nx1=    8
nx2=   10
ny1=    8
ny2=   10

Group  phi      c       psi    gamma      e           v
  1    7.00  792.00    0.00  140.00  0.1000E+06    0.30
  2    0.00  576.00    0.00  130.00  0.1000E+06    0.30

Property group assigned to each element
    1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1
    2   2   2   2   2   2   2   2
    2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
    2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
    2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
    2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
    2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
    2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
    2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
    2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
    2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2
    2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2

 tol=  0.000100
```

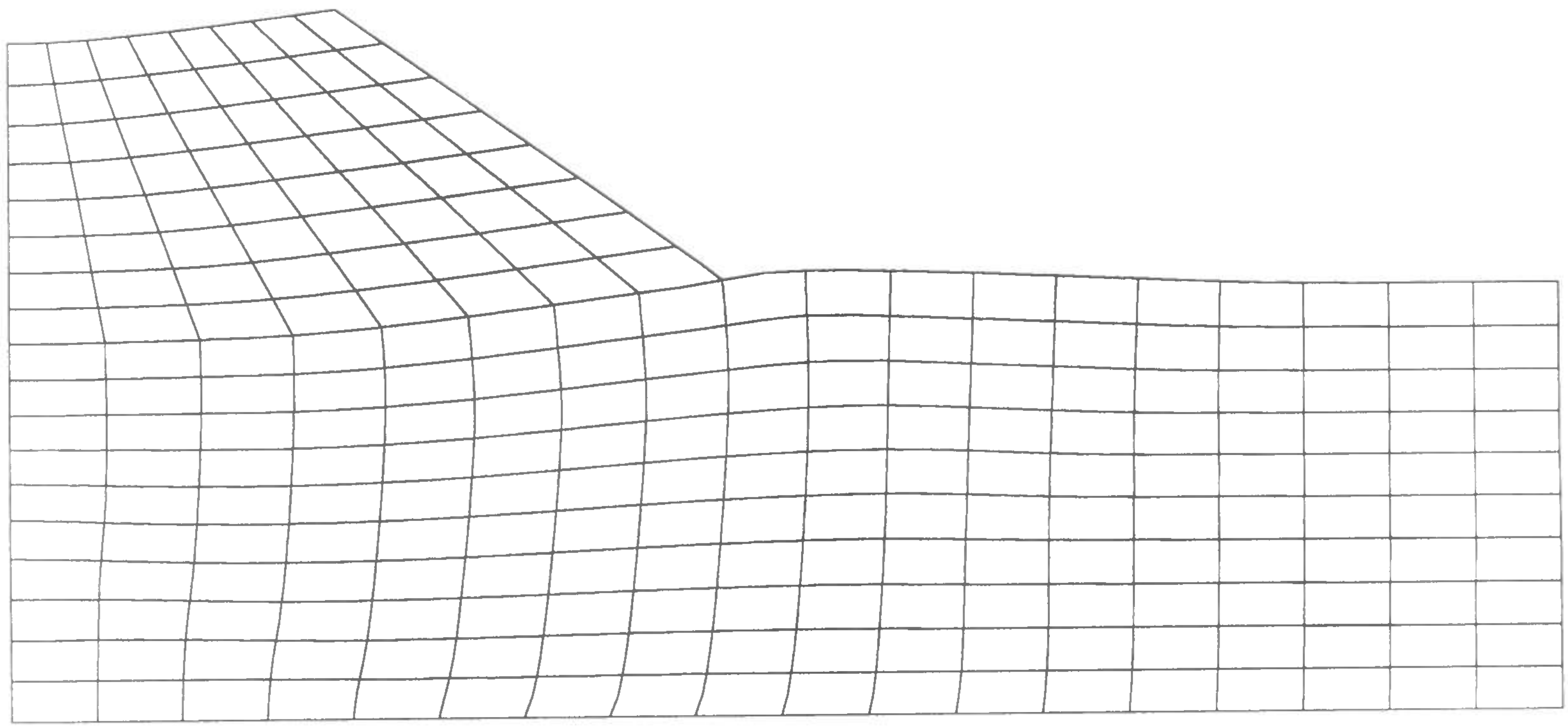
limit= 1000

trial factor	max displacement	iterations
0.2000E+01	0.2529E+00	37
0.2500E+01	0.3136E+00	56
0.2750E+01	0.3458E+00	65
0.3000E+01	0.6995E+00	1000

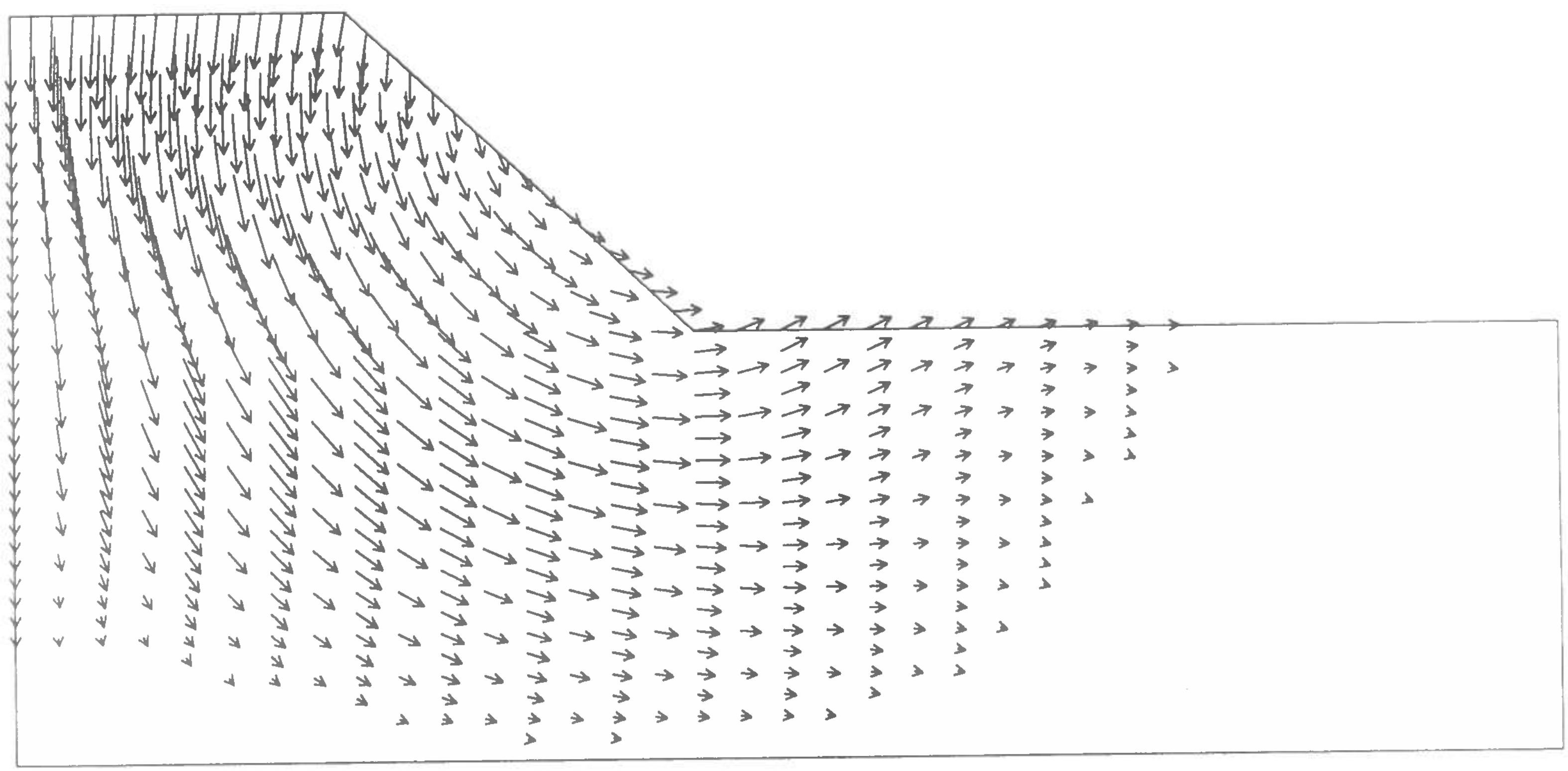
Section 4
Mesh



Section 4
Deformed Mesh

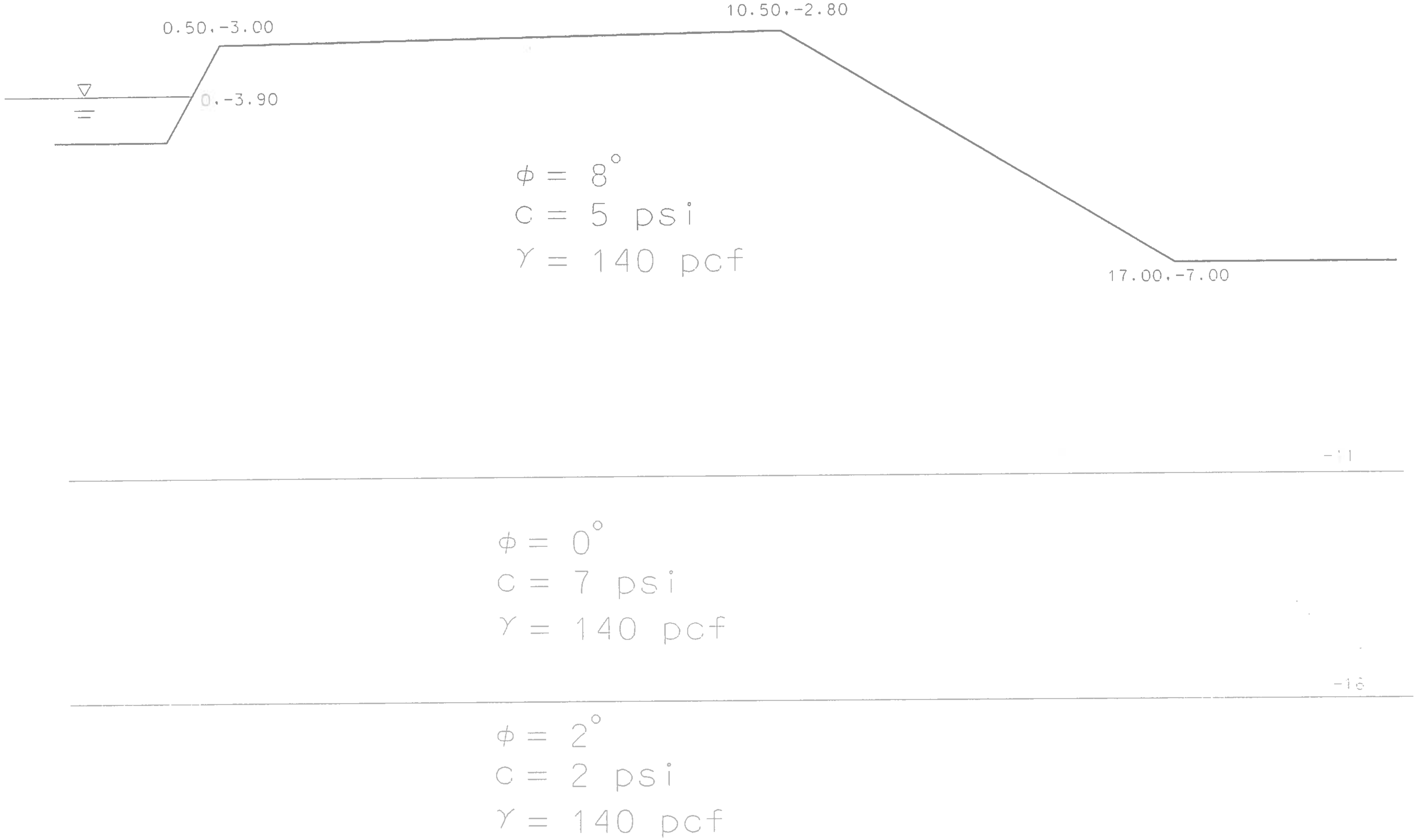


Section 4
Vector Trace



Section 5

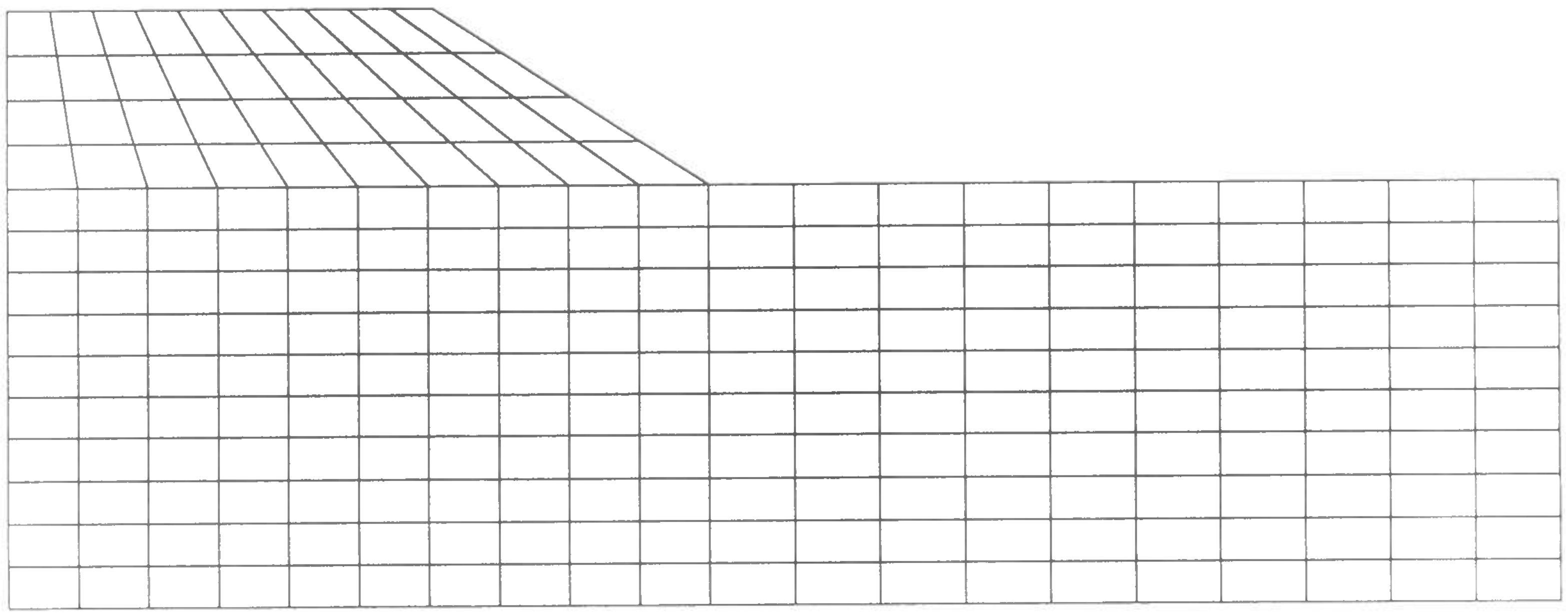
Factor Of Safety = 6.2



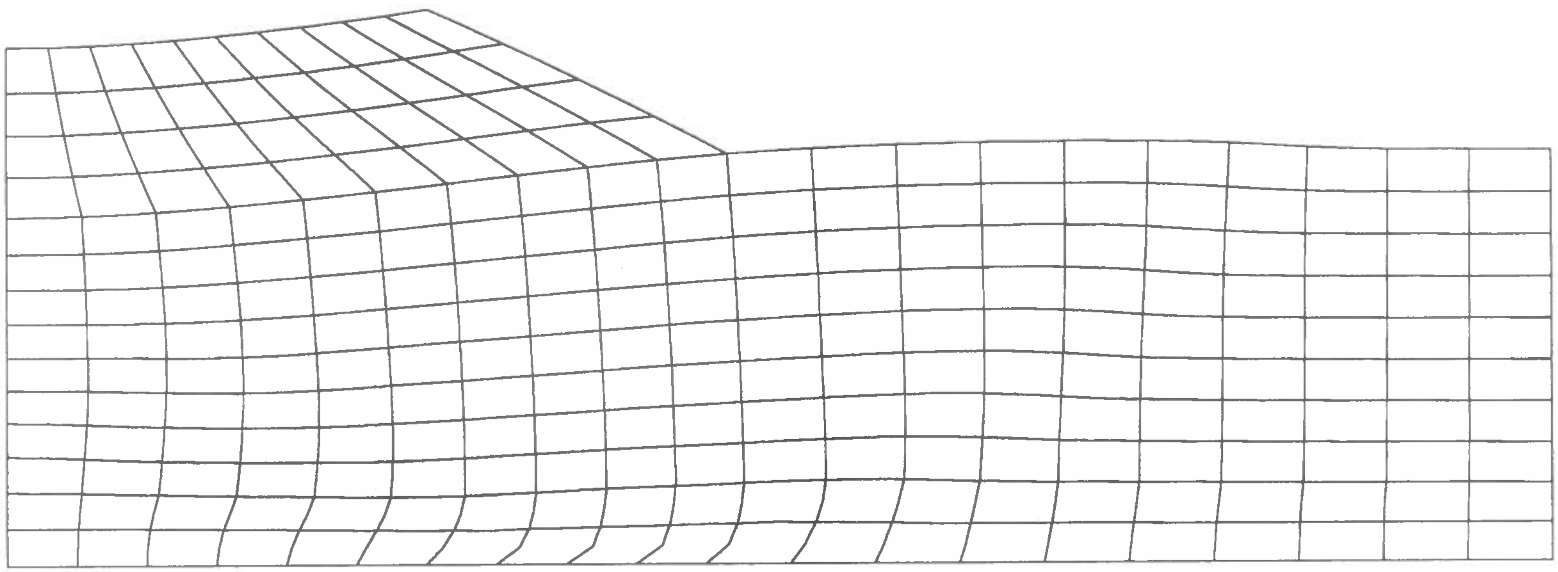
```
Section 5 Profile

w1=   10.00
s1=    6.50
w2=   20.00
h1=    4.20
h2=   10.00

nx1=   10
nx2=   10
ny1=    4
ny2=   10

Group  phi      c       psi    gamma      e          v
  1    8.00  720.00    0.00  140.00  0.1000E+06    0.30
  2    0.00 1008.00    0.00  140.00  0.1000E+06    0.30
  3    2.00  288.00    0.00  140.00  0.1000E+06    0.30

Property group assigned to each element
   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
 2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
 2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
 2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
 2   2   2   2
   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3
 3   3   3   3
   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3
 3   3   3   3

tol=  0.000100
limit= 1000

      trial factor    max displacement   iterations
```

0.5800E+01	0.2946E+00	127
0.6000E+01	0.3065E+00	168
0.6100E+01	0.3191E+00	252
0.6200E+01	0.3918E+00	1000

Section 5
Mesh

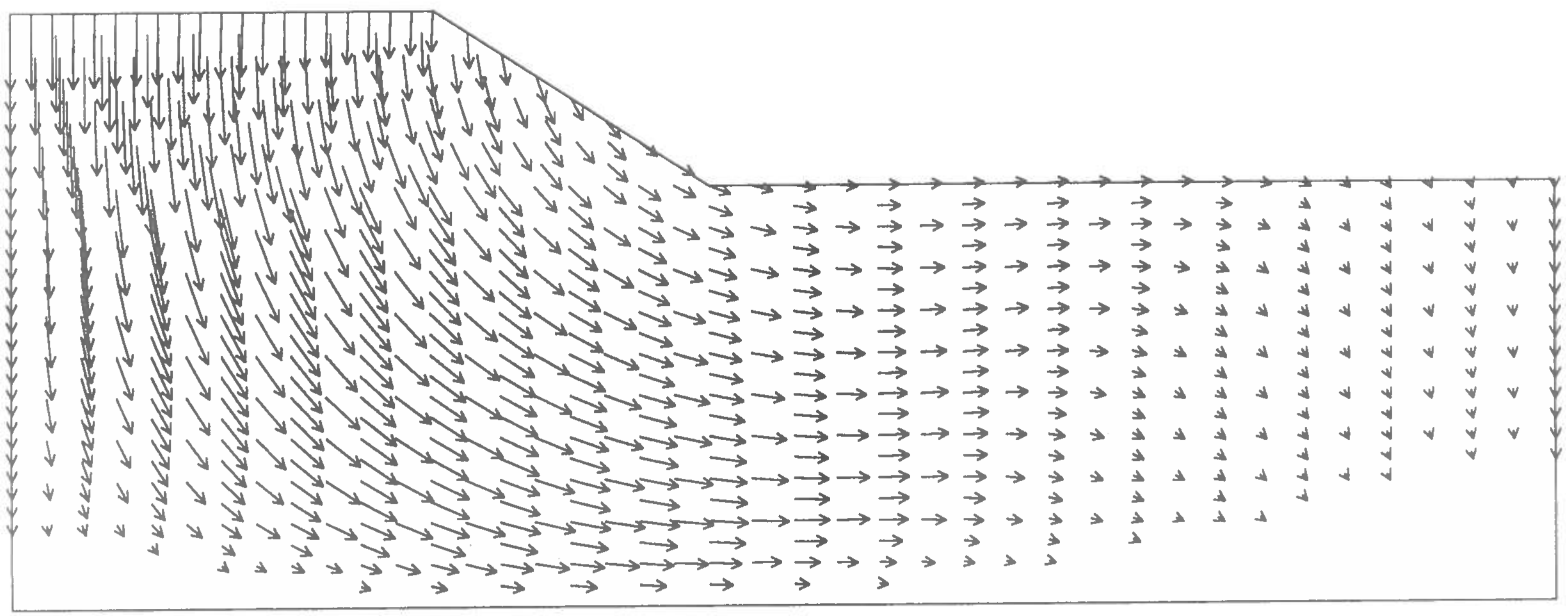


Section 5
Deformed Mesh



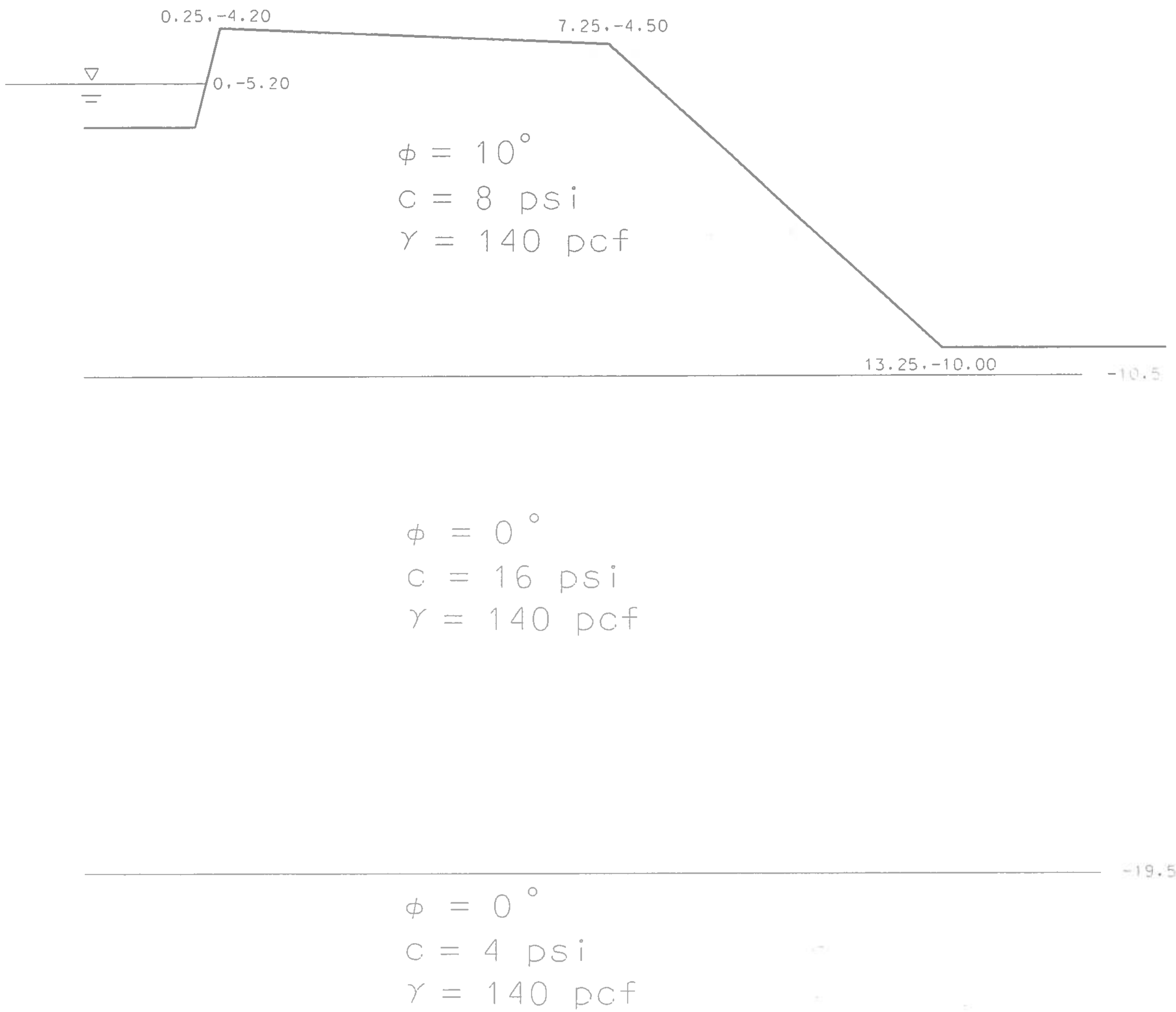
Section 5

Vector Trace



Section 6

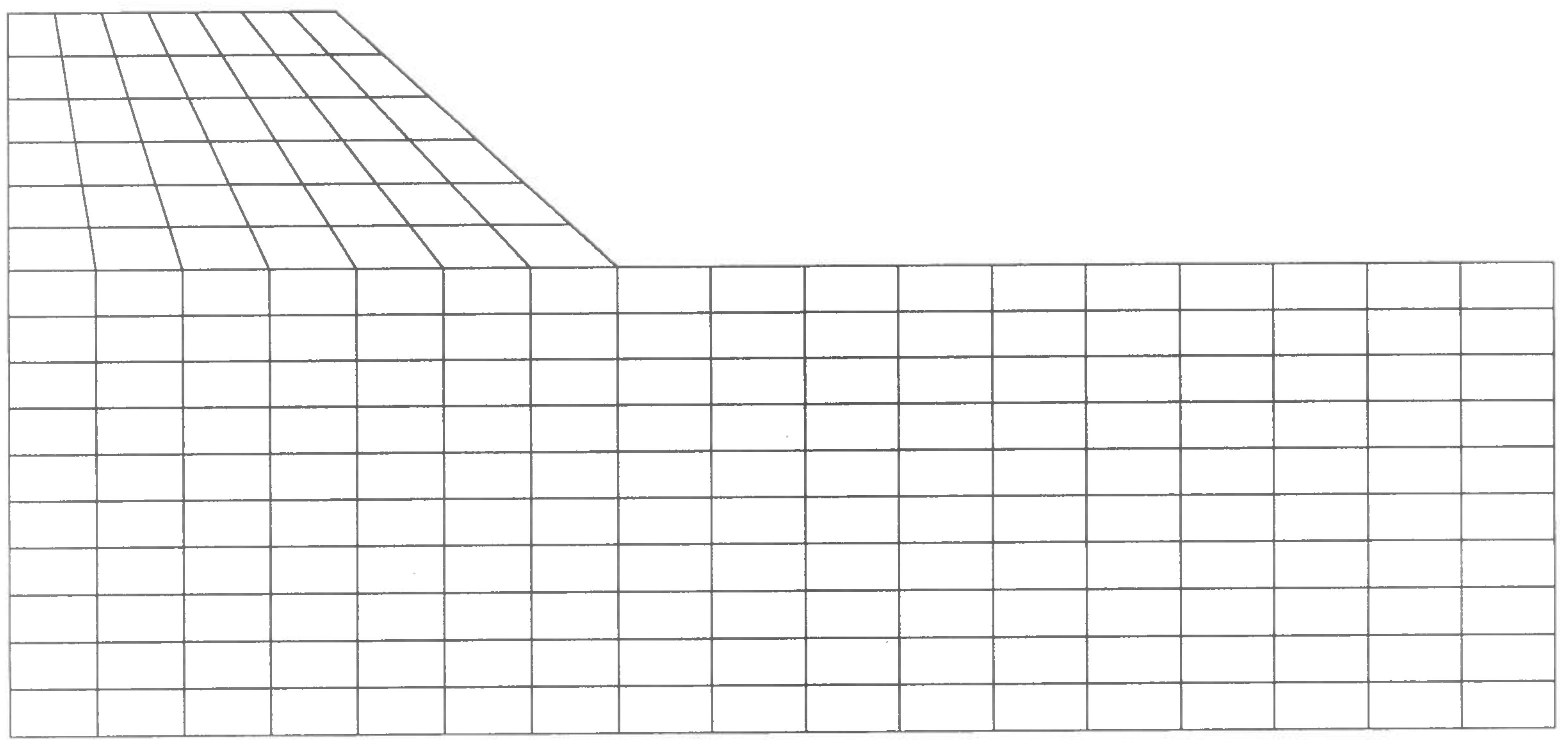
Factor Of Safety = 10.0



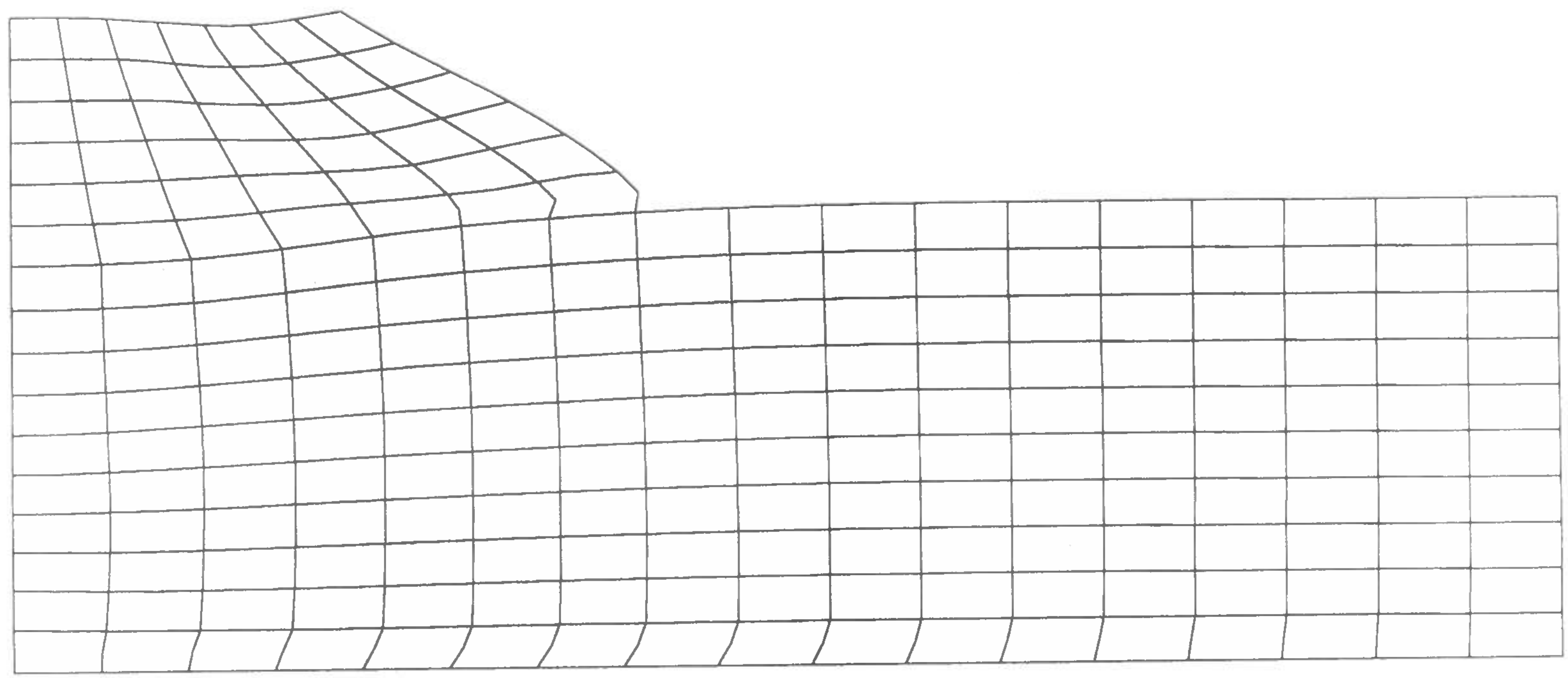
```
Section 6 Profile

w1=    7.00
s1=    6.00
w2=   20.00
h1=    5.50
h2=   10.00

nx1=    7
nx2=   10
ny1=    6
ny2=   10

Group  phi      c       psi    gamma      e          v
  1   10.00 1152.00    0.00  140.00  0.1000E+06    0.30
  2    0.00 2304.00    0.00  140.00  0.1000E+06    0.30
  3    0.00  576.00    0.00  140.00  0.1000E+06    0.30

Property group assigned to each element
   1   1   1   1   1   1   1
   1   1   1   1   1   1   1
   1   1   1   1   1   1   1
   1   1   1   1   1   1   1
   1   1   1   1   1   1   1
   1   1   1   1   1   1   1
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2
   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3
  3

 tol=  0.000100
 limit= 1000
```

trial factor	max displacement	iterations
0.9000E+01	0.3093E+00	149
0.1000E+02	0.3472E+00	324
0.1010E+02	0.3636E+00	584
0.1020E+02	0.4050E+00	1000

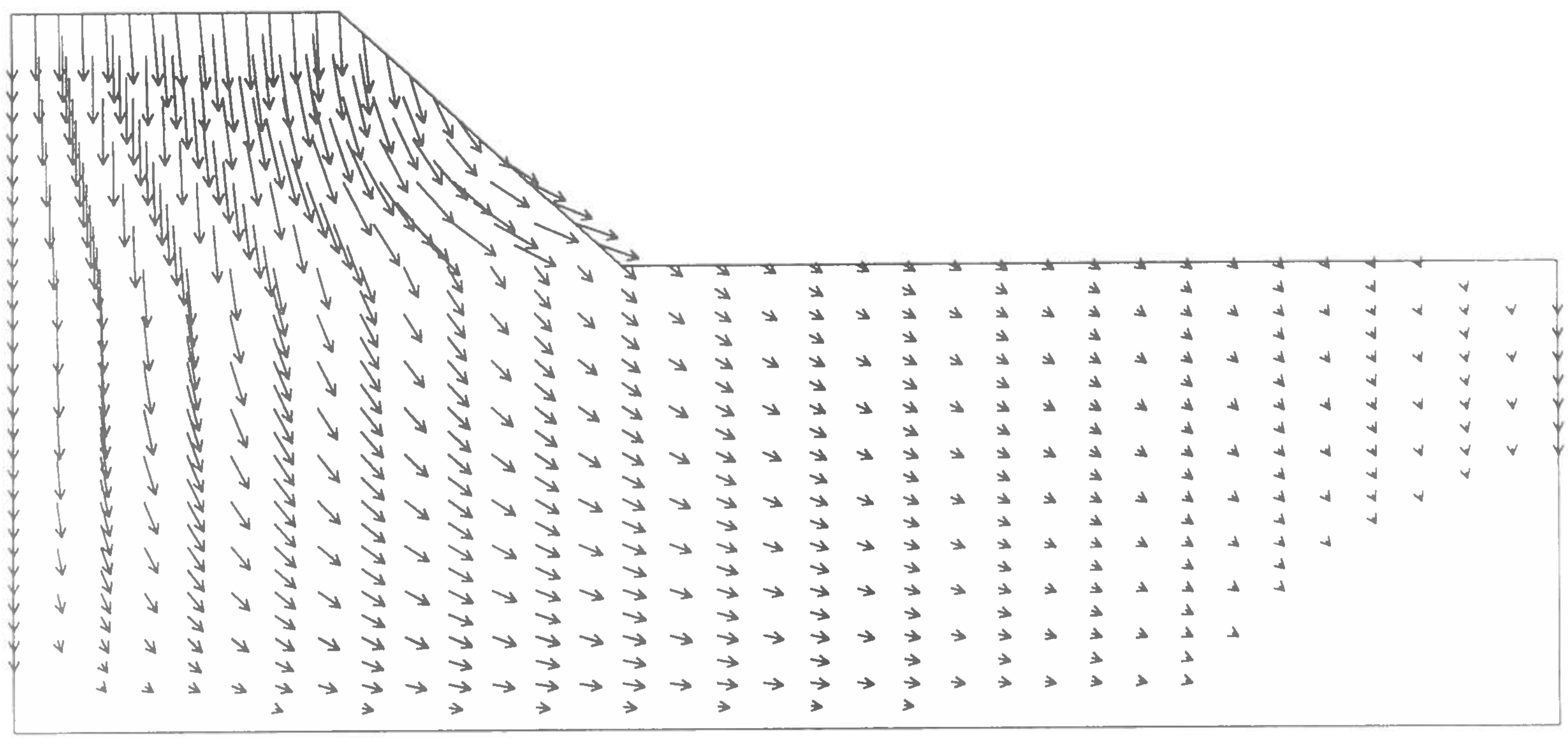
Section 6
Mesh



Section 6
Deformed Mesh

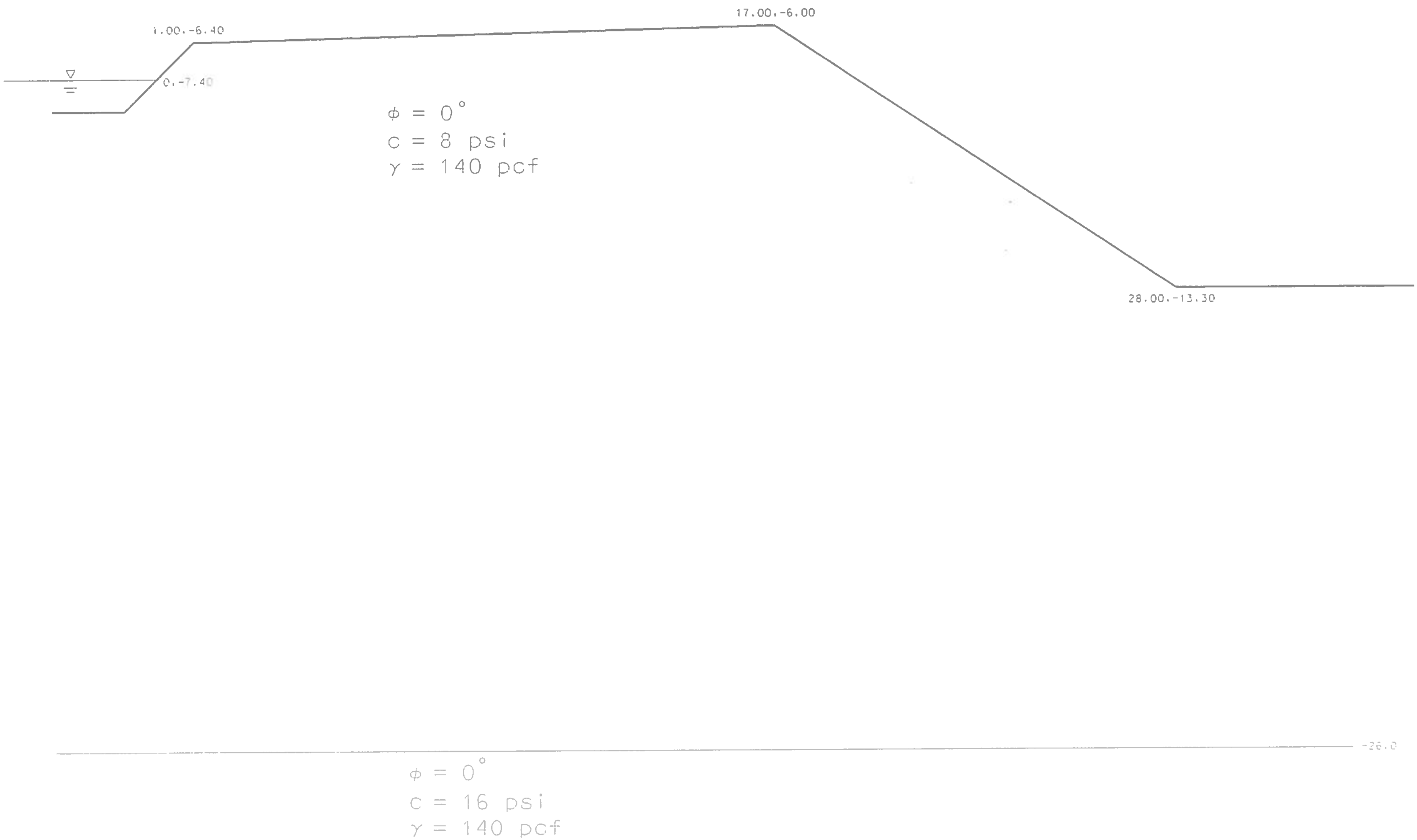


Section 6
Vector Trace



Section 7

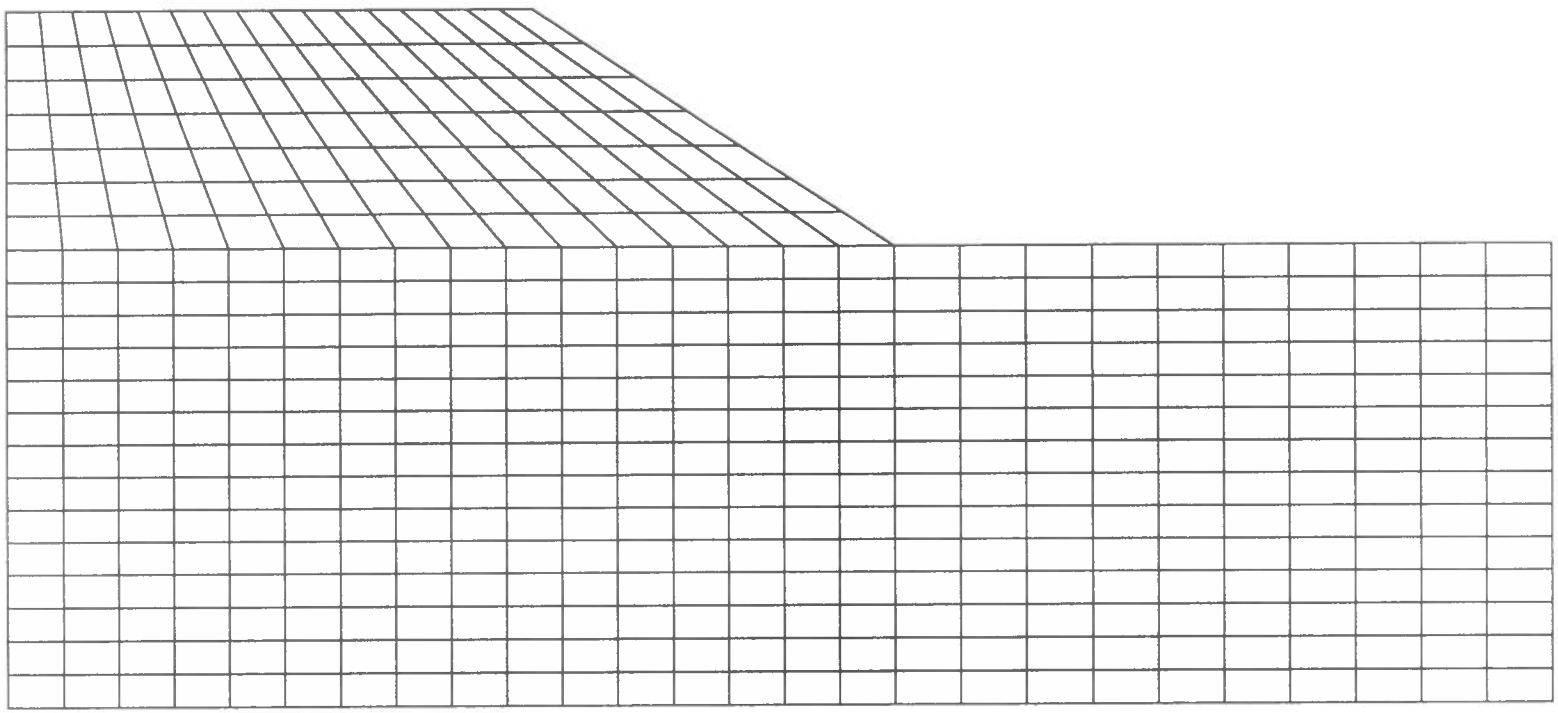
Factor Of Safety = 6.0



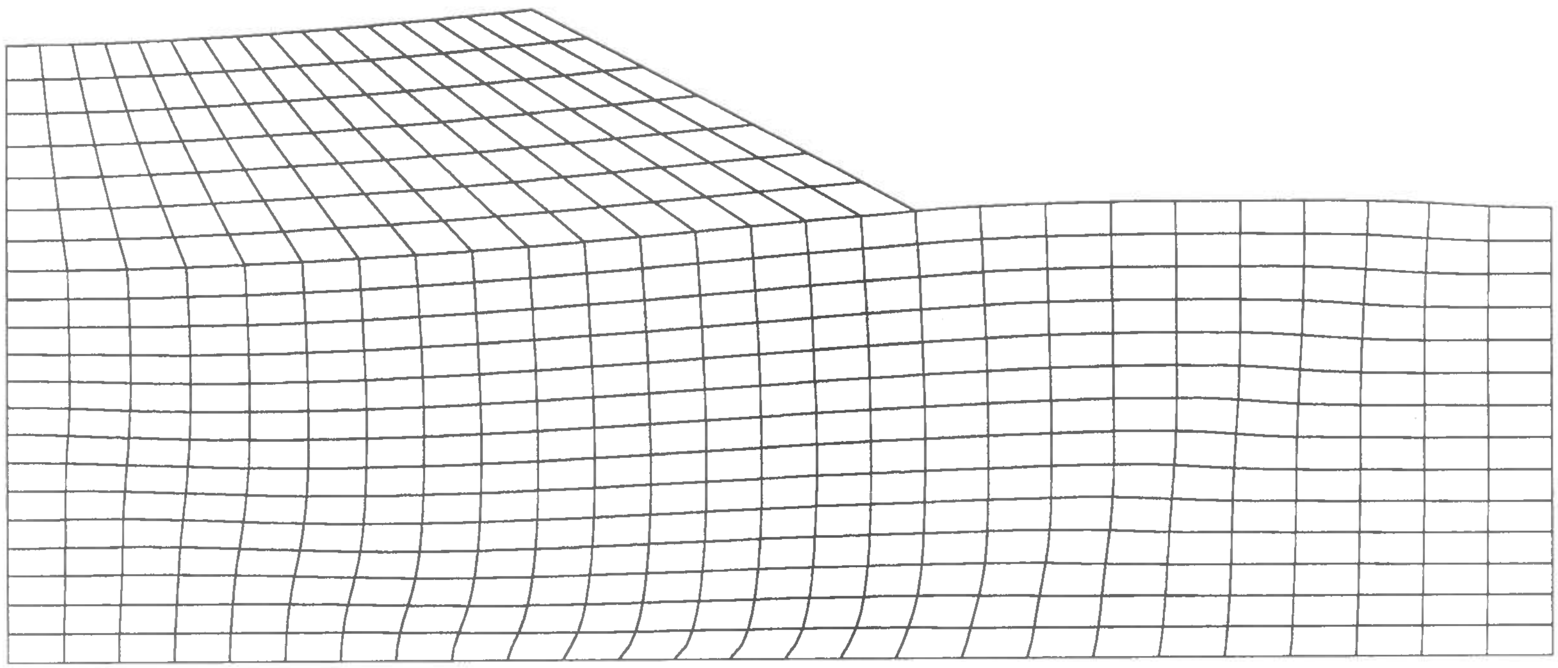
```
Section 7 Profile

w1=   16.00
s1=   11.00
w2=   20.00
h1=    7.30
h2=   14.00

nx1=   16
nx2=   10
ny1=    7
ny2=   14

Group  phi       c      psi    gamma       e          v
  1    0.00 1152.00    0.00  140.00  0.1000E+06    0.30

Property group assigned to each element
      1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
      1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
      1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
      1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
      1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
      1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
      1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
      1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
      1   1   1   1   1   1
      1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
      1   1   1   1   1   1
      1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
      1   1   1   1   1   1
      1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
      1   1   1   1   1   1
      1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
      1   1   1   1   1   1
      1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
      1   1   1   1   1   1
      1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
      1   1   1   1   1   1
```

```
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1   1

tol=  0.000100
limit= 1000

      trial factor    max displacement   iterations
      0.5500E+01      0.5128E+00            74
      0.5700E+01      0.5294E+00            83
      0.5800E+01      0.5405E+00            93
      0.5900E+01      0.5552E+00           110
      0.6000E+01      0.6942E+00          1000
```

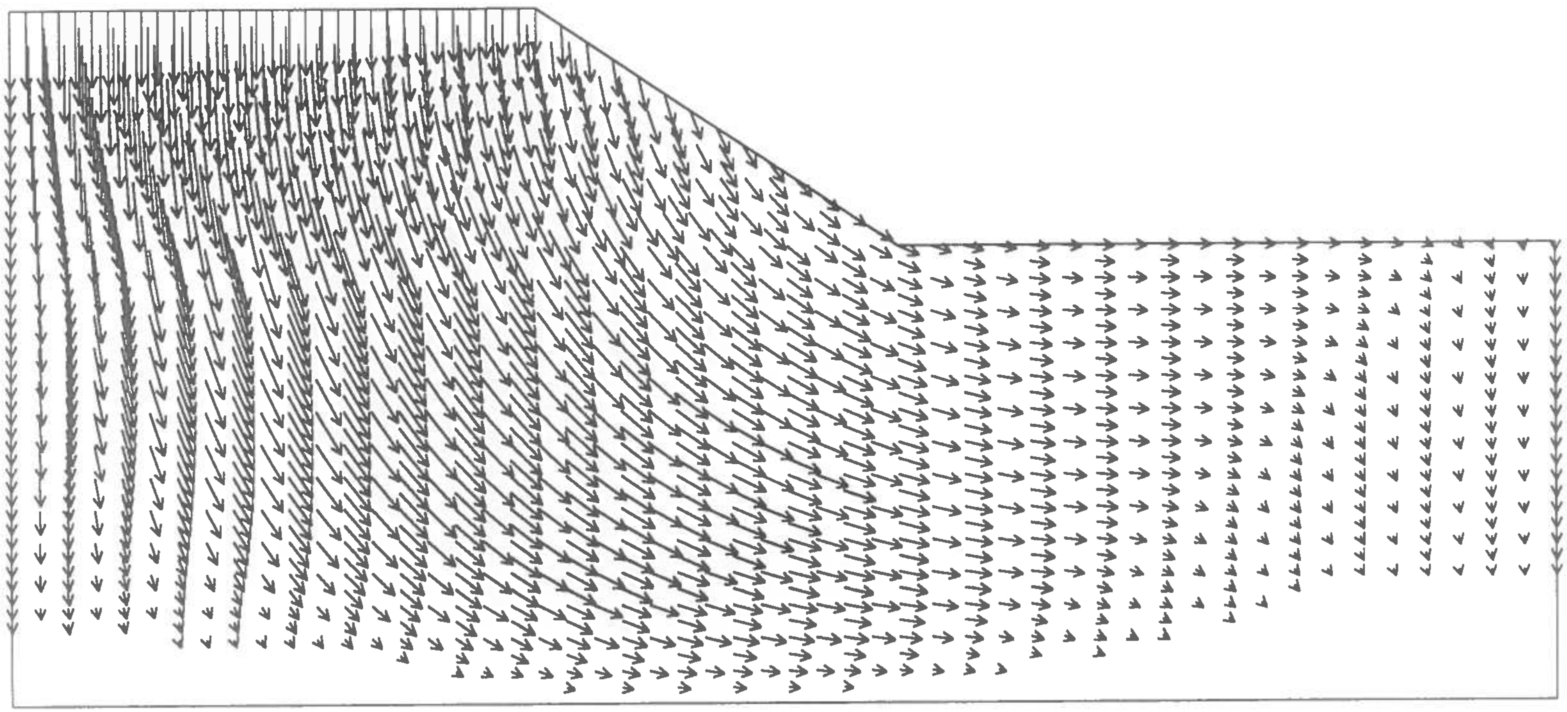
Section 7
Mesh



Section 7
Deformed Mesh

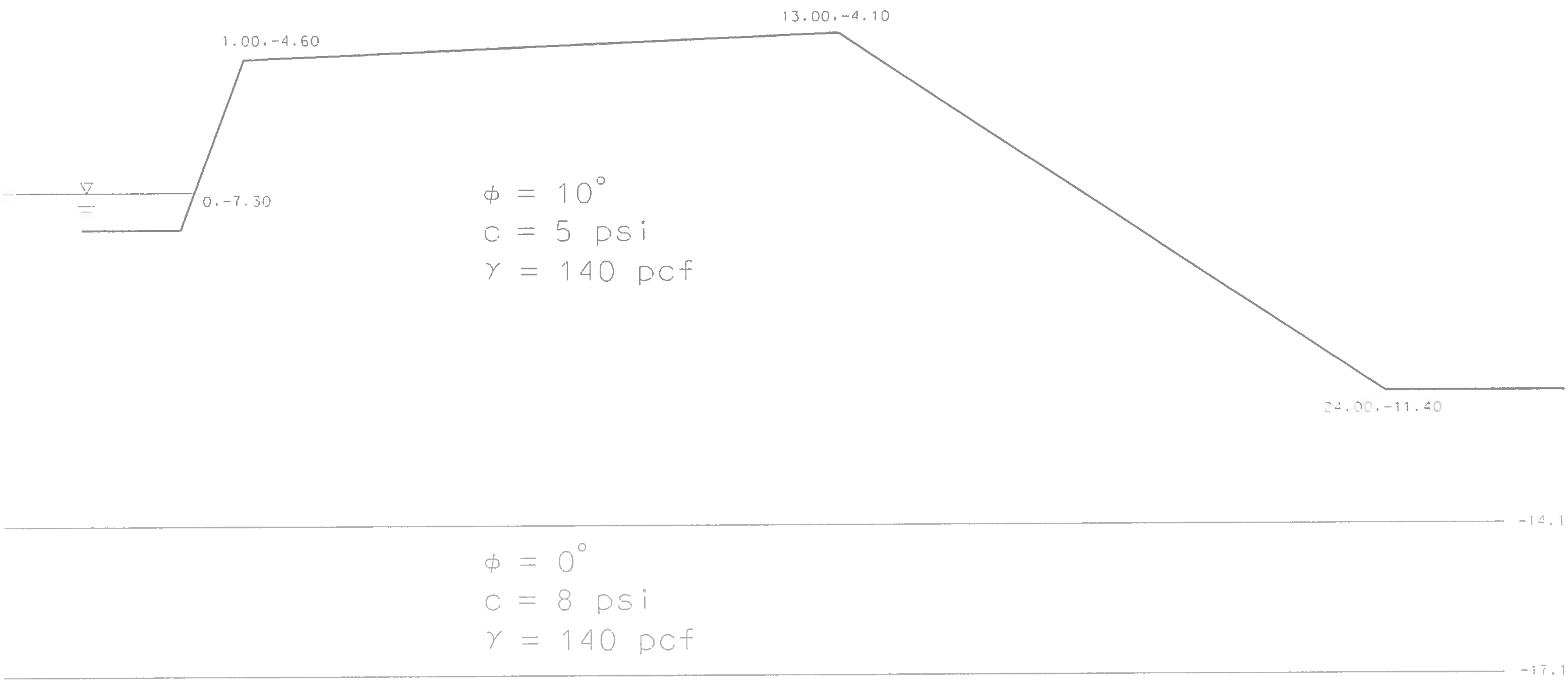


Section 7
Vector Trace



Section 8

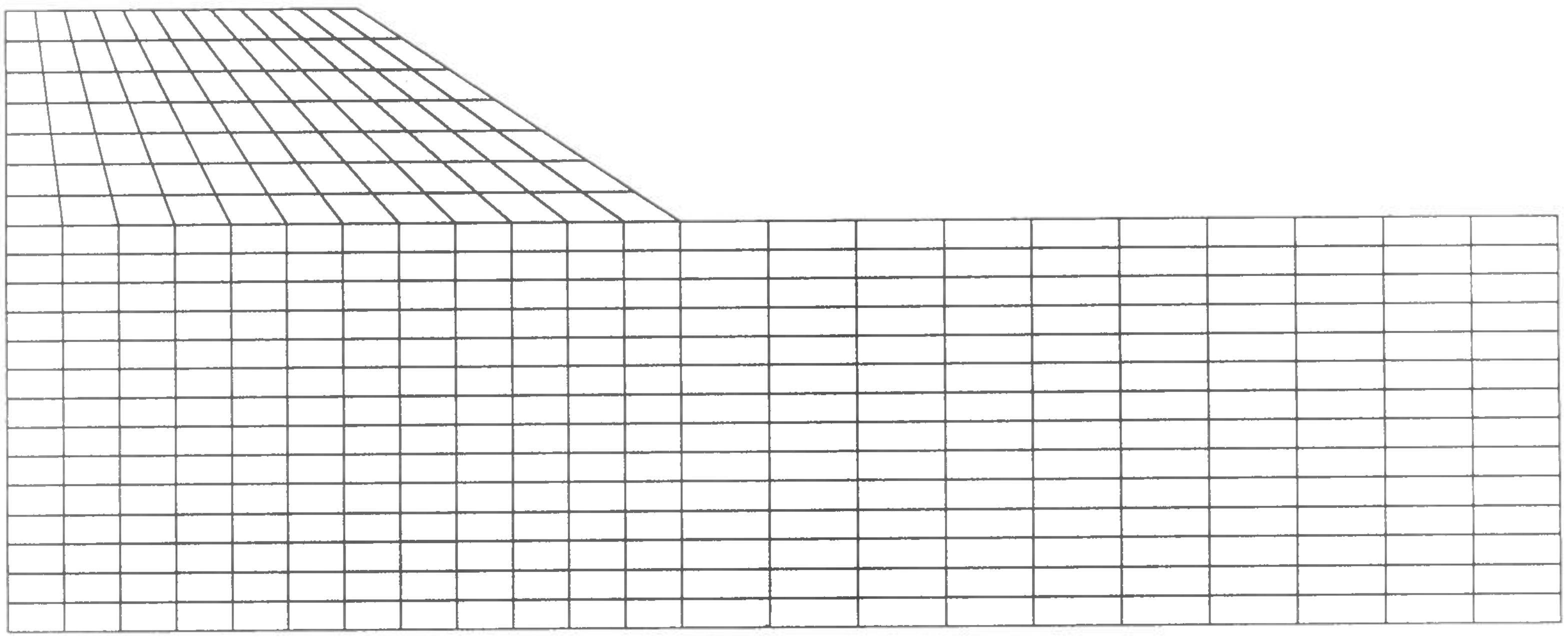
Factor Of Safety = 4.9



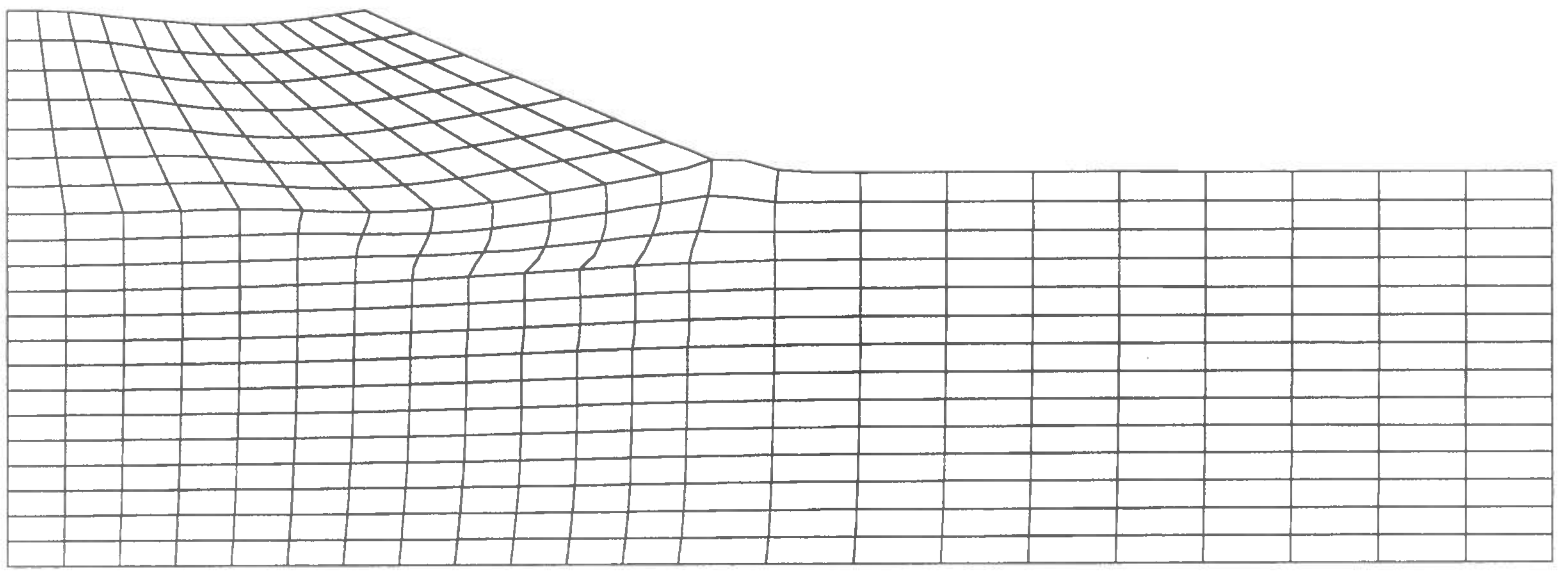
```
Section 8 Profile

w1=   12.00
s1=   11.00
w2=   30.00
h1=    7.30
h2=   14.00

nx1=   12
nx2=   10
ny1=    7
ny2=   14

Group  phi       c      psi    gamma       e          v
  1   10.00  720.00     0.00  140.00  0.1000E+06    0.30
  2    0.00 1152.00     0.00  140.00  0.1000E+06    0.30
  3    0.00 2304.00     0.00  140.00  0.1000E+06    0.30

Property group assigned to each element
   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
 2   2   2   2
   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
 2   2   2   2
   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
 2   2   2   2
   2   2
   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3
 3   3   3   3
   3   3
   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3
```

```
 3   3   3   3
   3   3
   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3
 3   3   3   3
   3   3
   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3
 3   3   3   3
   3   3
   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3
 3   3   3   3
   3   3
   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3
 3   3   3   3
   3   3
   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3
 3   3   3   3
   3   3
   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3
 3   3   3   3
   3   3

tol=  0.000100
limit= 1000

      trial factor    max displacement   iterations
      0.4600E+01      0.3695E+00            55
      0.4700E+01      0.3768E+00            89
      0.4800E+01      0.3859E+00           151
      0.4900E+01      0.4922E+00          1000
```

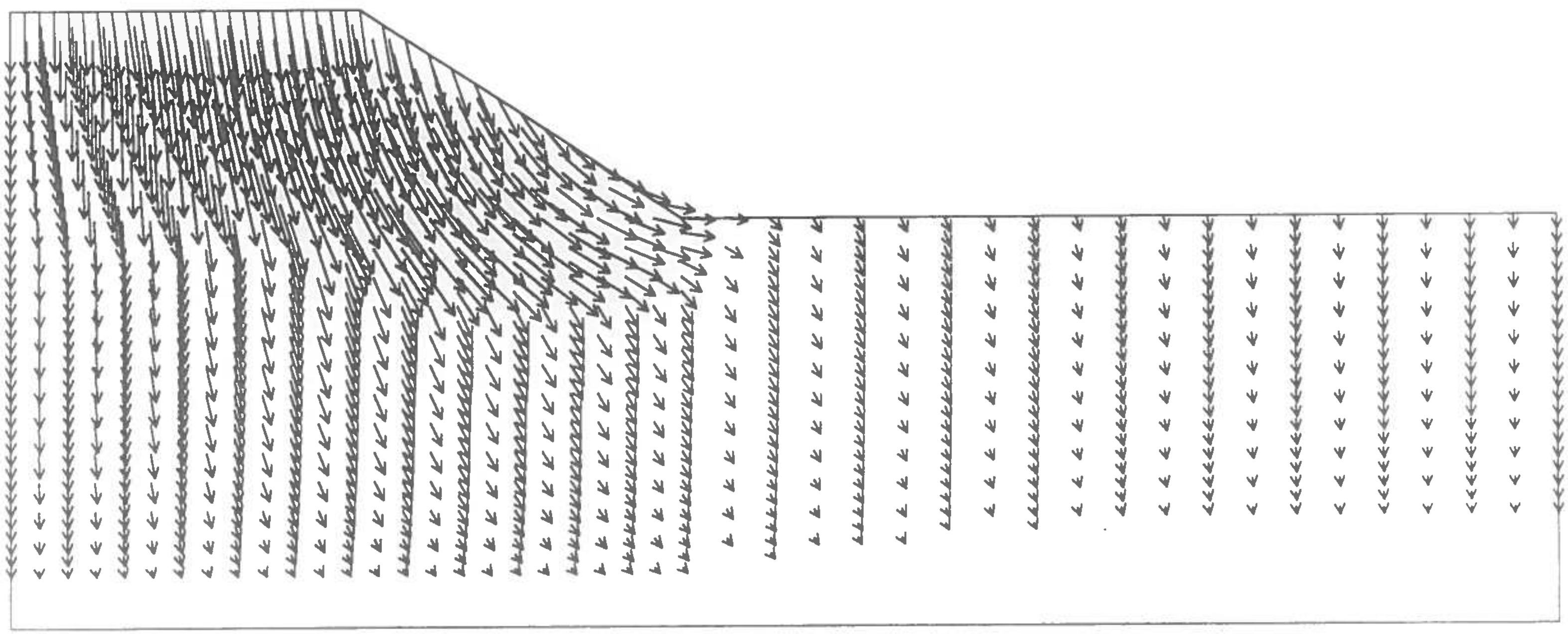
Section 8
Mesh



Section 8
Deformed Mesh

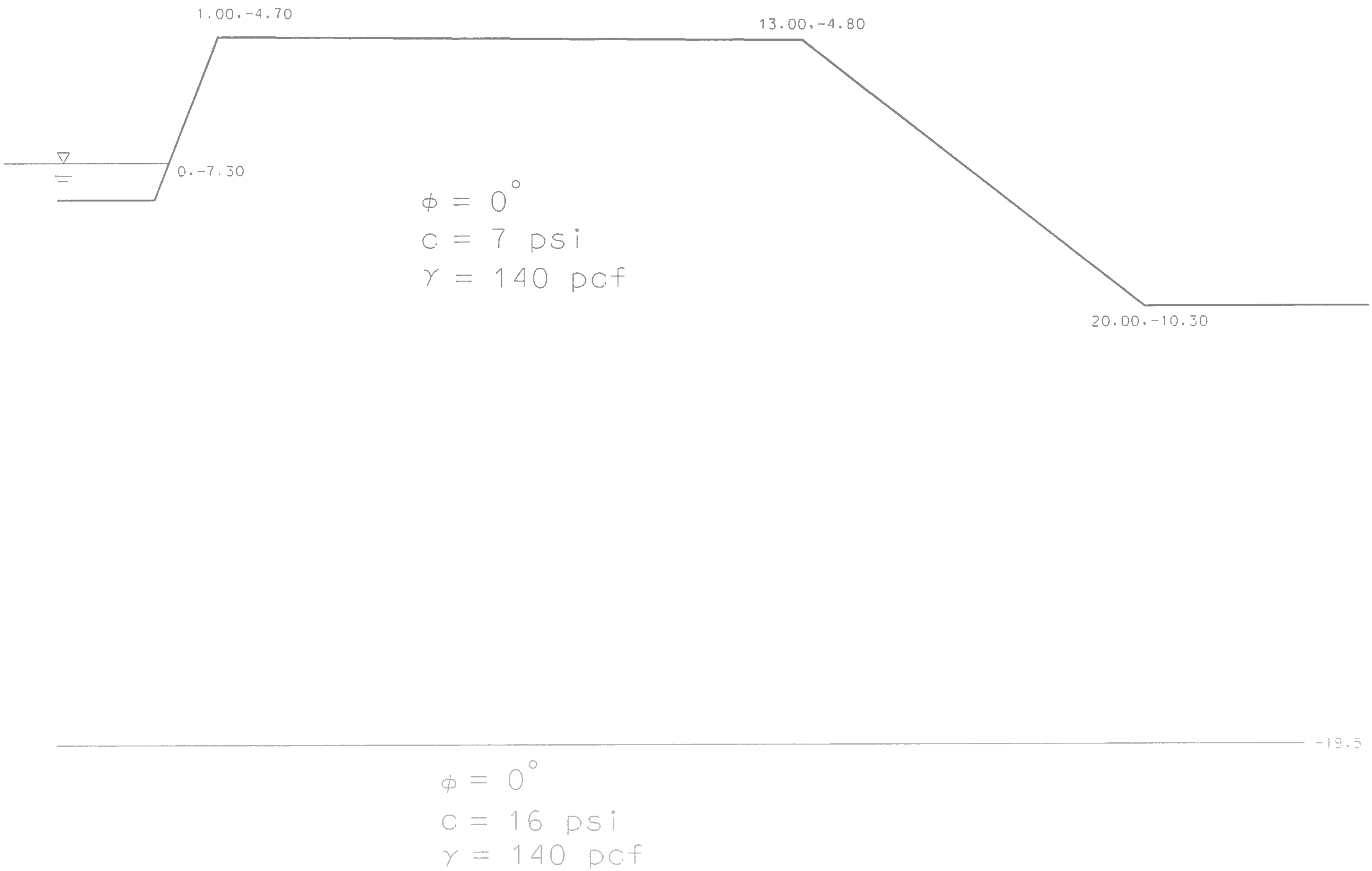


Section 8
Vector Trace



Section 9

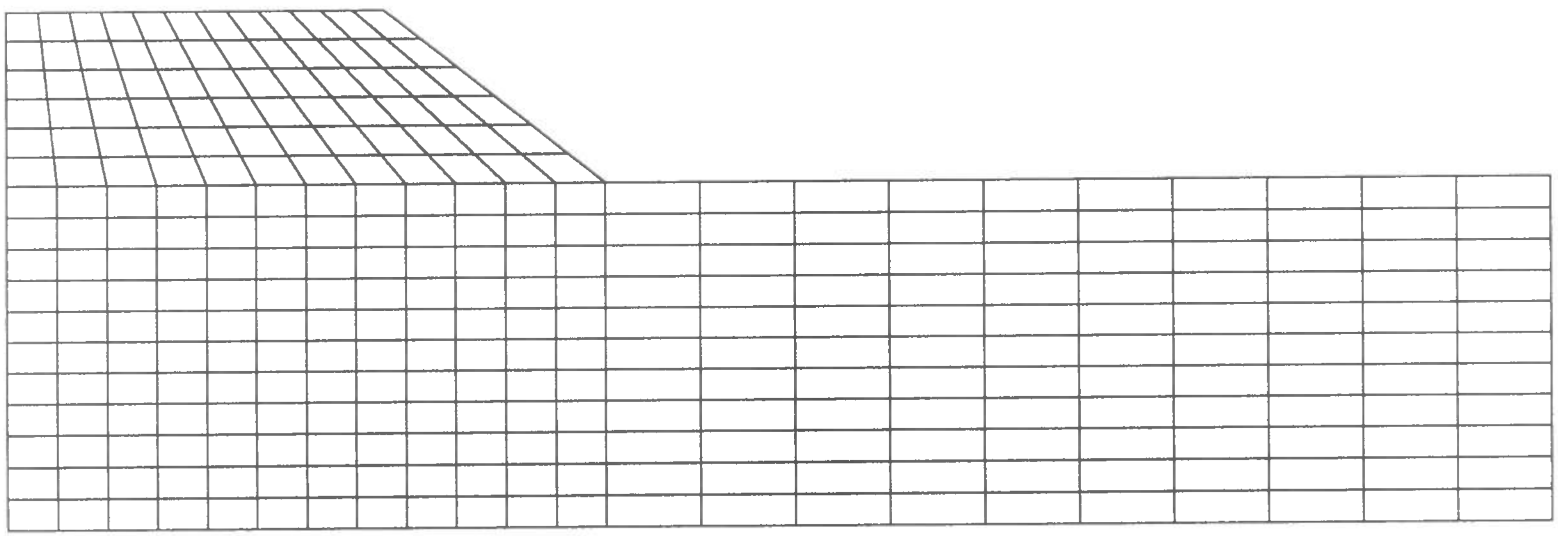
Factor Of Safety = 7.0



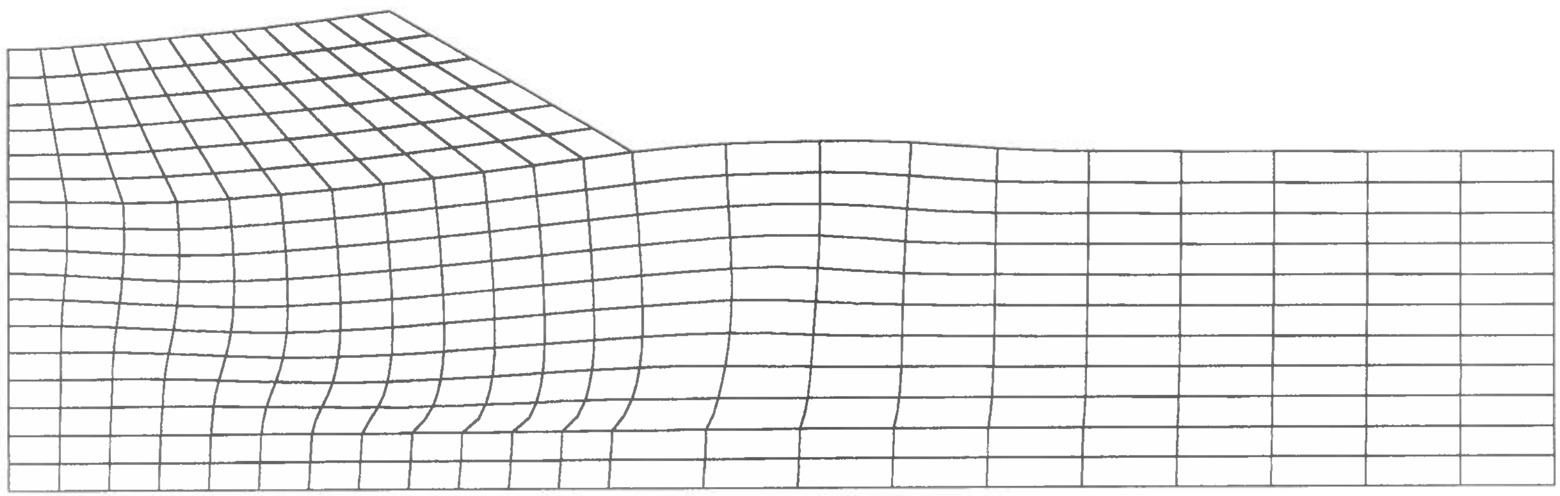
```
Section 9 Profile

w1=   12.00
s1=    7.00
w2=   30.00
h1=    5.50
h2=   11.00

nx1=   12
nx2=   10
ny1=    6
ny2=   11

Group  phi       c      psi    gamma       e          v
  1    0.00 1008.00     0.00  140.00  0.1000E+06     0.30
  2    0.00 2304.00     0.00  140.00  0.1000E+06     0.30

Property group assigned to each element
    1   1   1   1   1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
```

```
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
 2   2   2   2
   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
 2   2   2   2
   2   2

tol=  0.000100
limit= 1000

      trial factor    max displacement   iterations
      0.6500E+01      0.3177E+00            100
      0.6600E+01      0.3227E+00            104
      0.6700E+01      0.3283E+00            111
      0.6800E+01      0.3352E+00            122
      0.6900E+01      0.3451E+00            149
      0.7000E+01      0.4483E+00           1000
```

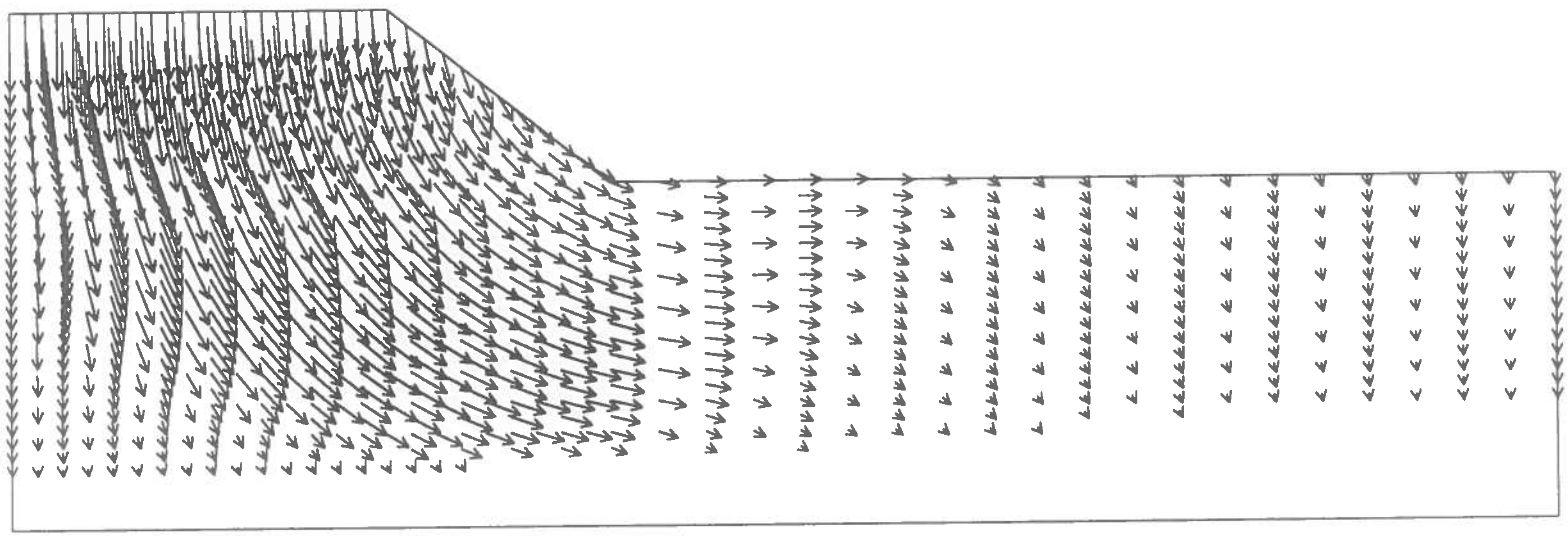
Section 9
Mesh



Section 9
Deformed Mesh

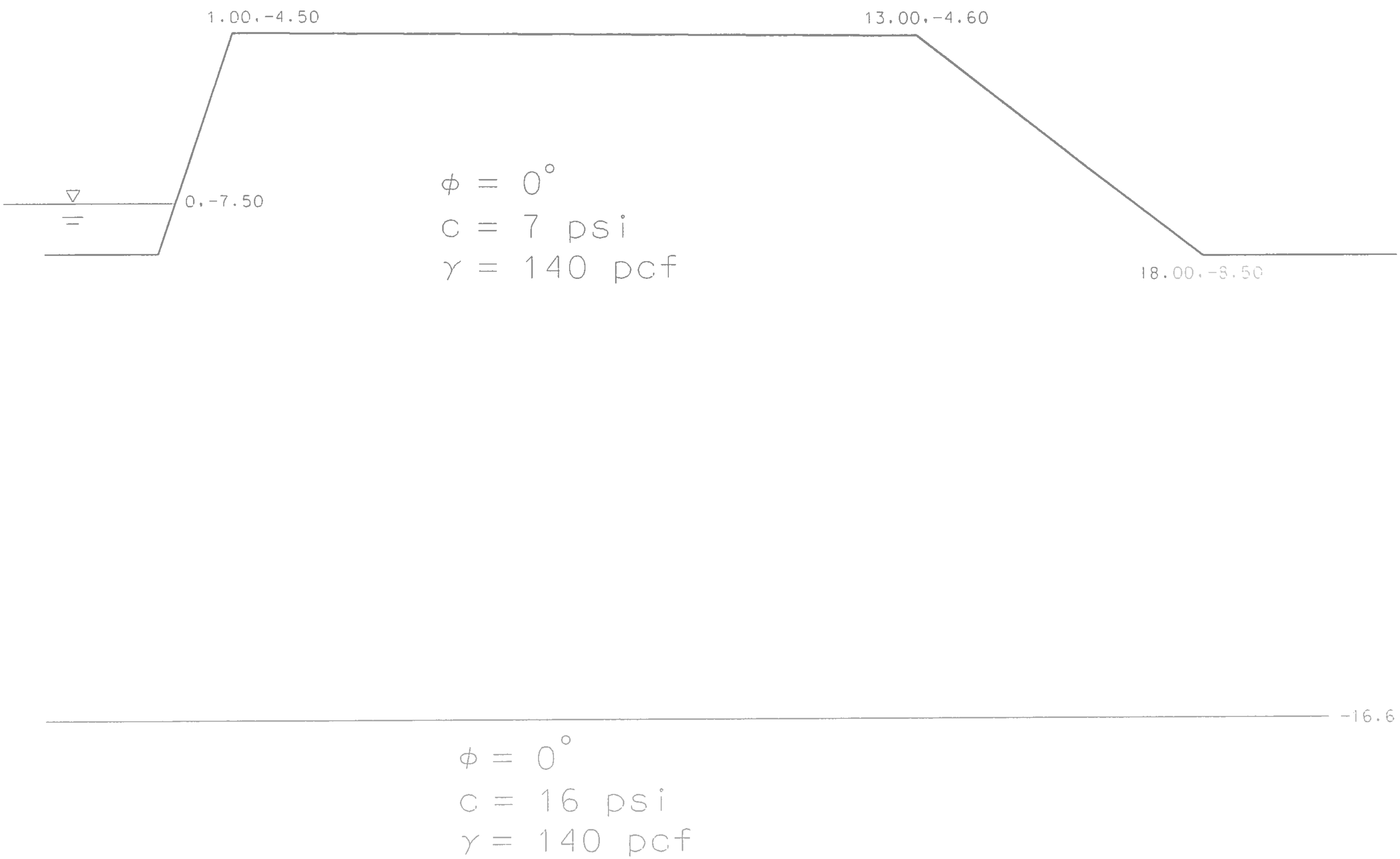


Section 9
Vector Trace



Section 10

Factor Of Safety = 10.0

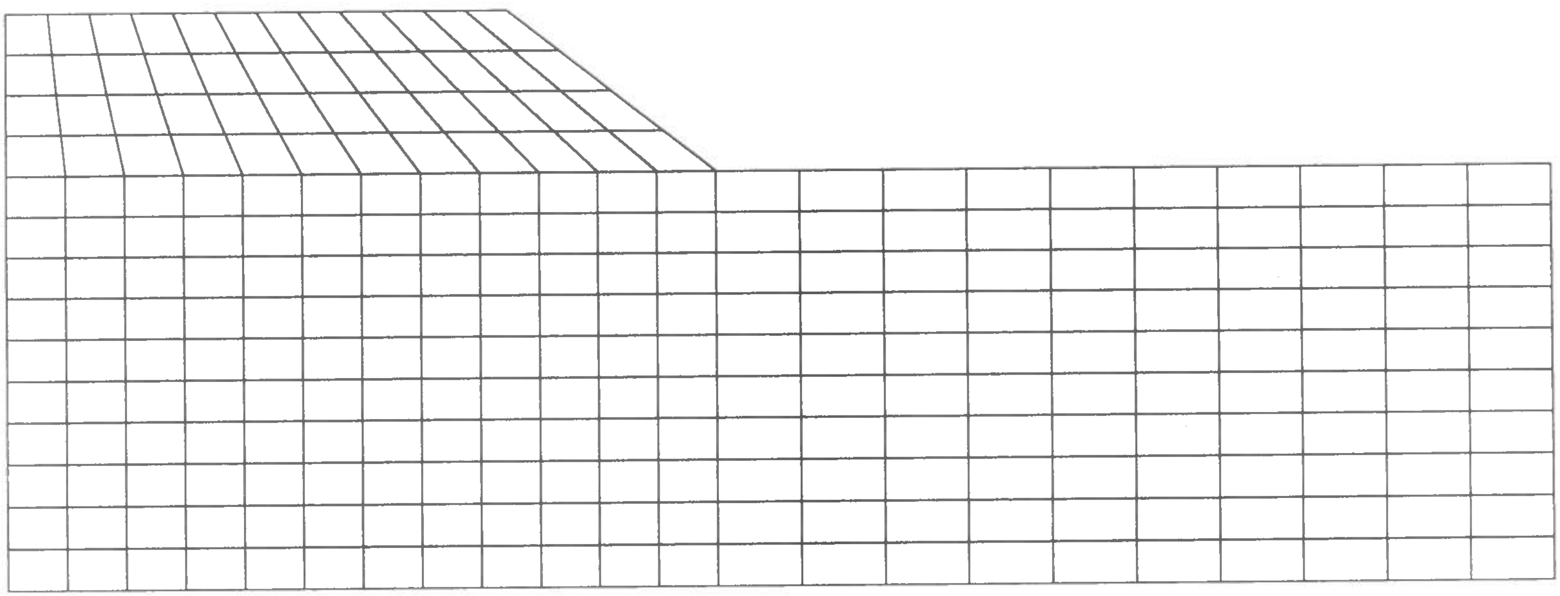


```
Section 10 Profile

w1=   12.00
s1=    5.00
w2=   20.00
h1=    3.90
h2=   10.00

nx1=   12
nx2=   10
ny1=    4
ny2=   10

Group  phi       c      psi    gamma       e          v
  1    0.00 1008.00    0.00  140.00  0.1000E+06    0.30
  2    0.00 2304.00    0.00  140.00  0.1000E+06    0.30

Property group assigned to each element
    1   1   1   1   1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1   1   1   1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  1   1   1   1
    1   1
    2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
  2   2   2   2
```

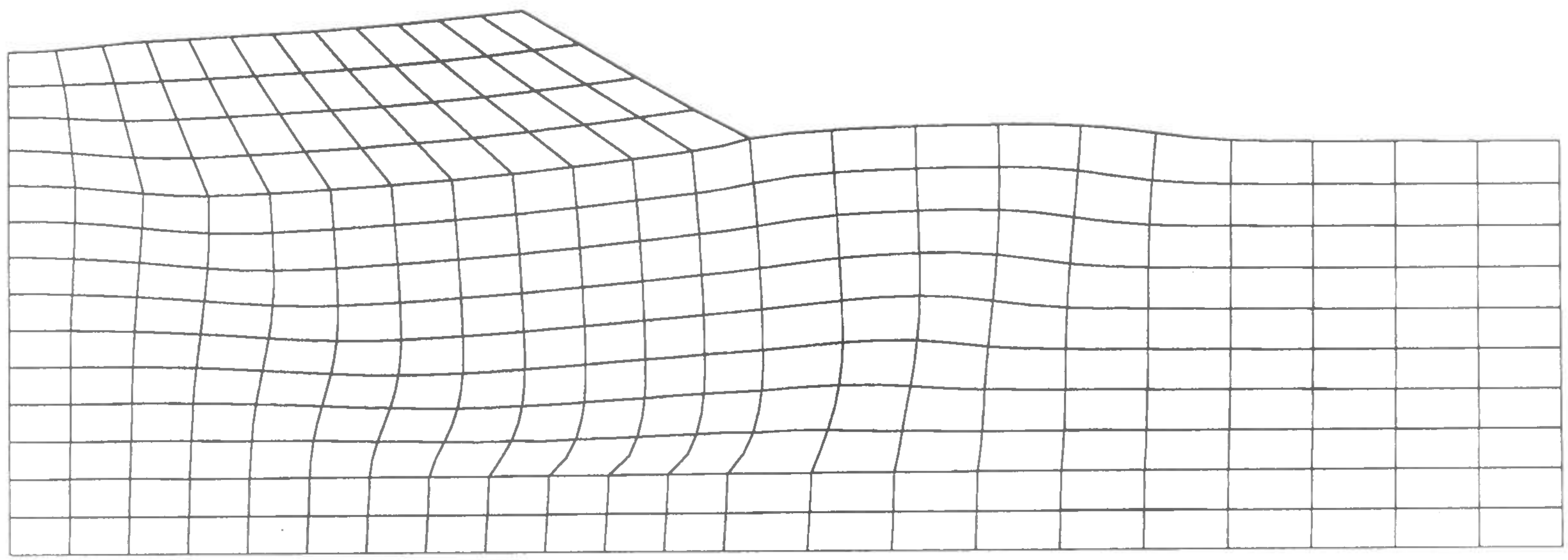
```
   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
2   2   2   2
   2   2

tol=  0.000100
limit= 1000

      trial factor    max displacement   iterations
      0.9500E+01      0.2121E+00            101
      0.9600E+01      0.2150E+00            110
      0.9700E+01      0.2184E+00            121
      0.9800E+01      0.2229E+00            144
      0.9900E+01      0.2381E+00            417
      0.1000E+02      0.3642E+00           1000
```

Section 10

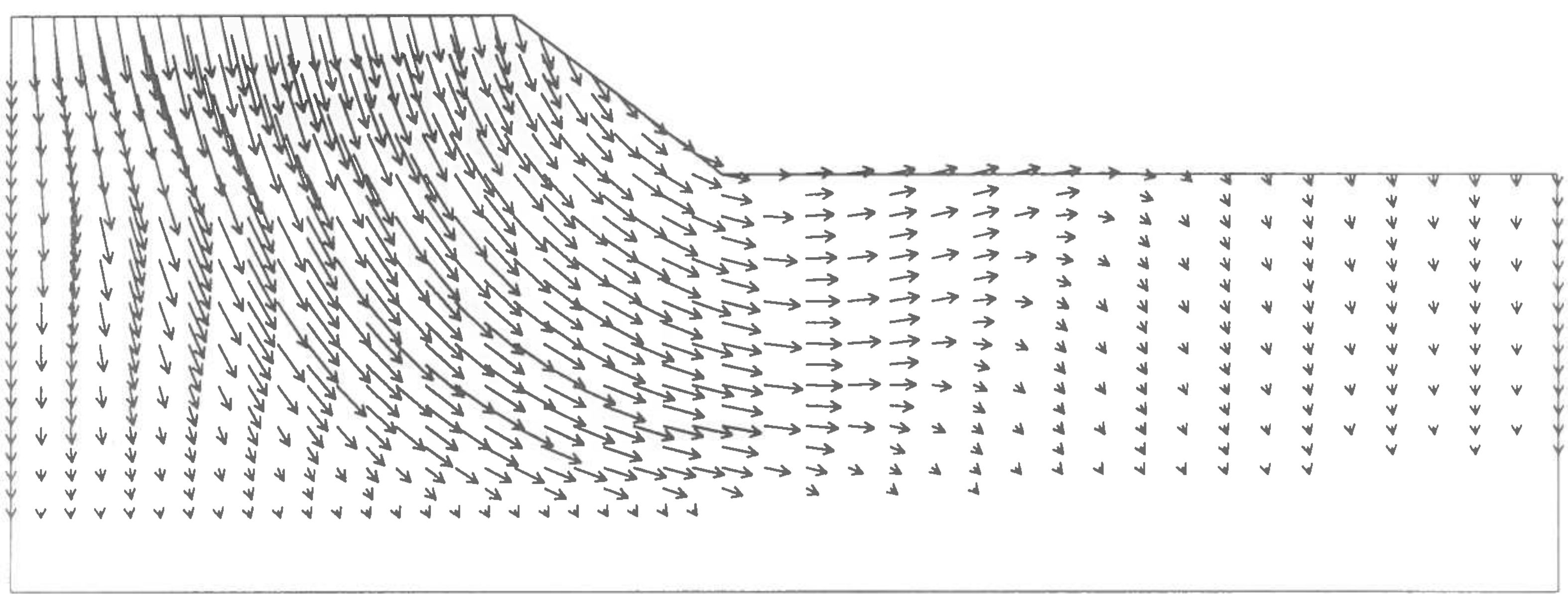
Mesh



Section 10
Deformed Mesh

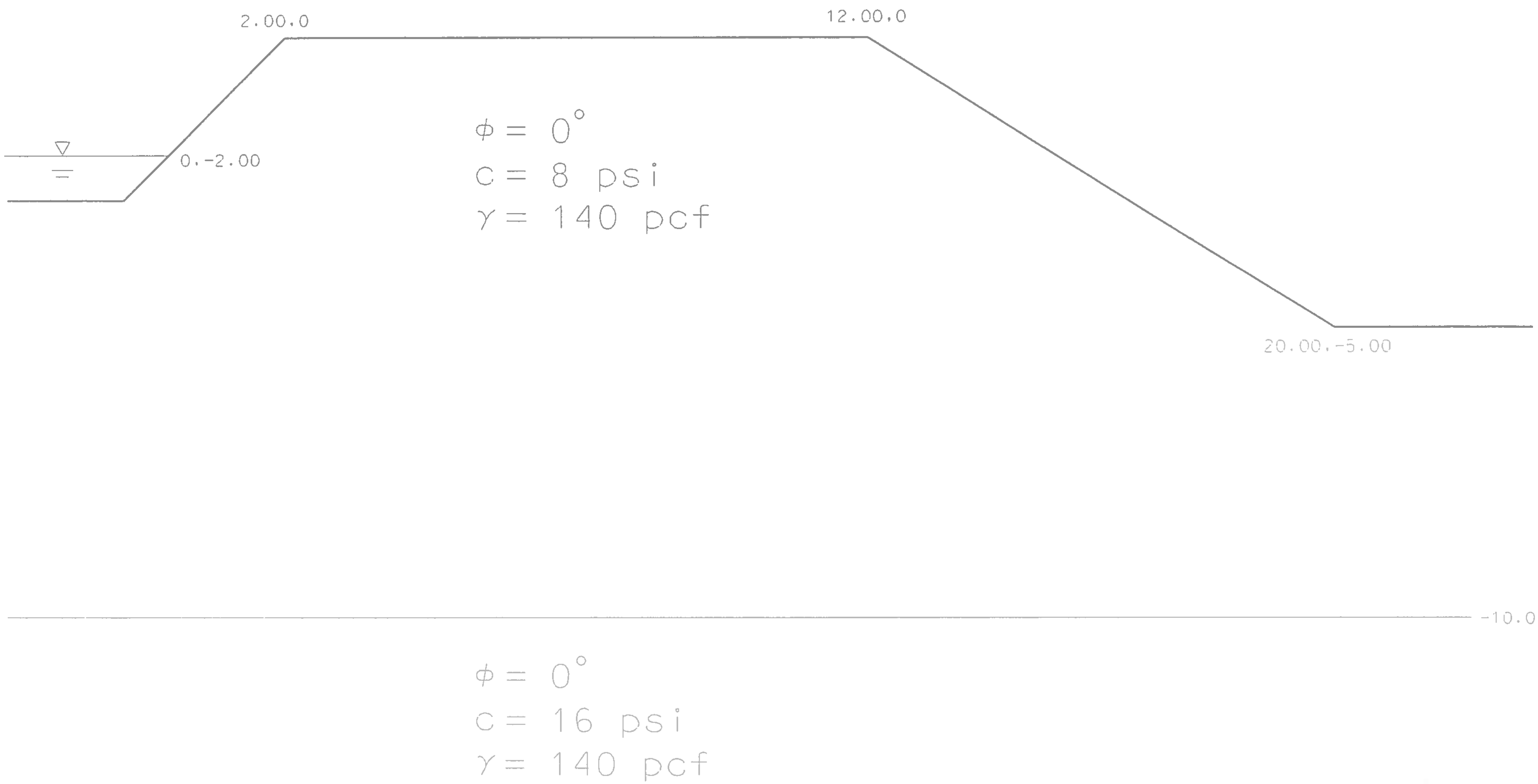


Section 10
Vector Trace



Section 11

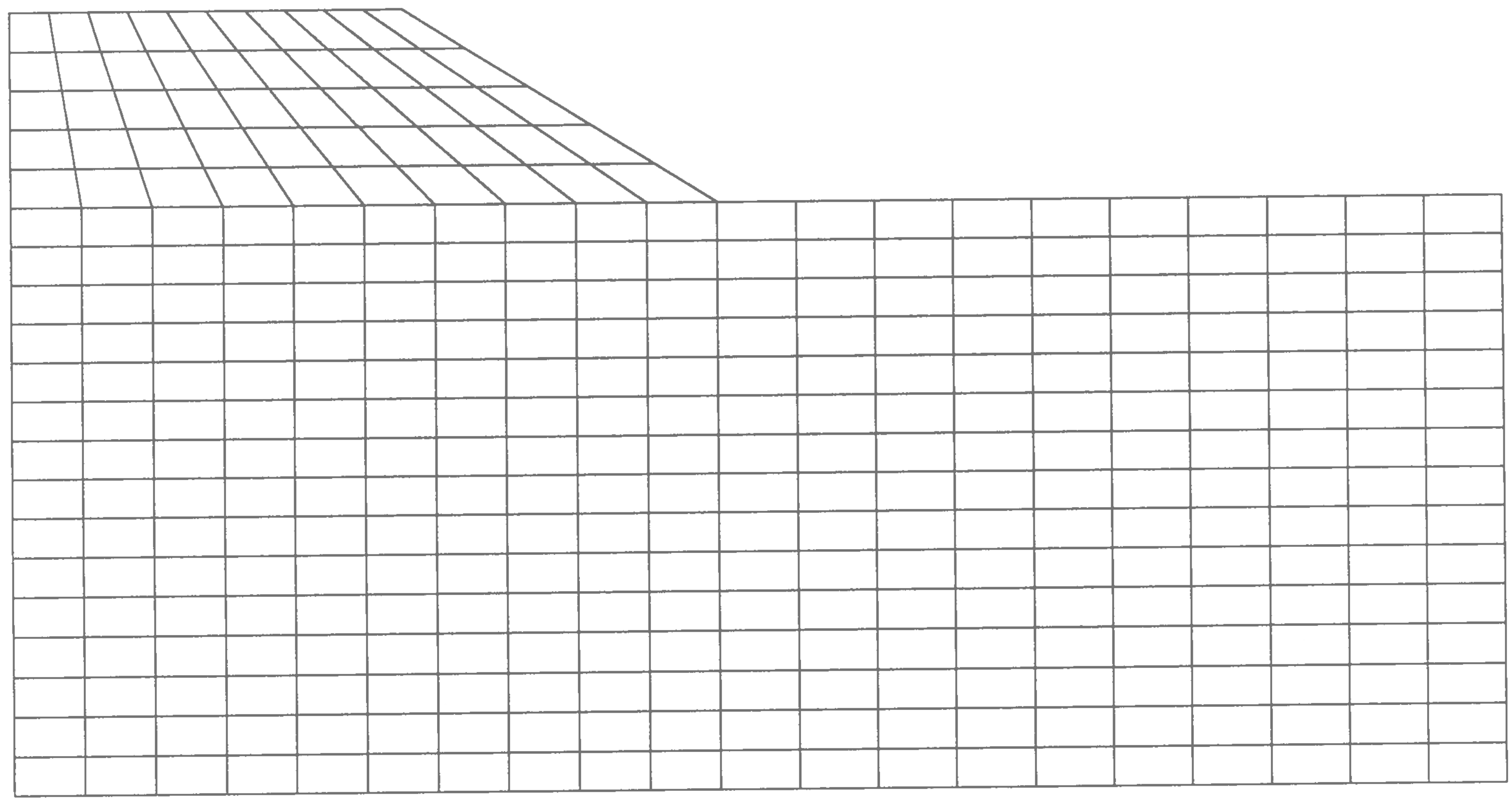
Factor Of Safety = 9.4



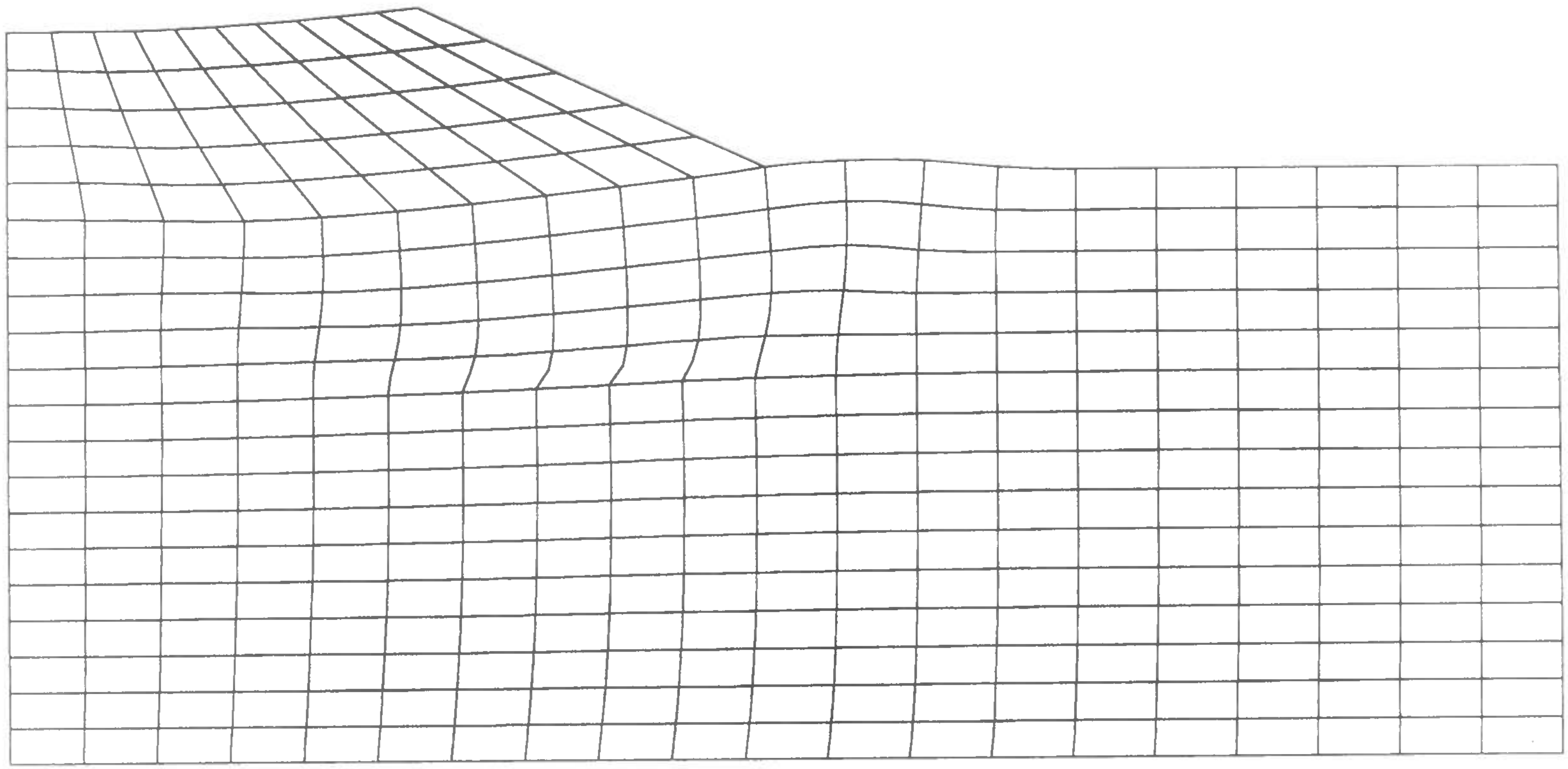
```
Section 11 Profile

w1=   10.00
s1=    8.00
w2=   20.00
h1=    5.00
h2=   15.00

nx1=   10
nx2=   10
ny1=    5
ny2=   15

Group  phi       c       psi    gamma       e          v
  1    0.00 1152.00     0.00   140.00  0.1000E+06    0.30
  2    0.00 2304.00     0.00   140.00  0.1000E+06    0.30

Property group assigned to each element
    1    1    1    1    1    1    1    1    1    1
    1    1    1    1    1    1    1    1    1    1
    1    1    1    1    1    1    1    1    1    1
    1    1    1    1    1    1    1    1    1    1
    1    1    1    1    1    1    1    1    1    1
    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
  1    1    1    1
    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
  1    1    1    1
    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
  1    1    1    1
    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
  1    1    1    1
    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
  1    1    1    1
    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
  2    2    2    2
    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
  2    2    2    2
    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
  2    2    2    2
    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
  2    2    2    2
    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
  2    2    2    2
    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
  2    2    2    2
    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
  2    2    2    2
    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
```

```
 2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
 2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
 2   2   2   2

tol=  0.000100
limit= 1000

      trial factor    max displacement   iterations
      0.9000E+01      0.4058E+00             83
      0.9100E+01      0.4124E+00            110
      0.9200E+01      0.4204E+00            148
      0.9300E+01      0.4331E+00            231
      0.9400E+01      0.5048E+00           1000
```

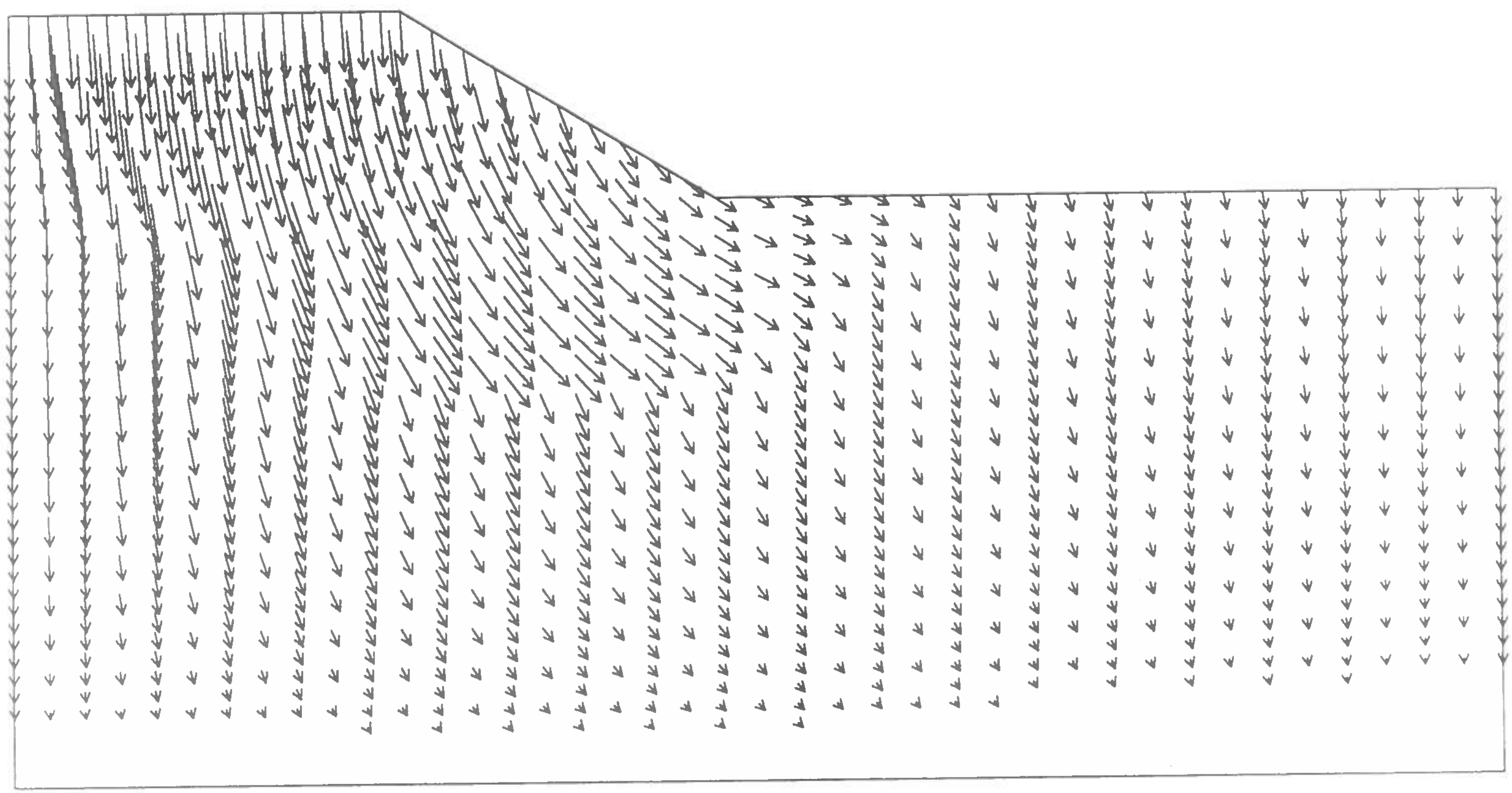
Section 11
Mesh



Section 11
Deformed Mesh

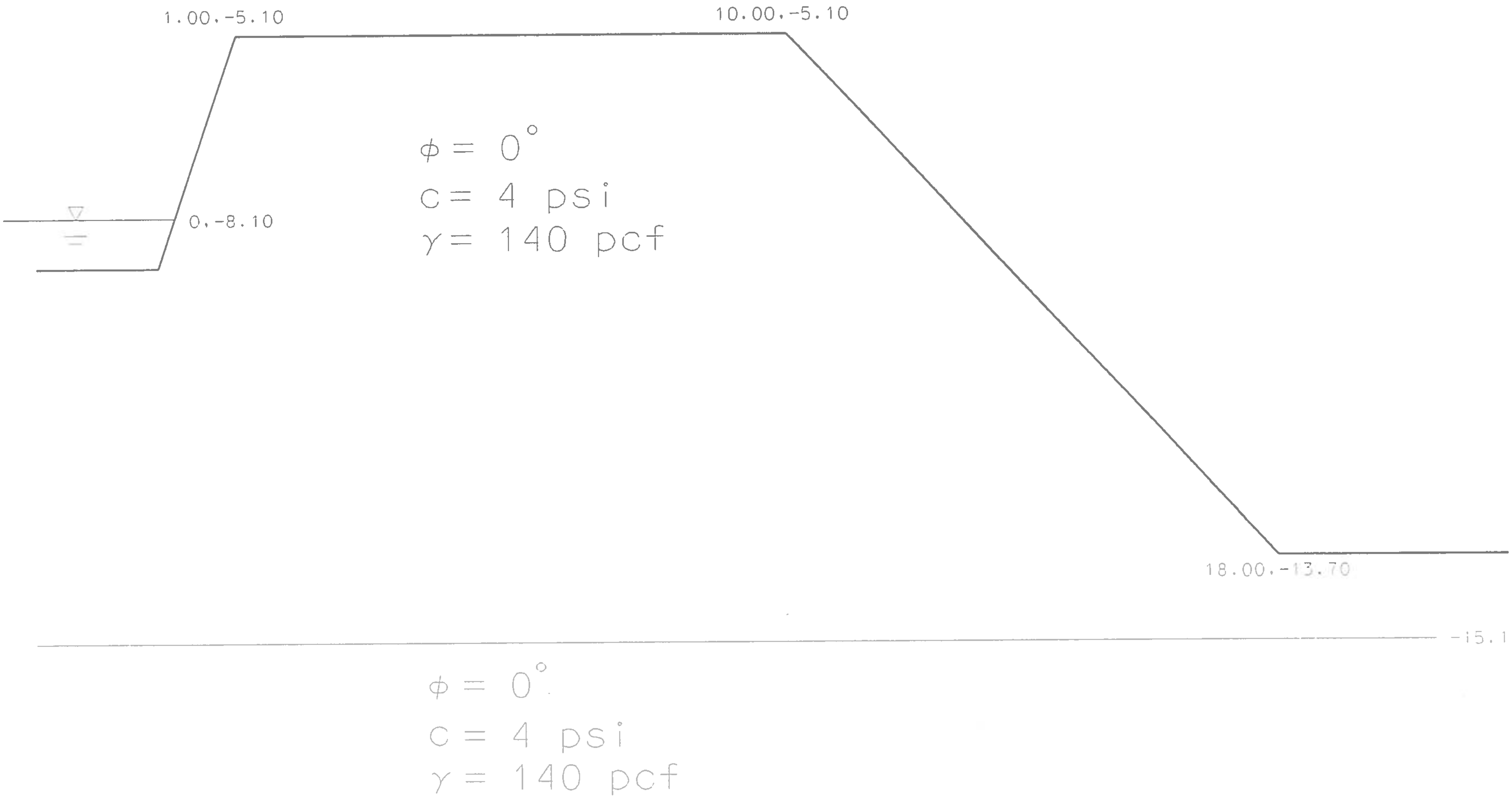


Section 11
Vector Trace



Section 12

Factor Of Safety = 2.5

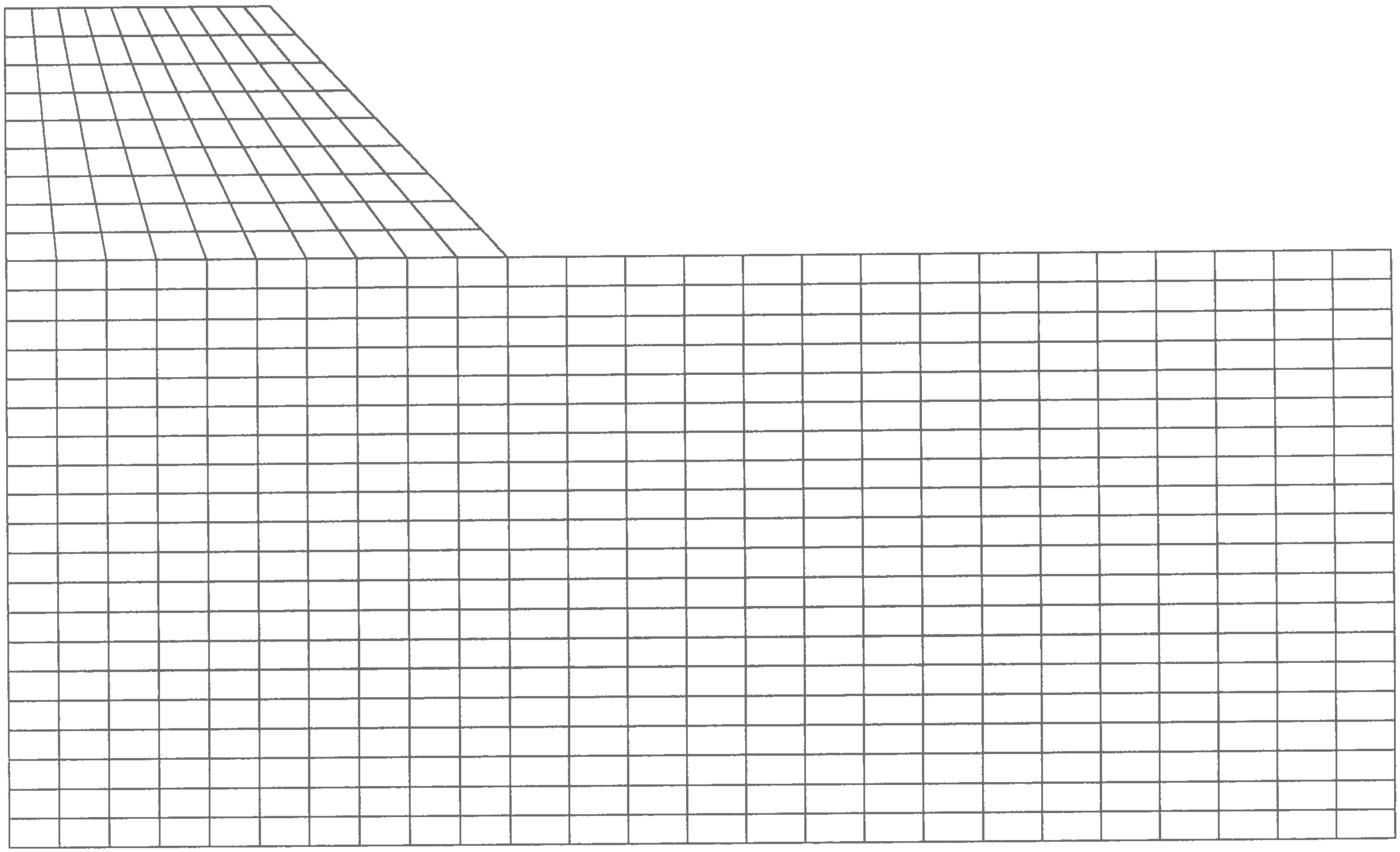


```
Section 12 Profile

w1=    9.00
s1=    8.00
w2=   30.00
h1=    8.60
h2=   20.00

nx1=   10
nx2=   15
ny1=    9
ny2=   20

Group  phi       c      psi    gamma       e          v
  1    0.00  576.00    0.00  140.00  0.1000E+06    0.30

Property group assigned to each element
   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
```

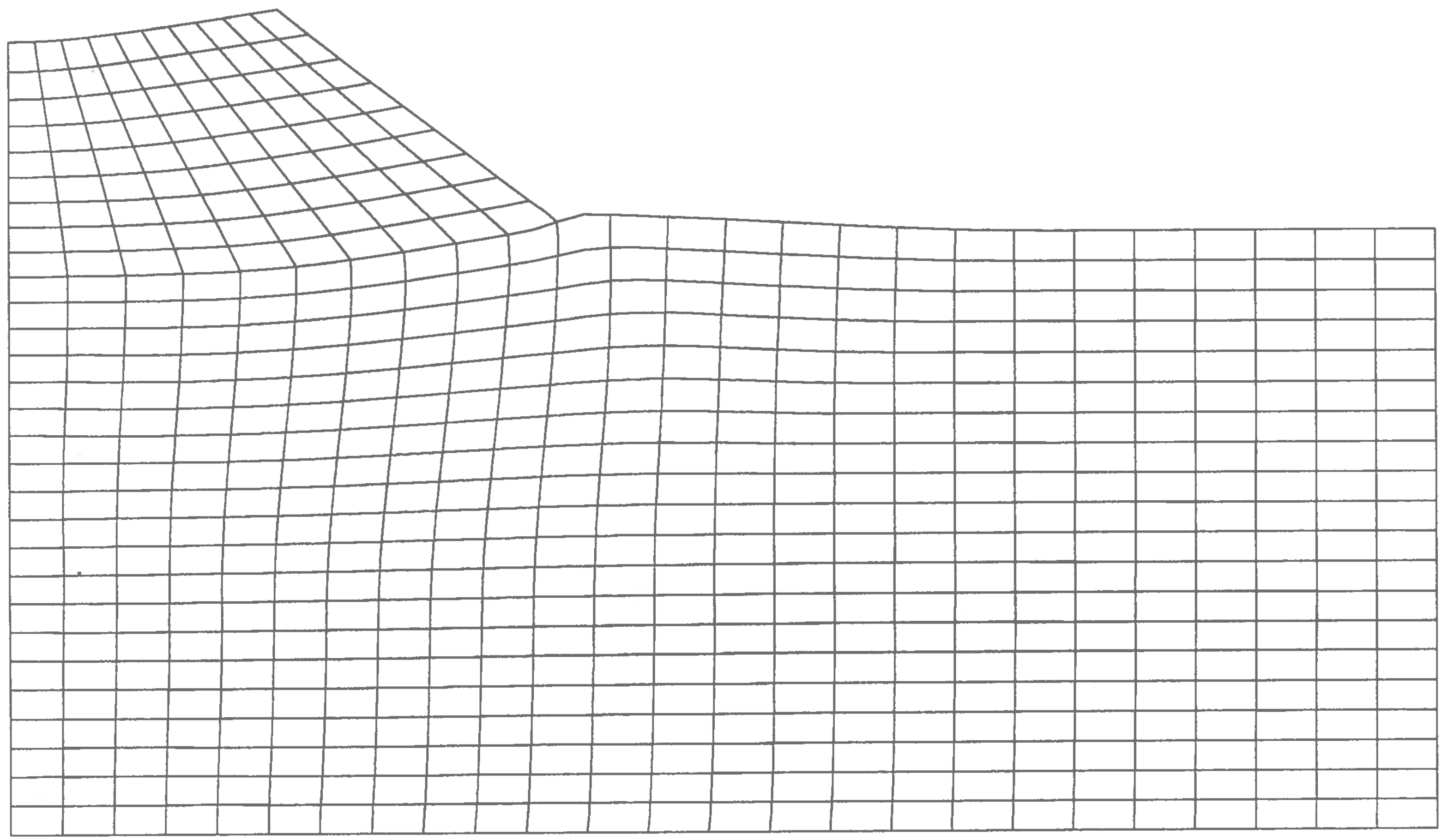
```
   1   1   1   1
     1   1   1   1   1
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1
     1   1   1   1   1
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1
     1   1   1   1   1
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1
     1   1   1   1   1
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1
     1   1   1   1   1
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1
     1   1   1   1   1
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1
     1   1   1   1   1
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1
     1   1   1   1   1
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1
     1   1   1   1   1
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1
     1   1   1   1   1
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1
     1   1   1   1   1
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1
     1   1   1   1   1
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1
     1   1   1   1   1

tol=  0.000100
limit= 1000

      trial factor    max displacement   iterations
      0.2000E+01      0.8471E+00             53
      0.2100E+01      0.8825E+00             60
      0.2200E+01      0.9211E+00             68
      0.2300E+01      0.9667E+00             76
      0.2400E+01      0.1049E+01            115
```

0.2500E+01	0.2617E+01	1000

Section 12
Mesh



Section 12
Deformed Mesh



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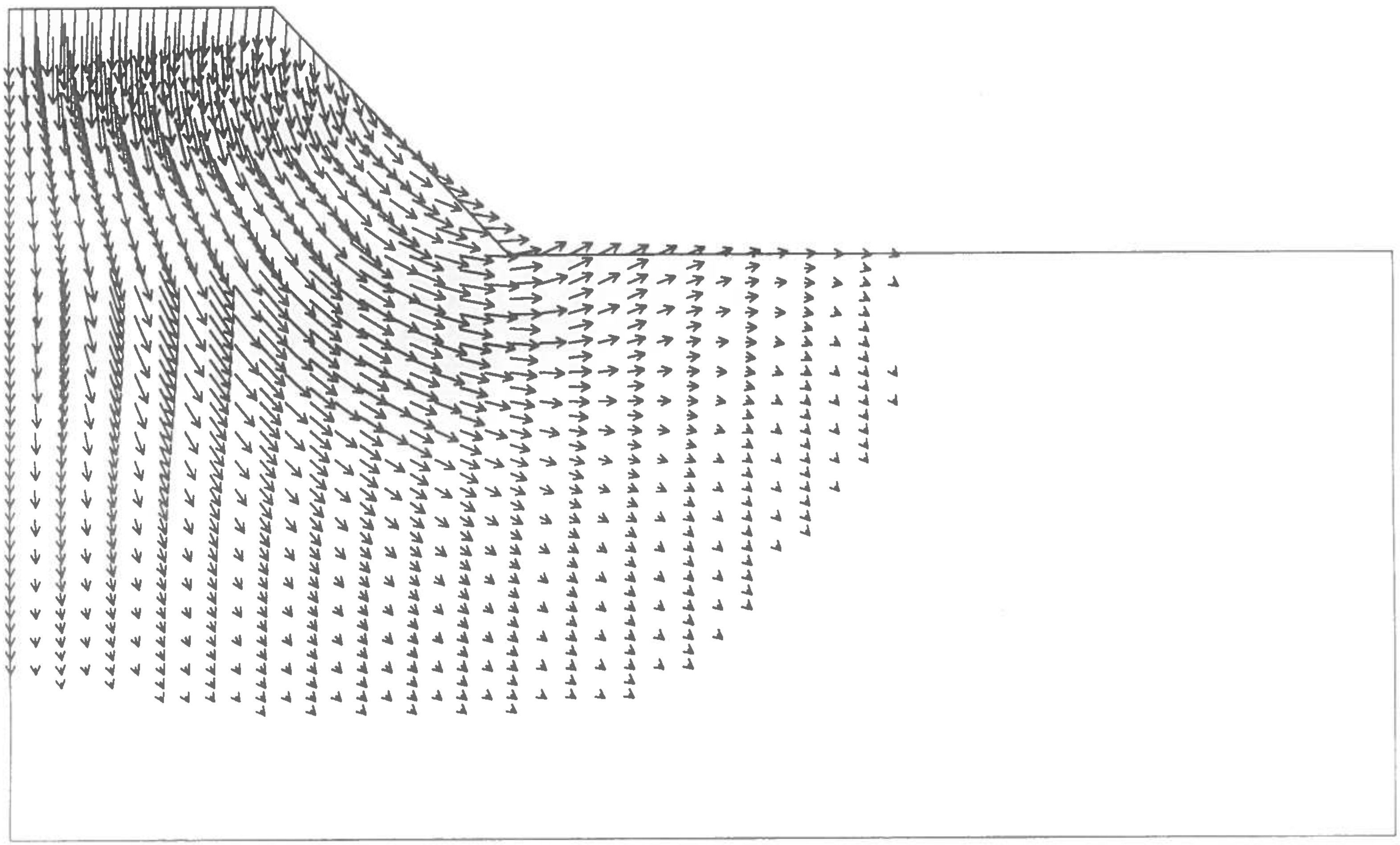

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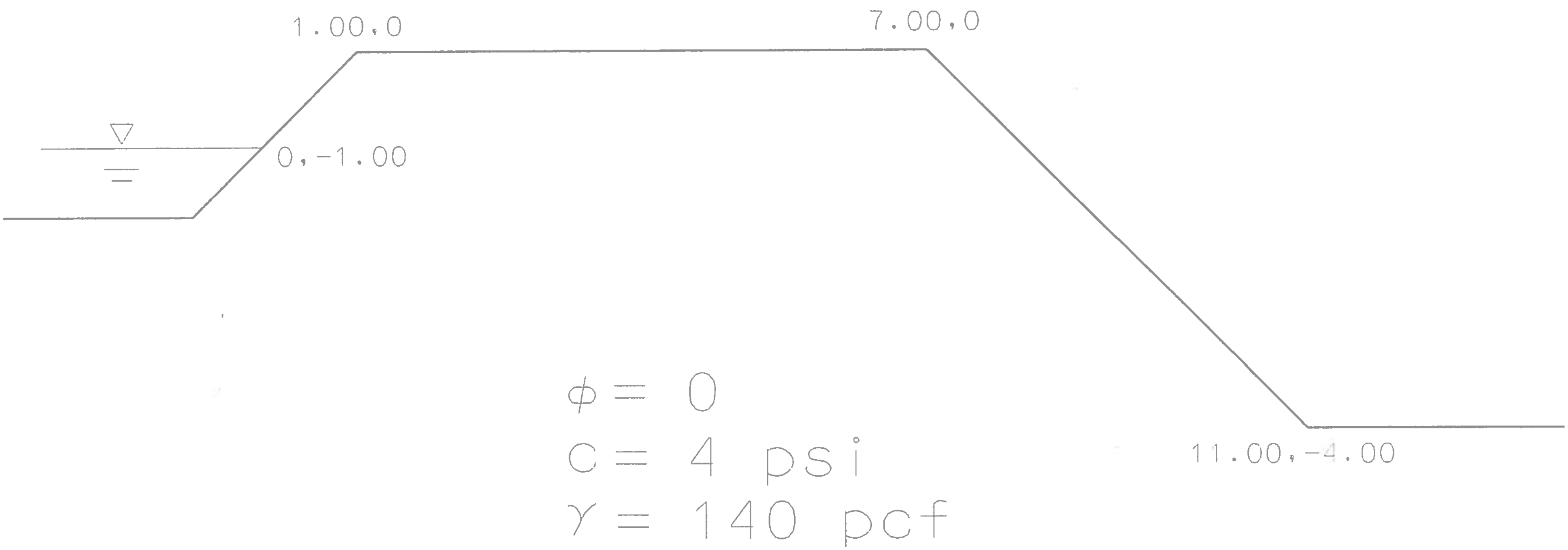

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Section 13 Profile

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h2=   10.00

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nx2=   10
ny1=    4
ny2=   10

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Property group assigned to each element
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   1   1   1   1   1   1
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limit= 1000

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      0.5100E+01      0.2652E+00              82
      0.5200E+01      0.2768E+00             105
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Section 13
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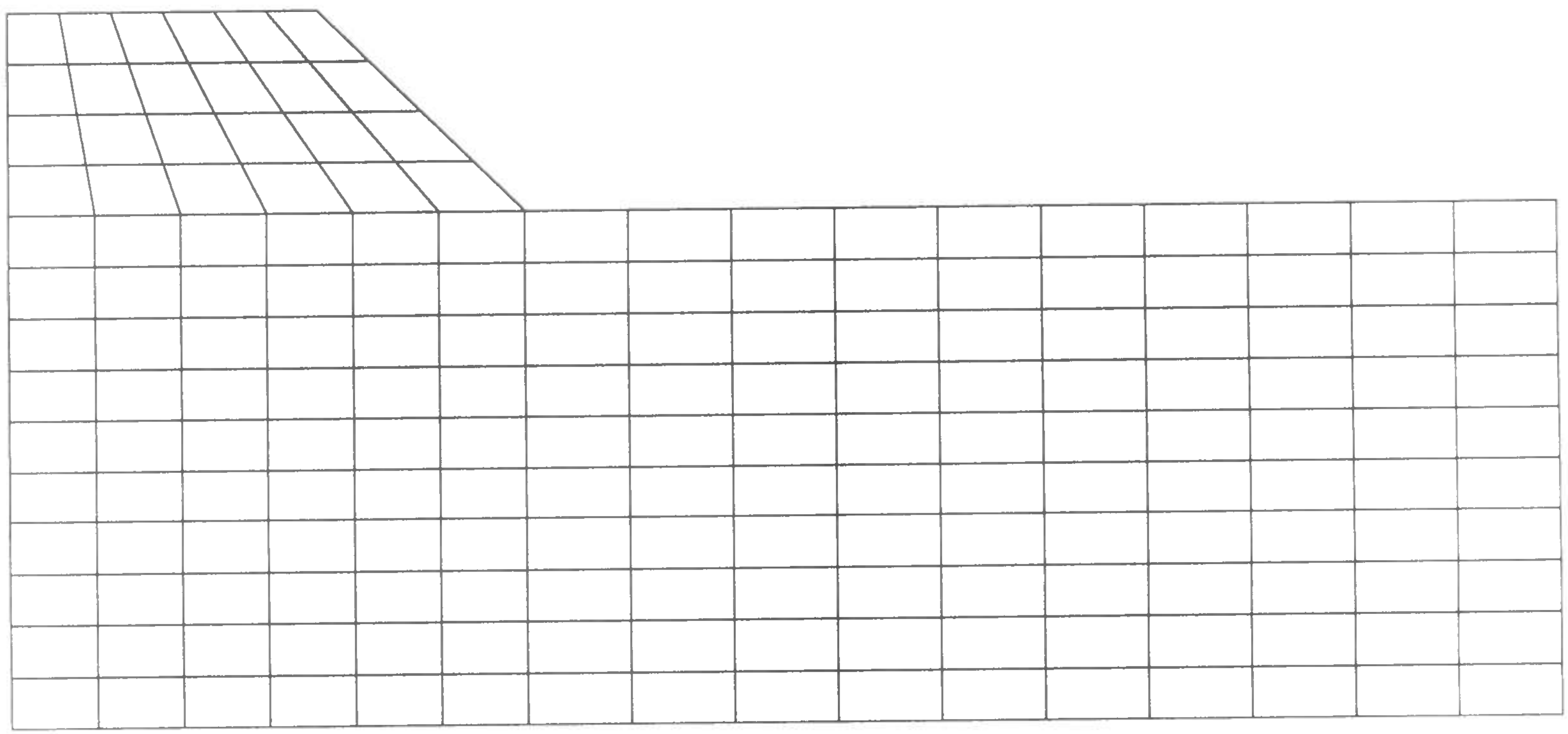

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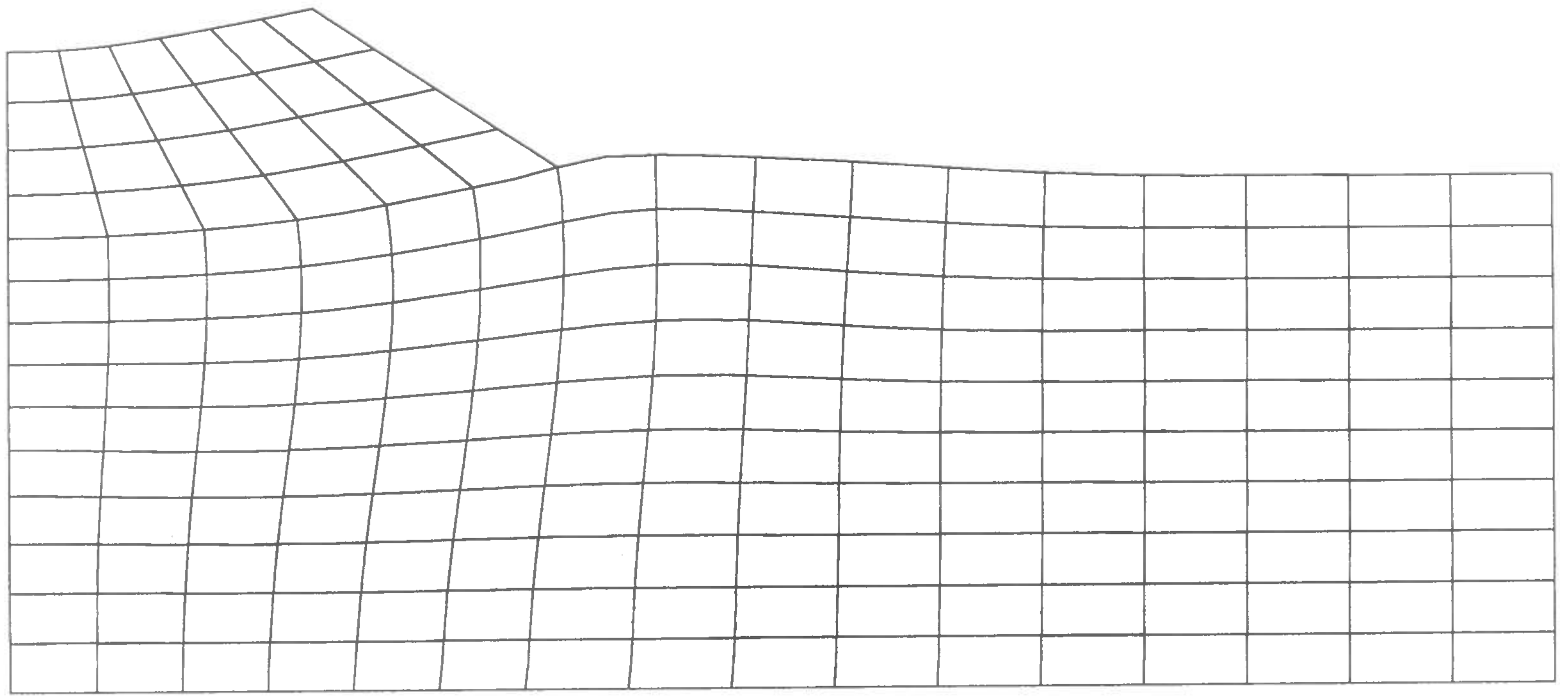

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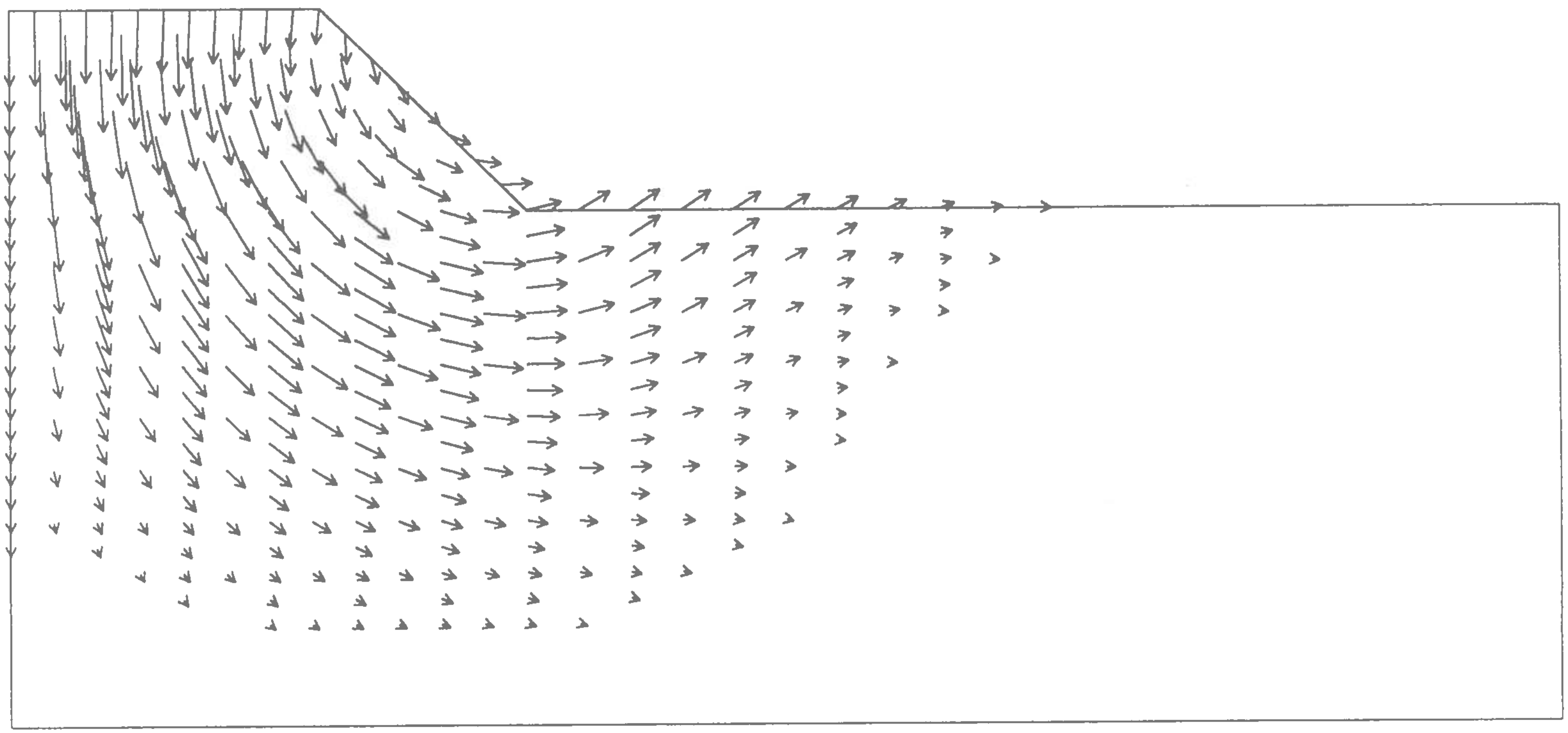


Triaxial Shear Results

Project: Ciniza Evaporation Lagoons

Project Number: 00-141

Sample #: 38631

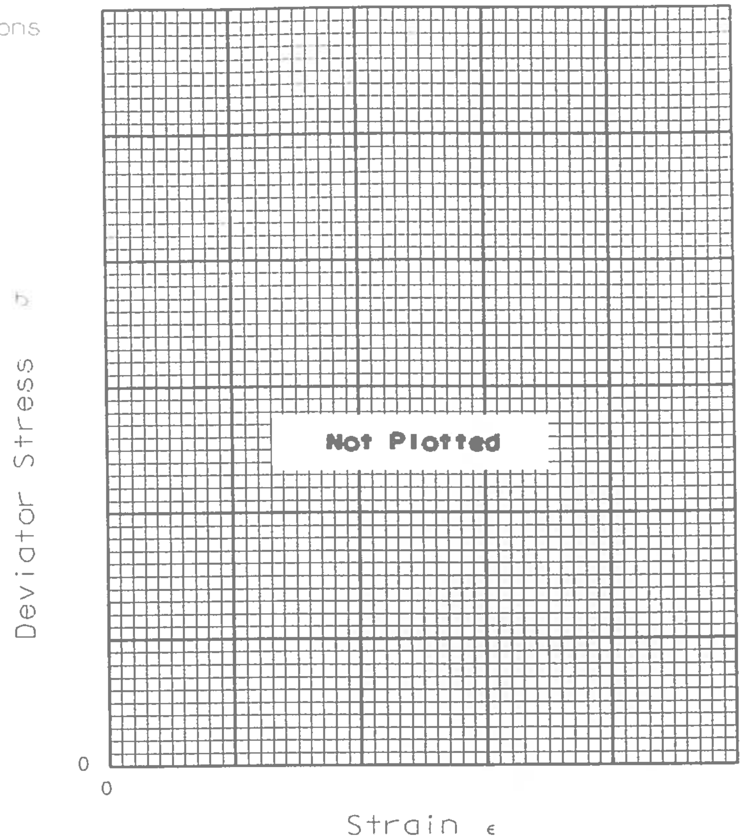
Unit Weight (pcf): 137.3 wet

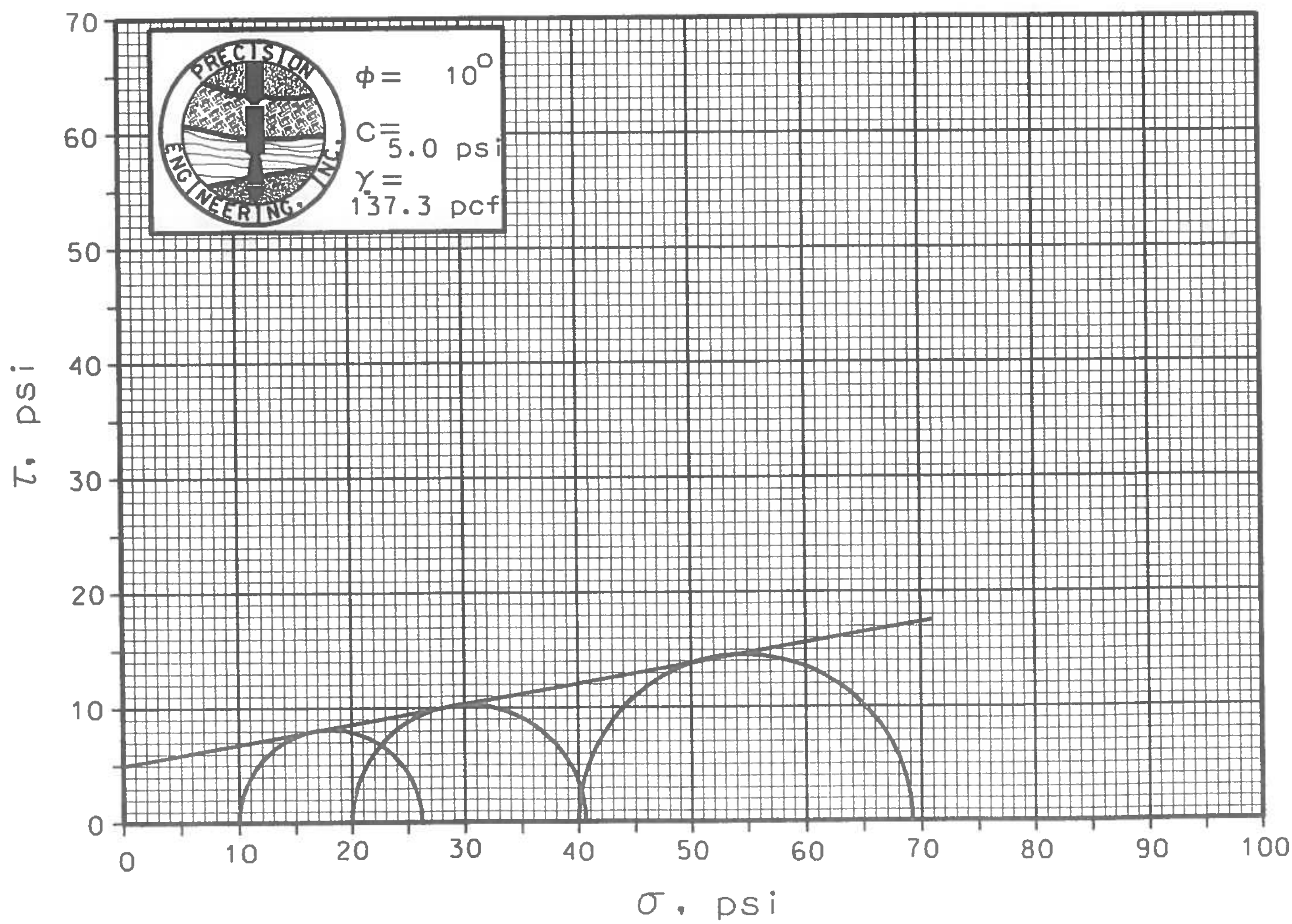
Lateral Pressure = σ_3

Max. Deviator Stress = σ

Max. Vertical Stress = σ_1

Sample	σ_3	σ	σ_1
1	10	16.2	26.2
2	20	20.8	40.8
3	40	29.1	69.1





Triaxial Shear Results

Project: Ciniza Evaporation Lagoons

Project Number: 00-141

Sample #: 38640

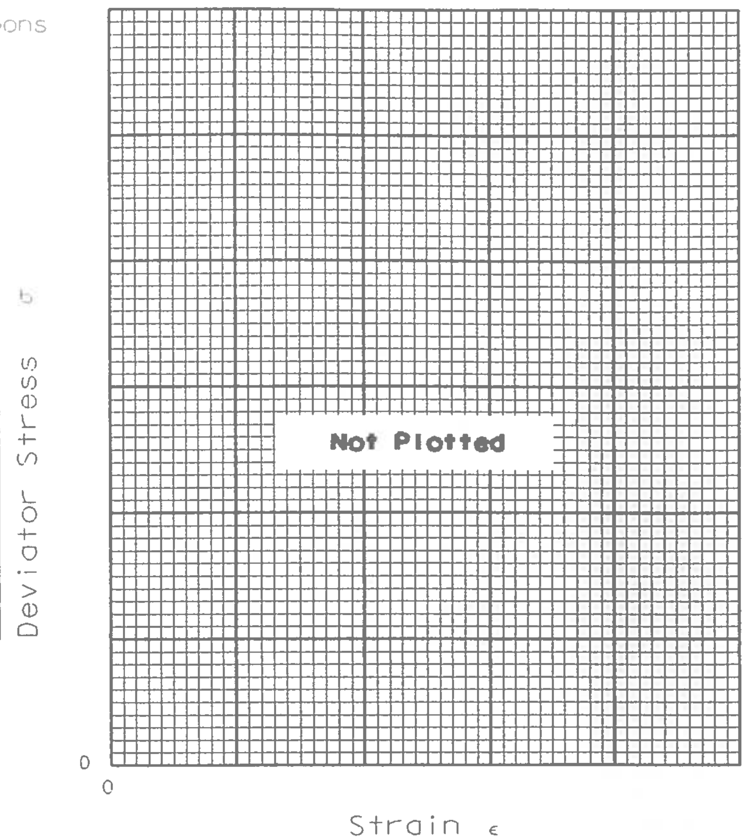
Unit Weight (pcf): 140.1 wet

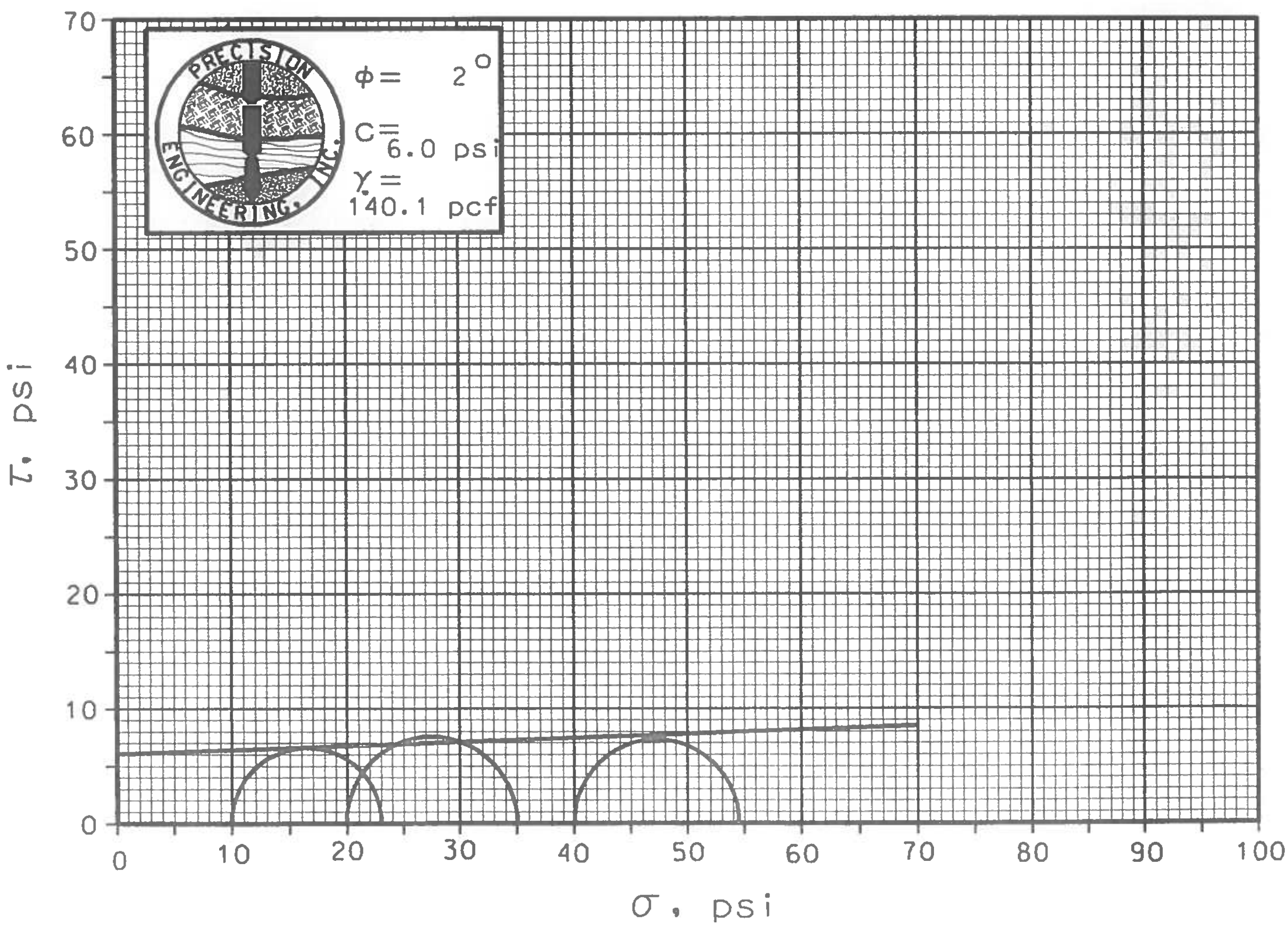
Lateral Pressure = σ_3

Max. Deviator Stress = σ

Max. Vertical Stress = σ_1

Sample	σ_3	σ	σ_1
1	10	24.0	23.0
2	20	29.9	35.0
3	40	24.1	54.5





Triaxial Shear Results

Project: Ciniza Evaporation Lagoons

Project Number: 00-141

Sample #: 38641

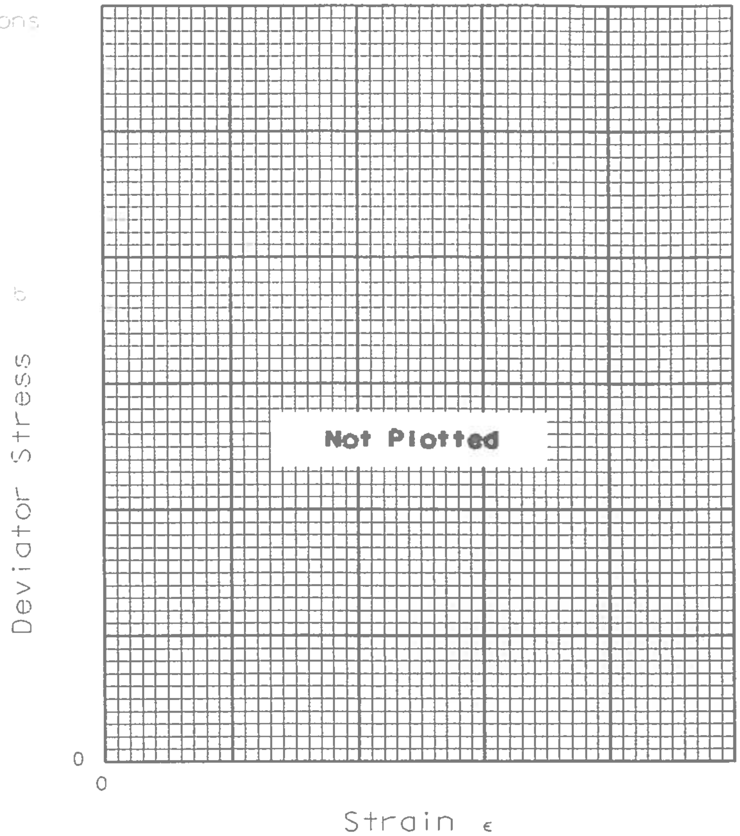
Unit Weight (pcf): 141.3 wet

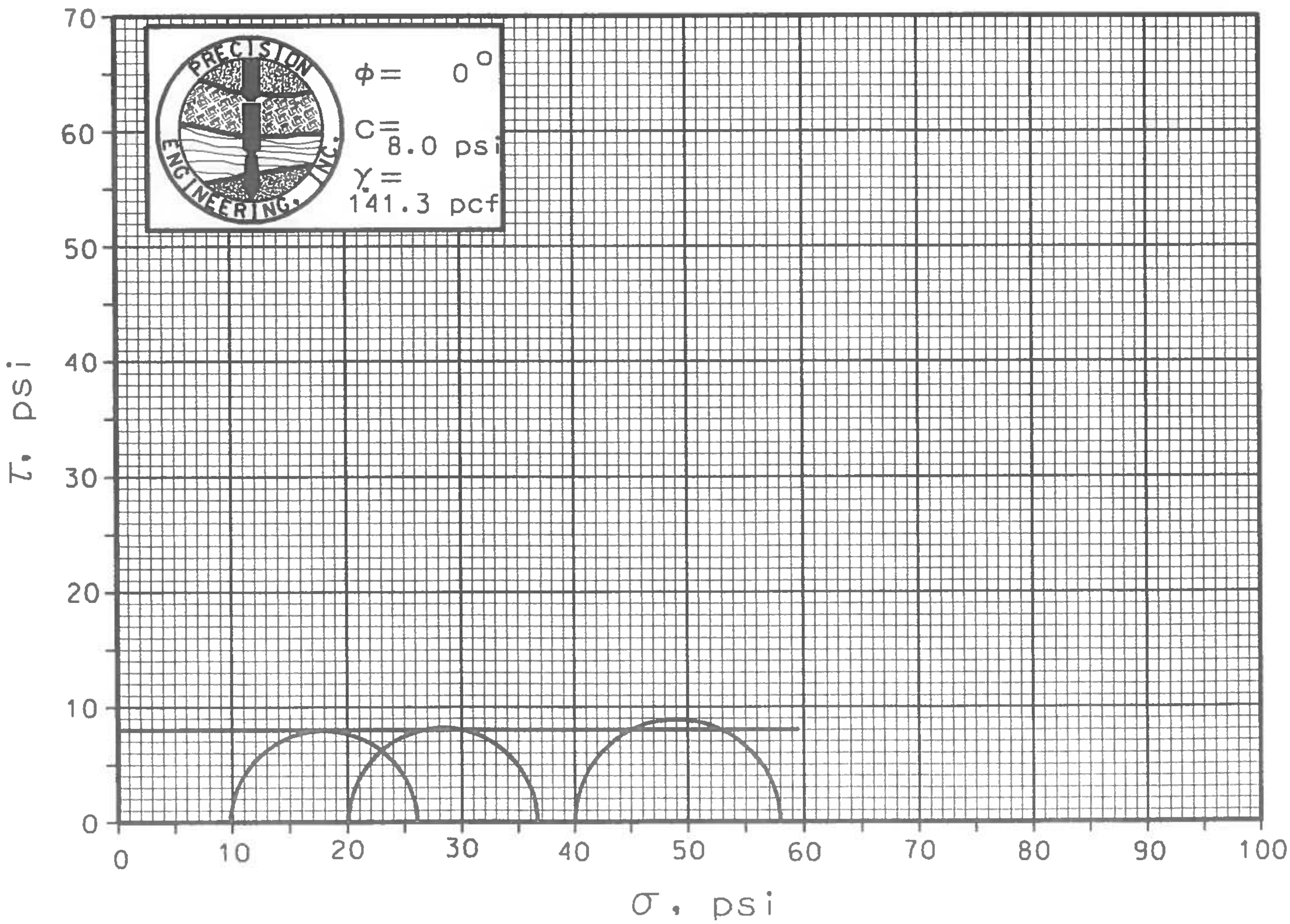
Lateral Pressure = σ_3

Max. Deviator Stress = σ

Max. Vertical Stress = σ_1

Sample	σ_3	σ	σ_1
1	10	16.1	26.1
2	20	16.7	36.7
3	40	18.0	58.0





Triaxial Shear Results

Project: 'riza Evaporation agoons

Project Number: 00-141

Sample #: 3864

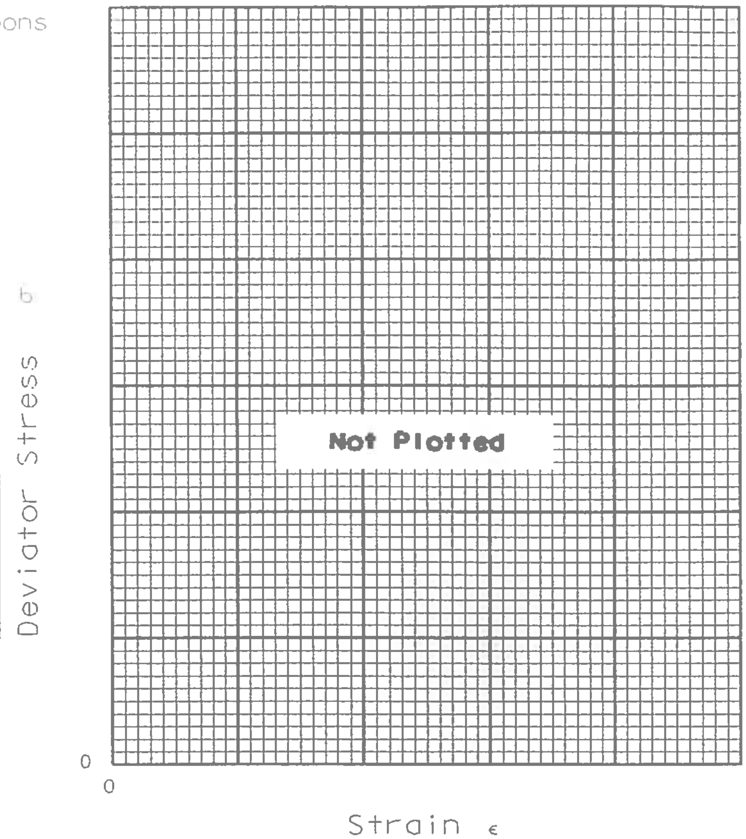
Unit Weight (pcf): 140.0 wet

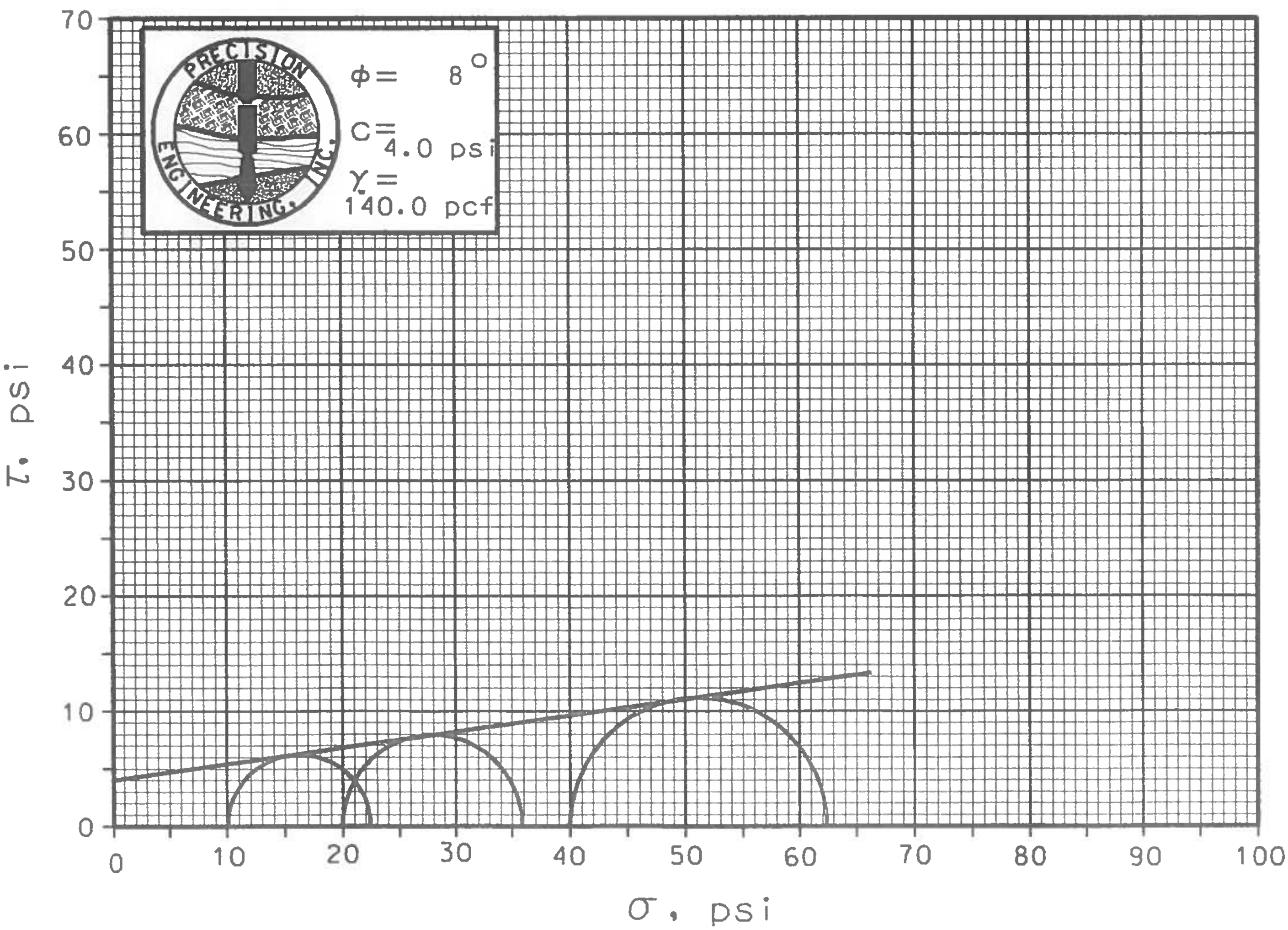
Lateral Pressure = σ_3

Max. Deviator Stress = σ_b

Max. Vertical Stress = σ_1

Sample	σ_3	σ	σ_1
1	10	12.3	22.3
2	20	15.9	35.9
3	40	22.4	62.4





Triaxial Shear Results

Project: Ciniza Evaporation Lagoons

Project Number: 00-141

Sample #: 38645

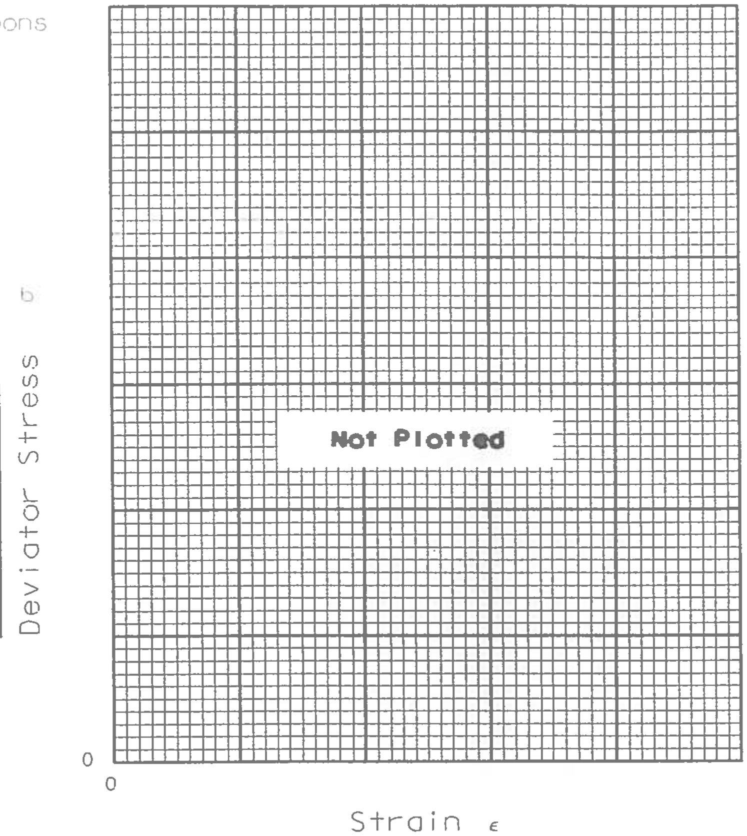
Unit Weight (pcf): 137.4 wet

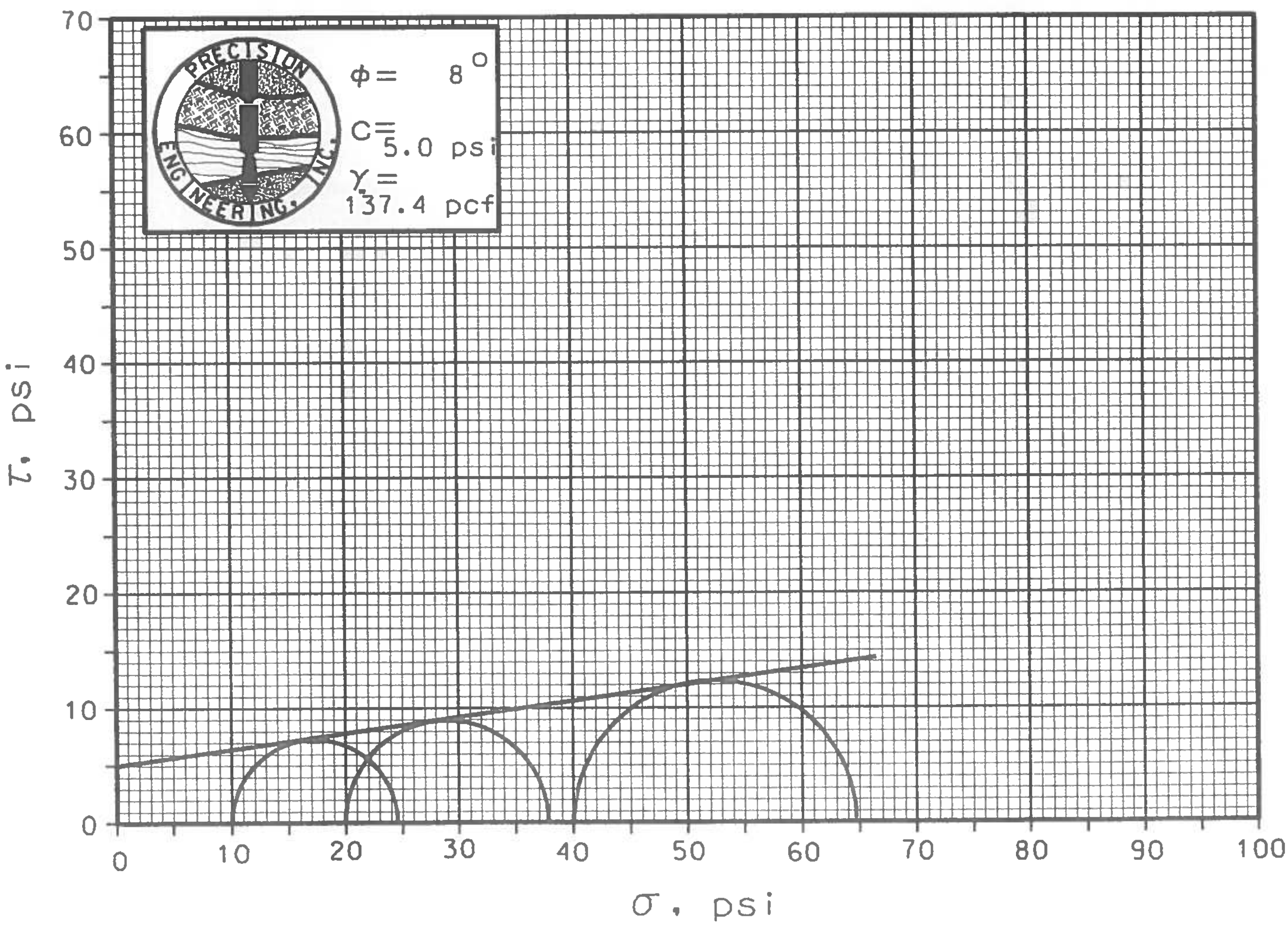
Lateral Pressure = σ_3

Max. Deviator Stress = σ

Max. Vertical Stress = σ_1

Sample	σ_3	σ	σ_1
1	10	14.5	24.5
2	20	17.9	37.9
3	40	24.8	64.8





Triaxial Shear Results

Project: Ciniza Evaporation Lagoons

Project Number: 00-141

Sample #: 38647

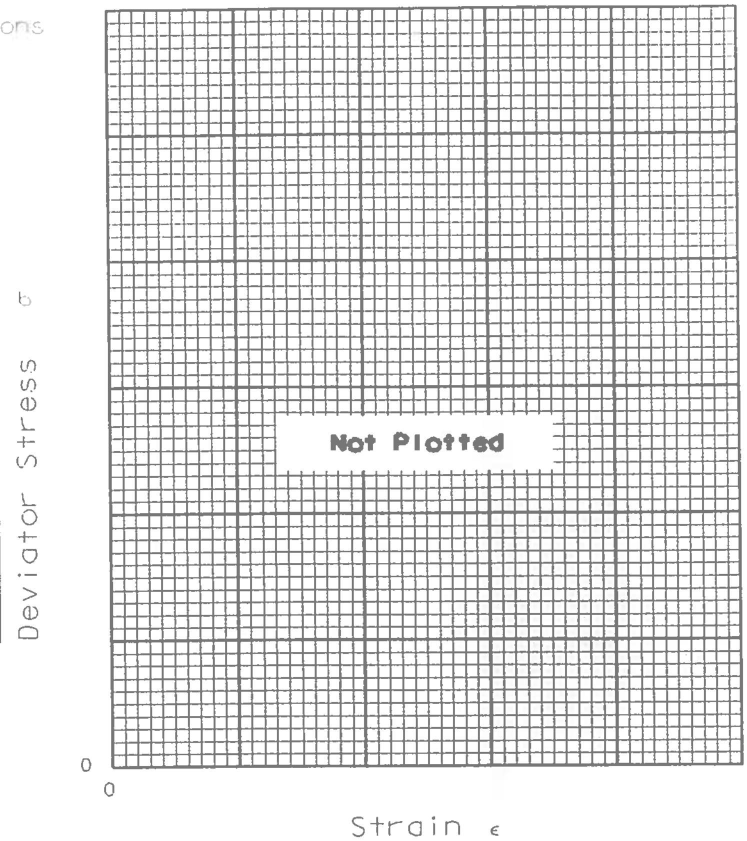
Unit Weight (pcf): 138.9 wet

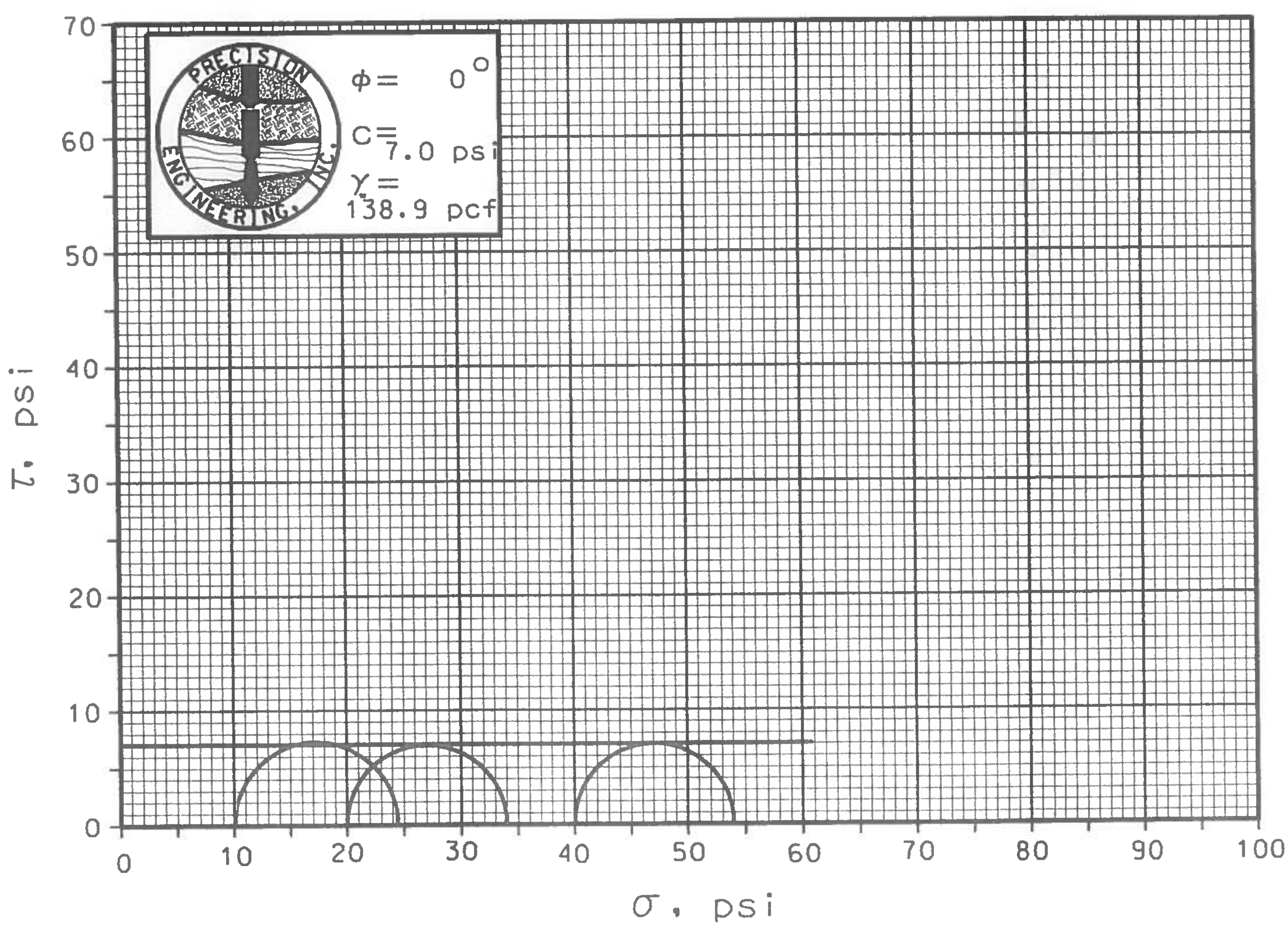
Lateral Pressure = σ_3

Max. Deviator Stress = σ

Max. Vertical Stress = σ_1

Sample	σ_3	σ	σ_1
1	10	14.4	24.4
2	20	14.0	34.0
3	40	14.0	54.0





Triaxial Shear Results

Project: Ciniza Evaporation Lagoons

Project Number: 00-141

Sample #: 38648

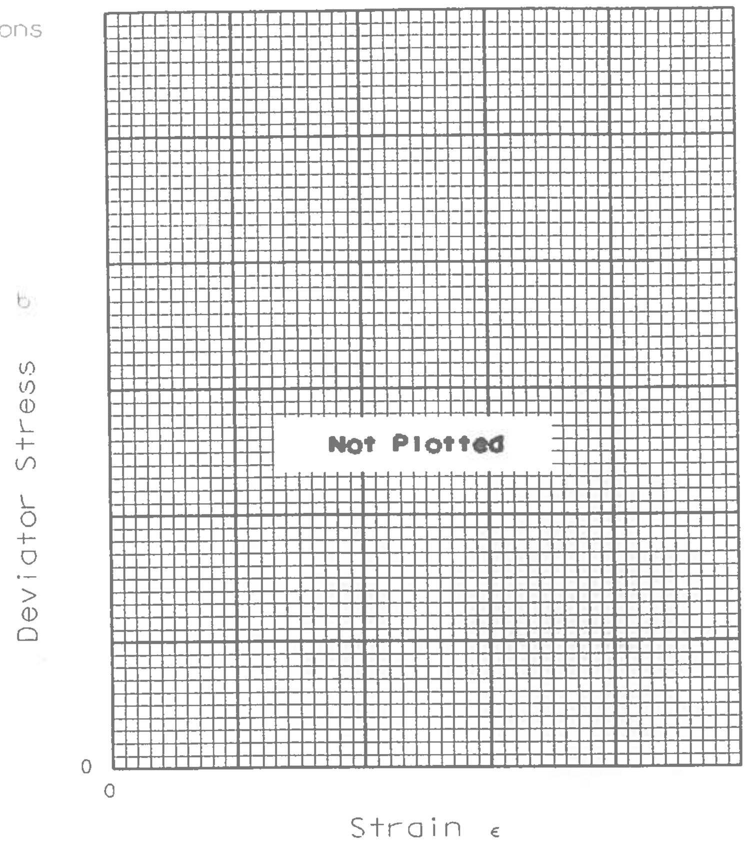
Unit Weight (pcf): 139.9 wet

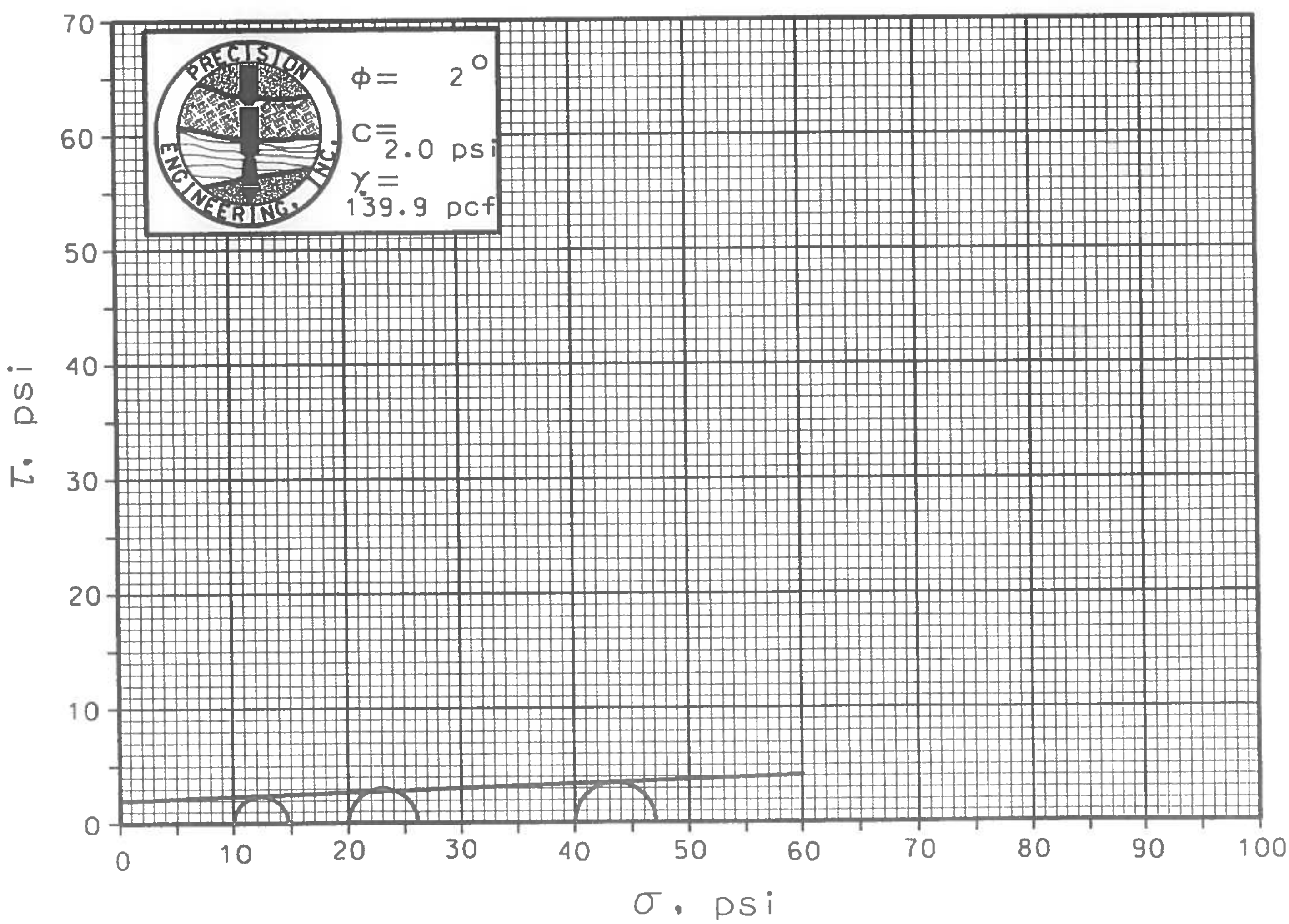
Lateral Pressure = σ_3

Max. Deviator Stress = σ

Max. Vertical Stress = σ_1

Sample	σ_3	σ	σ_1
1	10	4.9	14.9
2	20	6.1	26.1
3	40	7.1	47.1





Triaxial Shear Results

Project: Ciniza Evaporation Lagoons

Project Number: 00-141

Sample #: 38650

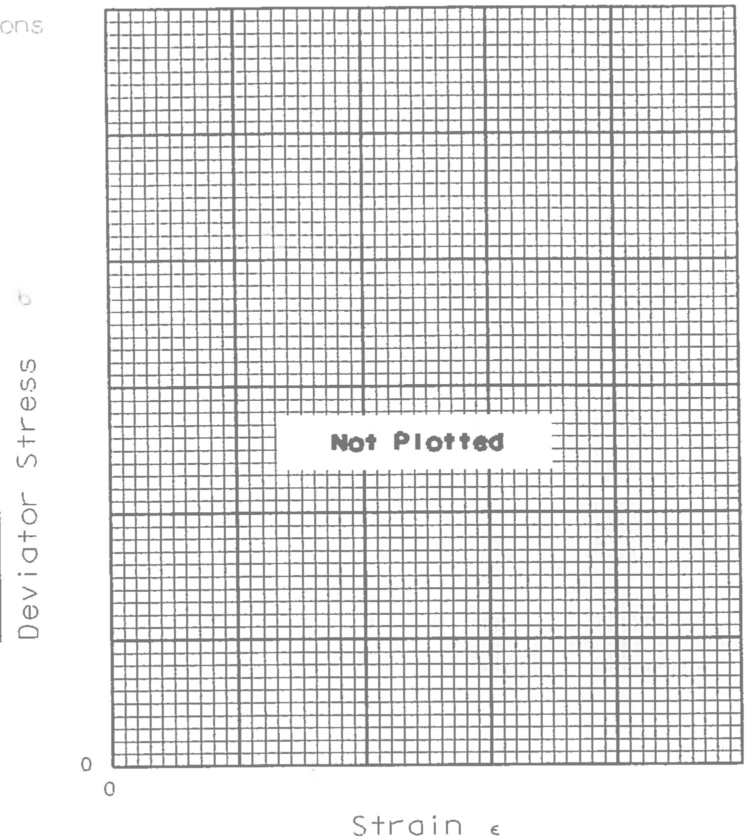
Unit Weight (pcf): 139.5 wet

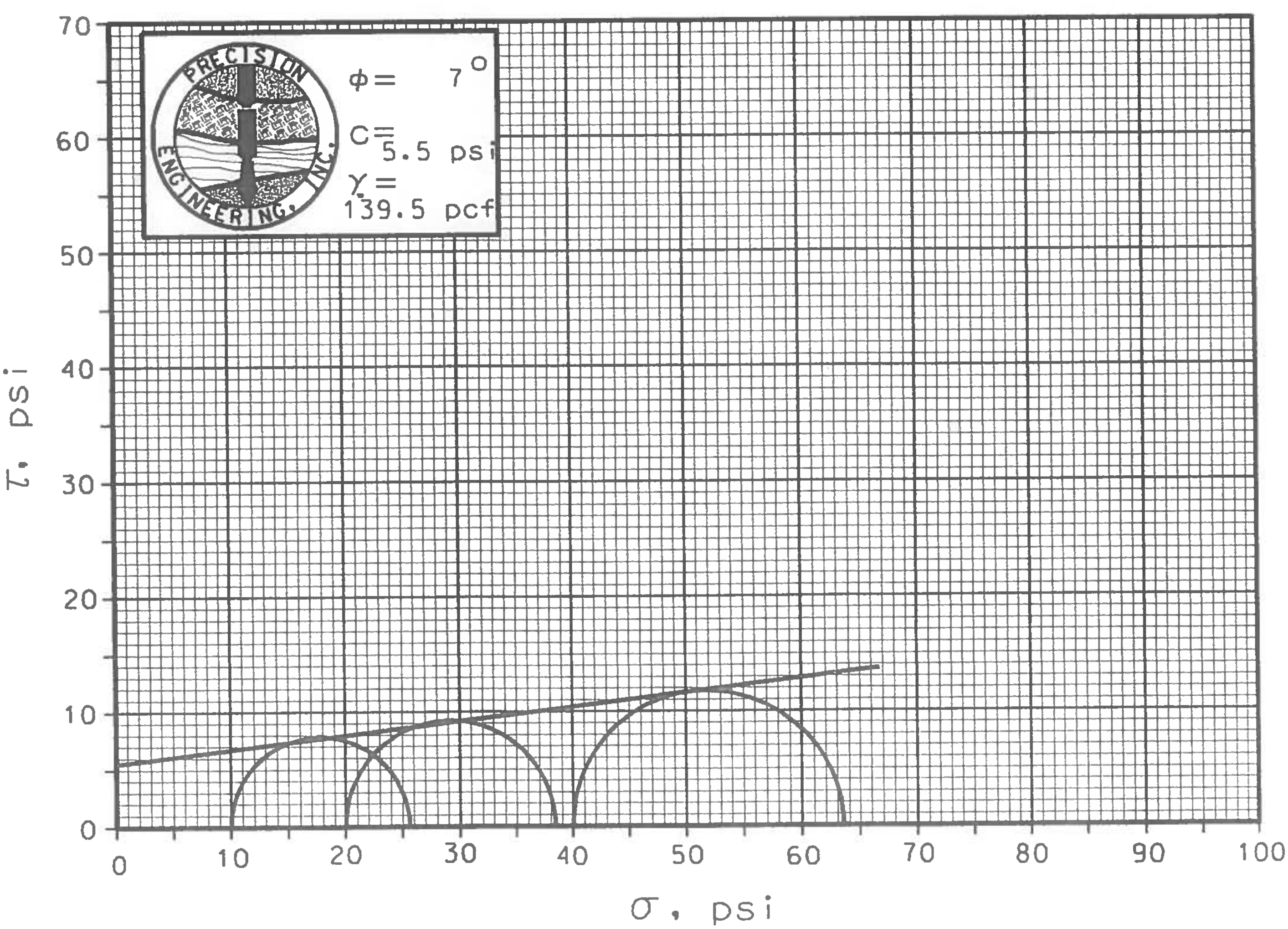
Lateral Pressure = σ_3

Max. Deviator Stress = σ

Max. Vertical Stress = σ_1

Sample	σ_3	σ	σ_1
1	10	15.7	25.7
2	20	18.3	38.3
3	40	23.4	63.4





Triaxial Shear Results

Project: Ciniza Evaporation Lagoons

Project Number: 00 141

Sample #: 38652

Unit Weight (pcf): 141.4 wet

Lateral Pressure = σ_3

Max. Deviator Stress = σ

Max. Vertical Stress = σ_1

Sample	σ_3	σ	σ_1
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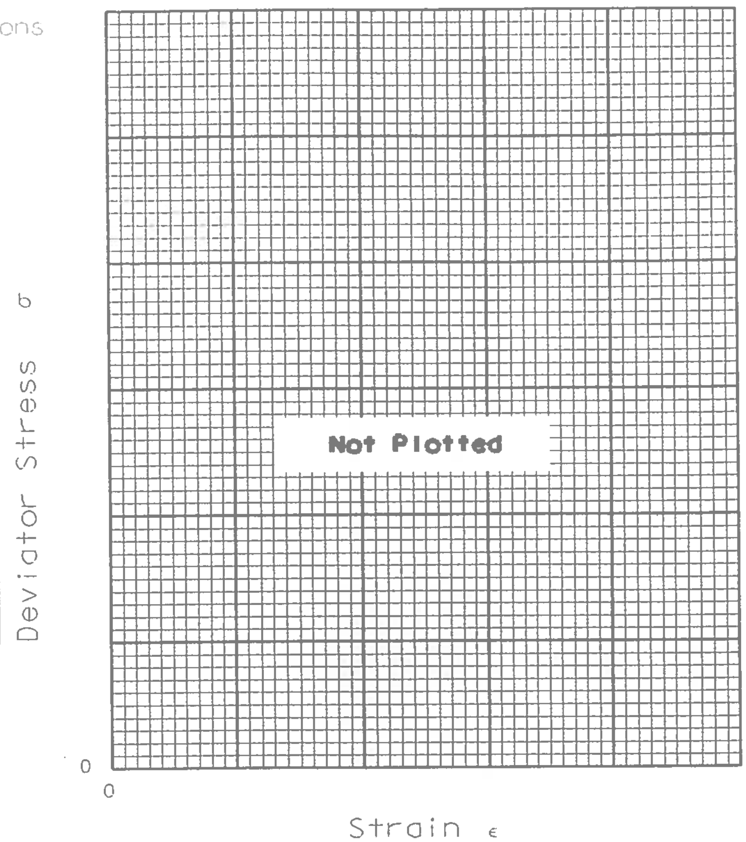
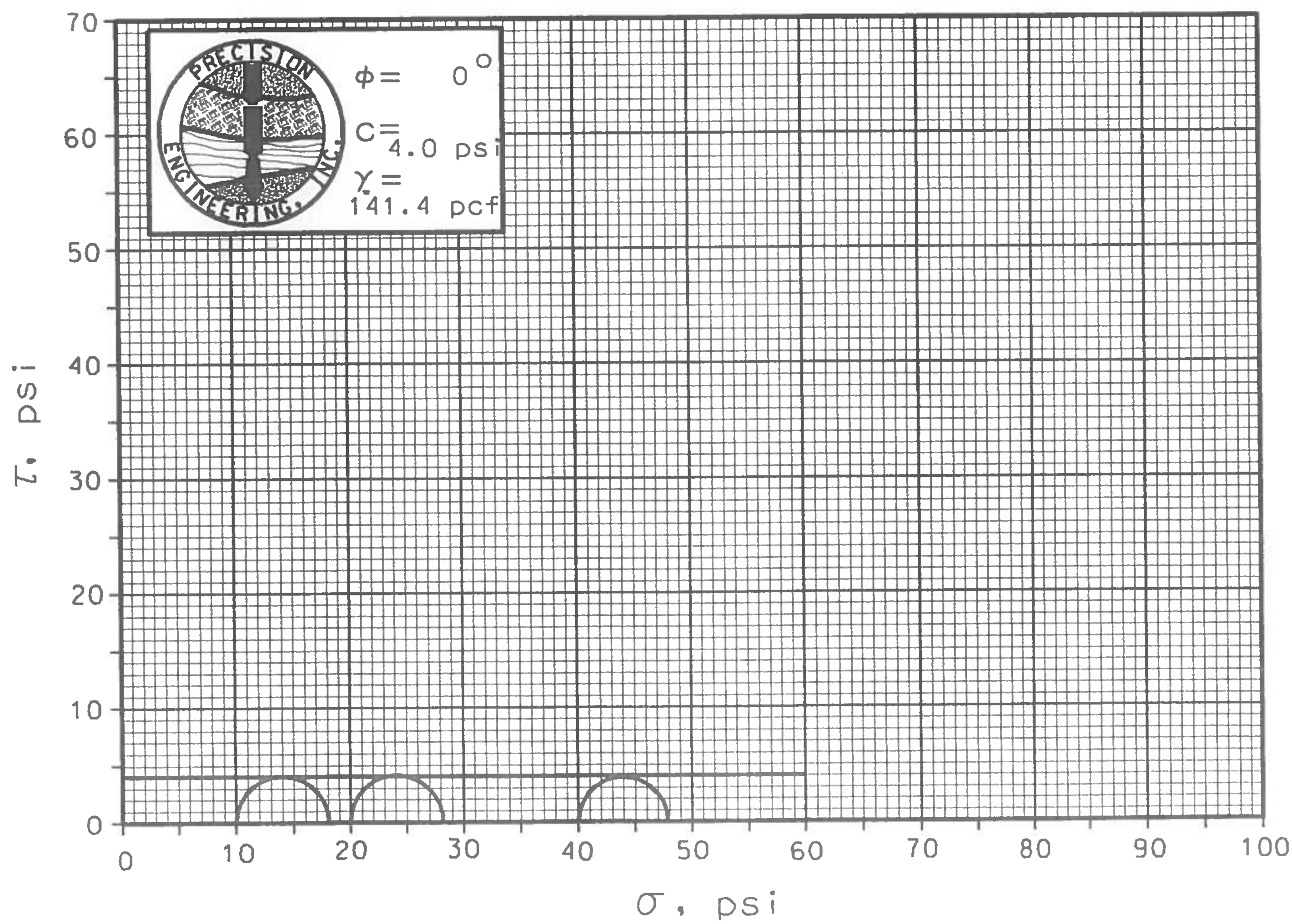
2	20	8.2	28.2
3	40	7.9	47.9





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GEOTECHNICAL & MATERIALS ENGINEERS

TESTING LABORATORY

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KEY TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPE / **SAMPLE TYPE**

```
GRAVEL    SAND     SILT     CLAY

 _____    _____    _____    _____    _____       _____    _____   _____     _____
 :O O:    :* *:    :- -:    :/ /:    :+ +:       : U :    : R :   : S :     : G :
 :O O:    :* *:    :- -:    :/ /:    :+ +:       : U :    : R :   : S :     : G :
 :---:    :---:    :---:    :---:    :+ +:       : U :    : R :   : S :     : G :
 : O :    : * :    : - :    : / :    :+ +:       : U :    : R :   : S :     : G :
 : O :    : * :    : - :    : / :    :+ +:       : U :    : R :   : S :     : G :
GRAVELLY  SANDY    SILTY    CLAYEY  CALCAREOUS   UNDIS-   ROCK    SPLIT     GRAB
                                    INDURATION   TURBED   CORE    SPOON     AUGER
```

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOIL

(major portion retained on #200 sieve)

Includes (1) clean gravels and sands described as fine, medium, or coarse,depending on grain size distribution and (2) silty or clayey gravels or sands.

Penetration Resistance**	Descriptive Term
0 - 5	Very Loose
6 - 10	Loose
11 - 15	Moderately Dense
16 - 30	Medium Dense
31 - 50	Dense
over 50	Very Dense

FINE GRAINED SOILS

(major portion passing a #200 sieve)

Includes (1) inorganic and inorganic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency rated according to shear strength.

Penetration Resistance**	Descriptive Term
1 - 3	Very Soft
4 - 6	Soft
7 - 11	Firm
12 - 19	Stiff
20 - 30	Very Stiff
over 30	Hard

Descriptive Term (in terms of % moisture)

Dry 0-4%, Damp 4-8%, Moist 8-20%, Wet >20%, Water Bearing is below water table

** Measured in blows/foot by a 140# hammer falling 30".

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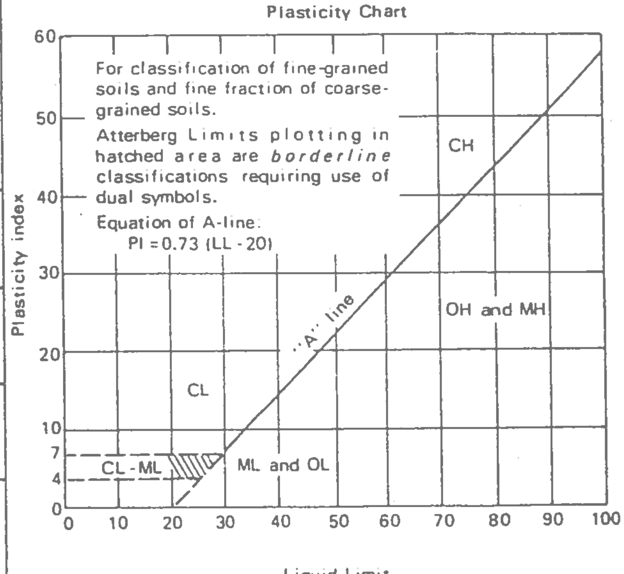
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation: D 2487 – 69 AND D 2488 – 69

(Unified Soil Classification System)

Major divisions			Group symbols	Typical names	Classification criteria		
Coarse-grained soils More than 50% retained on No. 200 sieve*	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines: Less than 5% pass No. 200 sieve . . . . . . GW, GP, SW, SP; More than 12% pass No. 200 sieve . . . . . . GM, GC, SM, SC; 5 to 12% pass No. 200 sieve . . . . . . *Borderline* classifications requiring use of dual symbols	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are *borderline* classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean sands	SW	Well-graded sands and gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		Sands with fines	SM	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are *borderline* classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils 50% or more passes No. 200 sieve*	Silts and clays Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	Plasticity Chart		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and clays Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity			
	Highly organic soils		Pt	Peat, muck and other highly organic soils	*Based on the material passing the 3 in. (76 mm) sieve.		

Plasticity Chart



*Based on the material passing the 3 in. (76 mm) sieve.

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AXIS GROUP INC.
1101 West Mineral Avenue
Suite 102
Littleton, CO 80120
Tel: (303) 332-5757
www.axisgroupinc.com

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REVISED SUMMARY REPORT
EVAPORATION POND REPAIRS

Prepared for:

Western Refining Southwest, Inc.
Gallup Refinery
92 Giant Crossing Road
Gallup, NM 87301

Original Date: December 17, 2015

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Revision 1 Date: February 15, 2017

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LIST OF TABLES, FIGURES and APPENDICES

TABLES

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FIGURES

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APPENDICES

Appendix A: Photographs

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Appendix B: Geotechnical Data

Appendix C: 2002 Slope Stability Analysis

Appendix D: Boring logs

Appendix E: Piezometer log forms

Appendix F: 2015 Slope Stability Analysis Updating the 2002 Slope Stability Analysis

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ABBREVIATIONS AND ACRONYMS

Axis	Axis Group Inc.
cm/sec	Centimeters per Second
Facility	Western Refining Southwest, Inc. Gallup Refinery
FOS	Factor of Safety
gpm	Gallons per Minute
~~GSF~~	~~Guida Slavich & Flores, P.C.~~
NMED	New Mexico Environment Department
OCD	Oil Conservation Division of the Energy, Minerals and Natural Resources Department
Ponds	Evaporation Ponds
RCRA	Resource Conservation and Recovery Act
Refinery	Western Refining Southwest, Inc., Gallup Refinery
RO	Reverse Osmosis (a treatment and filter method)
Site	Western Refining Southwest, Inc. Gallup Refinery
~~Sp.G.~~	~~Specific Gravity~~
STP-1	Sewage Treatment Pond 1
Western	Western Refining Southwest Inc.
WWTP	Waste Water Treatment Plant

~~EXECUTIVE SUMMARY~~

EXECUTIVE SUMMARY

Western Refining Southwest Inc. (Western) Gallup Refinery (~~Refinery~~Site) performed a significant amount of work on the evaporation pond earth berms in 2014 ~~and~~, 2015, and 2016, and is planning additional work in ~~2016.~~ 2017. Western's Summary Report, Evaporation Pond Repairs (December 17, 2015) was reviewed and comments were provided by the NMED Hazardous Waste Bureau (letter dated August 22, 2016). This report is revised to address the comments provided by the NMED and to include additional improvement work conducted in 2016 and potential future work.

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Work related to the ~~Refinery~~Site evaporation pond earth berms includes the following:

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1. 2014 Geotechnical investigation of borrow soil;
2. 2014 Improvements to Ponds 3, 4, 5, 6, 7, 8, 9, 11, 12A, and 12B ~~in 2014~~;
3. 2015 Improvements to Ponds 4, 5, 6, 7, and 8 ~~in 2015~~;
4. ~~Land~~2016 Improvements to Ponds 7 and 8, 9, 11, 12A, and 12B;
5. 2016 Improvements to the stormwater channel area proximate to Pond 6 and 9;

~~4.~~6. 2014, 2015, 2016 land surveying for updated topography on all pond berms ~~in 2014 and 2015~~;

~~5.~~7. 2015 Soil boring investigation in Pond 7 and Pond 8 west berm;

~~6.~~8. 2015 Drive point piezometers installed in Ponds 6, 7, 8, and 9;

~~7.~~9. 2015 Updated numerical slope stability analysis on Pond 6, 7, 8, and 9 ~~in 2015~~;

~~8.~~10. ~~Improvements to~~ 2014 to Present: Ongoing improvements to reduce water usage ~~and subsequent storage~~;

~~9.~~11. ~~Improvements to~~ 2014 to Present: Ongoing improvements to increase evaporation;

~~10. Planned~~Ongoing improvements to ~~Ponds 9, 11, 12A, and 12B; and~~

~~11.~~12. ~~Planned improvements to the stormwater channel between~~ Pond ~~6 and Pond 9~~berms as required.

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Previously in 2002, the containment earth berms were numerically evaluated for slope stability and the slopes were determined to be stable with sufficient Factors of Safety. Western updated the numerical slope stability analysis using the 2002 soil strength parameters, recent investigation data, and ~~current~~new berm geometry after the construction improvements~~.~~

in 2015. The results of the updated slope stability evaluation were included in the December 2015 Summary Report and indicated that the containment earth berms remain stable with appropriate Factors of Safety. ~~The following report provides additional detail on the work conducted to date and the planned work for 2016.~~

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Western continued to improve the earth berms addressed in the 2015 numerical slope stability work that were the subject of comments by the NMED. Accordingly, revising the numerical slope stability work to address the NMED comments is not appropriate until additional work is conducted as described in Section 4 of this report. The planned additional slope stability work includes collecting updated geotechnical values, evaluating the numerical slope stability after additional soil strength parameters are obtained, and providing an updated numerical slope stability analysis in a future addendum to this revised report.

~~1.0~~1.0 INTRODUCTION

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Axis Group Inc. (Axis) prepared this ~~letter~~revised report to summarize the repair and upgrade work conducted on the evaporation pond containment earth berms at the Western Refining Southwest, Inc. (Western) refinery in Gallup, New Mexico (Site). ~~This report covers work conducted as part of the berm upgrade and repair construction activities that have been ongoing at the Site since January 2014~~This report has been revised from the Summary Report submitted to the New Mexico Environment Department Hazardous Waste Bureau (NMED HWB) in December 2015. The revisions address the comments from NMED in their letter dated August 22, 2016 and include a summary of the additional improvement work conducted at the ponds during 2016.

Figure 1 illustrates the location of the Site and Figure 2 is a ~~pond~~ location map showing each of the evaporation ponds. As shown on Figure 2, the evaporation ponds lie west of the ~~Refinery~~Site process areas and tank ~~fields~~farms. In total, the evaporation ponds are approximately 110 acres in aerial extent and are numbered 2, 3, 4, 5, 6, 7, 8, 9, 11, 12A, and 12B. In this report Ponds 7 and 8 are ~~often~~ identified as Pond 7/8.

In summary, the ponds are operated as follows:

1. Water from the Waste Water Treatment Plant (WWTP) and the nearby Pilot Travel Center enters the Sewage Treatment Pond 1 (STP 1);
2. Water is pumped from STP 1 to Pond 2;
3. A portion of the Reverse Osmosis (RO) reject water from the process units flows directly to Pond 2 with the remaining RO water being recycled to the facility cooling towers;
4. As needed, WWTP operators move water from one pond to another using siphons or temporary diesel-powered pumps;
5. Water flows in a cascade fashion from Pond 2 through Ponds 3, 4, 5, then 6;
6. Water is also pumped from Pond 2 to Pond 12B and then flows in a cascade fashion into Ponds 12A, 11, and 7/8.

~~2.0~~2.0 WORK COMPLETED IN 2014 AND 2015

This section of the report describes the evaporation pond improvement work completed by Western during 2014 and 2015. —Photographs of the work are included in Appendix A.

~~2.1~~2.1 Summary of 2014 ~~Phase 1~~ Berm Repair and Upgrades

During January through April 2014 and November through December 2014, Western conducted repairs and upgrades to the containment berms surrounding Ponds 3, 4, 5, 6, 7, 8, 9, 11, 12A, and 12B. These repairs and upgrades included the following:

1. Adding additional new fill material to the outside slopes and crests of the containment berms;
2. Shaping the berm slopes; and
3. Building up the berm crest height and width;

The west ~~berms~~berm of Pond 7~~ and Pond ~~/8 ~~were~~was shaped such that the crest was widened and aligned further to the east so that the overall outer slope would be flatter and more stable.

Western's earth work contractor used on-site borrow areas for fill material (borrow locations shown on Figure 2). Fill material was excavated from the borrow areas using a track hoe and front-end loader, brought to the containment berms via off-road haul trucks, and placed using a Caterpillar D-6 dozer. The dozer was used to place, shape, and compact the fill material. Soil fill material consisted of a silty to sandy clay, similar in character to the soil that was used to construct the original earth berms.

Figures 3a, 3b, and 3c illustrate the pond limits and crest heights prior to the improvements made in 2014. Figures 4a, 4b, and 4c illustrate the pond limits and crest heights after ~~Phase 1~~2014 upgrades and repairs were complete. Figure ~~6b~~7b provides cross sections illustrating the limits where additional fill material was placed on the pond containment berms during 2014. —Photographs of the 2014 berm upgrade activities are included in Appendix A (Photos #1 through #6).

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~~2.2~~2.2 Summary of 2015 ~~Phase 2~~ Berm Repair and Upgrades

During March through October 2015, Western continued conducting repairs and upgrades to the containment berms surrounding Ponds 4, 5, 6, ~~7,~~ and 7/8. These repairs and upgrades included the following:

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1. Adding additional new fill material to the outside slopes of the containment berms;
2. Shaping the berm slopes; and
3. Building out the berm crest width;

The fill material was taken from an on-site borrow area (see Figure 2) via scraper to the berm area under construction, placed in horizontal lifts, and compacted using the scraper and a sheep-foot vibratory roller. Each soil lift was placed on a horizontal flat surface at a maximum depth of 8-inches ~~loose~~, keyed into the existing berm slope, and compacted to a minimum of 95-percent (95%) of a standard Proctor. A motor grader shaped the slopes as they were being constructed.

Figures 5a, 5b, and ~~5b~~5c illustrate the pond limits and crest heights after the ~~Phase 2~~2015 upgrades and repairs were complete. Figure ~~6b~~7b provides cross sections illustrating the limits where additional fill material was placed on the pond containment berms during 2015. ~~-~~Photographs of the 2015 berm upgrade activities are included in Appendix A (Photos #7 through #14).

2.3 Geotechnical Work in 2015

The following section describes the 2015 field investigation Western conducted at the Site to collect soil geotechnical material properties and determine the phreatic surface (i.e. water table surface) within the berms. To accomplish this investigation, Western drilled four soil borings along the crest of Pond 7/8 and installed 11 drive points at various locations in the Pond 6 and Pond 7/8 berms. Figure 7a illustrates the locations where soil borings and drive-point piezometers were installed.

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~~2.3~~2.3.1 Soil Geotechnical Properties

~~Geotechnical properties of~~In 2015 a soil sample was collected from the on-site borrow ~~material used include~~area and analyzed for geotechnical parameters which included the following:

1. Proctor values (i.e. laboratory maximum compaction and optimum water content);
2. Classification;
3. Sieve analysis (i.e. particle size gradation);
4. Field density and moisture content tests;
5. Permeability via flex-wall permeameter;

The on-site borrow soil that was used to repair and improve the earth berms is classified as a silty to sandy clay. Based on a flex-wall permeameter test, soil permeability for the borrow material is 1.~~9X~~9 X 10^{-7} cm/sec. Appendix B contains the laboratory results of the geotechnical tests conducted on the soil ~~fill and~~ borrow material.

2.3.2 Pond 7/8 West Berm Soil Borings

Western installed four soil borings along the west berm of Pond 7/8 as shown on Figure 7a and the boring logs in Appendix D. The borings were conducted to visually examine the berm soil at various depths, collect soil samples for potential geotechnical analysis, and to locate the phreatic surface within the earth berm (if present).

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Characterization soil samples collected from the soil borings indicated a relatively uniform soil material (i.e. no significant changes in soil type) within each boring from the crest down to the final boring depth. The berm fill soil was characterized as moist red silt and clay. The native material was encountered around 12 feet deep and was characterized as lenses of gray fine sand overlaying a stiff wet red clay. Boring logs for these four soil borings are included in Appendix D.

Western evaluated and compared some historical borings advanced in December 2000 to the borings advanced 2015. During the December 2000 boring program (Appendix C), 3 borings were installed on the Pond 7/8 west berm. The borings showed moist soil at depths ranging from 1 to 5 feet to final depth. None of the borings advanced in Pond 7/8 during 2000 indicated wet soil or water.

During the October 2015 boring program, the four borings indicated moist soil (indicative of the phreatic surface) at depths between 4 to 5 feet below the crest. Wet soil was observed at the berm fill/ native soil interface in three of the four borings. Appendix D contains the logs for each boring in Pond 7/8.

Soil classifications in the December 2000 Pond 7/8 boring logs correspond to classifications in the October 2015 boring logs. The sandy layer encountered and described on the 2015 boring logs SB-8N and SB-8S, is at a depth of 11.5 to 12 feet below the current crest elevation. This depth is consistent with the interface transition from berm fill material to native soil.

2.3.3 Temporary Drive Point Piezometers

In order to determine the phreatic surface within the Pond 6 and Pond 7/8 berms in 2015, Western installed 11 temporary drive-point piezometers at locations shown on Figure 7a.

Water levels (if present) were measured in the drive-point piezometers on three separate occasions since their installation. The water level data is shown on the piezometer logs in Appendix E. The drive-point piezometer logs also illustrate the phreatic surface. The depth to moist soil in the October 2015 borings is similar to the depth of water in the nearest piezometer (4-feet to moist soil in the boring versus 6.33-feet to water in the piezometer). The water level collected from the piezometer reading was used to model the phreatic surface during the slope stability modeling, as the water elevation in the pond was deeper than the elevation where the moist soil was encountered.

Note that piezometers installed at the toe of the berm slopes had screens that were close to the ground surface and therefore influenced by precipitation infiltration. Where precipitation infiltration was noted, the water level in that piezometer was not used for berm evaluation work.

The temporary drive-point piezometers installed in the Pond 7/8 berms were abandoned during the ongoing berm improvement activities which continued into 2016. Western will install new piezometers with casings that preclude surface water infiltration into the piezometers. A proposed piezometer installation and monitoring schedule is provided in Section 4.3 of this report. Piezometer water level data will be collected monthly for three months and the data will be provided in the annual Facility-Wide Groundwater Report.

3.0 WORK COMPLETED IN 2016

This section of the report describes the evaporation pond improvement work completed by Western during 2016. Figures 6a, 6b, and 6c illustrate the pond limits and crest heights after the 2016 upgrades and repairs were complete. Photographs of the work are included in Appendix A. The 2016 repairs and upgrades included the following:

1. Reworked and repaired the outer berms surrounding Ponds 11, 12A, and 12B;
2. Improved the Pond 9 north berm;
3. Regraded the stormwater drainage channel between Pond 6 and Pond 9;
4. Added fill material to buttress the Pond 7/8 west berm;

3.1 Ponds 11, 12A, and 12B Outer Berms

In 2016, Western reworked and repaired the soil material of the outer containment berms around Ponds 11, 12A, and 12B. During routine pond inspections, Western noted that soils in the upper two to three feet of the Pond 11, 12A, and 12B outer berms needed to be repaired. Figure 6a illustrates the 2016 repair work limits for Pond 11, 12A and 12B berms. Photographs of this work are included in Appendix A.

The 2016 repair work of the Pond 11, 12A, and 12B berms began by stripping vegetation from the upper three-feet of the berms. From stations 36+00 to 28+00 and 20+00 to 0+00, the upper 3 feet of soil was scraped from the berms and stockpiled at the toe of the slope where it was reworked and cleaned of any large pieces of wood or rocks. This reworked soil was then replaced on the outer slopes of the berms to flatten the outer slope. From stations 28+00 to 20+00, the upper 3 feet of soil was removed and placed in the nearby borrow area for future use. The removed soil could not be cast to the outer slope in this area as the berm is too close to the existing Land Treatment Unit.

Clay soil from the on-site borrow area was then used to rebuild the upper three feet of the berms to their original crest elevations. Prior to placing the first lift, the berm soil was scarified as appropriate, wetted, and then the borrow soil was placed in horizontal layers up to 8-inches thick. Each lift was moisture conditioned and compacted to a minimum of 95-percent (95%) of a standard Proctor as outlined in the specifications. The outer slopes were then graded meet the final design grades resulting in compacted and flatter outer slopes.

3.2 Pond 7/8 Berms

In 2016, Western improved the Pond 7/8 berms from Station 68+95 to Station 41+00 by adding fill material to buttress the outer slopes of the south and west berms. Figure 6a illustrates the 2016 repair work limits for Pond 7/8 berms. Photographs of this work are included in Appendix A.

Prior to beginning the improvement work, the west property line fence was temporarily removed and relocated to allow for construction vehicle access along the base of Pond 7/8 west berm. The construction area along the base of the Pond 7/8 outer slope was graded flat, scarified, and compacted.

Geotextile fabric was then placed onto the prepared surface as outlined in the design documents. Clay borrow soil was then placed in a horizontal layer on the geotextile fabric and compacted. These soils were placed in maximum of 8-inch lifts which were keyed into the existing berm slope and compacted as outlined in the project specifications.

Soil placement in uniform lifts continued until the outer slope was over-built and then graded back to the design grades. When completed, the toe of the outer slope was located adjacent to the west property boundary line. Once the berm improvement work was complete, the fence was relocated back to the property line and the disturbed area was restored by with seed and mulch.

3.3 Pond 9 North Berm

In 2016, the Pond 9 north berm was improved between Station 15+00 and Station 36+00. Figure 6c illustrates the work limits for Pond 9 completed in 2016. Photographs of this work are included in Appendix A.

Prior to beginning the improvement work, the existing power lines were removed from the toe of the Pond 9 outer north berm. Once the power lines were removed, the power poles were cut off at the base and removed. The power poles were not dug out to avoid disturbing the soil at the toe of the berm.

Once the area was cleared for improvements, soil deemed unacceptable to use as a base material was excavated and removed from the toe of the Pond 9 north berm outer slope. This material was placed on the inside slope of Pond 9 north berm and compacted. Once the soil was removed from the toe of the outer slope, the area was graded flat and geotextile fabric was placed on the prepared surface as outlined in the design documents.

Clay borrow soil was then placed in a horizontal layer on the geotextile fabric and compacted. These soils were placed in a maximum of 8-inch lifts which were keyed into the existing berm slope and compacted as outlined in the project specifications.

Soil was placed in uniform lifts and continued until the outer slope was graded to meet the original design grades.

3.4 Stormwater Channel Improvements

Non-contact stormwater is directed from the Site areas westward to the drainage channel between Pond 6 and Pond 9. From here, the non-contact stormwater collects at retention ponds located west of Pond 6 and south of Pond 7/8.

The stormwater channel between Pond 6 and Pond 9 was improved during the Pond 9 north berm work described in the previous section and shown on Figures 6b and 6c. Non-contact stormwater flow is directed into the improved channel which is sloped to drain to the west side of Pond 6.

During slope improvement work on the Pond 7/8 south berm, soil was placed between about Station 46+00 to about Station 49+00 south of the toe of the south berm. This strip of soil will act as a buffer and deter erosion between the existing stormwater detention basin and the toe of Pond 7/8 south berm.

4.0 SLOPE STABILITY ANALYSIS

The following sections describe the previous and planned numerical slope stability work for the evaporation pond berms. Based on the uniform soil and earth berm construction, the previous numerical slope stability analysis used an arc slip-type slope stability evaluation (versus block or other type of failure analysis). The resulting calculated Factor of Safety values were all greater than 1.0 in every analysis, indicating that the evaluated slopes are stable.

~~2.4~~4.1 2002 Geotechnical and Slope Stability Analysis

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In 2002, Precision Engineering, Inc. completed a geotechnical investigation as part of a slope stability analysis for the evaporation pond berms. The investigation included 10 soil borings and 7 Dutch Cone soundings. Soil samples and Shelby Tube samples were also collected from various strata throughout the investigation. Soil geotechnical properties derived from those samples (e.g. ~~Western elected~~triaxial shear strength, cohesion, internal angle of friction, and unit weights) were used for the slope stability analysis.

A total of 13 cross-sections were evaluated for the 2002 slope stability analysis resulting in a Factor of Safety ranging from 2.5 to 10. A summary of the 2002 soil geotechnical properties are included in Table 1. Table 2 summarizes the results from the 2002 slope stability analysis. A copy of the Precision Engineering Inc. report is included in Appendix C.

The soil strength parameters used in the numerical analysis included the total stress parameters for cohesion (c) and the angle of internal friction, phi (Ø). It is recognized that total stress strength parameters are appropriate for numerical slope stability analysis for end-of-construction analysis and for partially saturated soil. Based on historical and current soil borings, the soil in the berms is best categorized as partially saturated and therefore, the analysis method is considered appropriate.

4.2 Planned Slope Stability Investigation

In the original Summary Report, Evaporation Pond Repairs (December 2015), Western updated the 2002 numerical slope stability analysis. For completeness, the slope stability work is now provided in Appendix F of this Revised Summary Report, Evaporation Pond Repairs. Since the slopes on several evaporation ponds have already been changed, no adjustments to the 2015 updated numerical slope stability analysis have been made. Changes to the numerical slope stability analysis will be made after additional soil properties have been obtained as described below.

As described in Section 3 of this report, Western continued improving the earth berms in 2016 for evaporation ponds 7/8, 9, 11, 12A, 12B, and the stormwater channel between Pond 6 and Pond 9. During this work, the temporary drive-point piezometers installed to provide initial phreatic surface water levels in the earth berms, were abandoned. Additionally, the outer slopes of the evaporation ponds identified above have been significantly improved. Accordingly, the numerical slope stability work provided in 2015 will be updated with the current topography and updated phreatic water surface.

The NMED comments on the 2015 updated slope stability analysis indicated that effective stress strength parameters should be used to evaluate the effects of additional fill material on the outer slopes. NMED also indicated that more permanent piezometers should be installed in the outer downstream slopes of the berms.

Western intends to install new piezometers in the outer slopes of the earth berms along cross-sections that will be used in an updated numerical slope stability analysis. The new piezometers will be installed in borings with casings and bentonite seals above the screen interval to prevent surface water intrusion and interference. Piezometers will be installed in borings at selected cross-sections in the following earth berms:

- Pond 7/8 west berm
- Pond 6 west berm
- Pond 9 north berm

The water levels will be recorded monthly and when stable (likely 3 months), the water levels will be incorporated into the updated numerical slope stability analysis. Afterward, the water levels in the piezometers will be measured as appropriate and the water level data reported in the Facility Wide Groundwater Report.

Due to access constraints on the outer slopes, the borings for the piezometers will likely be hand-augured at each location. Soil samples will be collected using a hand-drive sampler as needed in the hand-auger borings.

The hand-auger will be used to advance a 4-inch diameter hole to depths required to install the new piezometer and collect the soil samples. The hand-drive sampler has a barrel that holds brass sleeves for the soil samples. The barrel is driven into the soil and then retrieved.

The brass liners are extracted from the barrel, sealed using Teflon™ patches, plastic caps, and tape. Each sleeve will be sealed in the field, labeled as required, and provided to a geotechnical laboratory for analysis. Soil analysis is expected to include:

- Soil characterization and classification
- West and dry unit weights with moisture content
- Atterberg Limits
- Sieve analysis
- Effective stress strength parameters (c' and Ø') from a triaxial sheer test

The soil data collected from this investigation will be used to update the numerical slope stability analysis. The cross-sections used in the 2002 and 2015 slope stability work will be used in the updated slope stability evaluation, with minor adjustments to the locations to evaluate the critical cross section. The following will be incorporated into the updated slope stability evaluation:

- Morgenstern Price limit-equilibrium analysis via GeoStudio 2012;
- Updated berm topography at slope stability cross-sections;
- Updated phreatic surface based on newly installed piezometers;
- Soil properties confirmed during the new geotechnical investigation; and
- Effective stress soil strength parameters cohesion (c) and angle of internal friction, phi (Ø).

The results will be prepared and submitted as an addendum to this report. The results will include the following:

- Description of the updated geotechnical parameters;
- Figure identifying the location of the geotechnical samples;
- Description of the slope stability work;
- Discussion of the phreatic surface and its potential affect on slope stability;
- Graphical output from the slope stability program; and
- Tabulated factor of safety for each critical cross-section.

4.3 Proposed Work Schedule

Western intends to install the new piezometers in the appropriate locations by the end of Q4 2017. Once the geotechnical report is available with the updated soil data described above, Western will prepare a revised numerical slope stability analysis. Western expects this work to be complete by the end of Q2 2018 and an addendum report prepared and submitted by the end of Q3 2018.

5.0 ONGOING IMPROVEMENT WORK

5.1 Water Use Reduction

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Western is continually improving operations at the evaporation ponds. For example, Western has implemented several water saving measures at the process units to minimize the amount of water being routed to the evaporation ponds. As of November 2015, the flow rate of water to the evaporation ponds is approximately 150 gpm, down from the previous average of 340 gpm.

Part of the work included minimizing the reverse osmosis (RO) reject water flow to Pond 2. The majority of RO water is now directed to the cooling towers with the net effect of minimizing RO reject water to Pond 2.

5.2 Additional Evaporation

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In 2014, Western added two additional evaporation blowers to improve evaporation rates at the ponds. As shown on Figure 2, two blower units are located on the west berm of Pond 2 and the two newer blower units are located on the west berm of Pond 3.

The evaporation blowers operate continuously during the peak evaporation season (about April through October) except when they are shut down for maintenance purposes or when the temperature makes evaporation inefficient. Western is internally evaluating additional improvements to enhance evaporation at the ponds.

TABLES

FIGURES

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APPENDICES

APPENDIX A

Photographs

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APPENDIX B

Geotechnical Data

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APPENDIX C

2002 Slope Stability Analysis

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APPENDIX D

Boring logs

APPENDIX E

Piezometer log forms

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APPENDIX F

~~as the containment earth berm crests have been raised, widened, additional fill material was placed on the outer slopes, and the~~ 2015 Slope Stability Analysis

Updating the 2002 Slope Stability Analysis

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F-1 Updates to the 2002 Slope Stability Analysis

In the original Summary Report, Evaporation Pond Repairs (December 2015), Western updated the 2002 numerical slope stability analysis using the following:

- Morgenstern Price limit-equilibrium analysis via GeoStudio 2012
- Updated berm topography at slope stability cross-sections
- Updated phreatic surface based on temporary drive-point piezometers
- Existing soil properties confirmed during 2015 geotechnical investigation
- Existing total stress soil strength parameters cohesion (c) and angle of internal friction, phi (Ø)

Based on the updated slope stability modeling, the earth berms remain stable against a circular slip-type failure with Factor of Safety values ranging from 4.7 to 7.1.

The soil strength parameters used in the numerical analysis included the total stress parameters for cohesion (c) and the angle of internal friction, phi (Ø). It is recognized that total stress strength parameters are appropriate for numerical slope stability analysis for end-of-construction analysis and for partially saturated soil. Based on historical and current soil borings, the soil in the berms is best categorized as partially saturated and therefore, the analysis method is considered appropriate.

Because significant berm improvement work was conducted since 2002, the configurations of the berms (i.e. berm crest widths and outer slopes) were different in many locations. Additionally the pond water elevations have increased since 2002.

Accordingly, Western (via Hammon Enterprises Inc.) . ~~—~~conducted an updated topographic land survey of the earth berms. The updated topography was used to track the changes to the earth berms and create the cross-section geometry required for the updated slope stability analysis described in this section. Figure 7b provides cross-sections that illustrate changes in the geometry of the earth berms with time and shows the current surface at the end of 2015.

Prior to performing the updated slope stability analysis, Western conducted a field investigation to collect current soil geotechnical material properties and determine the phreatic surface (i.e. water table surface) within the berms. The methods and results of this field investigation are described in Section 2.3 of this report.

The model used to conduct the slope stability analysis was GeoStudio 2012 produced by Geo-slope International. Western used the limit-equilibrium analysis, Morgenstern-Price Method of Slices to analyze the numerical Factor of Safety for stability of the slopes.

The soil material used in constructing and upgrading the earth berms is a uniform material. Accordingly, Western numerically analyzed the slopes using an arc-type or circular slip-type of failure. ~~The output from the slope stability analysis provides a numerical Factor of Safety against a slope stability failure. A Factor of Safety greater than 1.0 indicates that the slope is stable from a typical arc-type slope failure. Based on previous slope stability work, the earth berms at the Site were stable against an arc- or circular slip-type failure with Factor of Safety values ranging from 2.5 to 10.~~

~~The analysis was conducted using the program GeoStudio 2012 produced by Geo-slope International. The program uses limit-equilibrium analysis based on the Method of Slices to analyze the Factor of Safety for stability of the slopes.~~

Based on the updated slope stability modeling, the earth berms remain stable against an arc-type failure with Factor of Safety values ranging from 4.7 to 7.1. The sections below provide a discussion of the methods and soil values used in the updated slope stability modeling work.

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~~*1.2.4.1 2002 Geotechnical and Slope Stability Work*~~

~~Precision Engineering, Inc. conducted a geotechnical analysis in 2002 which is included in Appendix C. The site investigation conducted as part of that analysis included 10 soil borings and 7 Dutch Cone soundings. Soil samples and Shelby Tube samples were collected from various strata throughout the investigation. Soil geotechnical properties derived from those samples (e.g. triaxial shear strength, cohesion, and unit weights) were used in the slope stability analysis. A summary of the soil geotechnical properties are included in Table 1. A total of 13 cross-sections were evaluated for slope stability and the resulting Factor of Safety ranged from 2.5 to 10. Table 2 summarizes the results from the Precision Engineering Inc. report.~~

~~*1.2.4.2 2015 Geotechnical and Slope Stability Investigation*~~

~~The 2002 Precision Engineering, Inc. slope stability analysis was conducted prior to the recent repair work on the pond containment berms. As shown on Figure 6b, the configurations of the berms (i.e. berm crest widths and outer slopes) were different in many locations in 2014 and 2015 due to the repair work, resulting in new slope cross-sections. The new cross sections as well as higher water levels in the ponds were factored into the updated earth berm slope stability analysis.~~

~~Prior to performing the updated slope stability analysis, Western conducted a field investigation to evaluate current soil geotechnical material properties and to locate the phreatic surface (i.e. water table surface) within the berms. To accomplish this work, Western drilled four soil borings along the crest of Pond 7/8 and installed 11 drive points at various locations in Pond 6 and 7/8 berms. Figure 6a illustrates the locations where soil borings and drive-point piezometers were installed. The text below provides more detail on the boring and drive-point programs.~~

~~*1.2.4.3Pond 7/8 West Berm Soil Borings*~~

~~Western installed soil borings at four locations along the Pond 7/8 west berm at locations that correspond to cross-sections used in the slope stability analysis. The borings were conducted to visually examine the berm soil at various depths, collect soil samples for potential geotechnical analysis, and to locate the phreatic surface within the earth berm (if present).~~

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~~Samples collected from the soil borings indicated a relatively uniform soil material (i.e. no significant changes in soil type) within each boring from the crest down to the final boring depth. The berm fill soil was characterized as a red, silt to clay moist soil, until the native material was encountered around 12 feet deep. Native material was characterized as gray fine sand overlaying a stiff wet red clay. Boring logs for these four soil borings are included in Appendix D.~~

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~~*1.2.4.4Drive Point Piezometers*~~

~~Western installed 11 drive-point piezometers at locations in the Pond 6 north and west berms, Pond 7 west berm, and Pond 8 south berm at locations that correspond to cross-sections used in the slope stability analysis. The drive-point piezometers were installed to measure the phreatic surface (if present) within the earth berms.~~

~~Water levels (if present) have been measured in the drive-point piezometers three times since installation (as of November 11, 2015) and that data is contained in the piezometer logs in Appendix E. Due to the low permeability clay soil in the berms, as of December 2015, the water levels in the piezometers have not yet completely stabilized. Western will continue to monitor the water levels in the piezometers as needed. The drive-point piezometer logs also visually illustrate the location of the phreatic surface.~~

~~*1.2.4.5Slope Stability Modeling*~~

~~As discussed above, the geometry of the earth berms changed as a result of the earth berm repairs in 2014 and 2015.~~ **F-2 Soil Characterization Properties**

Soil characterization~~Accordingly, Western (via Hammon Enterprises Inc.) conducted an updated land survey of the earth berms. The updated topography was used to track the changes to the earth berms and create the cross-section geometry required for the current slope stability analysis described in this report. Historic survey topography and the cross-sections used in the previous stability analysis were used to establish the historic cross-sections of the earth berms. Figure 6b provides cross-sections that illustrate changes in the geometry of the earth berms with time and shows the current surface at the end of 2015.~~

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~~Soil~~ properties from the previous investigation (Precision, 2002) were compared to the soil characterization properties from the 2014 and 2015 borrow and berm soil investigations. The 2002 soil investigation results are consistent with the current geotechnical characterization data. Accordingly, the previous soil investigation data were used in the ~~current~~2015 slope stability analysis.

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Slope stability modeling data input includes soil type, unit weight, angle of internal friction (phi angle), shear strength, and cohesion values. The 2002 data included triaxial sheer strength values and were classified into two categories:

1. Berm material ranging from a depth of 5-7 feet; and
2. Subgrade material ranging from 10-17 feet.

This resulted in two sets of soil properties for the berm slope stability analysis:

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1. Berm material (unit weight 140 pcf, cohesion 720 psf, phi 8 degrees); and
2. Native soil (unit weight 140 pcf, cohesion 1152 psf, phi 0 degrees).

The phreatic surface used for the analysis was derived from current water level data measured in the drive-point piezometers installed along the cross sections of the berms.

F-3 2015 Slope Stability Results
~~2.4.6~~

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A Factor of Safety greater than 1.0 indicates that the slope is numerically stable from a typical arc-type slope failure. Factors of Safety against a deep slip surface failure in the berms before and after repair work are shown on Table 3.

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Based on the slope stability modeling, the berms are stable against an arc-type failure with Factor of Safety values ranging from 4.5 to 7.1. Note that the Factor of Safety from the previous investigation ranged from 2.5 to 10. The change in the Factor of Safety values is largely the result of changes in the berm geometry and the elevation of the water within the ponds. Detailed results from the numerical slope stability modeling are included ~~in Appendix F~~below.

~~1.3 2016 PHASE 3 POND REPAIR AND UPGRADES~~

~~Western plans to continue the ongoing repairs and upgrades to the evaporation ponds during 2016. Planned work includes:~~

1. ~~Rework and repair the berm material on Ponds 11, 12A, and 12B as required;~~
2. ~~Improve the Pond 9 north berm;~~
3. ~~Regrade the stormwater drainage channel between Pond 6 and Pond 9;~~
4. ~~Improve the west berm along Pond 7 and Pond 8;~~

~~1.3.1 Ponds 11, 12A, and 12B~~

~~Western plans to rework and repair the material along the containment berms of Ponds 11, 12A, and 12B. Figure 8 illustrates the design work limits for Ponds 11, 12A, and 12B. Western intends to complete this work in 2016.~~

~~1.3.2 Pond 9 North Berm~~

~~The Pond 9 north berm will also be reconstructed to improve integrity and involves adding fill material to the outer slopes of the Pond 9 north berm. Figure 7a illustrates the design work limits for Pond 9 intended to be completed in 2016.~~

~~1.3.3 Stormwater Channel Improvements~~

~~Currently, non-contact stormwater is directed from the Refinery areas westward toward the drainage channel between Pond 6 and Pond 9 and exits at the west side of Ponds 6 and 9. The portion of the stormwater channel between Pond 6 and Pond 9 will be improved during the construction of the Pond 9 north berm. Non-contact stormwater flow will be directed in an engineered channel sloped to drain and exit at the west side of Pond 6 and Pond 9. From there, non-contact stormwater will flow toward the small retention pond located south of the south west corner of Pond 8. Figure 7b illustrates the design for this work.~~

~~1.3.4 Ponds 7 and 8 West Berm~~

~~Western is evaluating potential improvements to the Pond 7/8 west berm. Potential improvement work may include adding fill material to the outer slope of the west berm. Western intends to complete this evaluation in 2016.~~

~~1.4 ONGOING IMPROVEMENT WORK~~

~~4.1Water Use Reduction~~

~~Western is continually improving operations at the evaporation ponds. For example, Western has implemented several water saving measures at the process units to minimize water to the evaporation ponds. As of November 2015, the flow rate of water to the evaporation ponds is about 150 gpm, down from a previous average of 340 gpm.~~

~~Part of the work included minimizing the reverse osmosis (RO) reject water flows to Pond 2. The majority of RO water is now directed to the cooling towers with the net effect of minimizing RO reject water to Pond 2.~~

~~4.2Additional Evaporation~~

~~In 2014, Western added two additional evaporation blowers to improve evaporation rates at the ponds. As shown on Figure 2, two blower units are located on the west berm of Pond 2 and the two newer blower units are located on the west berm of Pond 3. Western is internally evaluating additional improvements to enhance evaporation at the ponds.~~

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~~TABLES~~

~~FIGURES~~

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~~APPENDICES~~

~~APPENDIX A~~

~~Photographs~~

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~~APPENDIX B~~

~~Geotechnical Data~~

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~~APPENDIX C~~

~~2002 Slope Stability Analysis~~

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~~APPENDIX D~~

~~Boring logs~~

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~~APPENDIX E~~

~~Piezometer log forms~~

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~~APPENDIX F~~

~~Slope Stability Analysis~~

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