AP___111____

Evaporation Pond Repairs
(1 of 2)

2017

Western Refining
GALLUP

WNR LISTED NYSE

February 17, 2017

Mr. John E. Kieling, Chief
New Mexico Environment Department
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Bldg 1
Santa Fe, New Mexico 87505-6303

RE: RESPONSE TO DISAPPROVAL LETTER REPORT
EVAPORATION POND 7 DIKE BREACH AND SUMMARY REPORT EVAPORATION POND REPAIRS
WESTERN REFINING SOUTHWEST, INC. GALLUP REFINERY
EPA ID # NMD000333211
HWB-WRG-15-006

Dear Mr. Kieling:

The enclosed revised Report was prepared pursuant to your disapproval letter dated August 22, 2016 mentioned above. Your twelve comments have been addressed in the attached letter from Axis Group Inc. and incorporated into the Revised Summary Report, Evaporation Pond Repairs, as appropriate. Two bound paper copies and also an electronic copy that includes a redline-strikeout version of the Report are enclosed.

If there are any questions regarding the enclosed Report, please contact Mr. Ed Riege at (505) 722-0217.

Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

92 Giant Crossing Road, Gallup, New Mexico 87301 • 505 722-3833 • www.wnr.com

Sincerely,

Mr. Daniel J. Statile
VP Refining
Western Refining Southwest, Inc. – Gallup Refinery

Ed Riege
Remediation Manager
Western Refining Southwest, Inc. – Gallup Refinery

cc C. Chavez, OCD
A. Hains, WR El Paso

February 12, 2002

PRECISION ENGINEERING INC.

GEOTECHNICAL EVALUATION OF EVAPORATION PONDING CONTAINMENT BERMS

GIANT REFINING COMPANY
CINIZA REFINERY

FILE NO. 00-141

Submitted To:

Ms. Dorinda Mancini
Giant Refining Company
Route 3, Box 7
Gallup, New Mexico
87301

GEOTECHNICAL EVALUATION OF

EVAPORATION PONDING

CONTAINMENT BERMS

GIANT REFINING COMPANY
CINIZA REFINRY
GALLUP, NEW MEXICO

FILE NO: 00-141

PREPARED BY

PRECISION ENGINEERING, INC.
P.O. BOX 422
LAS CRUCES, NEW MEXICO

APPROVED BY

WILLIAM H. KINGSLEY, PE
PE NO. 8313

FEBRUARY 12, 2002

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Appendix Contents

1.0 General

An evaluation of the structural integrity of the evaporation lagoon berms located at the Giant Refining Company's Ciniza Refinery has been performed. There are a total of twelve (12) lagoons located in three (3) impoundment areas. Within the major impoundment areas individual lagoons are separated by interior dikes. The structural analysis of the exterior containment berms was performed using a conventional method of slices as well as finite element analyses of the berm sections. A total of thirteen (13) sections were evaluated for stability at the lagoons. Critical section locations were established based on visual inspection of the lagoons as well as a survey of the lagoon berms.

Soil profiles were established based on information obtained from ten subsurface investigation locations. Representative samples were obtained from borings through the berms. The boring depths range from fifteen (15) to twenty (20) feet. The borings were advanced using a truck-mounted CME 75 drill equipped with eight and five-eighths ($8\text{-}\frac{5}{8}$) inch outside diameter, continuous flight, hollow-stemmed auger. The borings were completed in accordance with ASTM D-1452: Standard Method for Soil Investigation and Sampling by Auger Methods.

As the auger was advanced, continuous visual inspection of cutting returns was maintained. Samples were taken at five (5) foot intervals throughout the boring and at major soil changes. Standard penetration resistance determinations were accomplished in accordance with ASTM D-1586: Standard Method for Penetration Test and Split-Barrel Sampling of Soils. Relatively undisturbed samples were obtained using Shelby tubes in accordance with ASTM D-1587: Thin-Walled Tube Sampling of Soils for Geotechnical Purposes. Following field classification, the samples were identified and transported to the laboratory for further study.

In addition to borings Dutch Cone soundings were used to evaluate the insitu soil properties and stratigraphy of the embankments and founding soils. Soundings were advanced in accordance with ASTM D-3441: Deep, Quasi-Static, Cone and Friction-Cone Penetration Tests of Soil. Soundings were taken at one (1) foot intervals from the surface through the total depth of the sounding. The soundings were advanced using the hydraulic push capabilities of the CME 75D drill unit.

The logs for the auger borings, and the boring location plan are provided in the appendix of this report. The locations of the sections used for the analysis of the berm embankments are also shown on the boring plan.

2.0 Laboratory Investigation

Representative soil samples obtained from the field investigation were examined and classified based on the Unified Classification System (ASTM D-2487) and the AASHTO Classification System (AASHTO M-145). Particle size analyses were conducted on representative samples. Moisture content determinations were made on all samples to establish moisture content profiles. Atterberg Limits were established on representative samples that exhibited a cohesive nature. All of the above indicator tests were used to aid in defining soil stratification and general insitu soil conditions. The mechanical grain size analyses and soil classification summaries are provided in the appendix of this report.

Unit weight and triaxial shear testing was performed on representative samples to determine strength properties for structural analysis of the soils in the embankments. Test results are shown in the appendix of this report. All testing was conducted in accordance with procedures outlined in the ASTM Standard Methods.

3.0 General Site and Soil Conditions

The evaporation lagoons are located at the southern edge of a broad valley formed as the result of the weathering of relatively soft shales (mudstones and siltstones) of the Petrified Forest Member of the Chinle Formation. These siltstones and mudstones of the Chinle have a high montmorillonite clay content. As a result the soils that have developed at the site are comprised of clays of moderate to high plasticity. All boring and soundings indicate the embankments have been constructed of clay taken from the valley floor. The embankments are founded on the native clays of the valley floor.

The Chinle Formation serves as the bedrock formation at this site. Generally, the formation dips to the north-northwest at approximately three (3) degrees. At the southerly edge of the lagoons the formation was encountered at approximately fifteen (15) feet below the natural ground elevation. At the northerly side of the lagoon site the formation has been encountered in past studies at a depth on the order of sixty (60) feet.

Groundwater was not encountered in any of the embankments. The only groundwater that was encountered during the investigation was a boring eight (8). This location is at the extreme southerly edge of the valley floor. During the drilling the groundwater was encountered at a depth of eighteen

(18) feet below the top of the berm. After twenty-four hours the water level had risen to slightly greater than six (6) feet below the boring elevation (top of the containment berm). At that location the berm height is approximately five (5) feet in height, making the water level approximately one (1) foot below the toe of the embankment. It should be noted that no free water was encountered during the drilling of boring eight (8) until the eighteen (18) foot depth. At that depth a water bearing sandy layer approximately two (2) feet in thickness was encountered. This sandy zone immediately overlies the Chinle Formation. The mudstone of the Chinle Formation is not water bearing. The sandy zone is a confined water bearing zone that is artesian. Nearly every boring that has been drilled to the undisturbed Chinle Formation at the Ciniza site has penetrated this overlying sand zone. The zone serves as an excellent marker for the top of the Chinle. There is no evidence of water migration at this location, or the other investigation locations, which can be attributed to leakage from the ponds.

4.0 Analysis

Thirteen (13) sections through the exterior embankments have been analyzed for stability. Both interior as well as exterior stability of the embankments has been checked. Because the interior height of the embankments are low, factors of safety for the interior slopes are very high. The controlling failure mechanism is associated with the geometry of the exterior slope (the slope that defines the outside or nonwetted face of the lagoon group).

The analyses demonstrate that the berms are structurally stable. Factors of safety against failure for the sections analyzed range from a high of 10.0 to a low of 2.5. Typical minimum desirable factors of safety for this type of structure are in the range of 1.3 to 1.5. As mentioned previously the embankments were evaluated using the method of slices (Bishop's Modified Method) as well as finite element evaluation. A computer program developed by the New York State Highway Department named SLOPES was used to evaluate the berms with Bishop's Modified Method. A program developed at the Colorado School of Mines, Geomechanics Research Center by D. V. Griffiths was used to perform the finite element evaluation. The program, named SLOPE1 is well documented in the book "Programming the Finite Element Method" by I. M. Smith and D. V. Griffiths. Plots of the finite element (FE) mesh, deflection data, and vector traces of the deflected mesh were made using a separate plotting program and are presented in the appendix of this report. The deflected mesh graphically shows the result of the FE analysis at the most critical factor of safety identified. There was excellent correlation between the two analysis types where a circular failure provided the critical factor of safety.

The program SLOPES forces a circular failure where the FE program evaluates translation of nodes of the finite element mesh. The finite element program in this respect provides a more critical evaluation of the failure mode. It may be seen with the FE program that although the higher embankments show the critical failure mode to be a circular failure, the lower embankments tended to identify settlement as a more likely failure mode. The observation is somewhat academic, however, since the associated factors of safety against failure are 2.5 at the worst. Structurally, the berms are sound.

The soils comprising the embankments were tested to evaluate their propensity for being dispersive. Pinhole dispersion testing was performed on the materials in the constructed embankments. The soils were found to be in the category of nondispersive. Piping failure is unlikely to occur in the exterior containment embankments.

5.0 Observations and Recommendations

5.1 Wave Damage

A visual examination of the ponds was performed as a portion of the field investigation. Notes made during the field observation indicated there is no obvious structural failure that is occurring on the embankments. It was noted, however, that although the lagoon depth tended to not exceed two to three feet in total depth substantial wave erosion is occurring on the interior portion of the exterior containment embankments. Similarly, wave erosion is occurring along the interior pond separation dikes. Some, generally minor, erosion is occurring on the exterior faces of the perimeter containment berms.

A conscientious effort of embankment maintenance will easily control the exterior erosion of the containment berms. Although continual maintenance of the interior wave damage on the outside containment berms could also be made, over time significant pond volume loss would be realized as material is continually added to the interior of the lagoons at wave damage locations. It is recommended that a more permanent interior wave energy dissipation system be considered.

Wave damage may be reduced by plating the active wave areas with nonerosive material such as rock, grout blankets, or similar materials. If rock is selected at this site it should be placed on a geogrid material such as Tensar®, in Maccaferri® Reno Mattresses, or similar geotextile materials. These materials will prevent the rock from sinking into the soft soils or sliding off the slope where it will be ineffective against wave damage. It is recommended that wave protection be placed such that it extends from the top of the embankment to a minimum of twenty-four (24) inches below the lowest water level.

Where twenty four (24) inches extends below the bottom of the interior slope elevation, the slope protection material should key into the bottom of the lagoon impoundment a minimum of eight (8) inches. Because the lagoons are used as evaporation ponds the slope protection will likely be required on the entire interior face of the outside containment lagoons. Because of the lack of high quality aggregates in the Gallup area, rip-rap type energy dissipation, although permanently effective, will be costly to install.

An alternate wave protection system involves dissipation of the wave energy prior to reaching the embankment berms. Such systems involve the use of geogrids, fabrics, or liner materials constructed as a fence approximately three (3) to five (5) feet away from the wave impact area of the containment berms. It is the intent that these materials reflect or dissipate the majority of the wave energy prior to reaching the embankment material. Floating systems have also been used to reduce minor wave action. Materials such as partially submerged plastic drums have been successfully used to reduce the effects of wave action. These systems should be used to protect interior pond separation dikes as well as the exterior containment berms.

Should Giant Refining Company require assistance in design of these systems or require design review, Precision Engineering, Inc. can assist as required.

5.2 Berm Height

It was noted during the visual inspection that at some locations the impounded water level was within one (1) foot of the containment berm crest elevation. Should an interior dike be breached or high winds cause large waves the exterior containment dike could easily be overtopped. It is strongly 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.

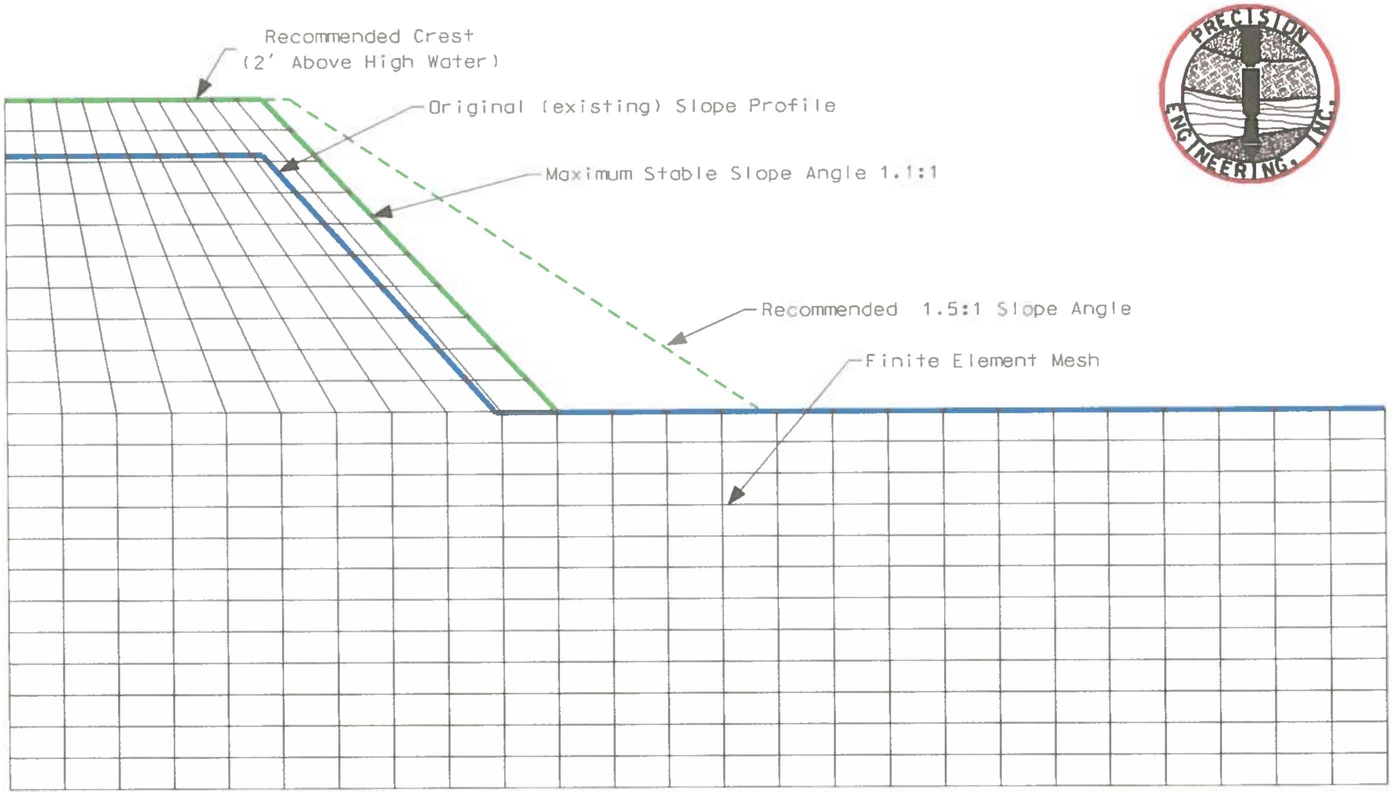
Analysis indicates that when the elevation of the top of the outside containment berms are elevated approximately two (2) feet the minimum factor of safety against failure is 2.1. This minimum critical section is represented by Section 12 on the west side of the ponds (see boring plan). The failure mechanism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

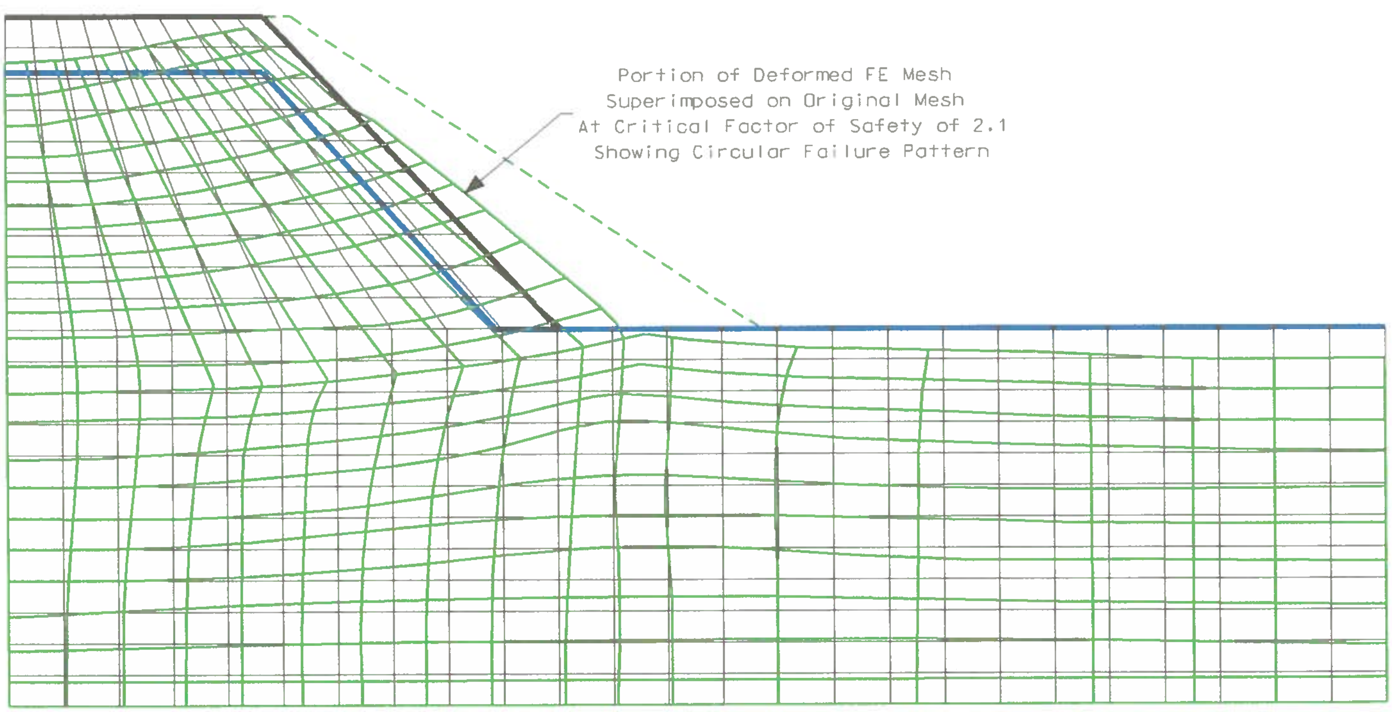
It is recommended that the berm elevations be adjusted to be two (2) feet above the maximum anticipated water level elevation. It is recommended that the minimum width of the top of the containment berms be ten (10) feet. For structural stability, the side slopes of the berms should not exceed their 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.

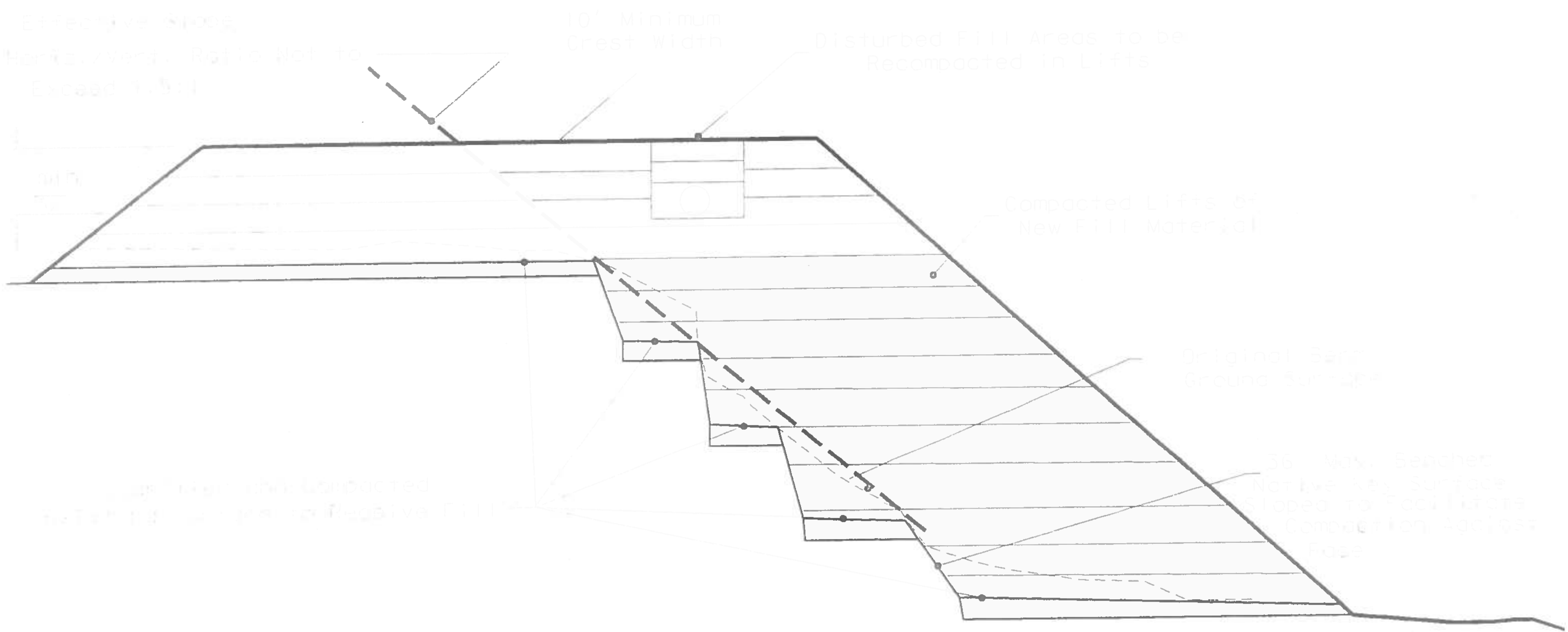
Soil placed on the berms should be keyed into the berms to provide the maximum strength. The side slopes of the existing embankments should be benched to create a horizontal surface for fill construction. This will provide structural interlock with the existing material. All new fill should be placed 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

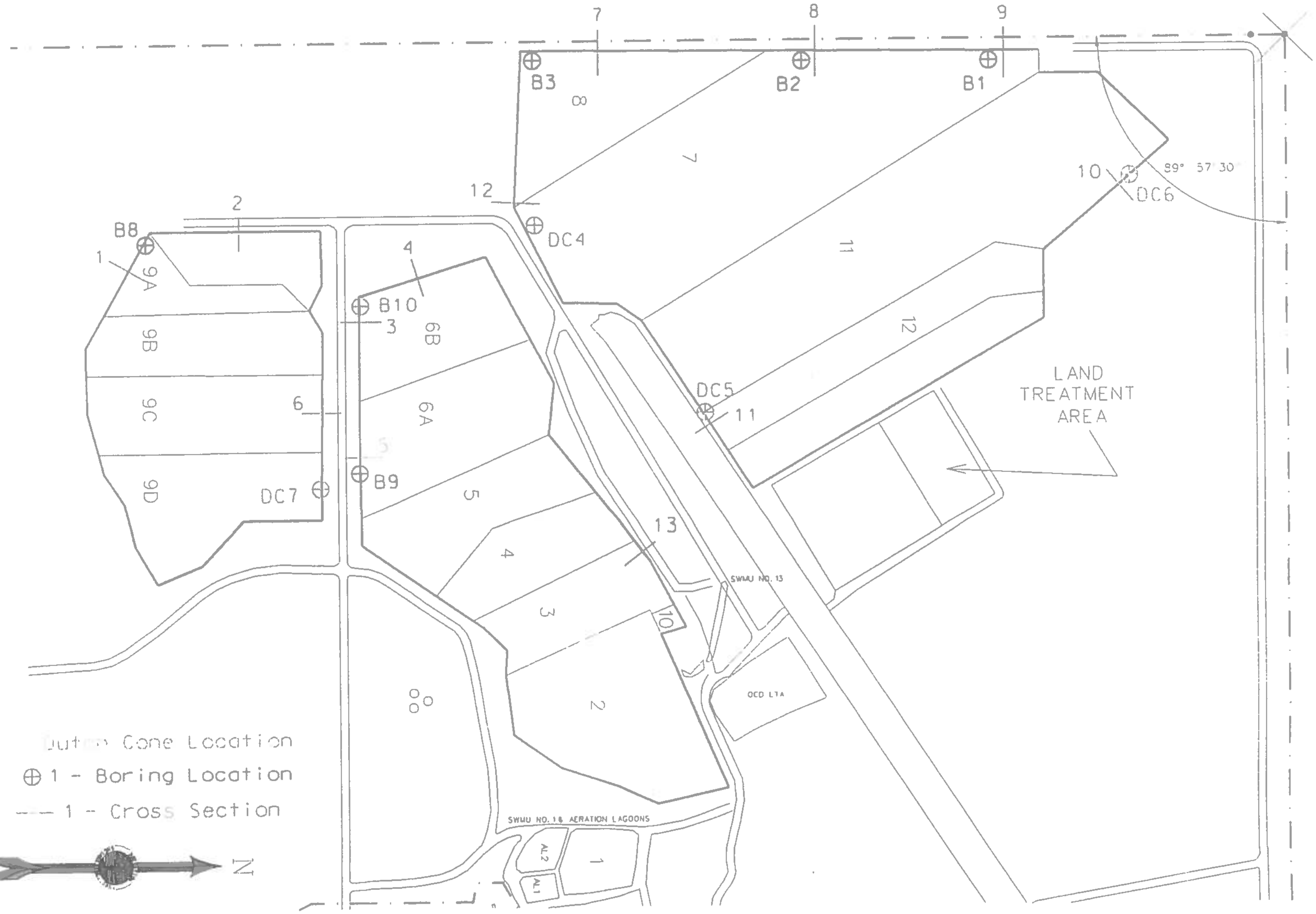
free board above the maximum anticipated water level. Recommendations for fill placement have been provided. The freeboard area should be protected from erosion degradation.

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		//////							
38628	15.0-16.5	12-16-23	//-///	15	SSS	**CLAY**, SLIGHTLY SILTY, REDDISH BROWN, MOIST, 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

PRECISION ENGINEERING, INC.

File #: 00-141

LOG OF TEST BORINGS

Bore Point: SEE SITE PLAN
WEST DYKE CENTER

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

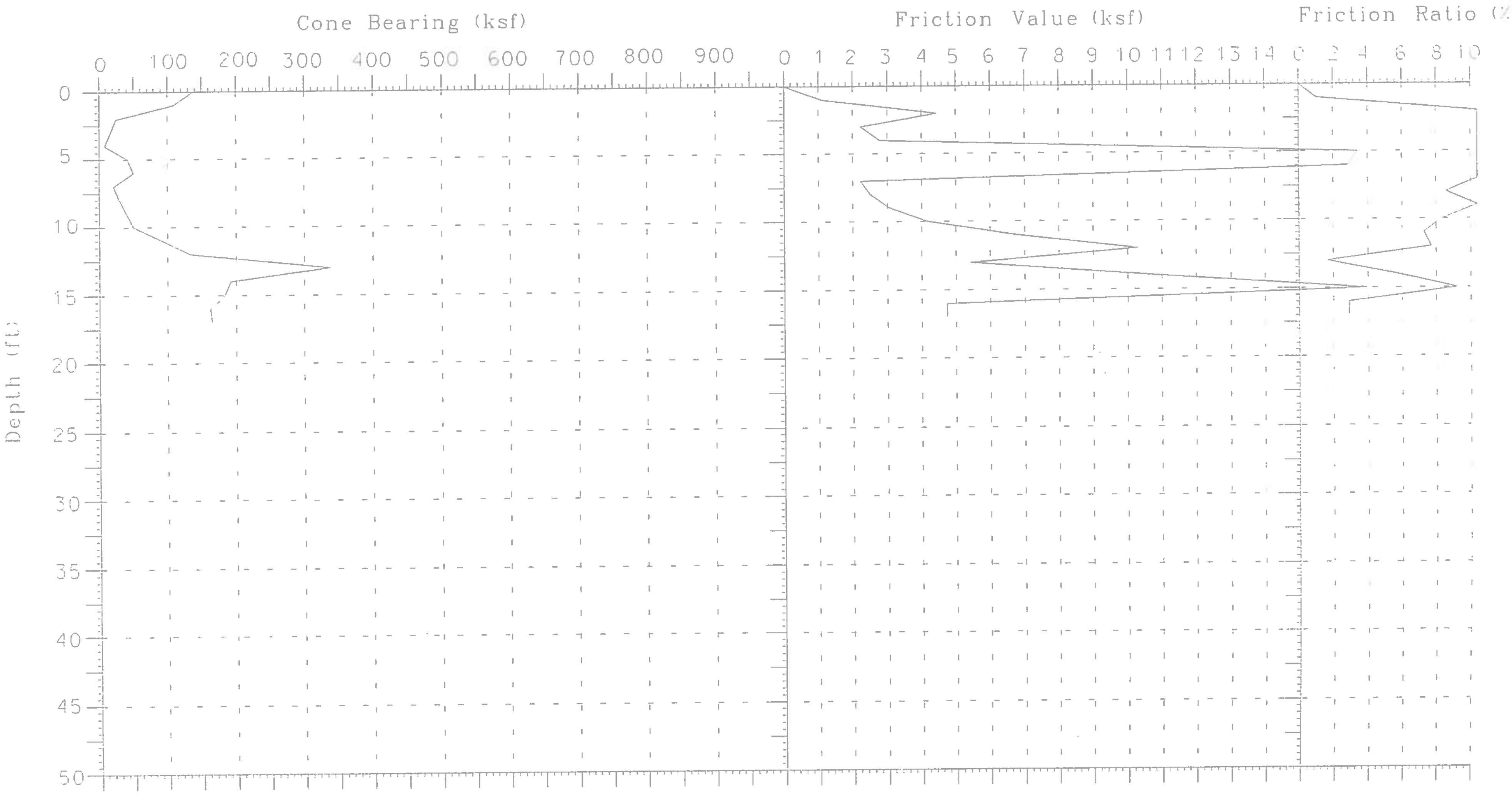
Logged By: WHK

Quasi-Static Penetration Sounding Log

ASTM D-3441

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

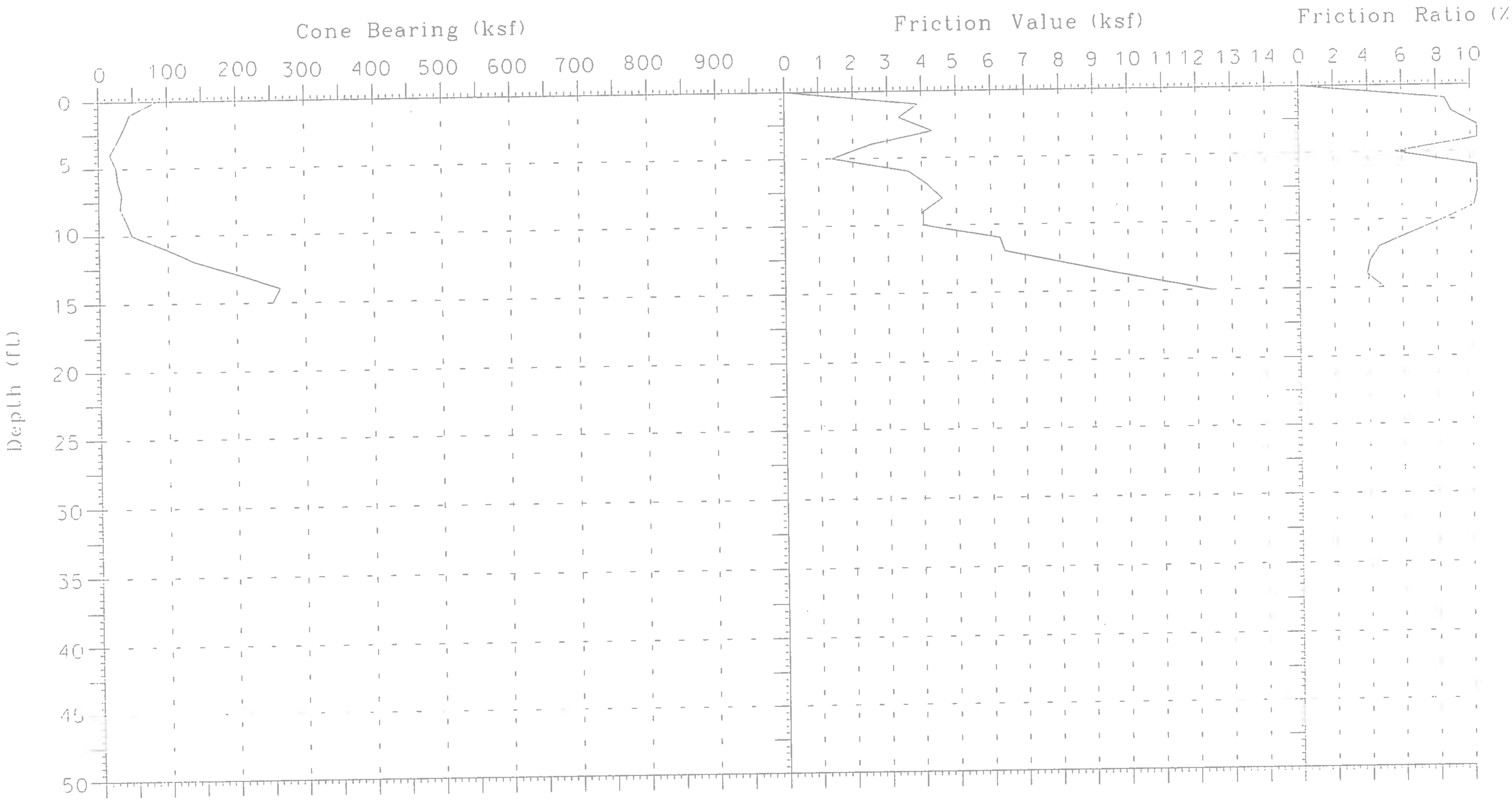
Sounding Number: 4
Sounding Location: see plan



Quasi-Static Penetration Sounding Log
ASTM D-3441

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

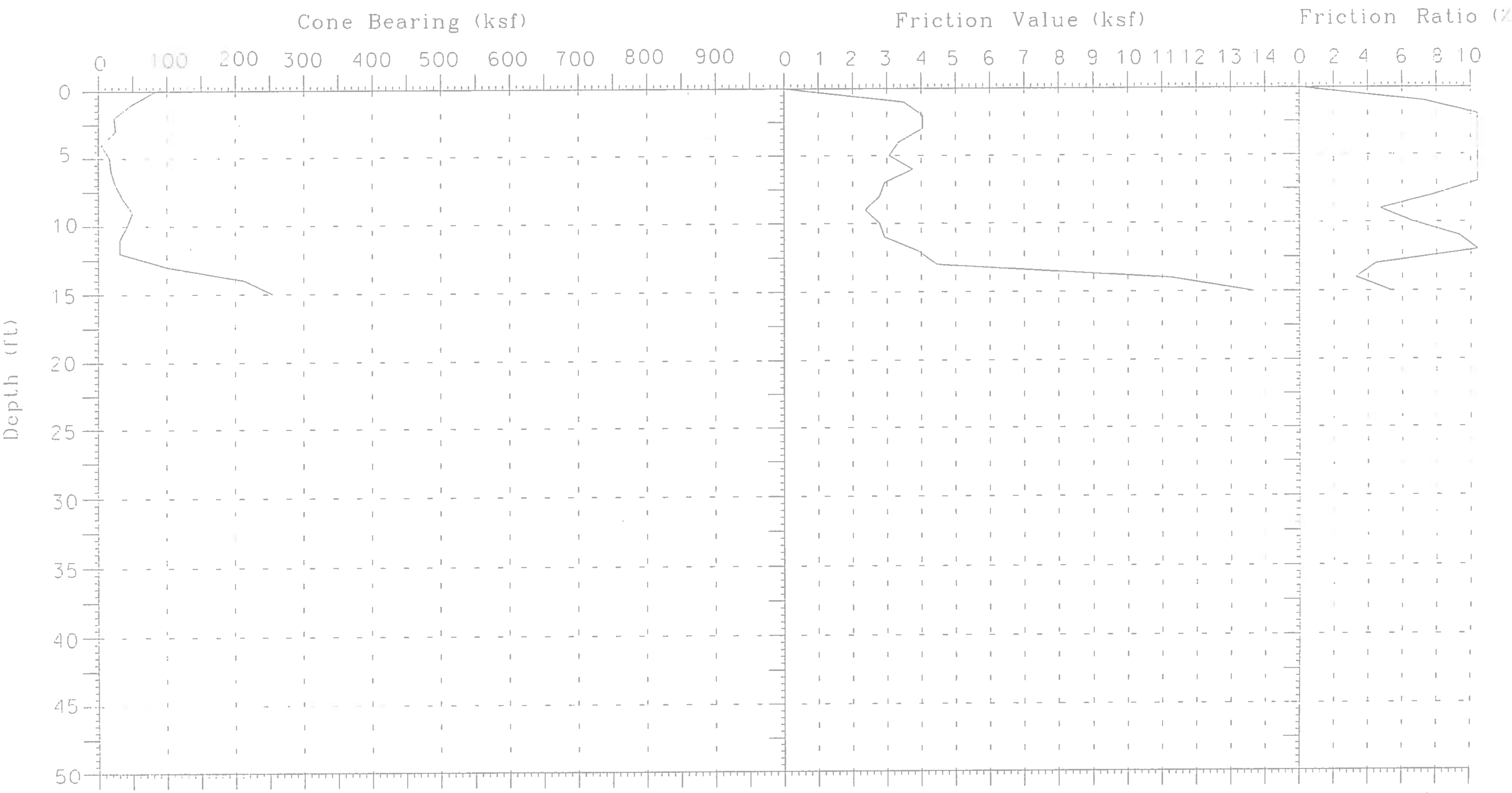
Sounding Number: 5
Sounding Location: see plan



Quasi-Static Penetration Sounding Log
ASTM D-3441

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

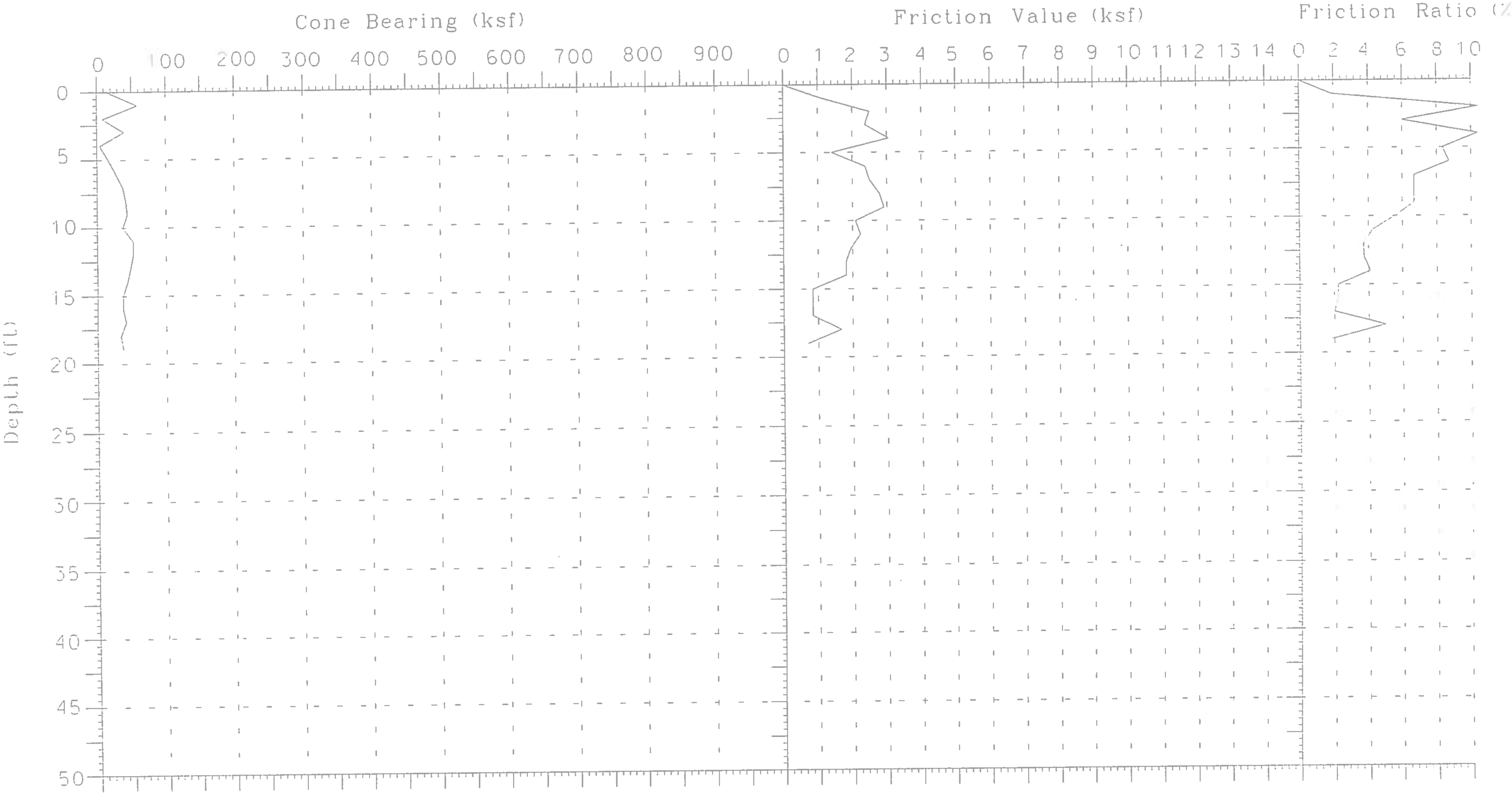
Sounding Number: 6
Sounding Location: see plan



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



Sheet: 8 OF 10

PRECISION ENGINEERING, INC.

File #: 00-141

Bore Point: SOUTHWEST CORNER OF POND 9A

LOG OF TEST BORINGS

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
FILE NO: 00-141

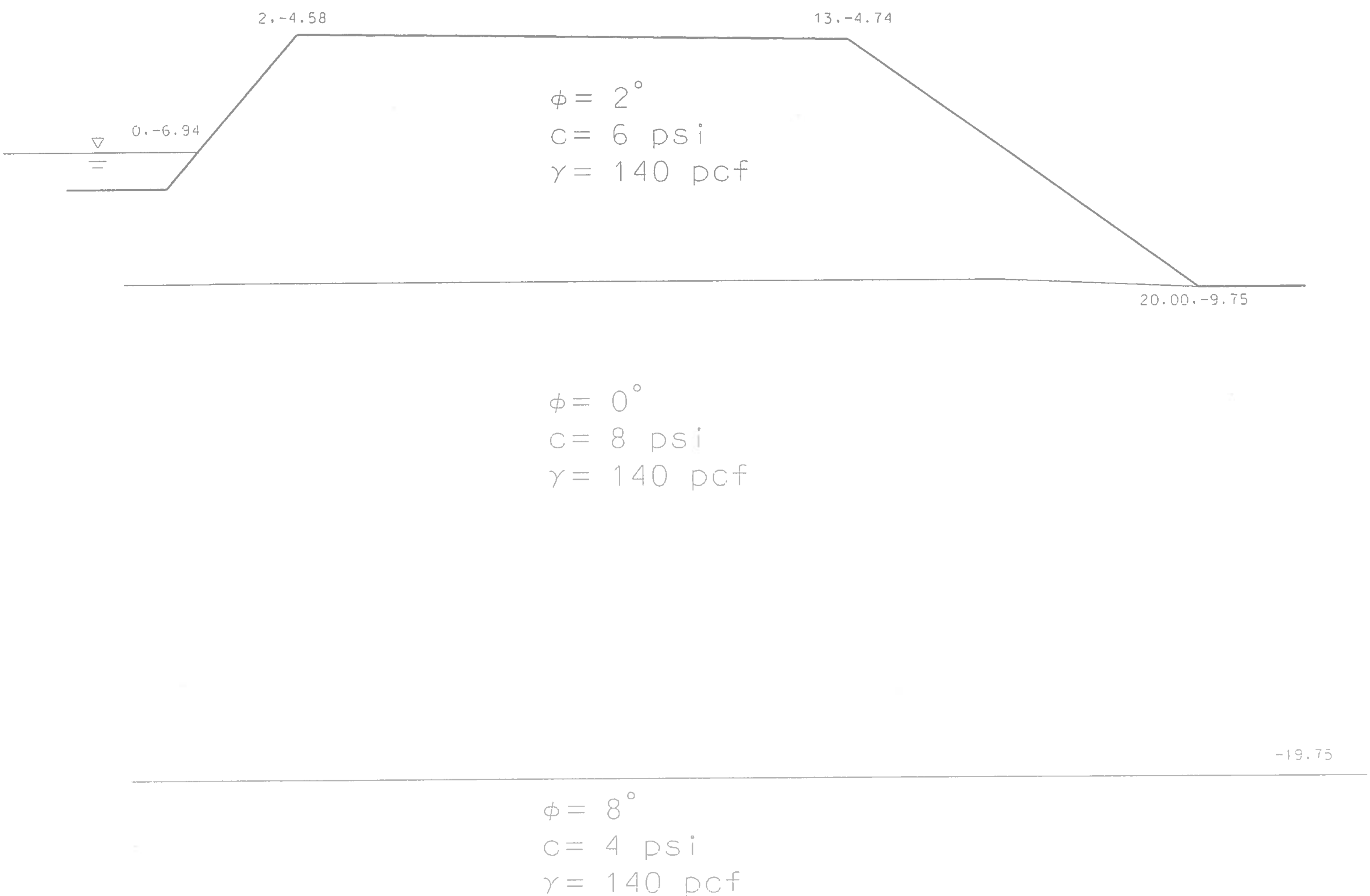
LOCATION: CINIZA, NM

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

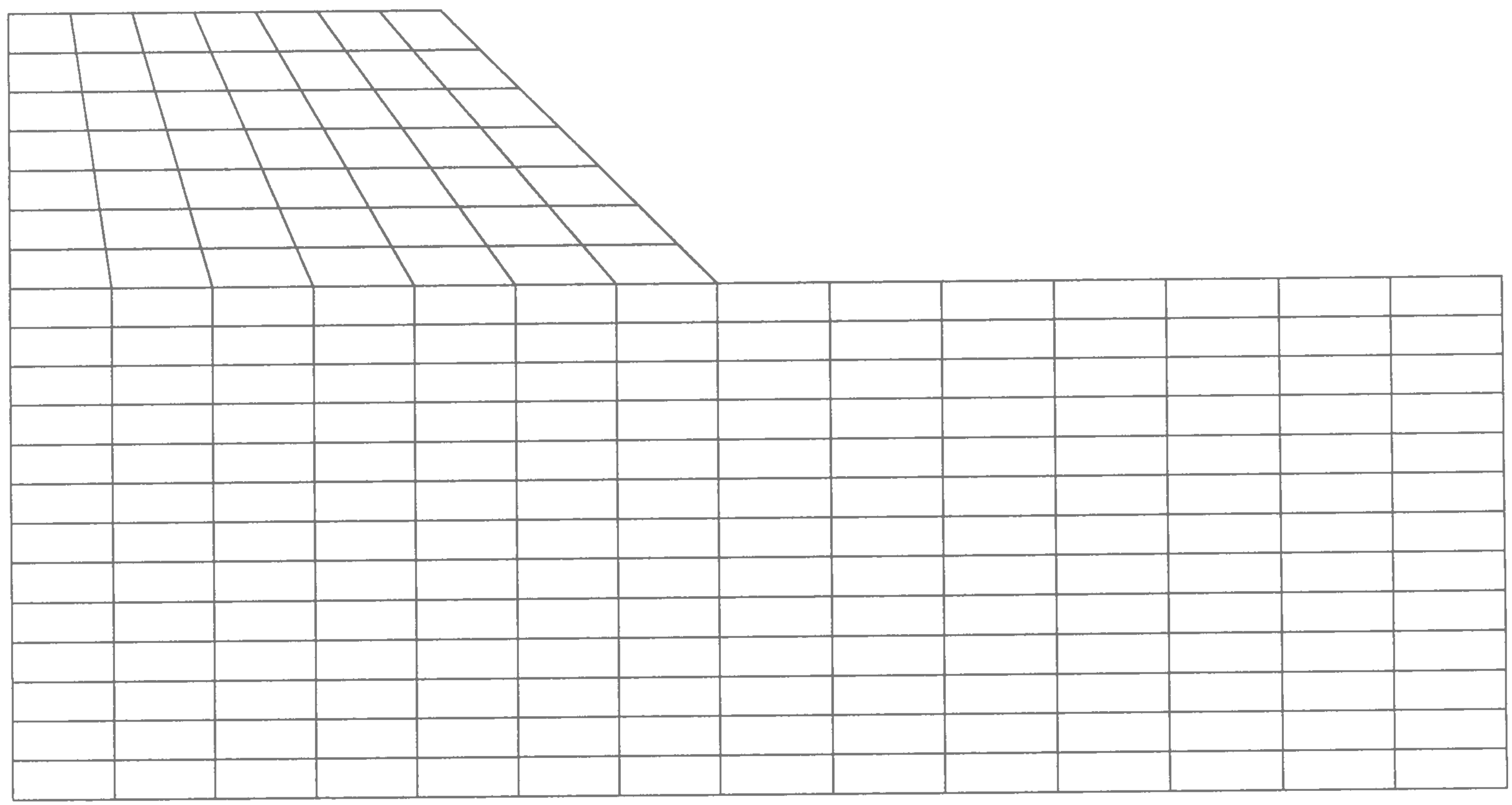
Property group assigned to each element

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
2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	2	2	2	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

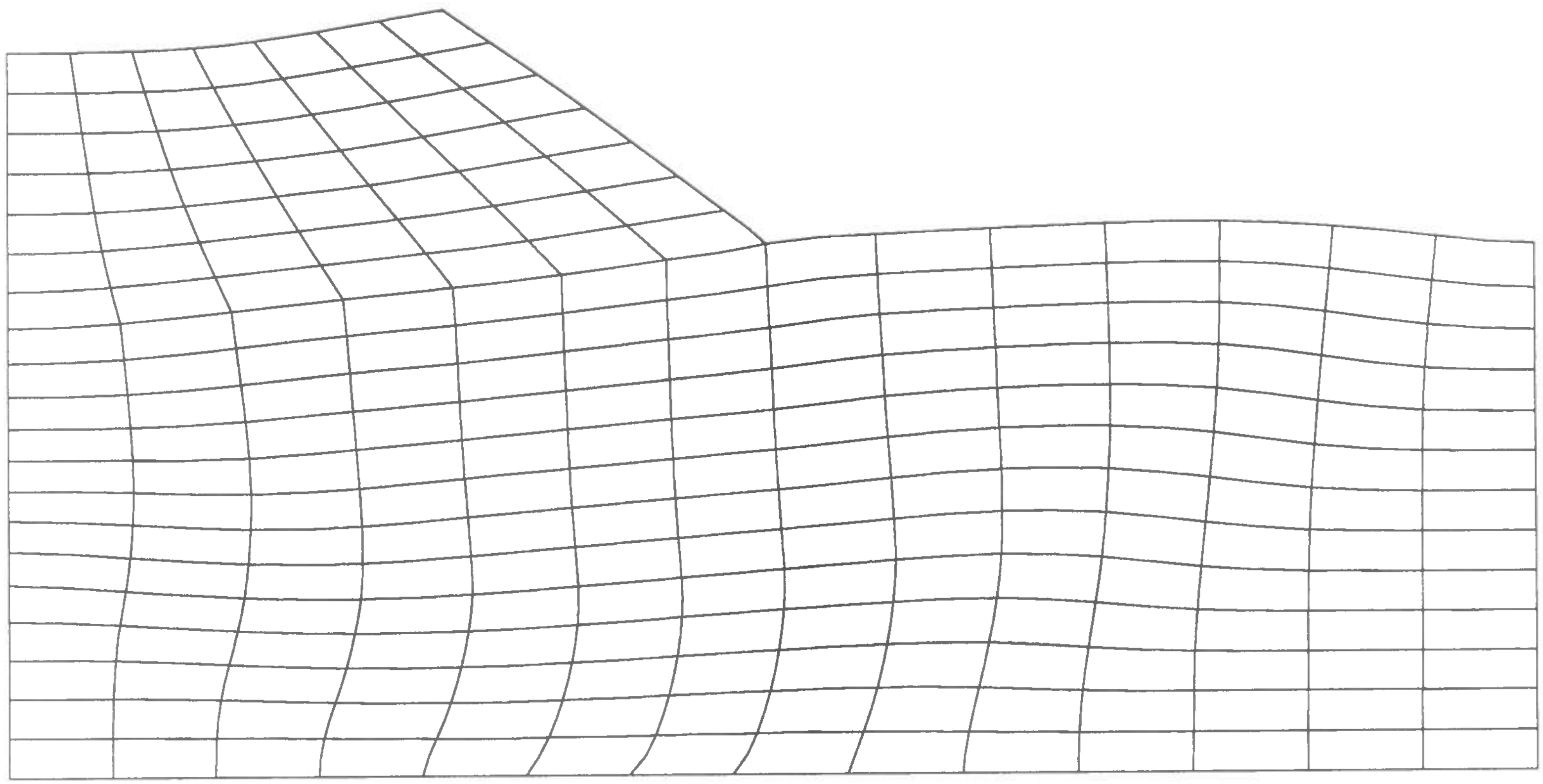
```
tol=  0.000100
limit= 1000
```

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

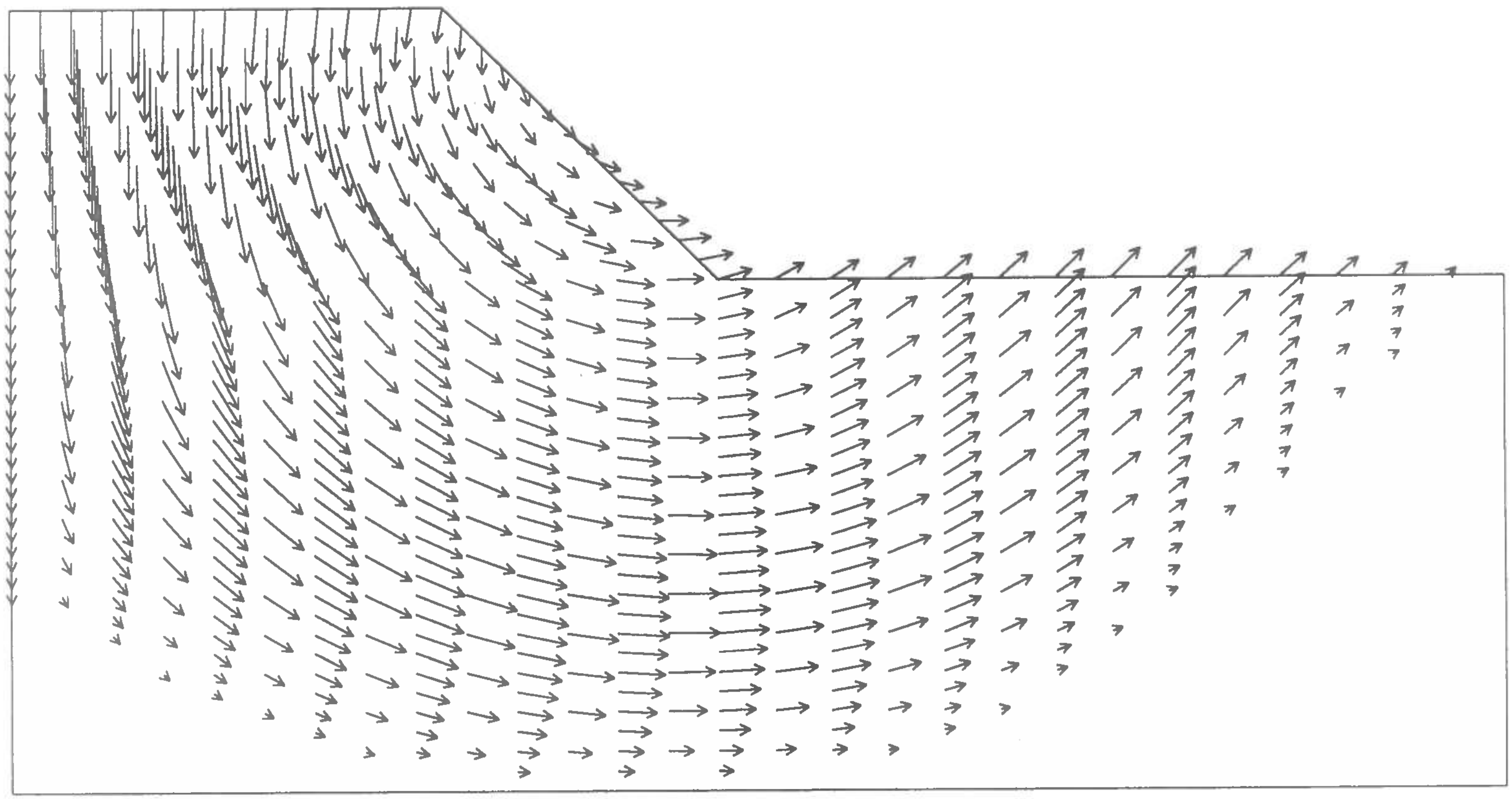
Section 1
Mesh



Section 1
Deformed Mesh

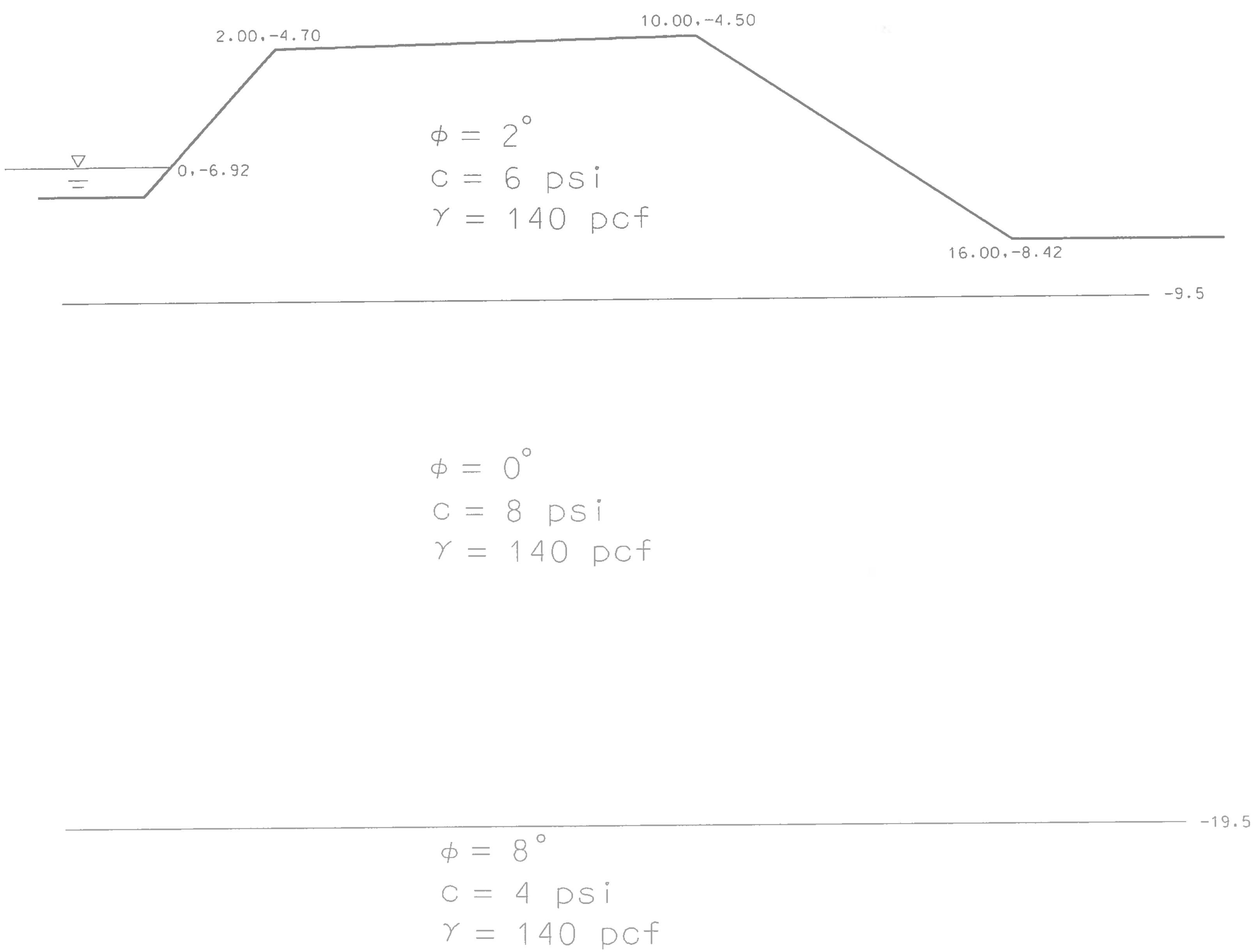


Section 1
Vector Trace



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

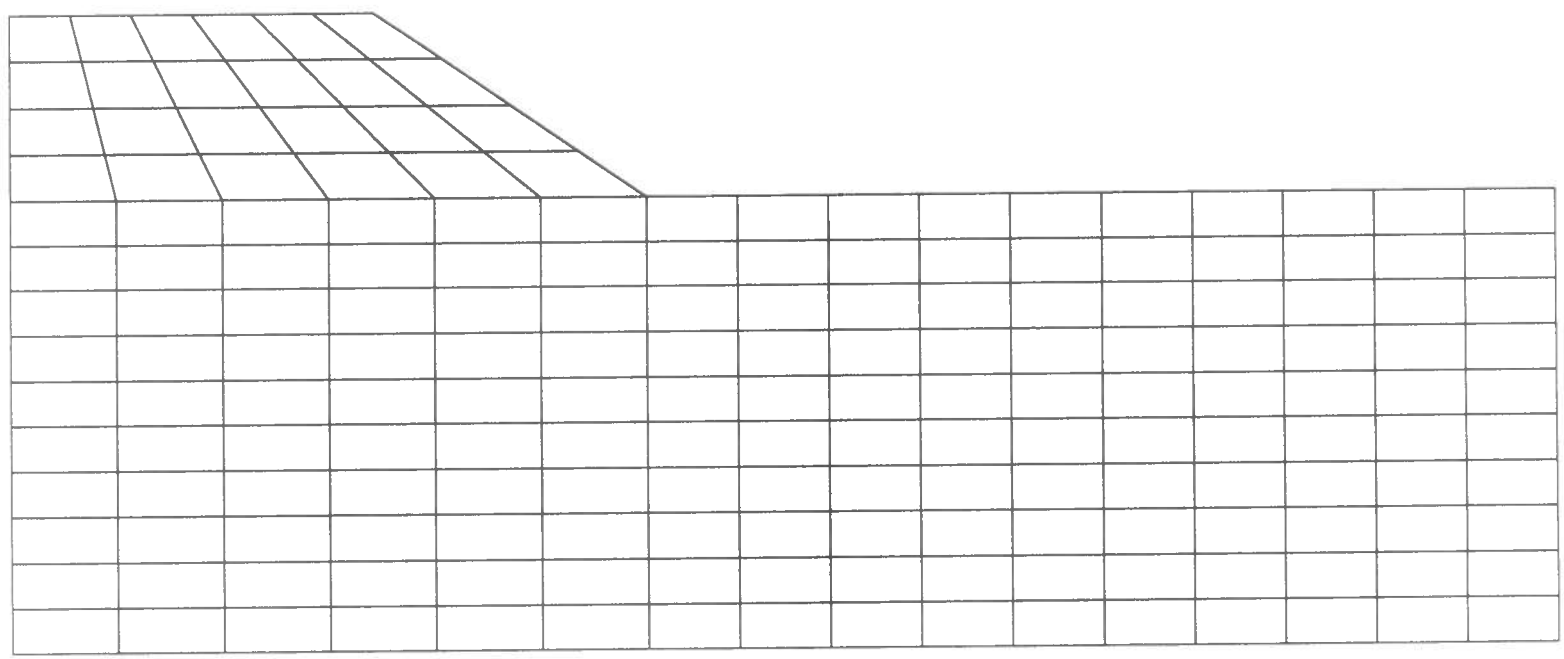
Property group assigned to each element

```
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
```

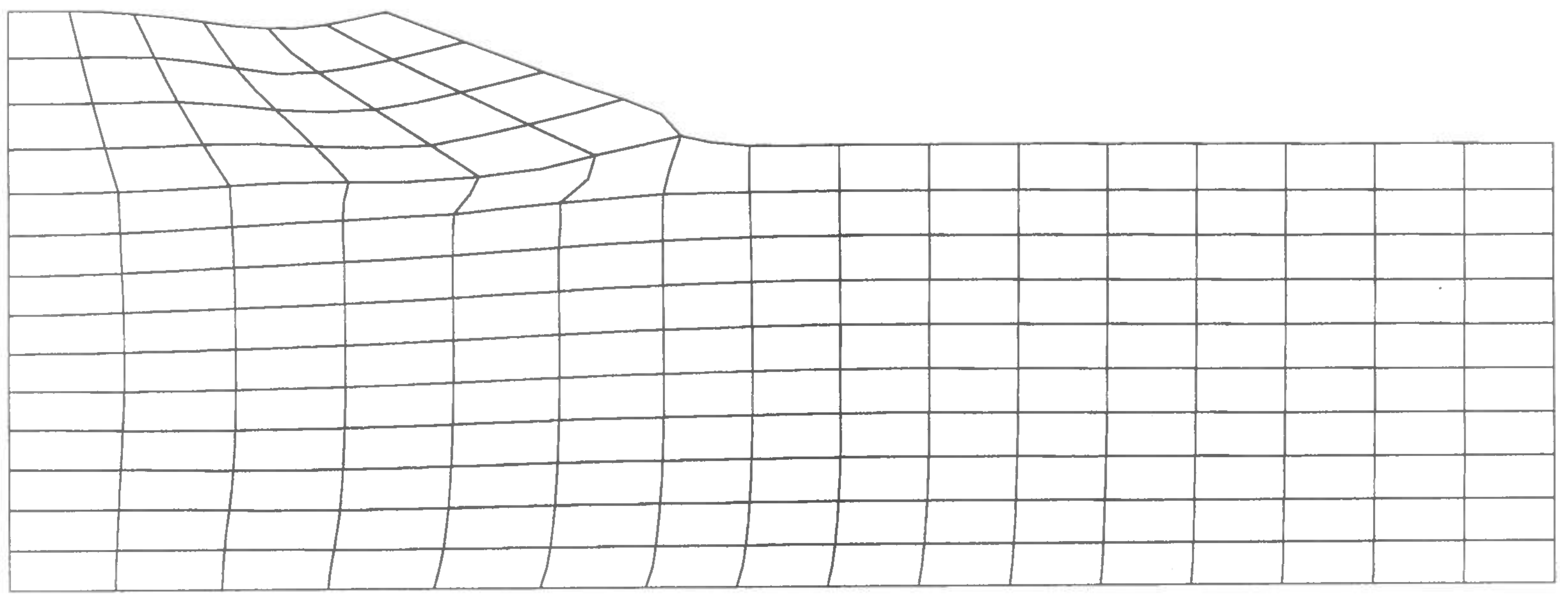
```
tol=  0.000100
limit= 1000
```

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

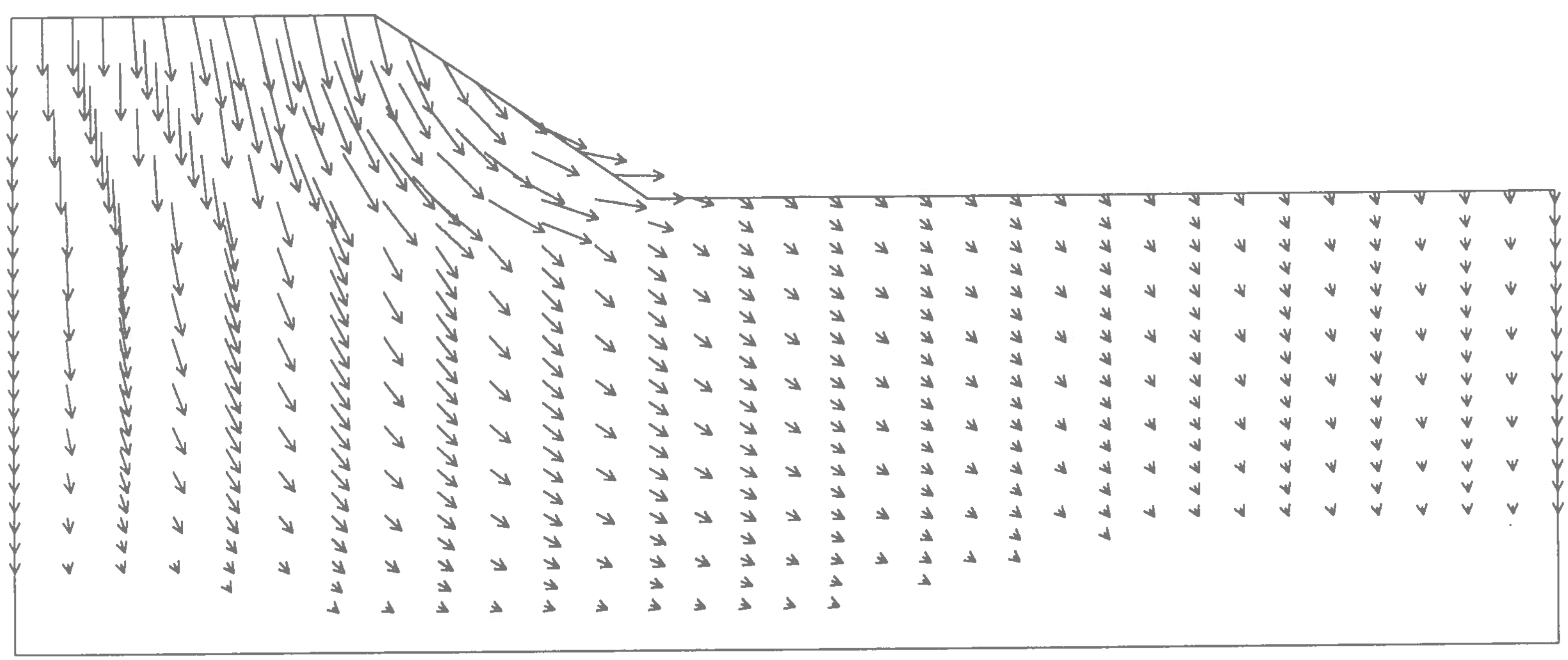
Section 2
Mesh



Section 2
Deformed Mesh

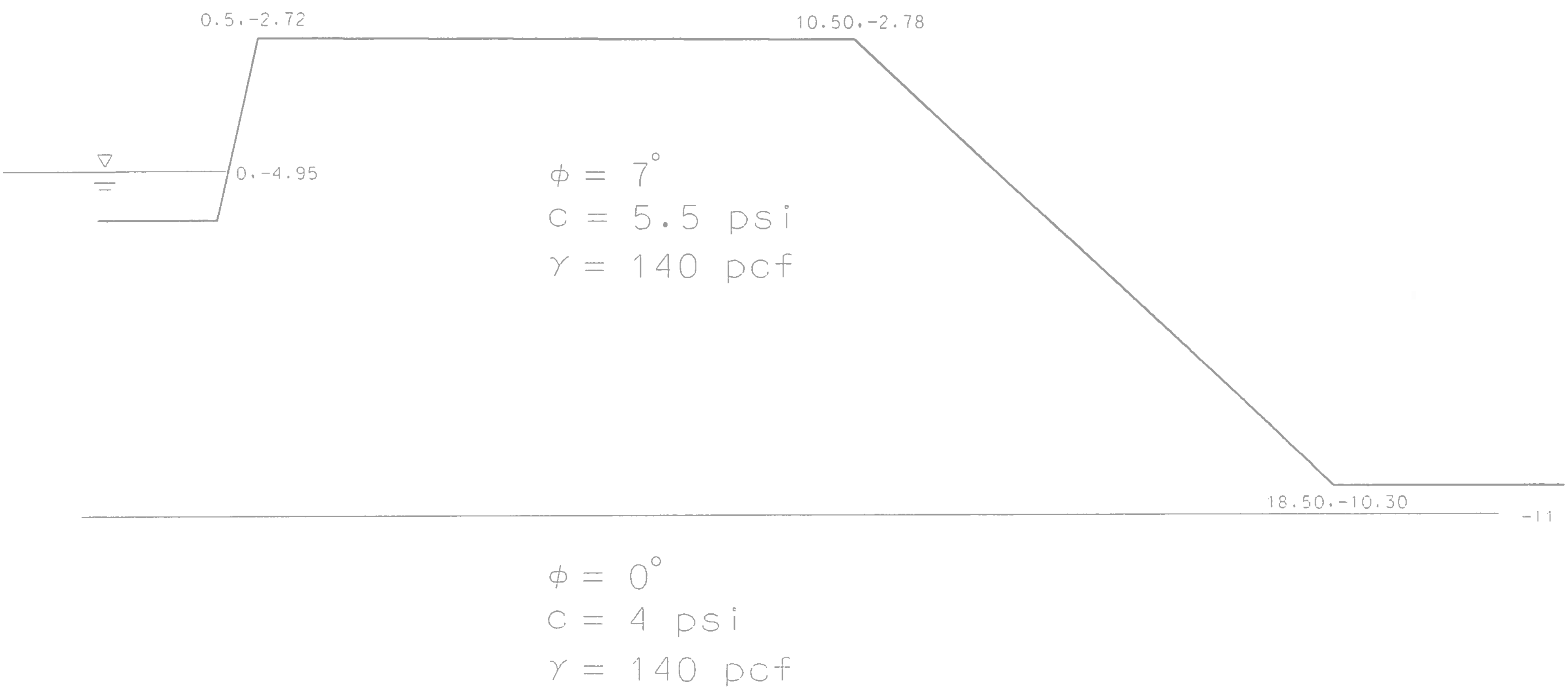


Section 2
Vector Trace



Section 3

Factor Of Safety = 3.0



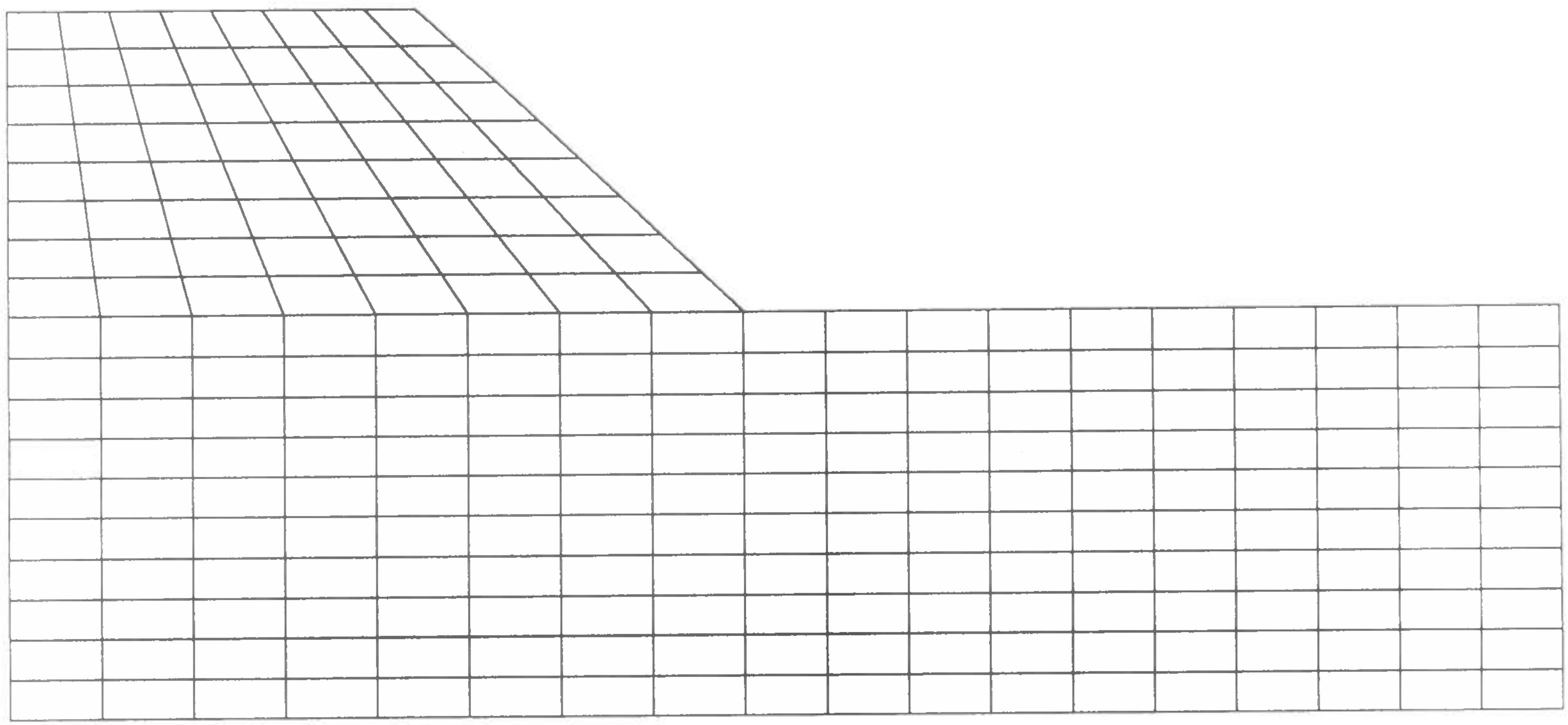
Section 3 Profile

```
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
```

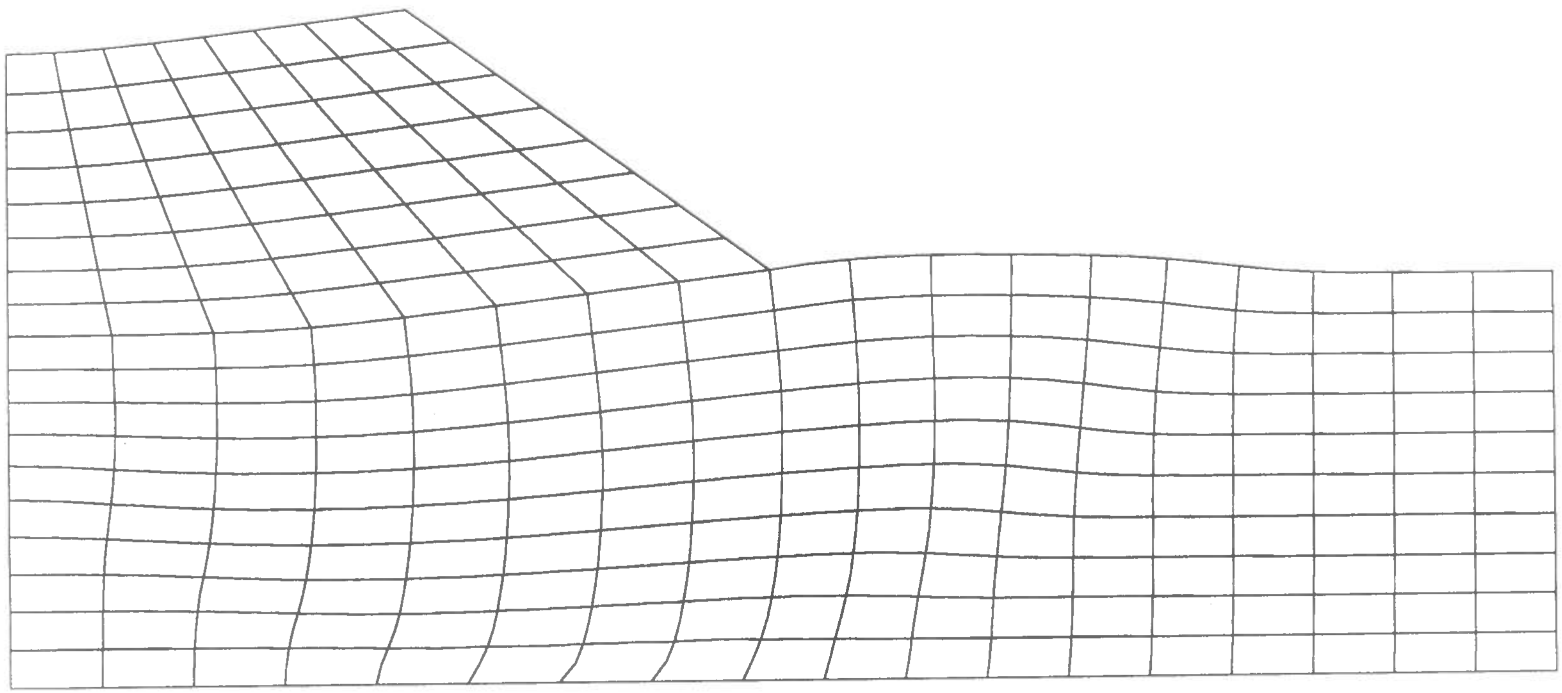
limit= 1000

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

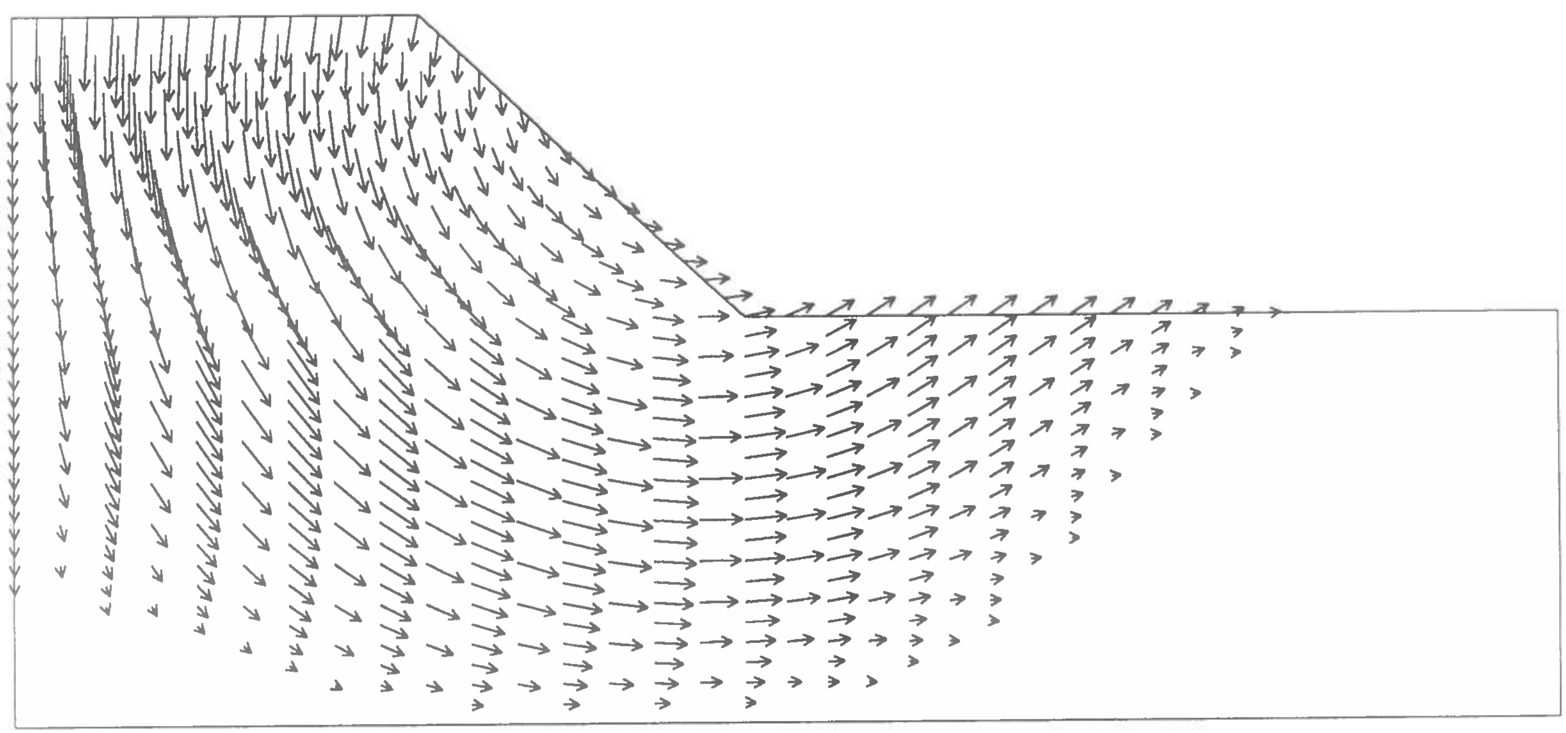
Section 3
Mesh



Section 3
Deformed Mesh

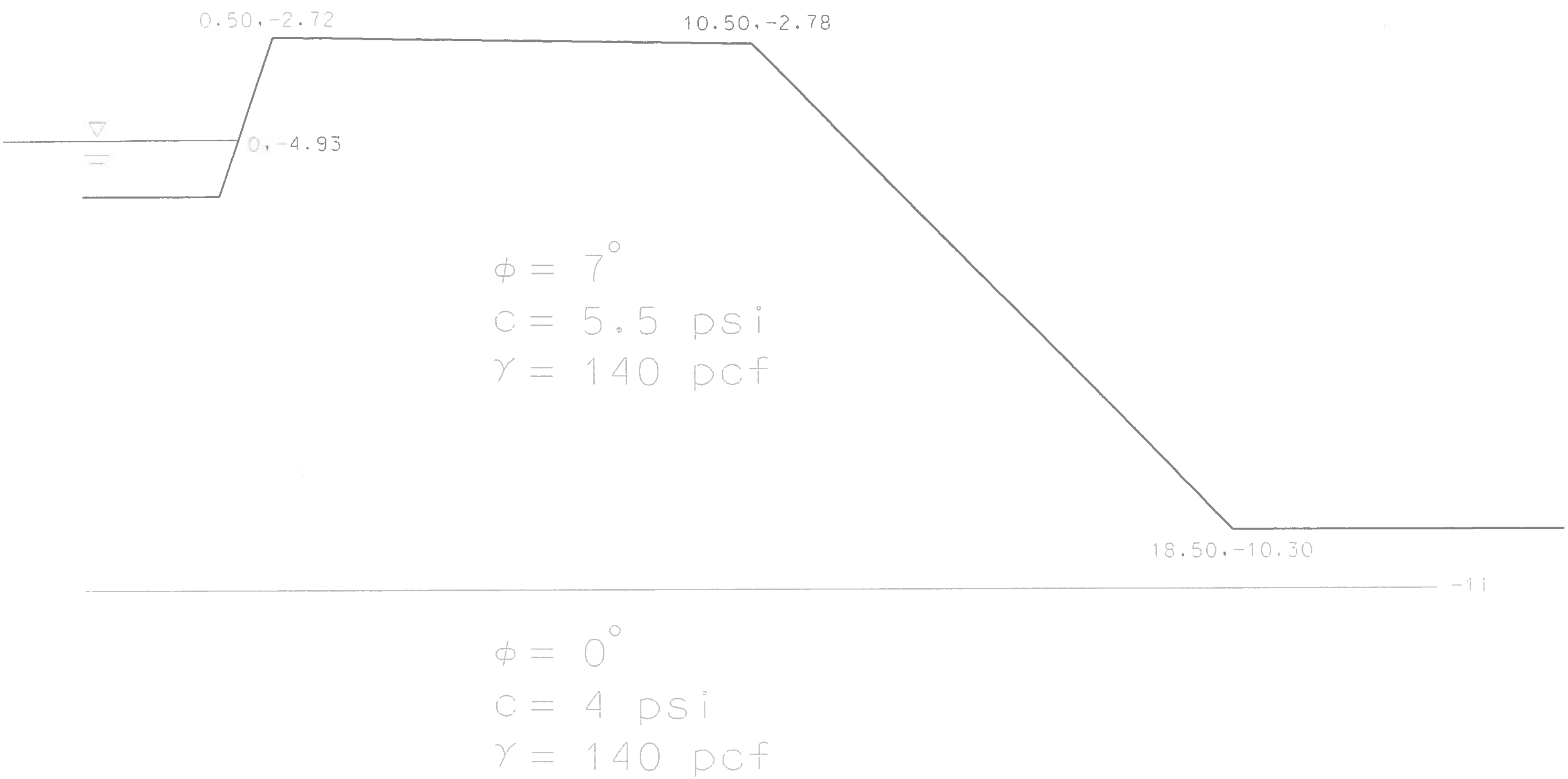


Section 3
Vector Trace



Section 4

Factor Of Safety = 3.0

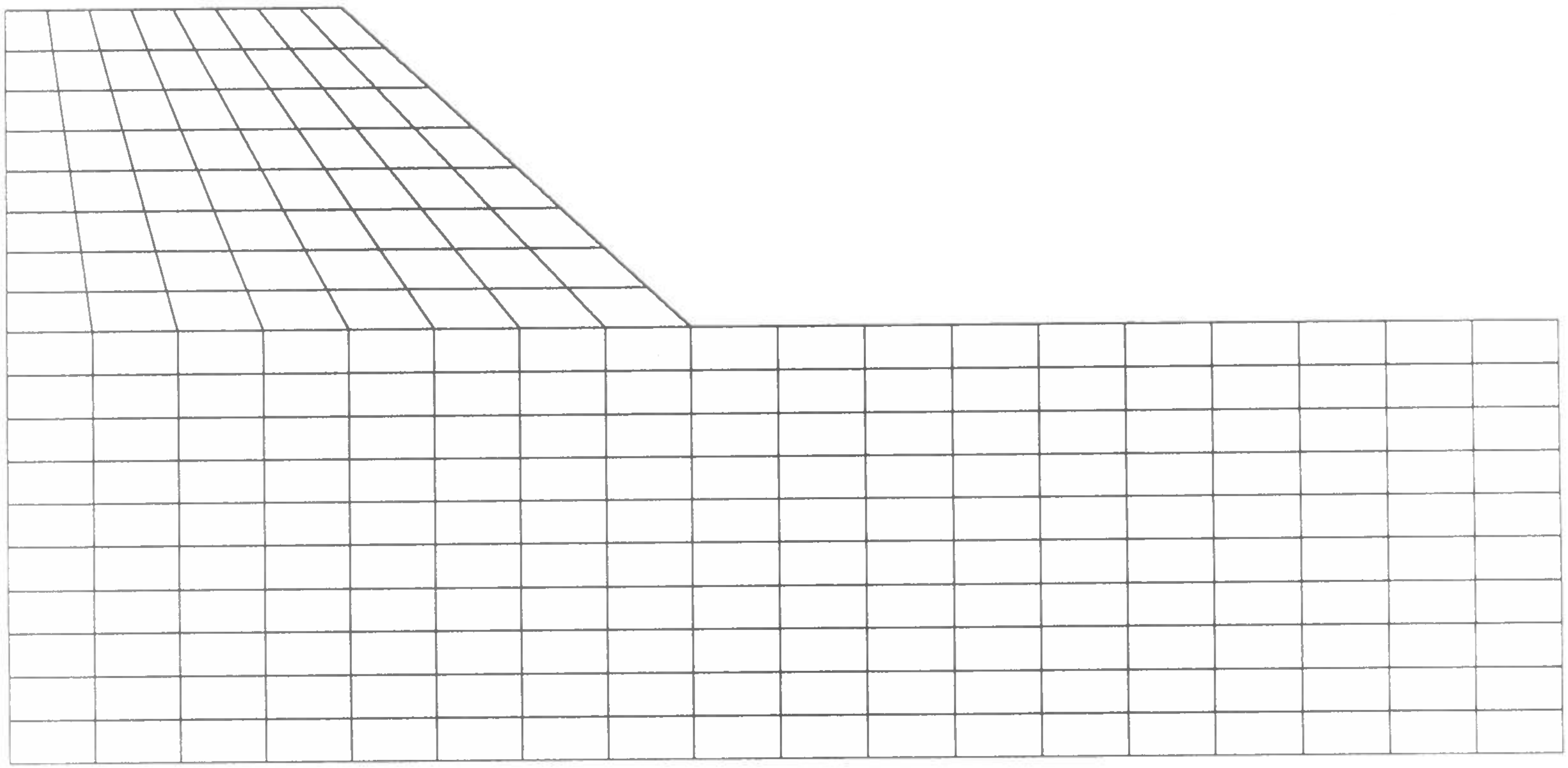


```
Section 4 Profile

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
```

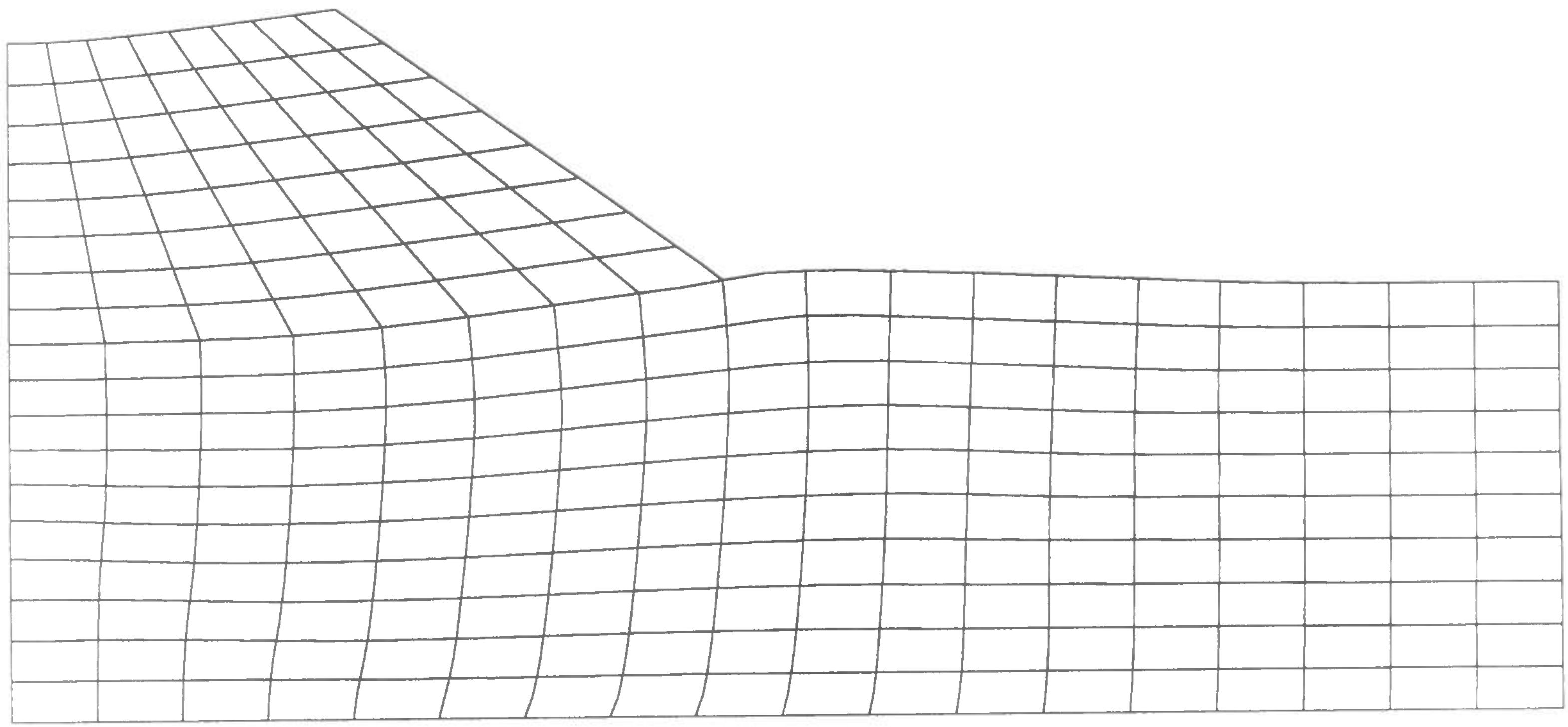
limit= 1000

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

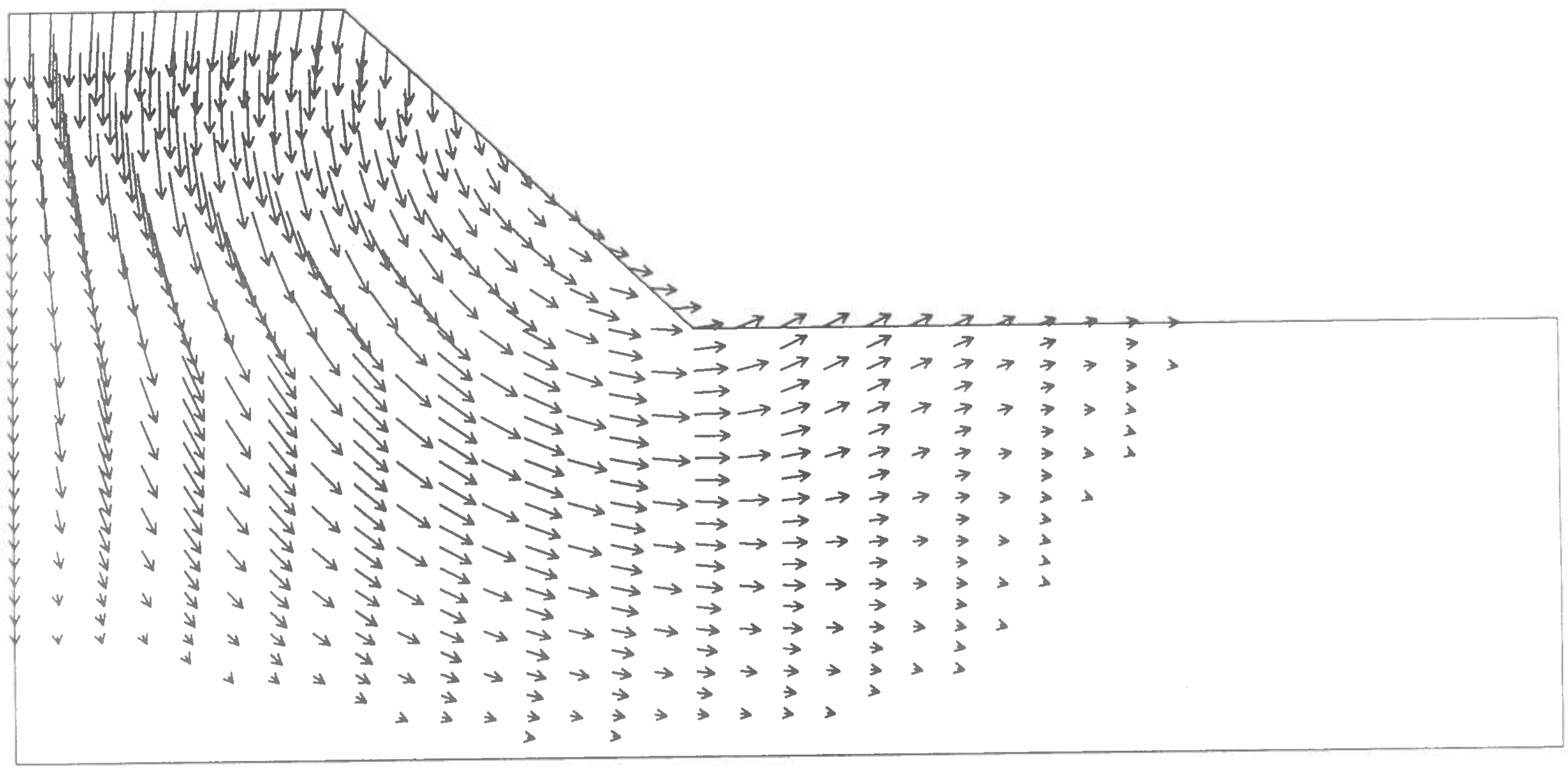
Section 4
Mesh



Section 4
Deformed Mesh

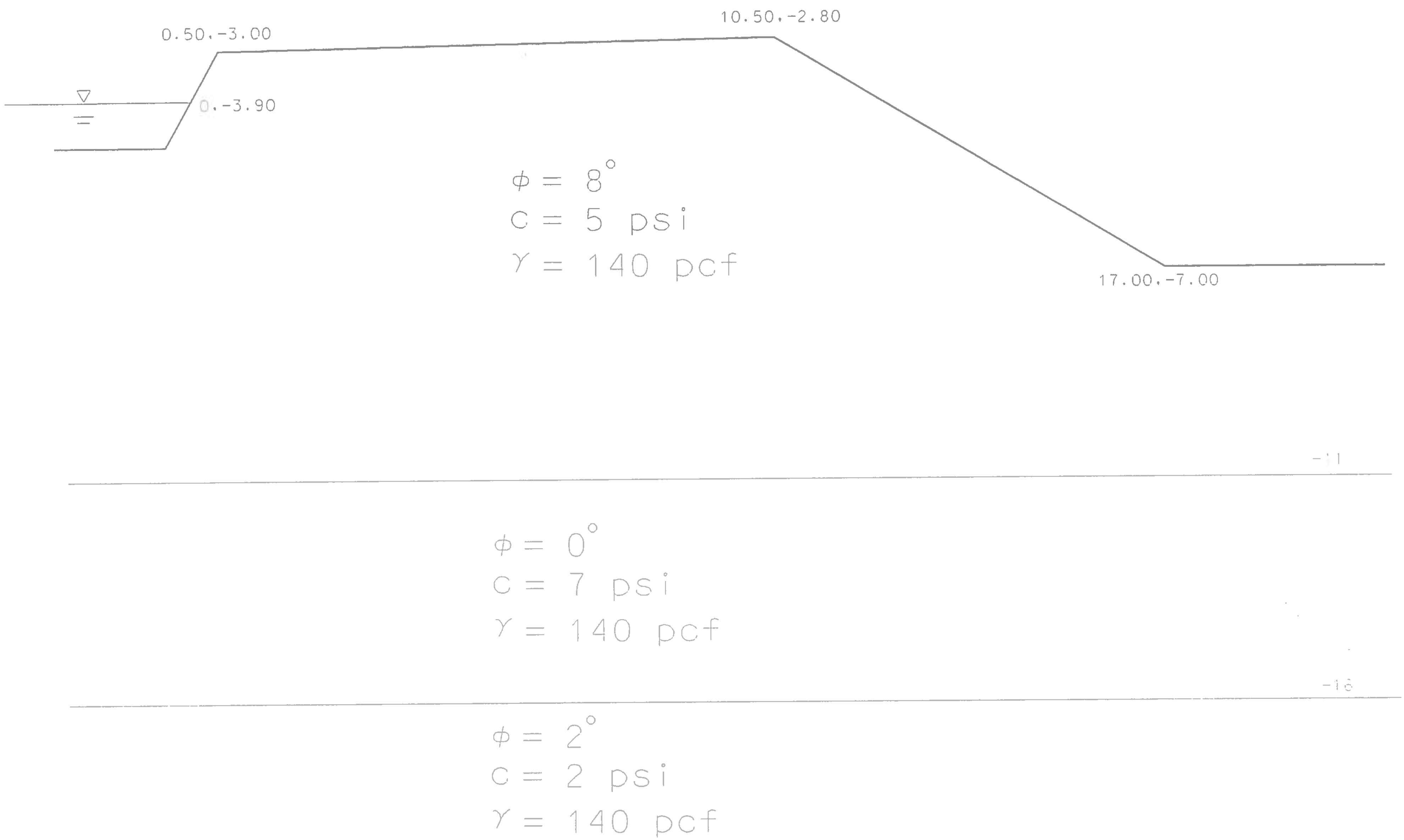


Section 4
Vector Trace



Section 5

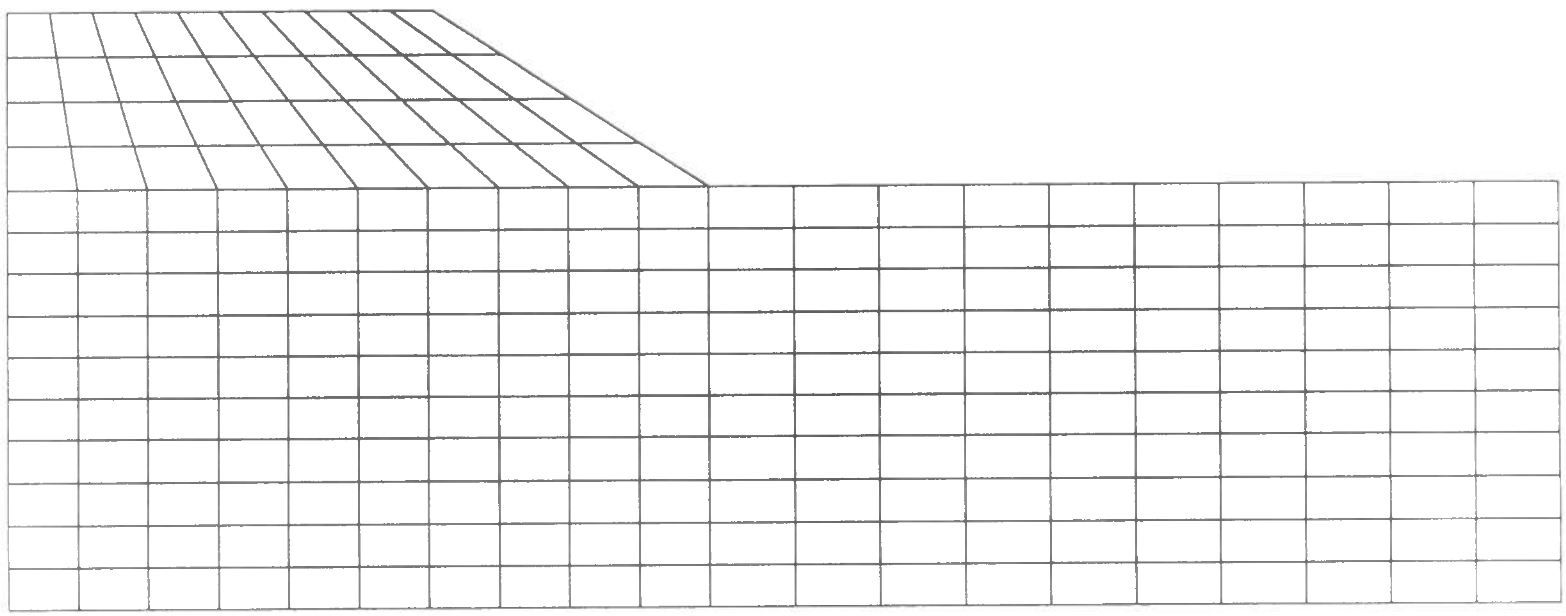
Factor Of Safety = 6.2



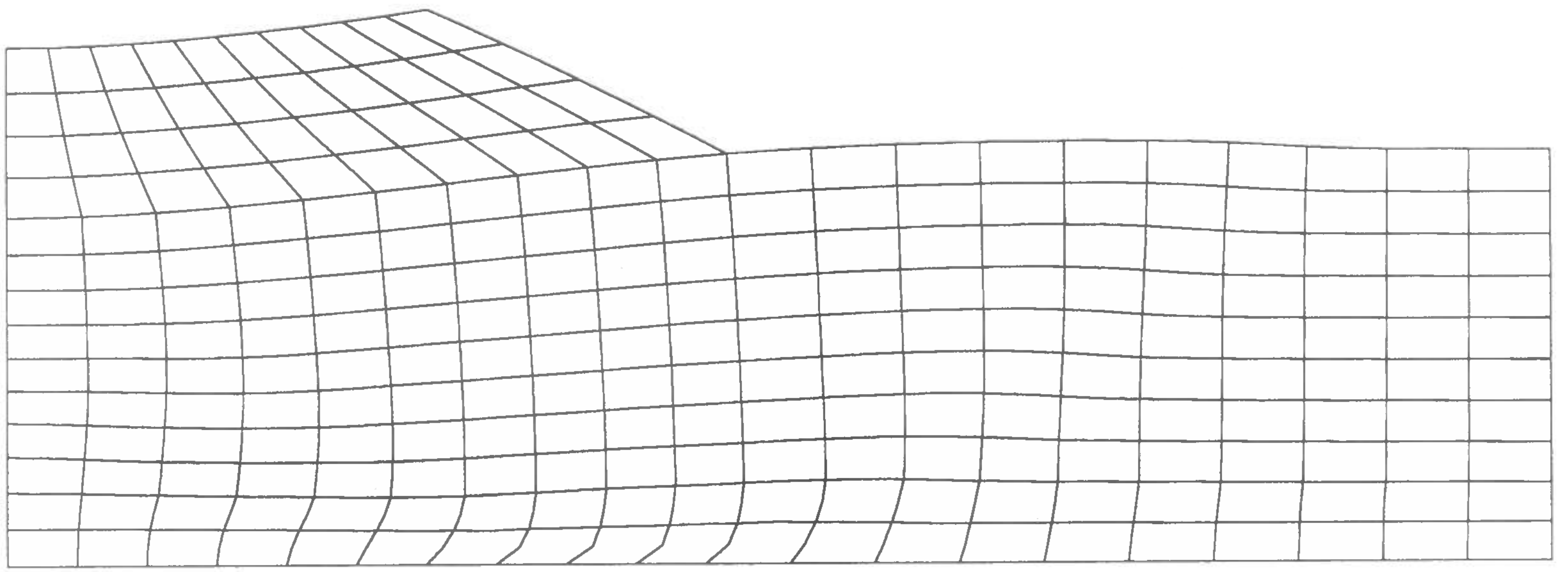
```
Section 5 Profile

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

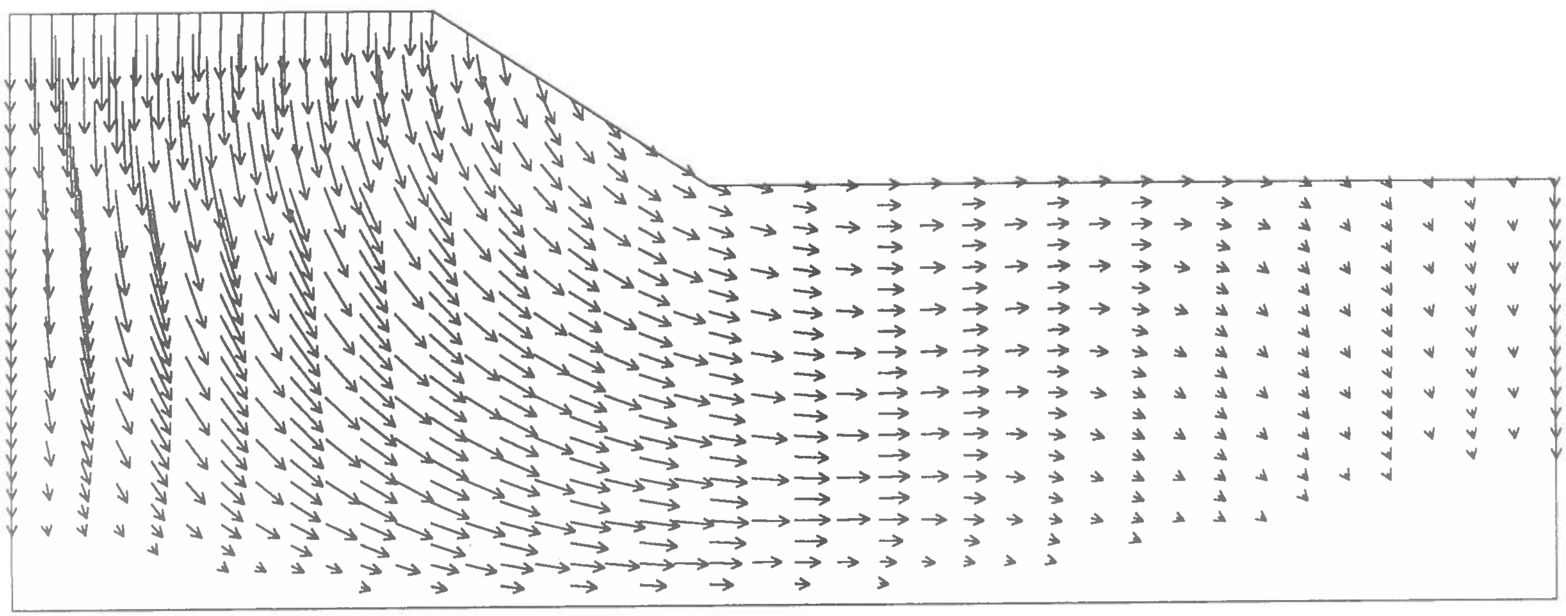
Section 5
Mesh



Section 5
Deformed Mesh

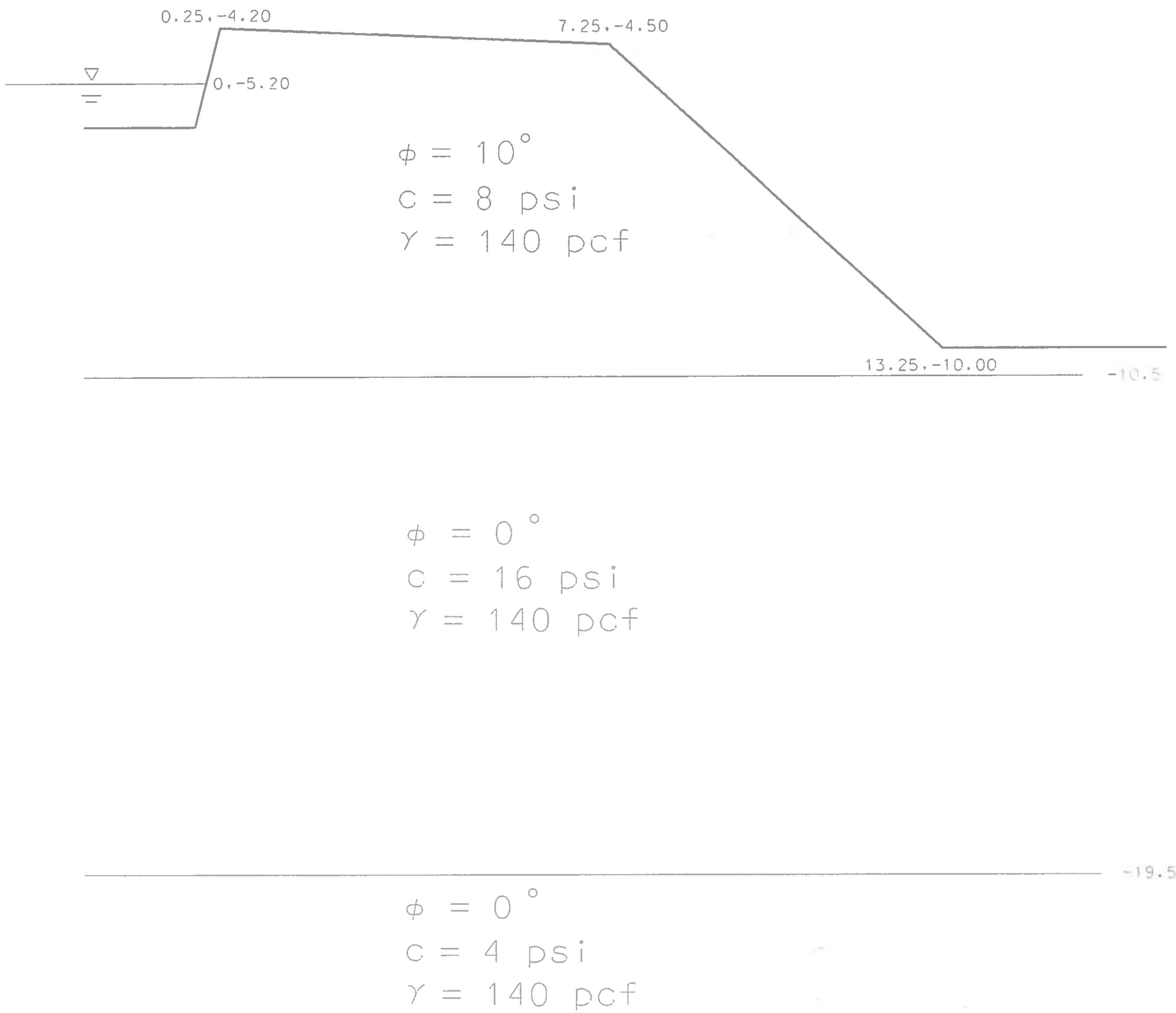


Section 5
Vector Trace



Section 6

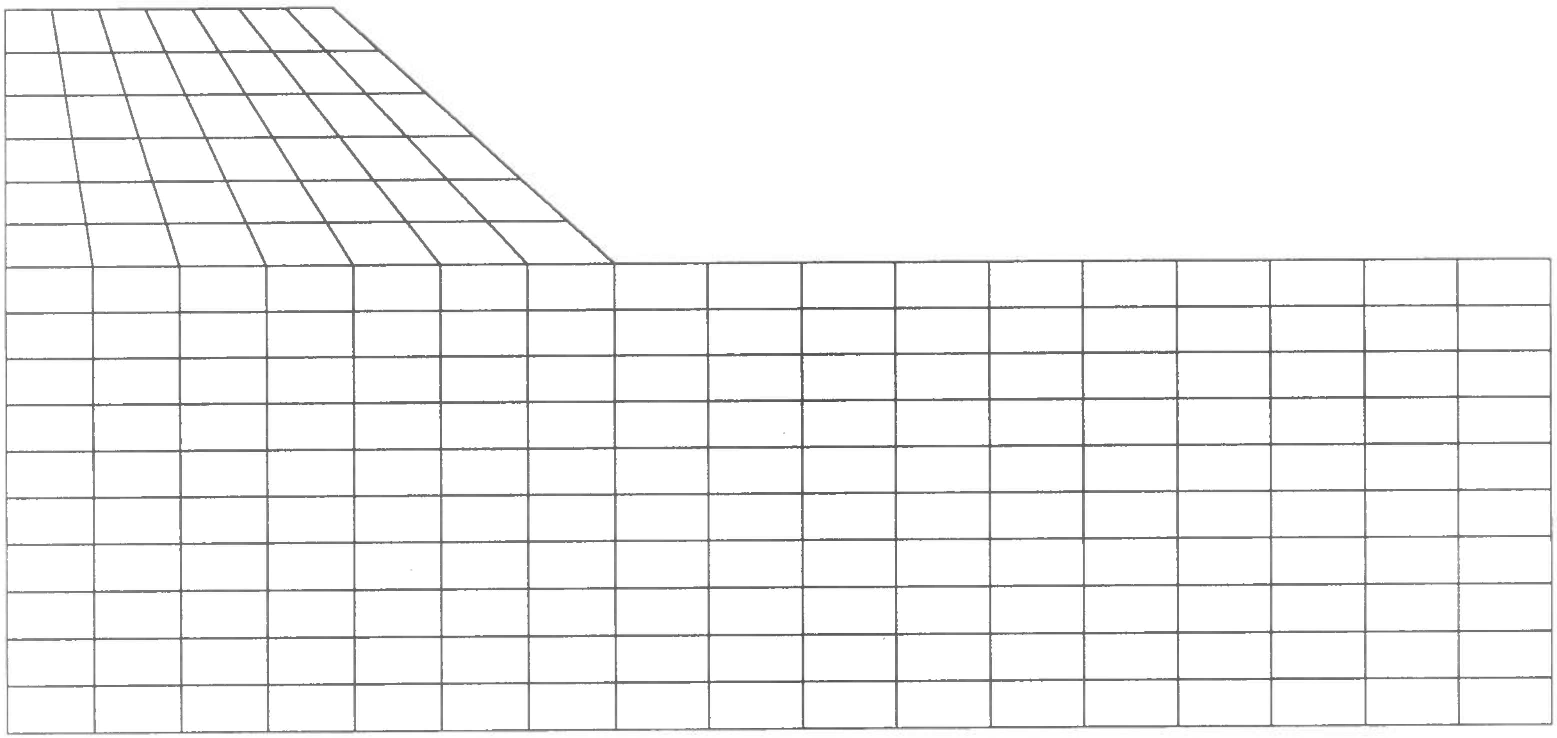
Factor Of Safety = 10.0



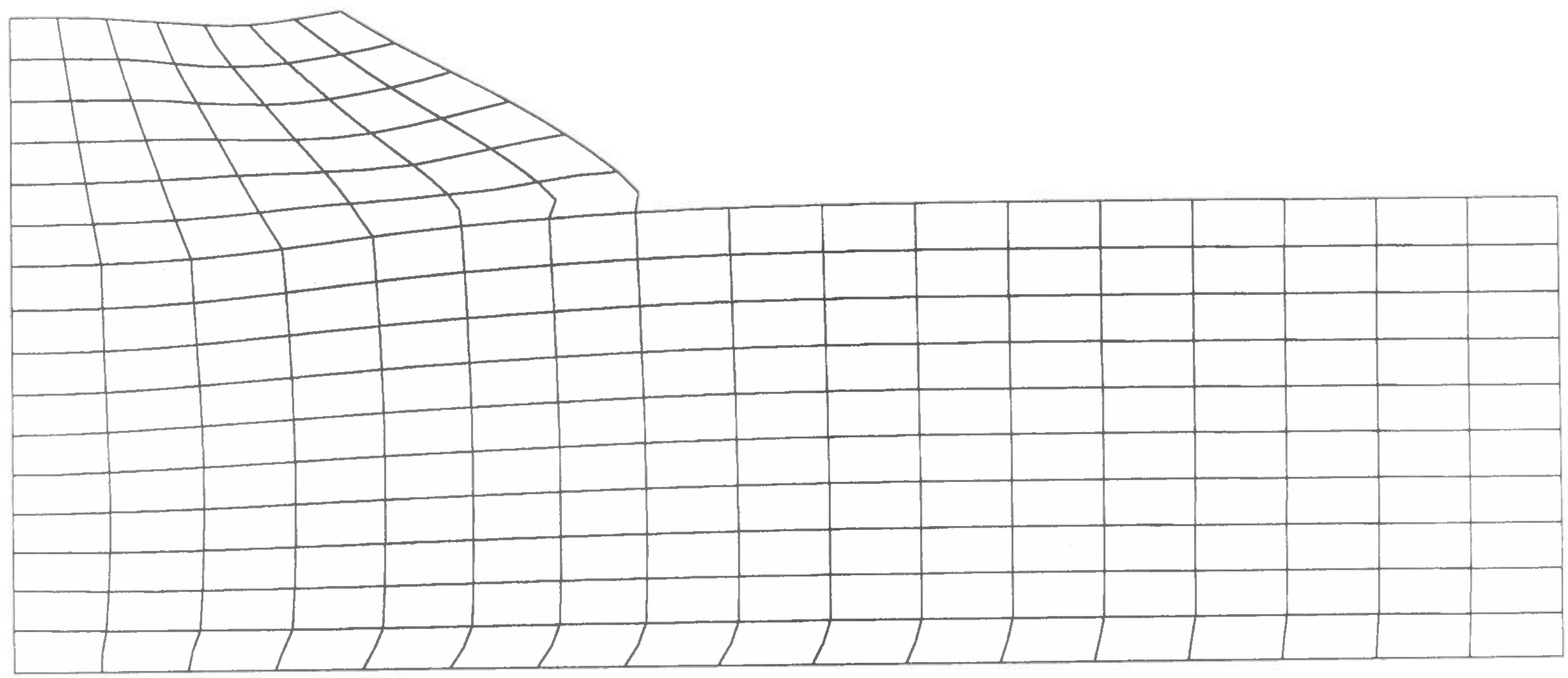
```
Section 6 Profile

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

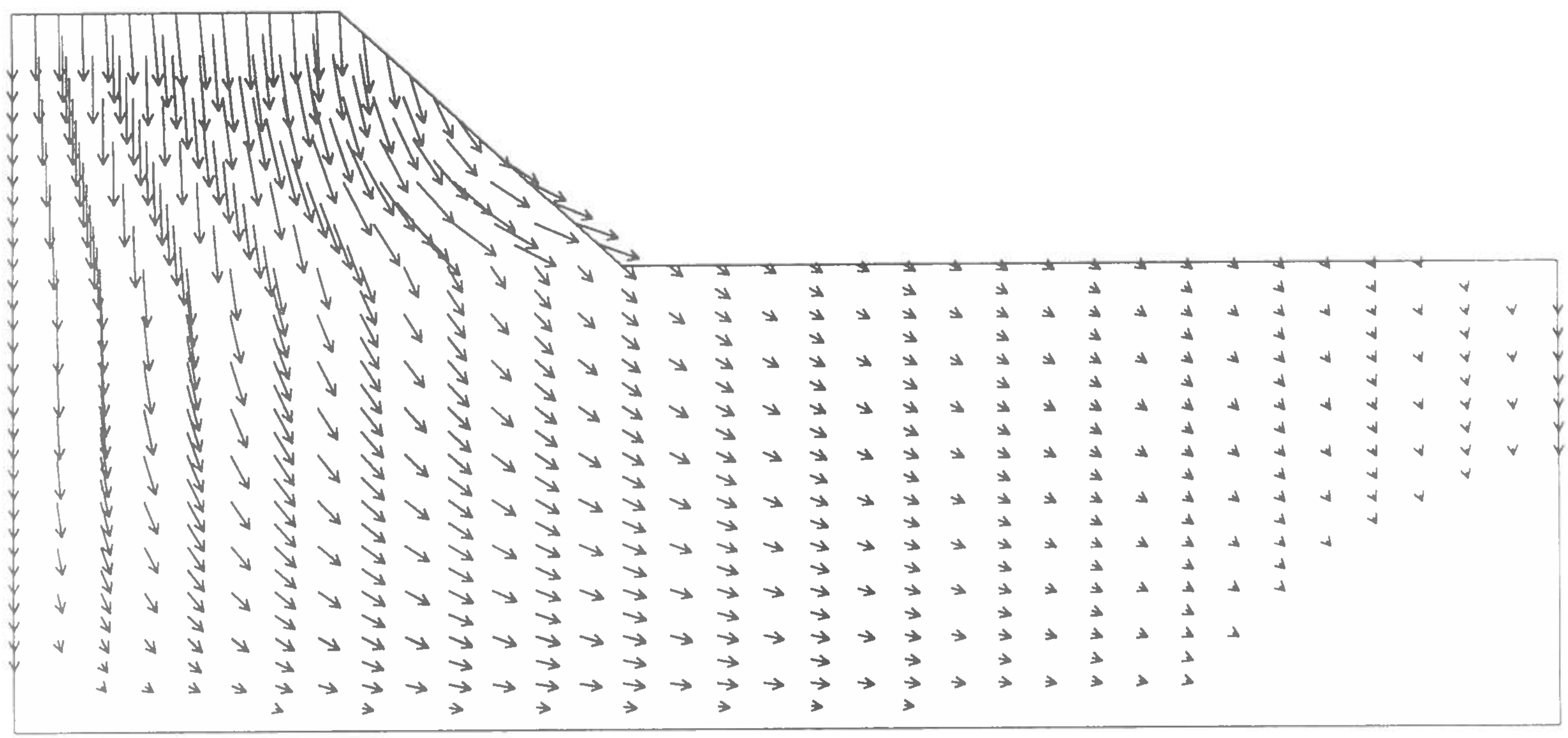
Section 6
Mesh



Section 6
Deformed Mesh

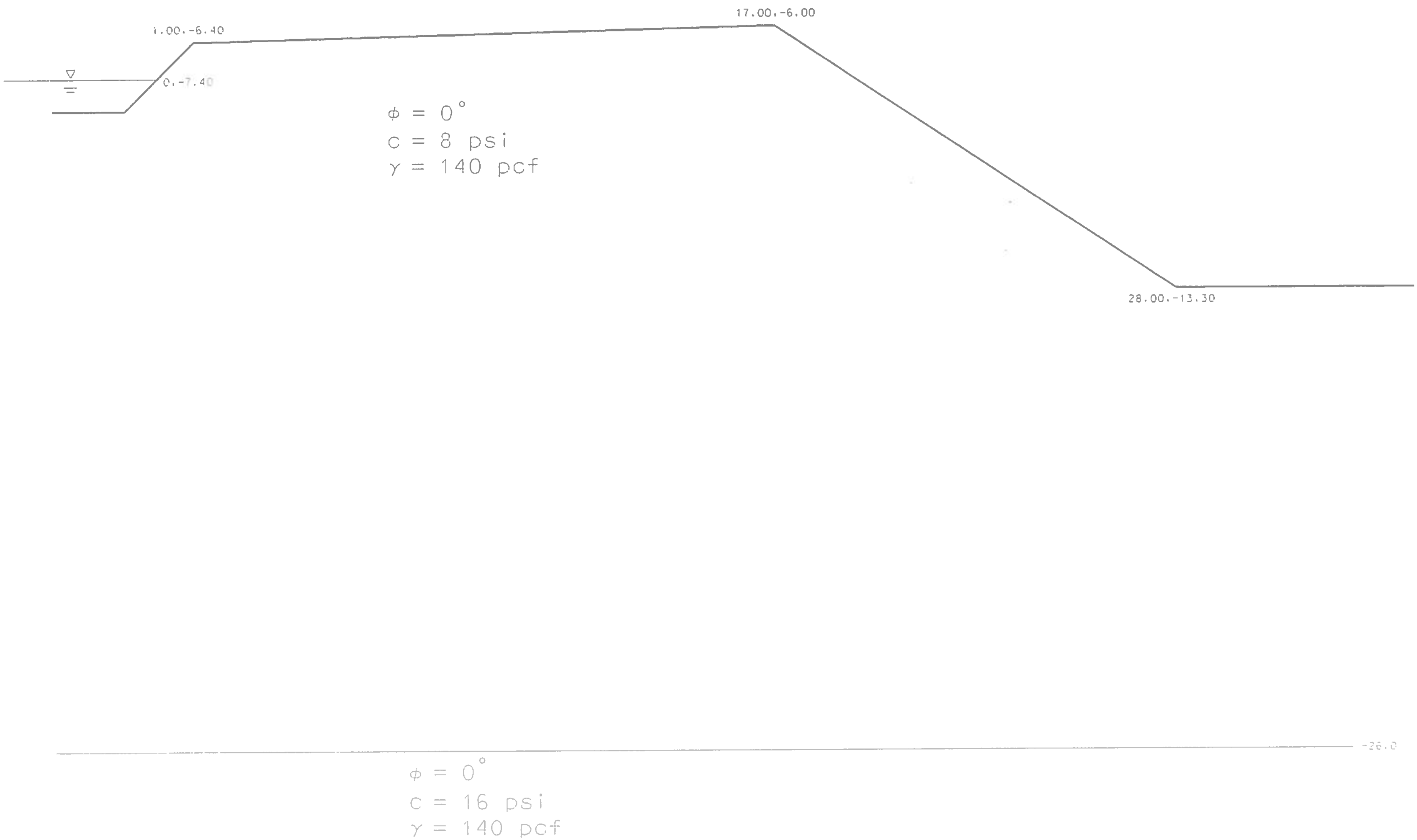


Section 6
Vector Trace



Section 7

Factor Of Safety = 6.0

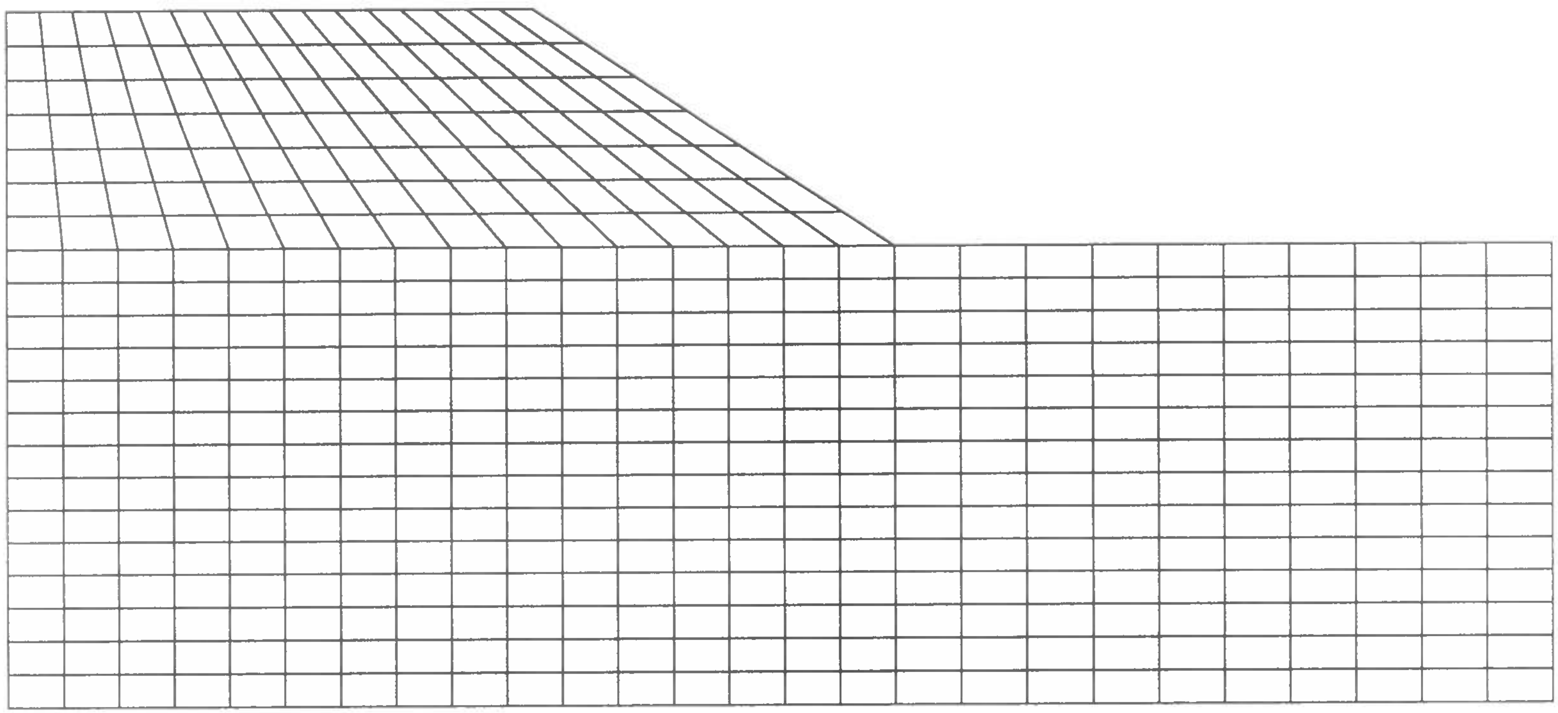


```
Section 7 Profile

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
```

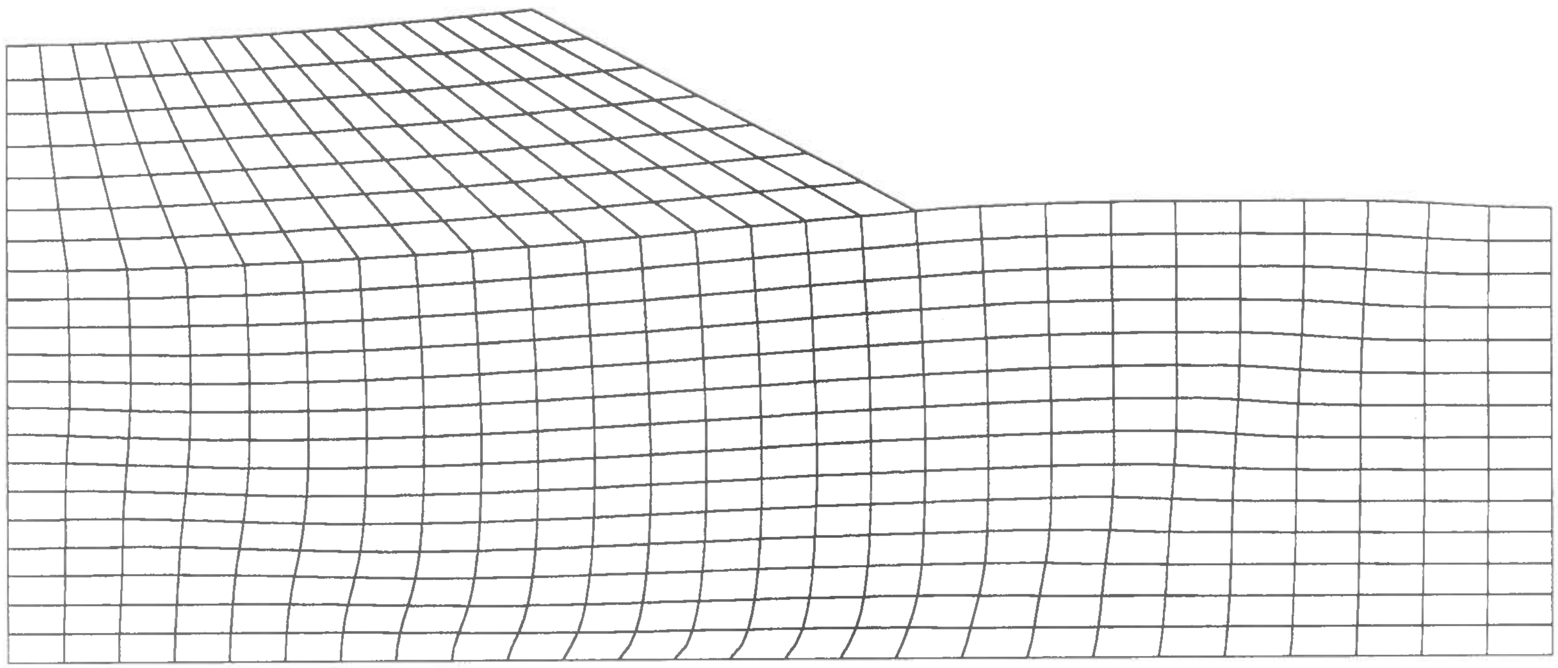
```
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1
     1   1   1   1   1   1
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1   1   1
     1   1   1   1   1   1
     1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   1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

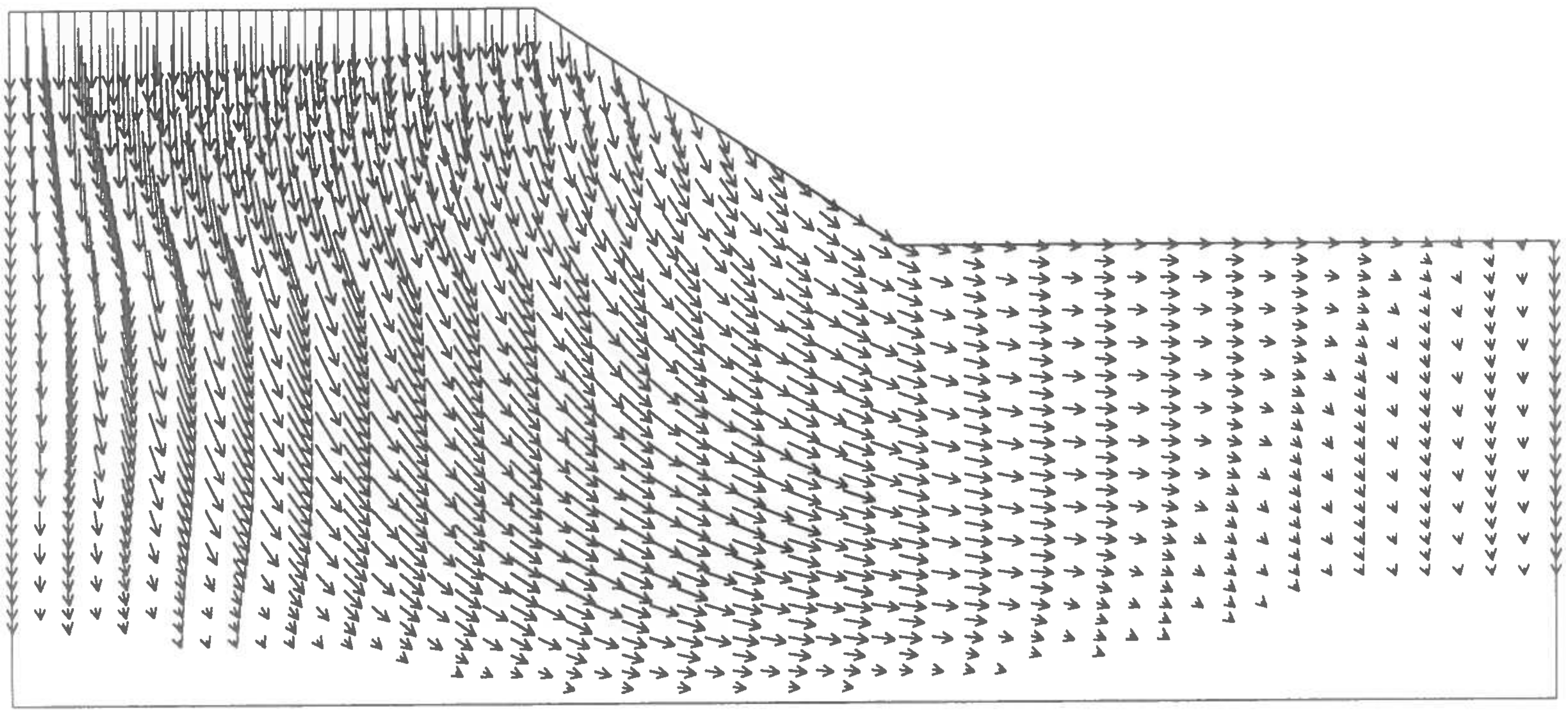
Mesh



Section 7
Deformed Mesh

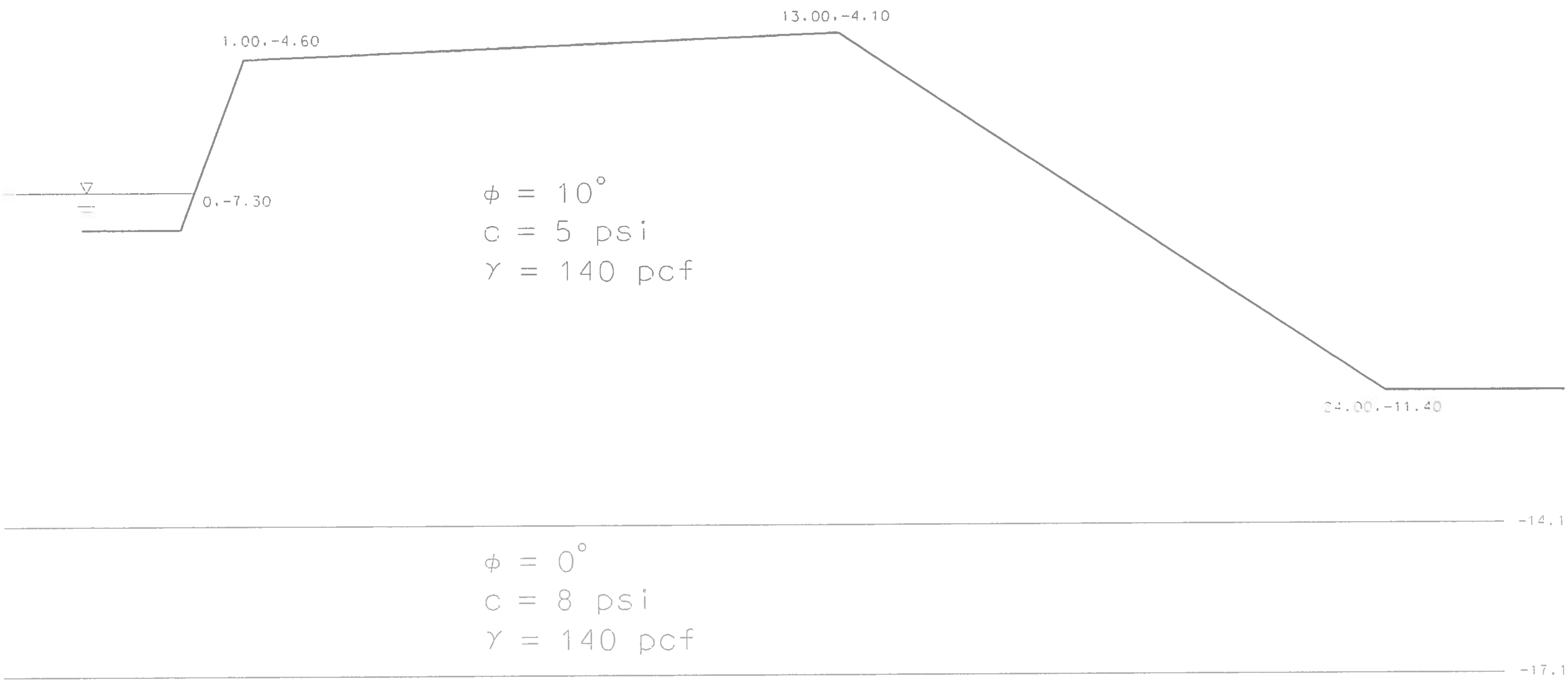


Section 7
Vector Trace



Section 8

Factor Of Safety = 4.9

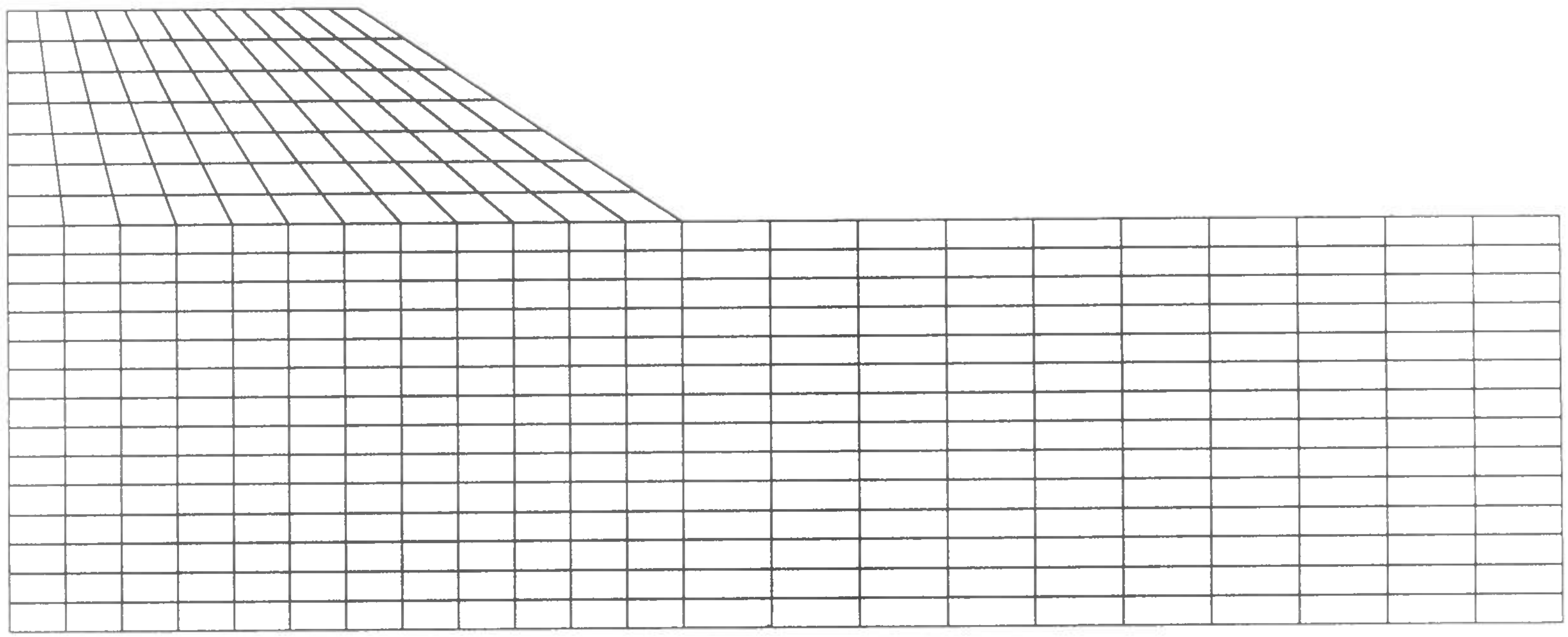


```
Section 8 Profile

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
```

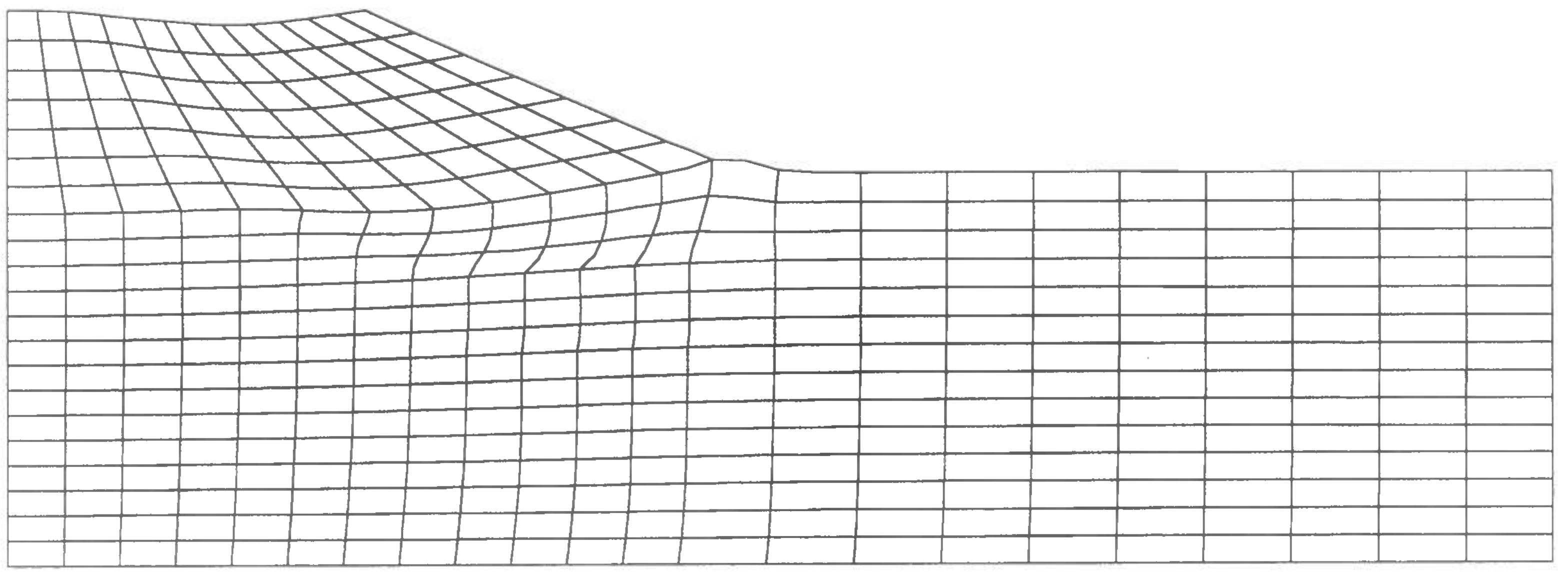
```
 3   3   3   3
   3   3
   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3
 3   3   3   3
   3   3
   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3
 3   3   3   3
   3   3
   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3   3
 3   3   3   3
   3   3
   3 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

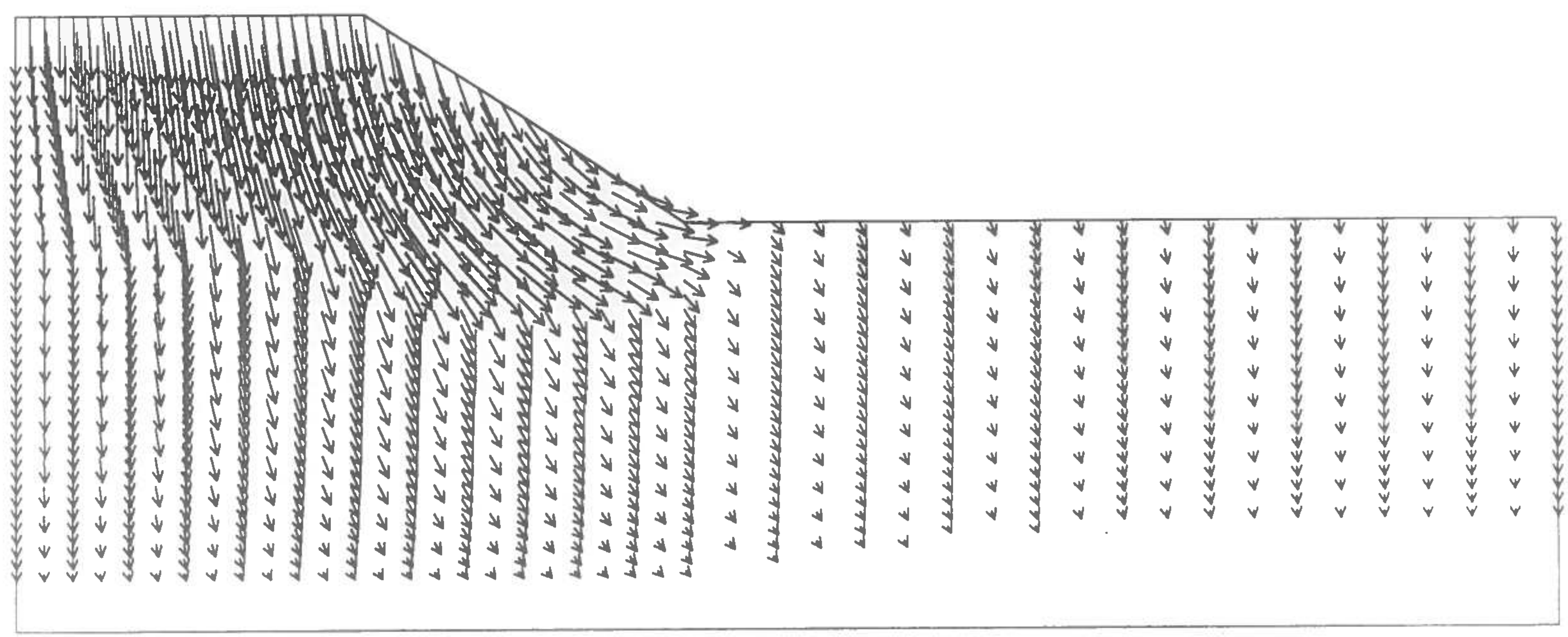
Mesh



Section 8
Deformed Mesh

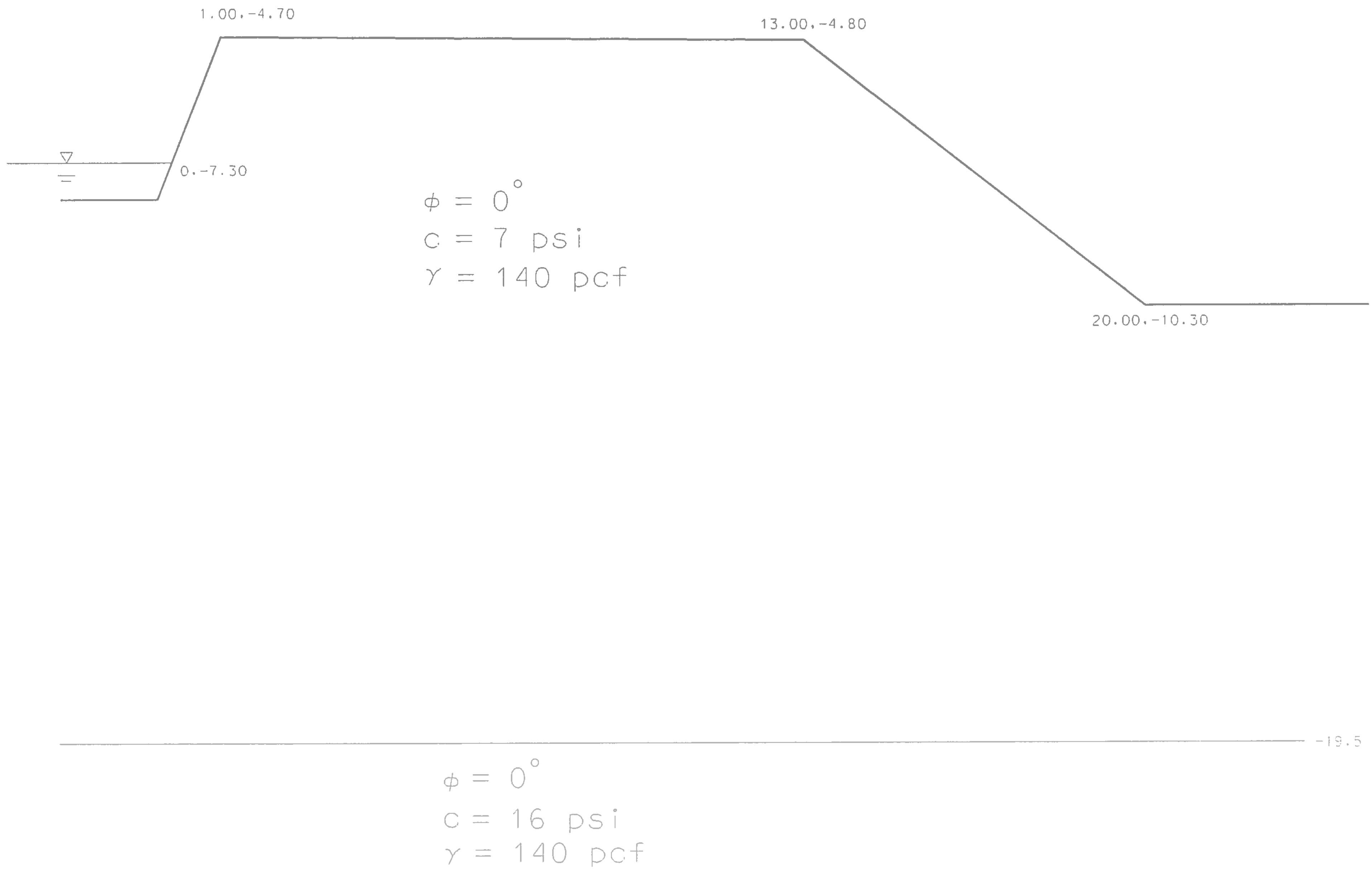


Section 8
Vector Trace



Section 9

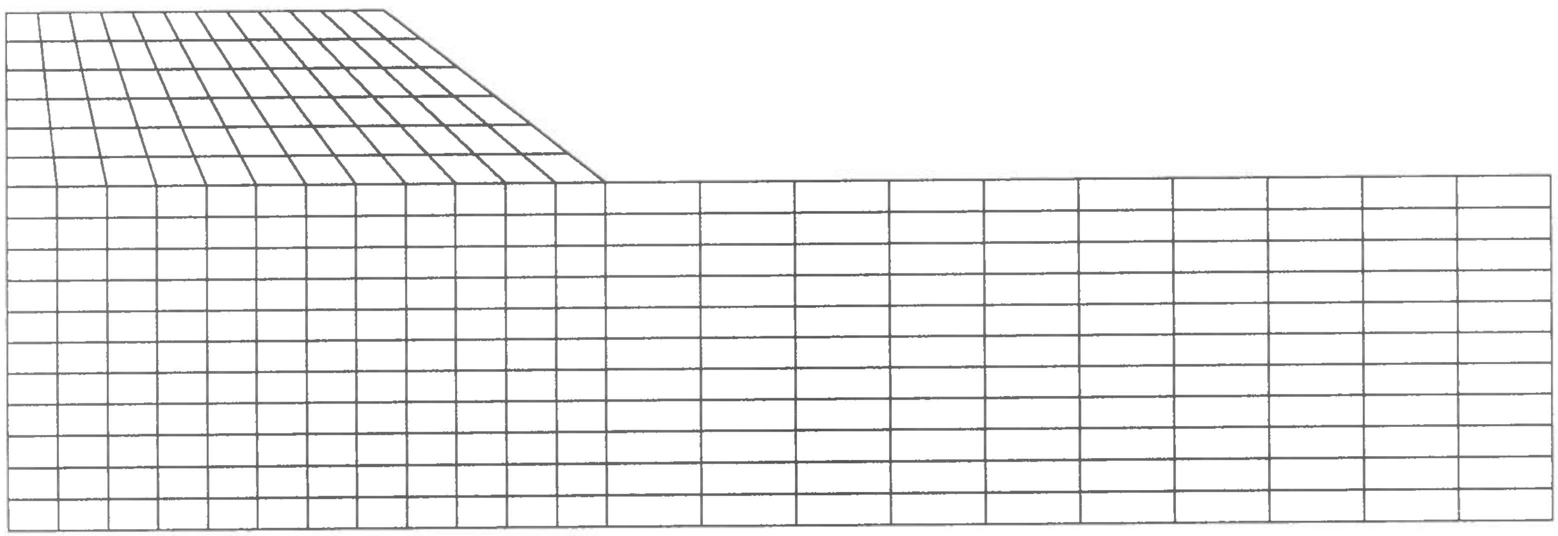
Factor Of Safety = 7.0



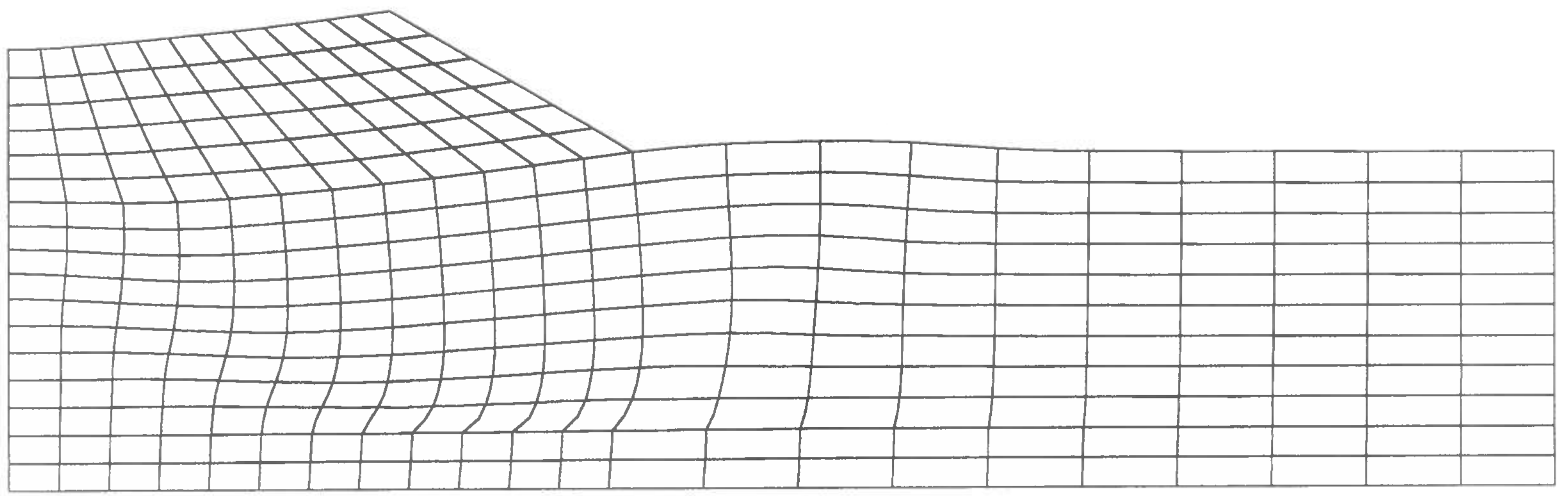
```
Section 9 Profile

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
```

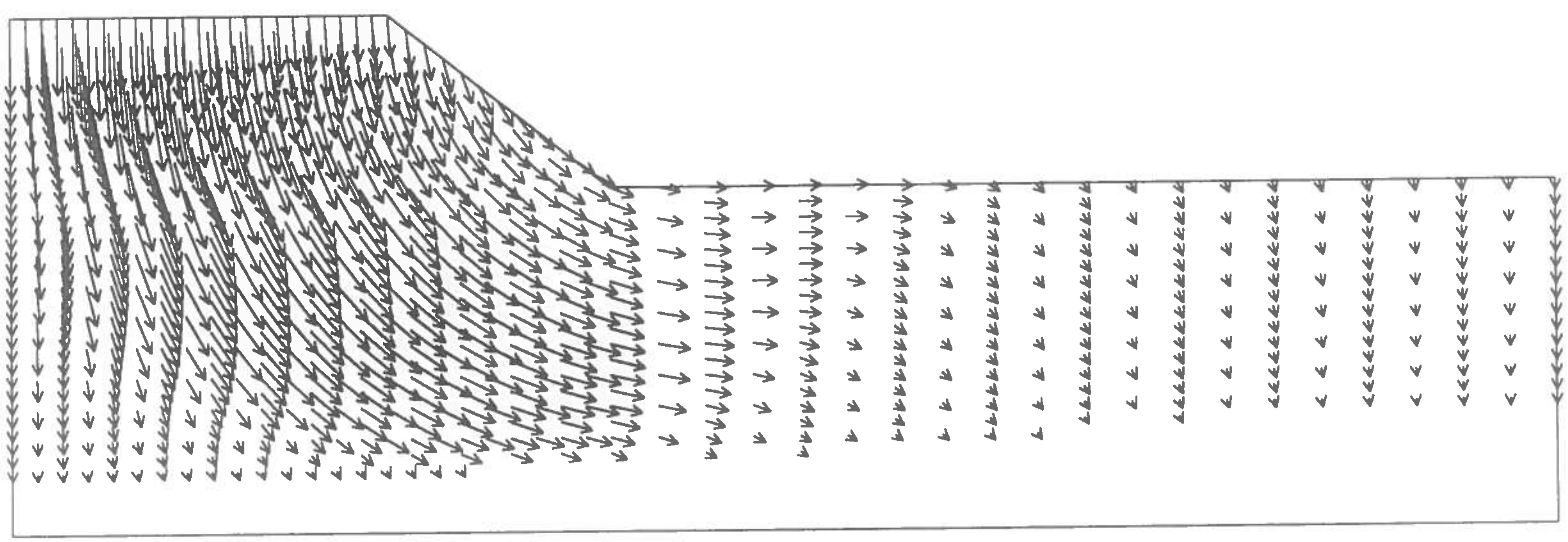
Section 9
Mesh



Section 9
Deformed Mesh

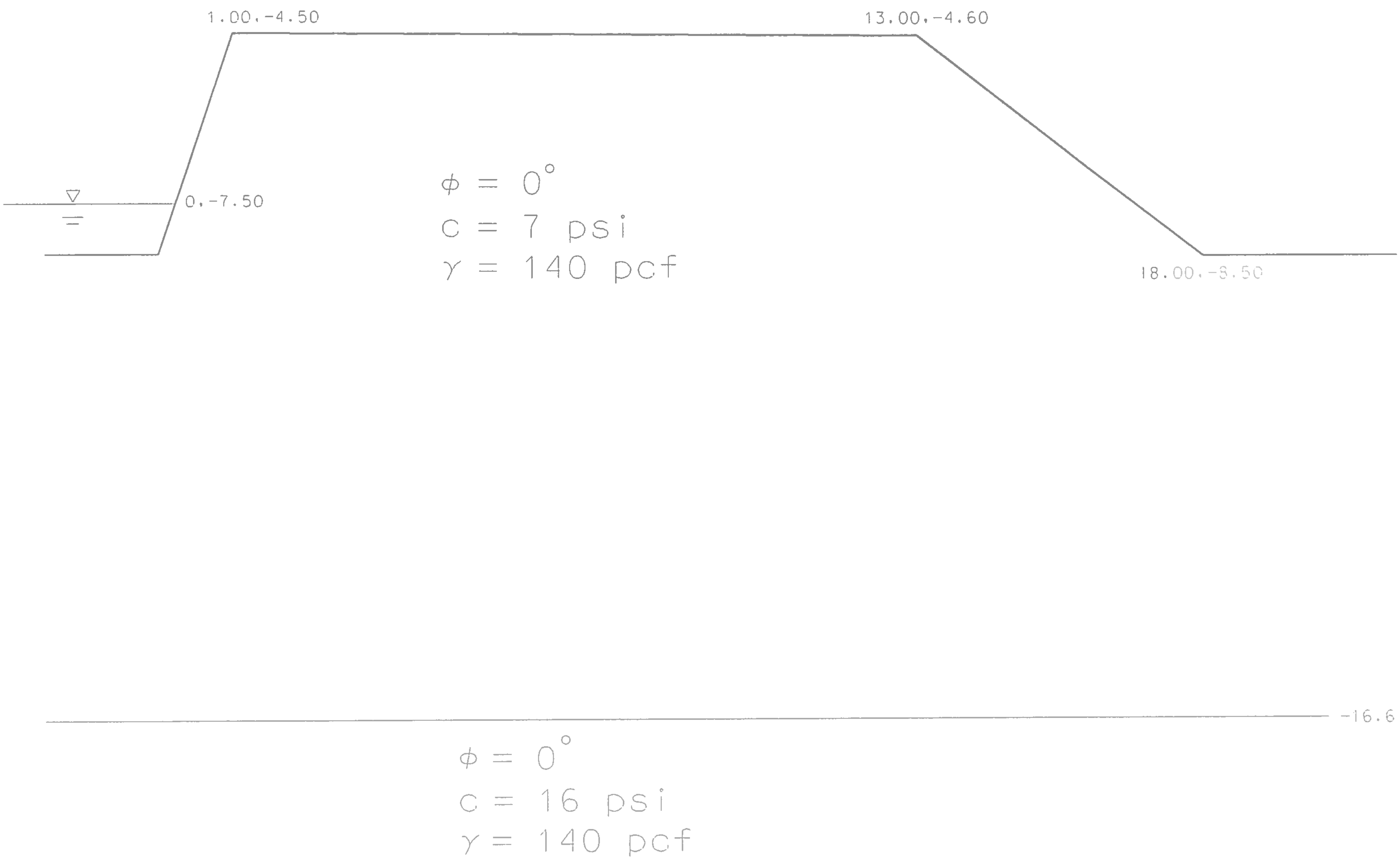


Section 9
Vector Trace



Section 10

Factor Of Safety = 10.0

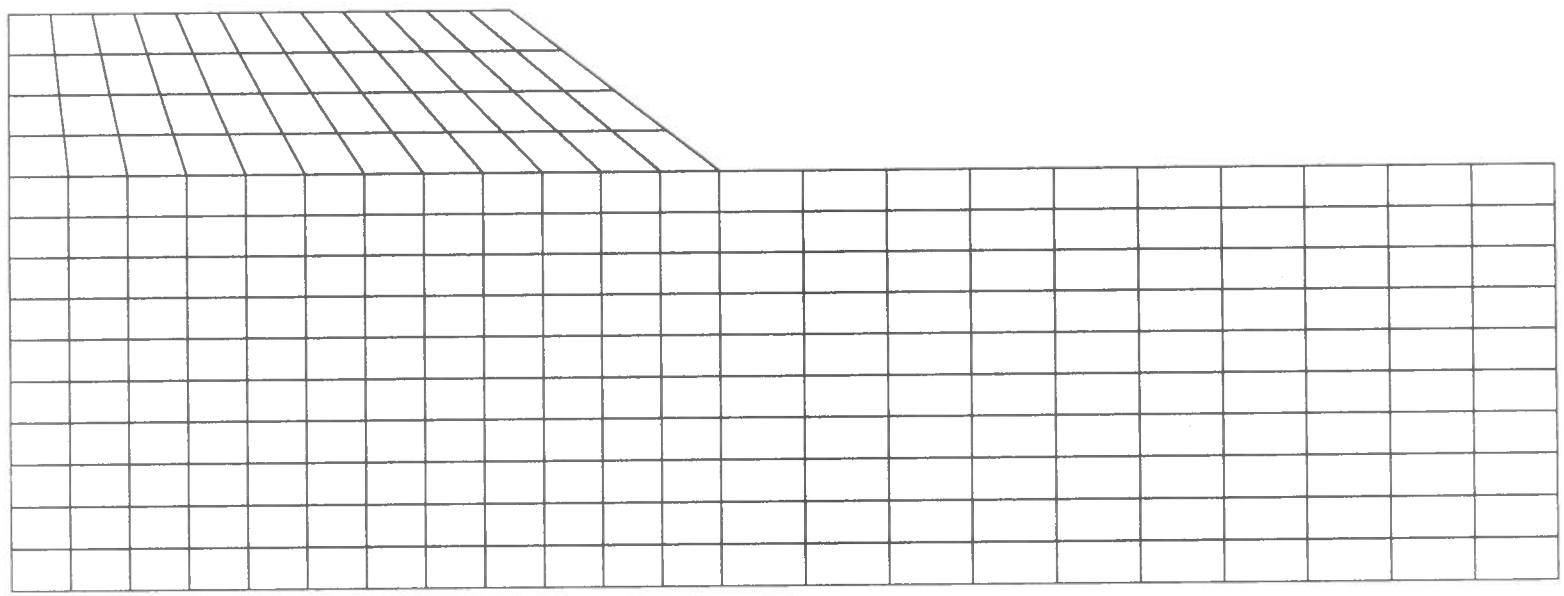


```
Section 10 Profile

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
```

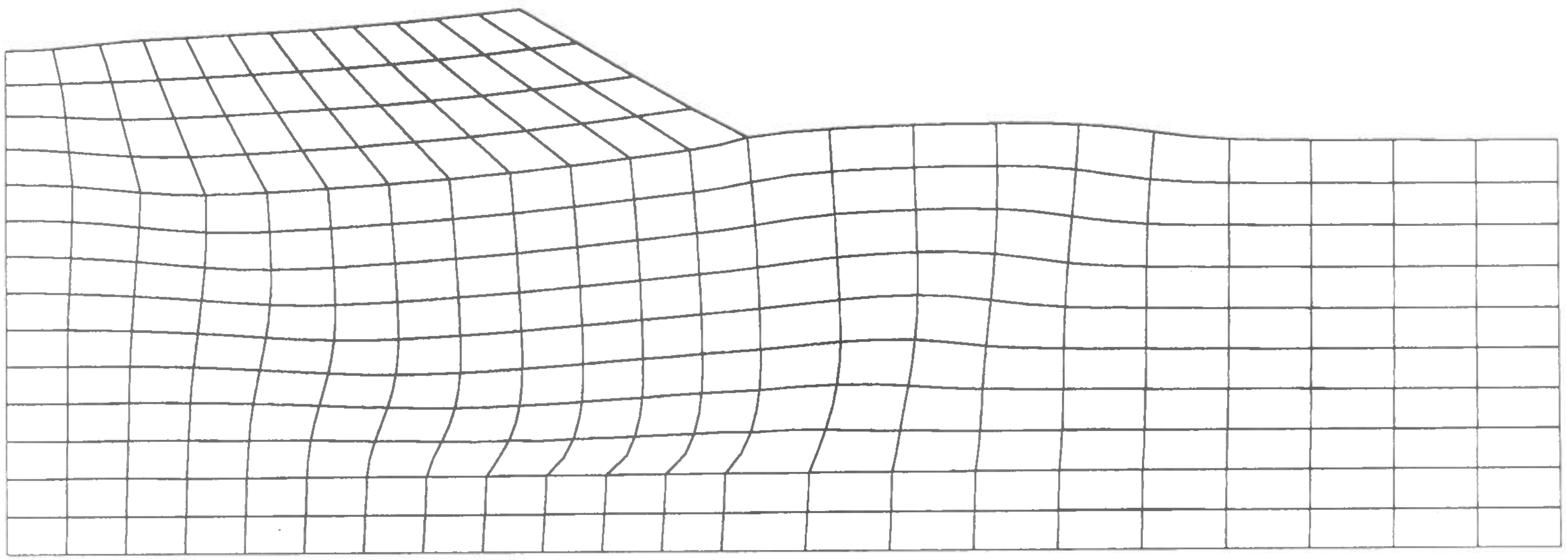
```
     2   2
     2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
 2   2   2   2
     2   2

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

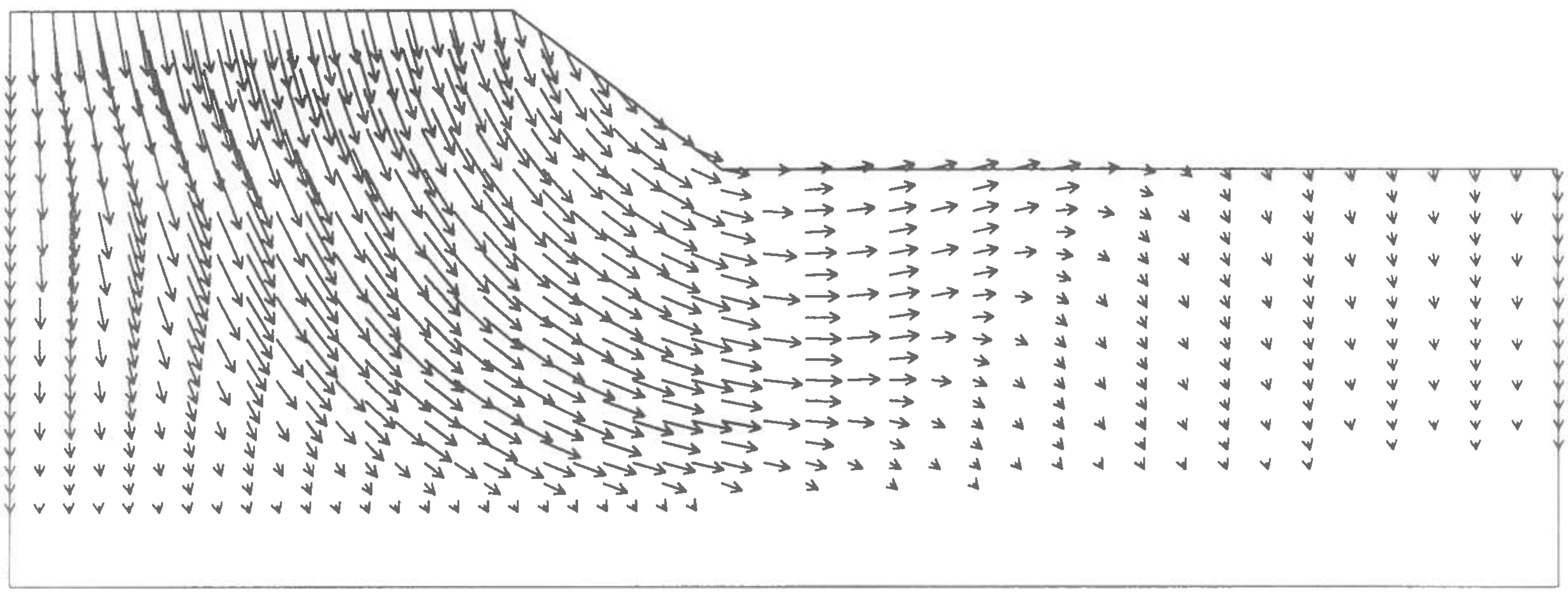
Mesh



Section 10
Deformed Mesh

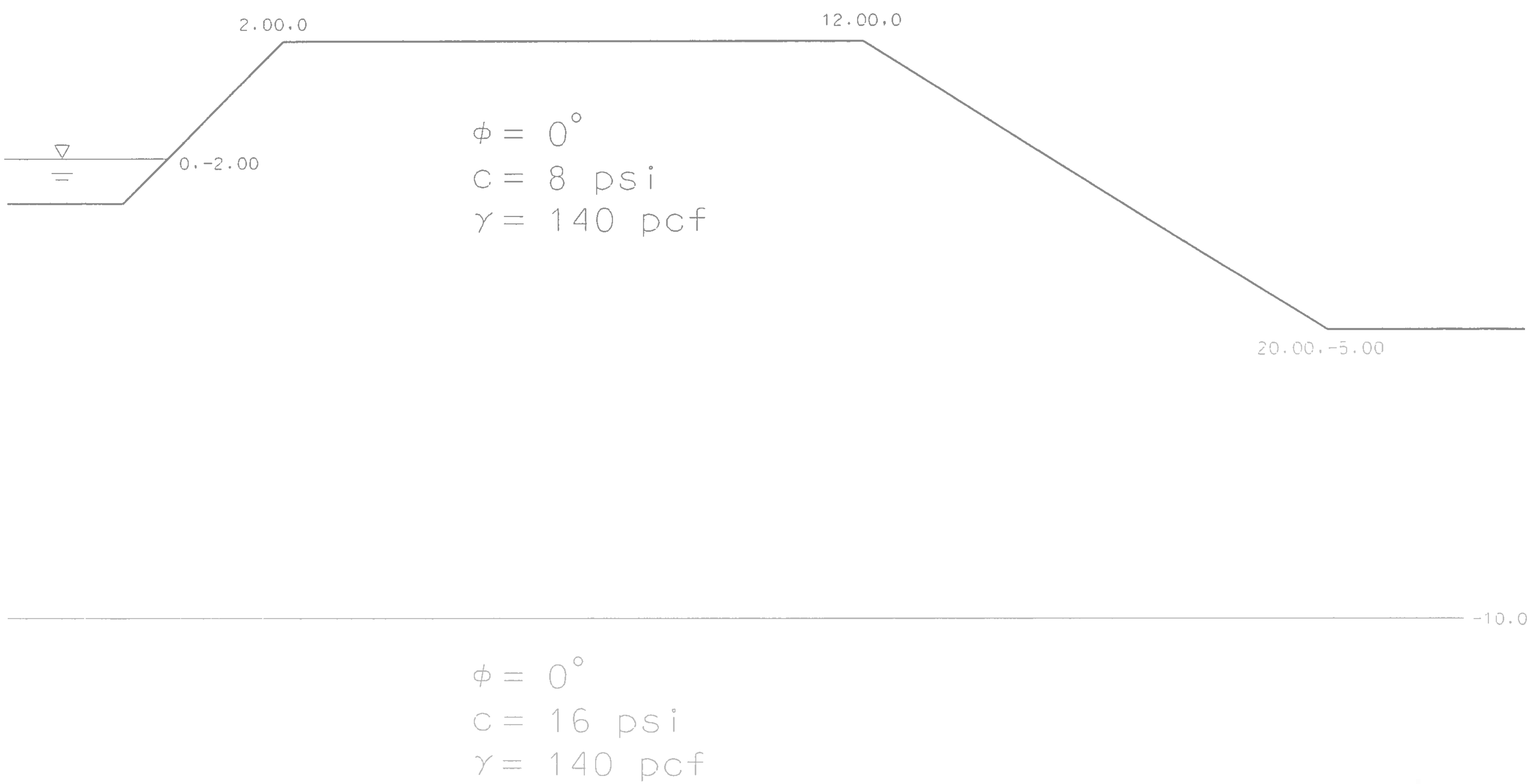


Section 10
Vector Trace



Section 11

Factor Of Safety = 9.4

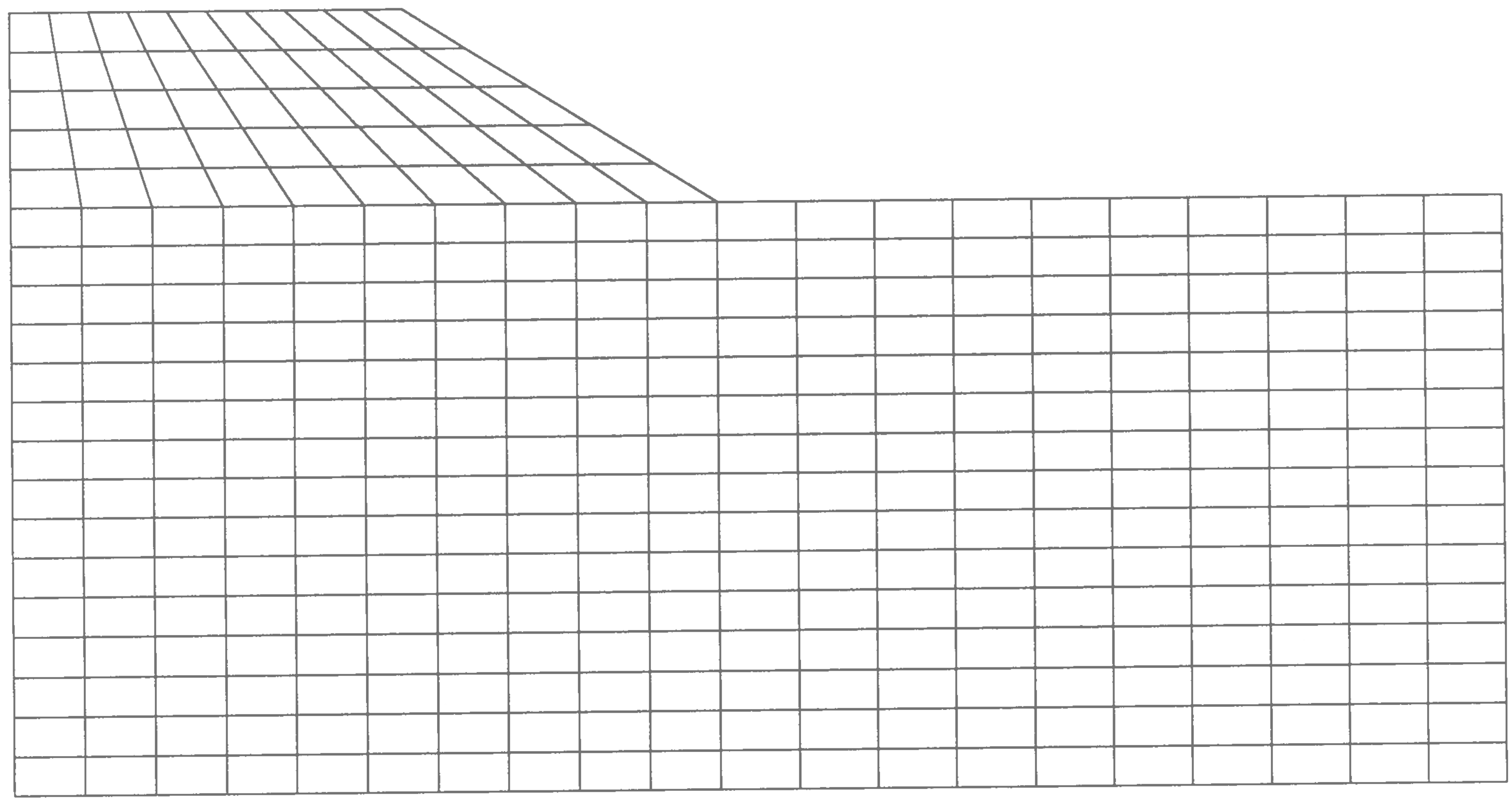


```
Section 11 Profile

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
```

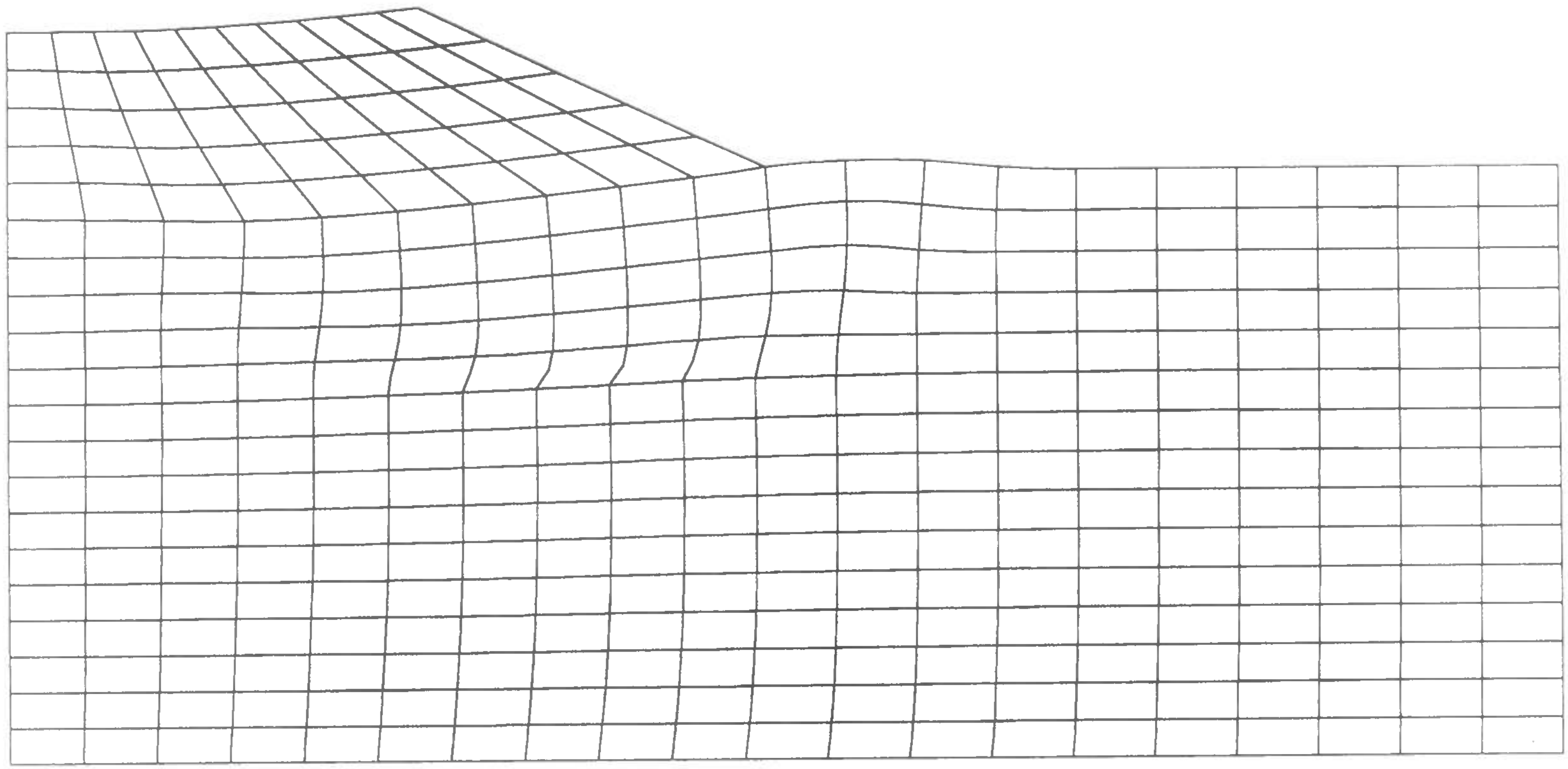
```
 2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
 2   2   2   2
   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2
 2   2   2   2

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

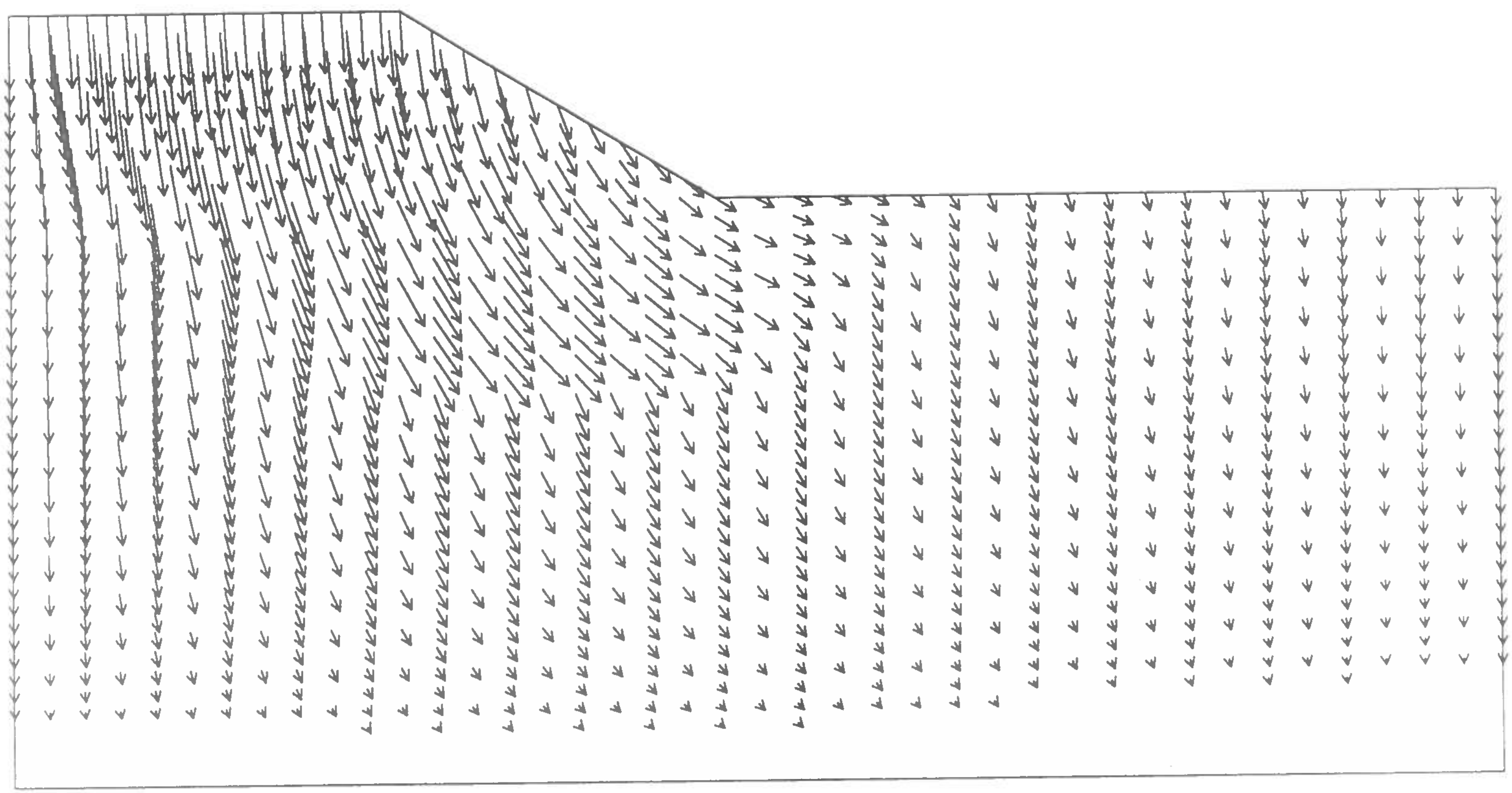
Mesh



Section 11
Deformed Mesh

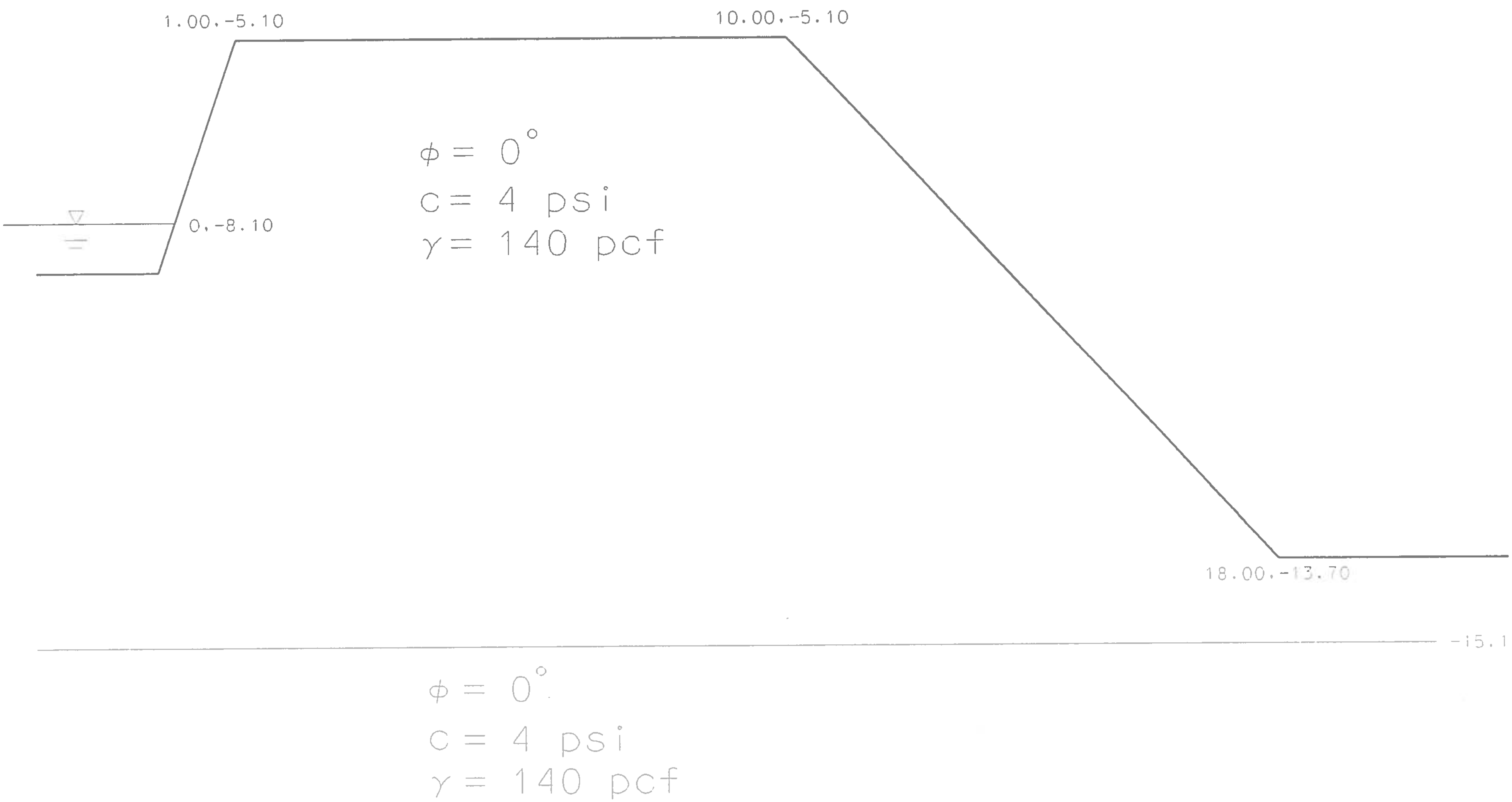


Section 11
Vector Trace



Section 12

Factor Of Safety = 2.5

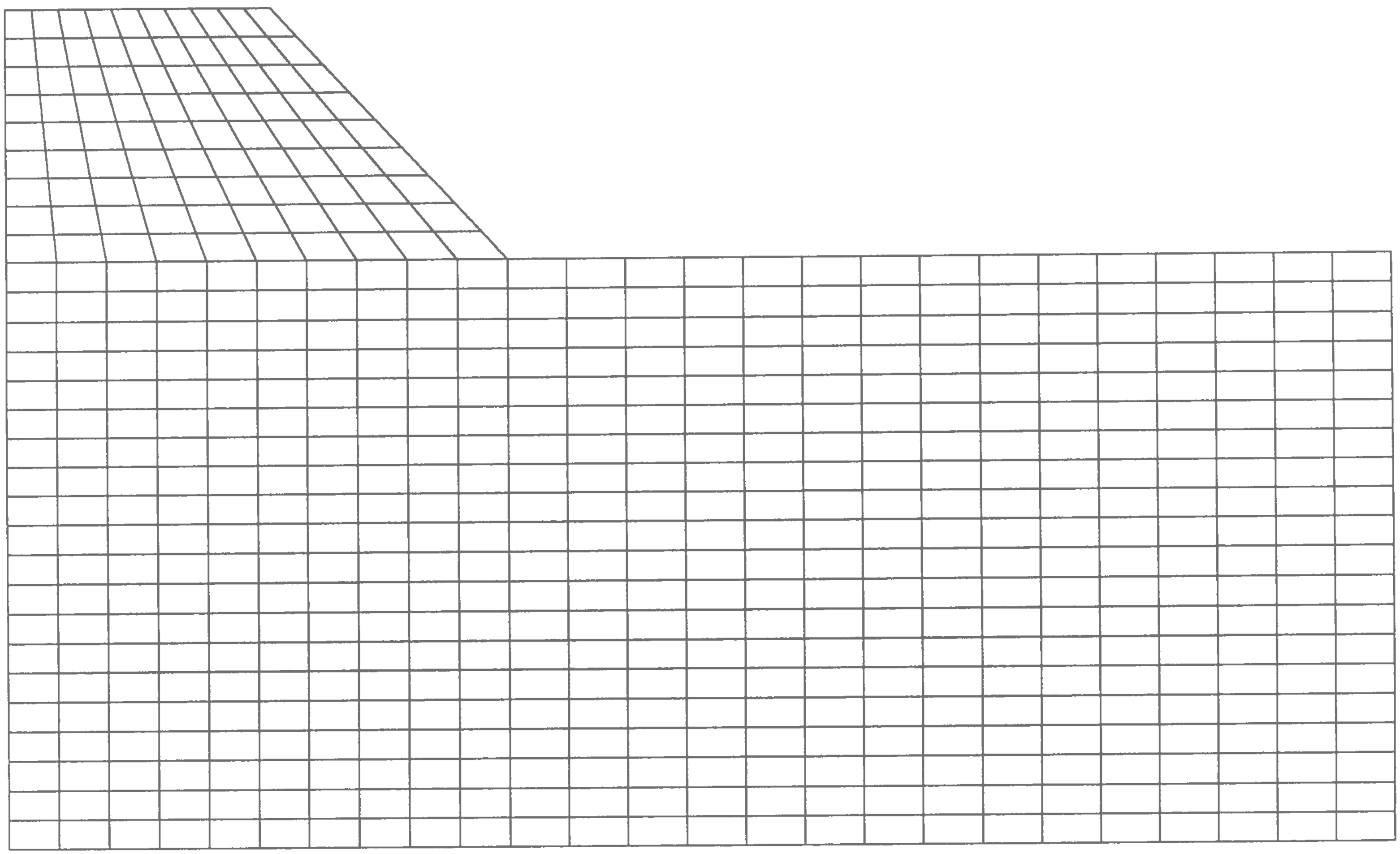


```
Section 12 Profile

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
```

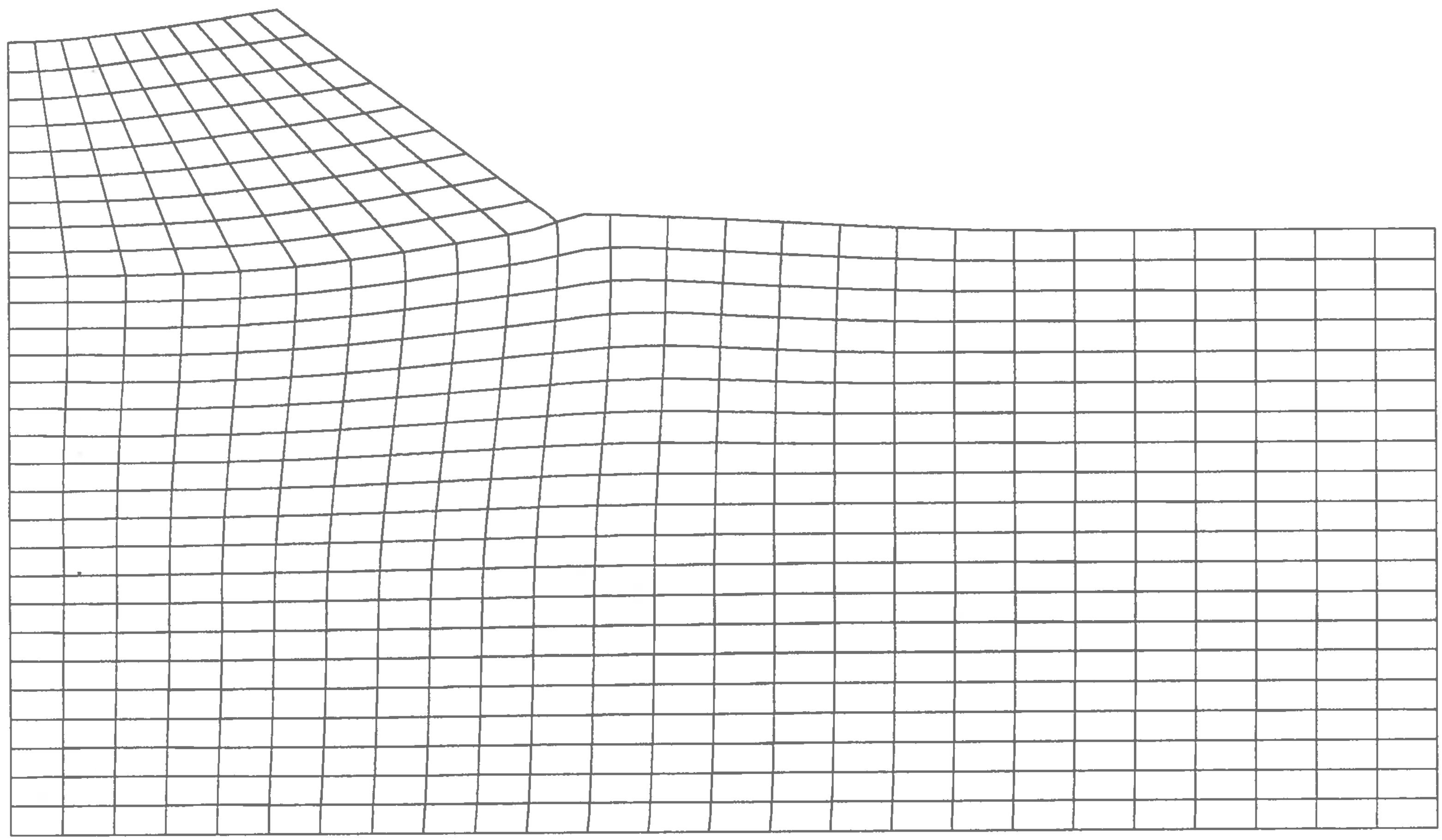
```
 1   1   1   1
   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
 1   1   1   1
   1   1   1   1   1
   1   1   1   1   1   1   1   1   1   1   1   1   1   1  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

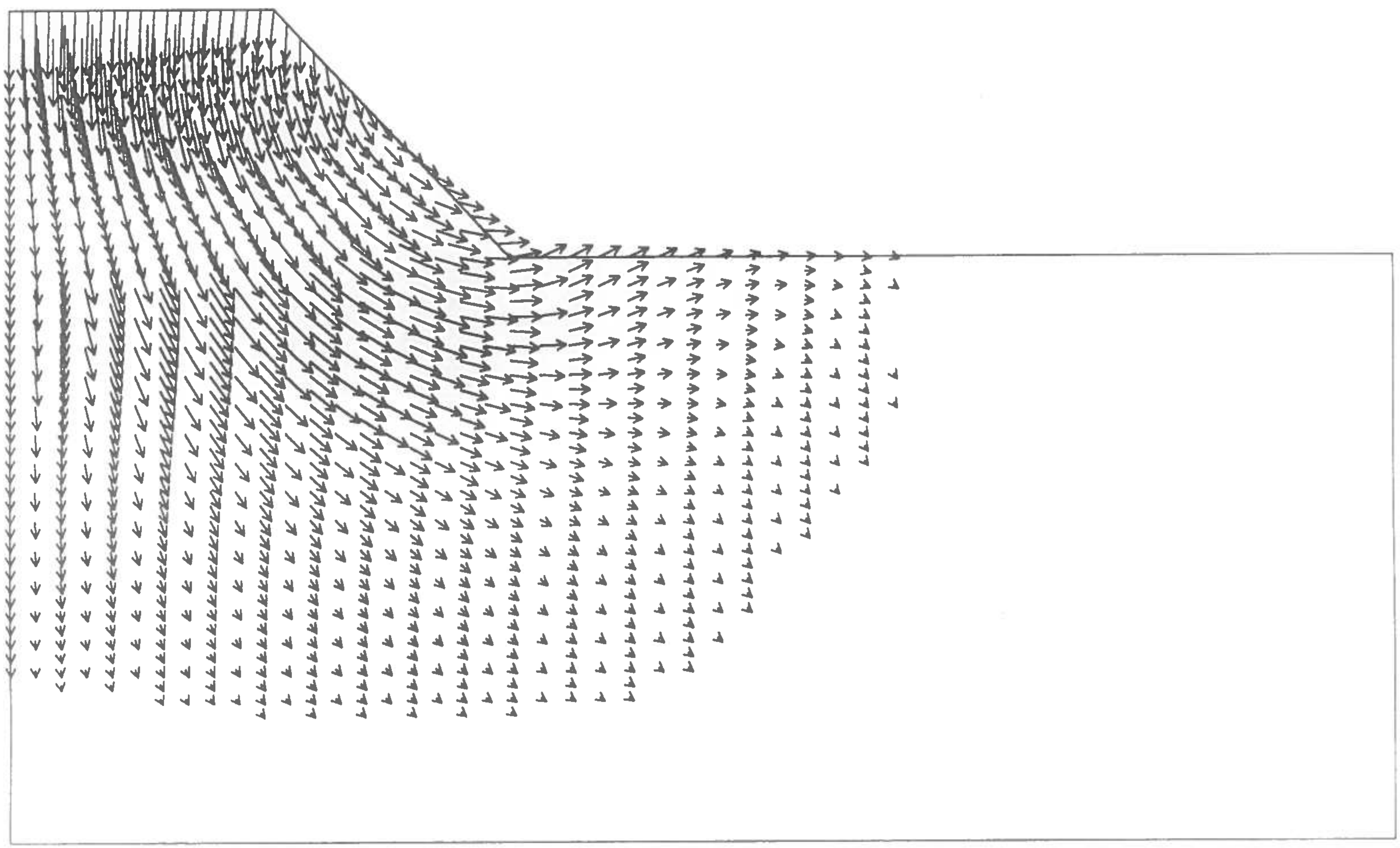
Section 12
Mesh



Section 12
Deformed Mesh

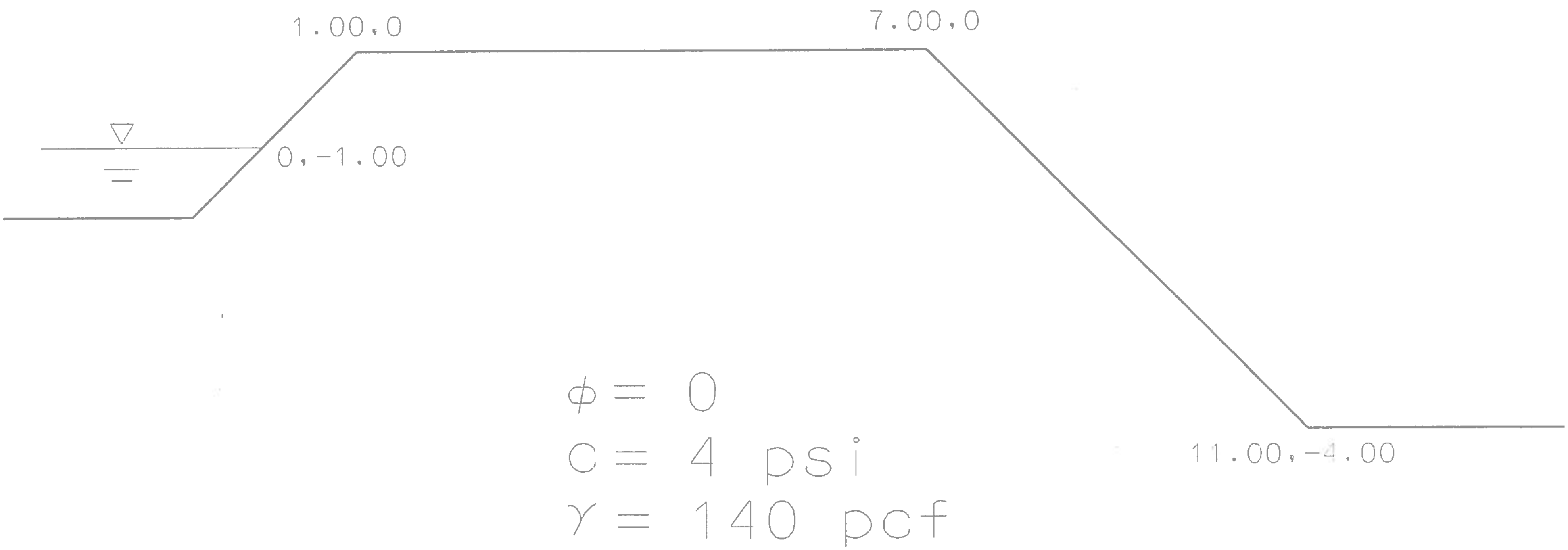


Section 12
Vector Trace



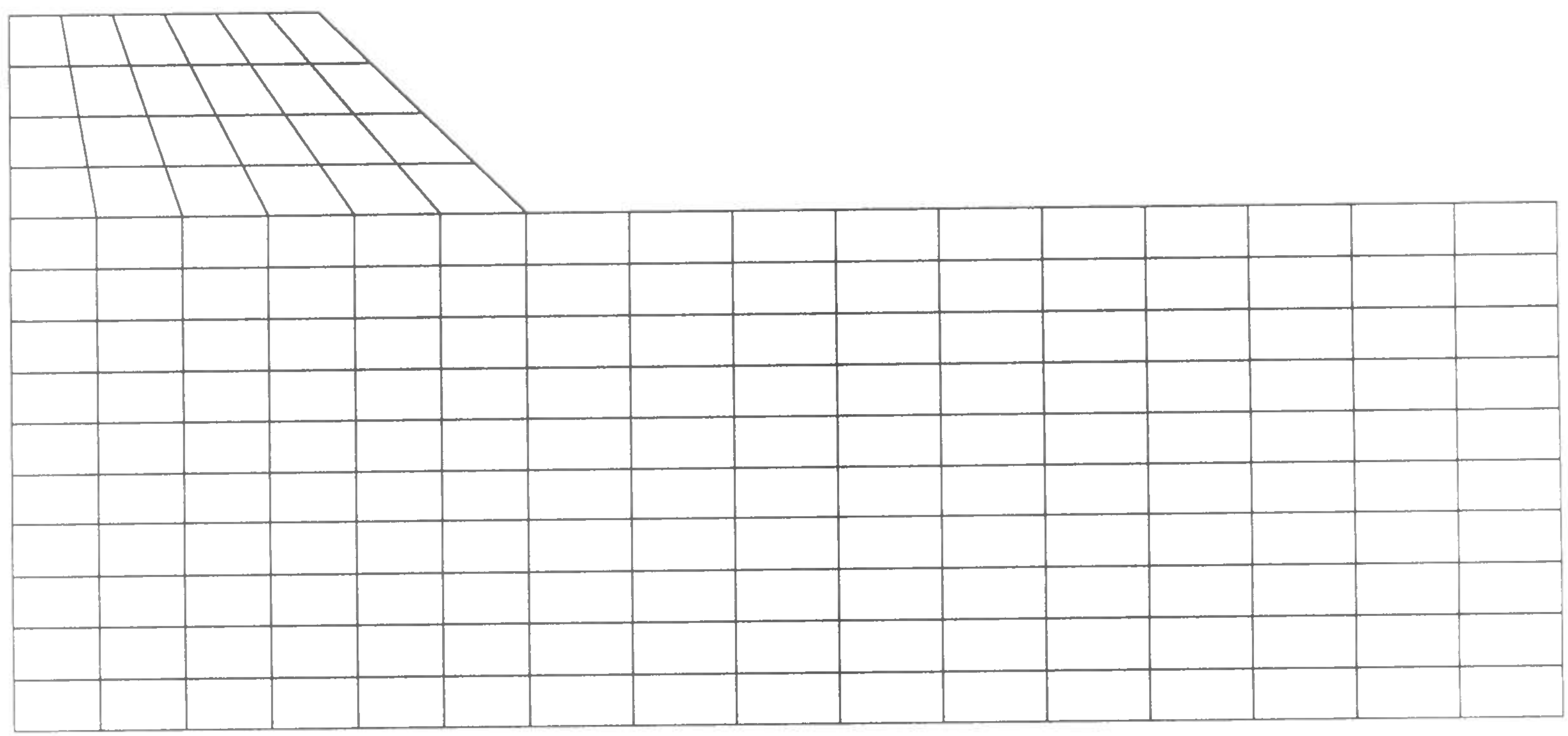
Section 13

Factor Of Safety = 5.4

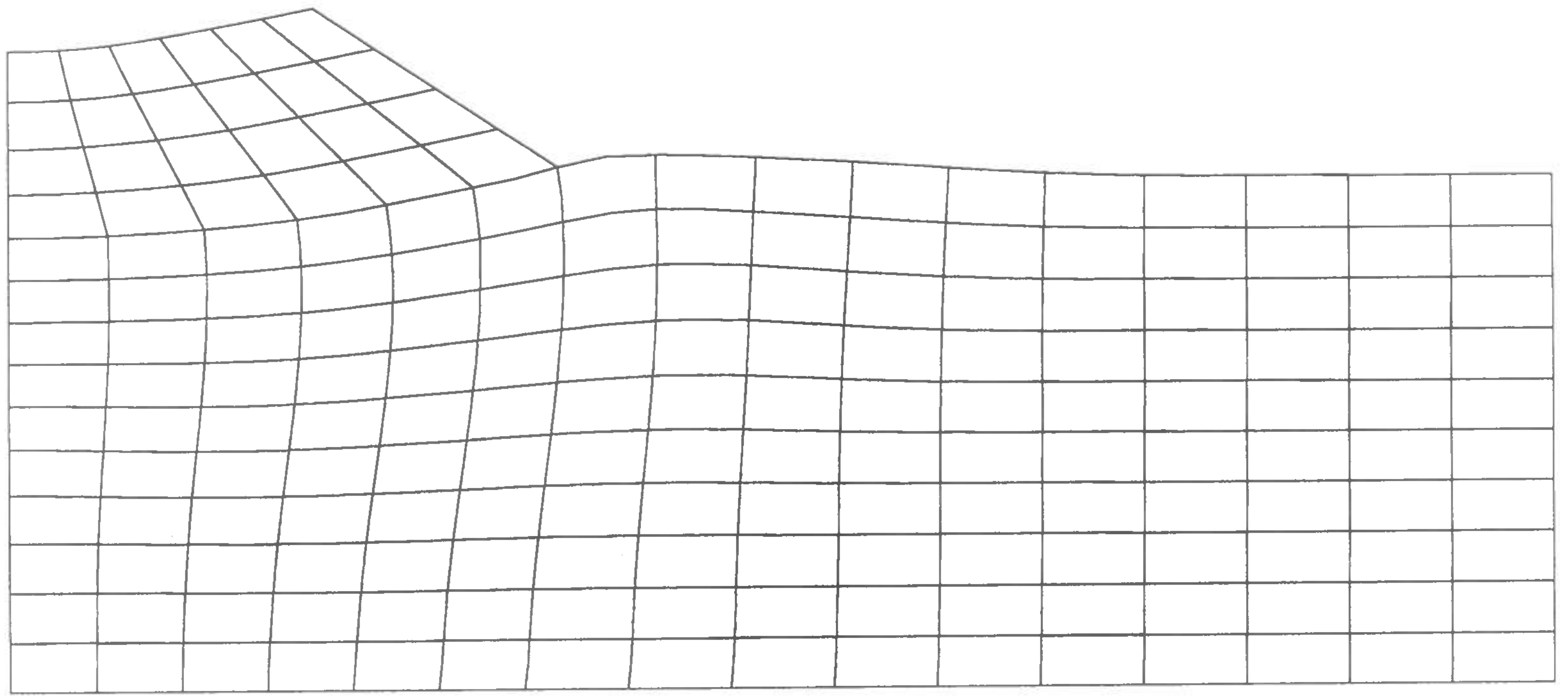


```
Section 13 Profile

w1=    6.00
s1=    4.00
w2=   20.00
h1=    4.00
h2=   10.00

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

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

tol=  0.000100
limit= 1000

      trial factor    max displacement   iterations
      0.5000E+01      0.2583E+00              75
      0.5100E+01      0.2652E+00              82
      0.5200E+01      0.2768E+00             105
      0.5300E+01      0.3485E+00             570
      0.5400E+01      0.8591E+00            1000
```

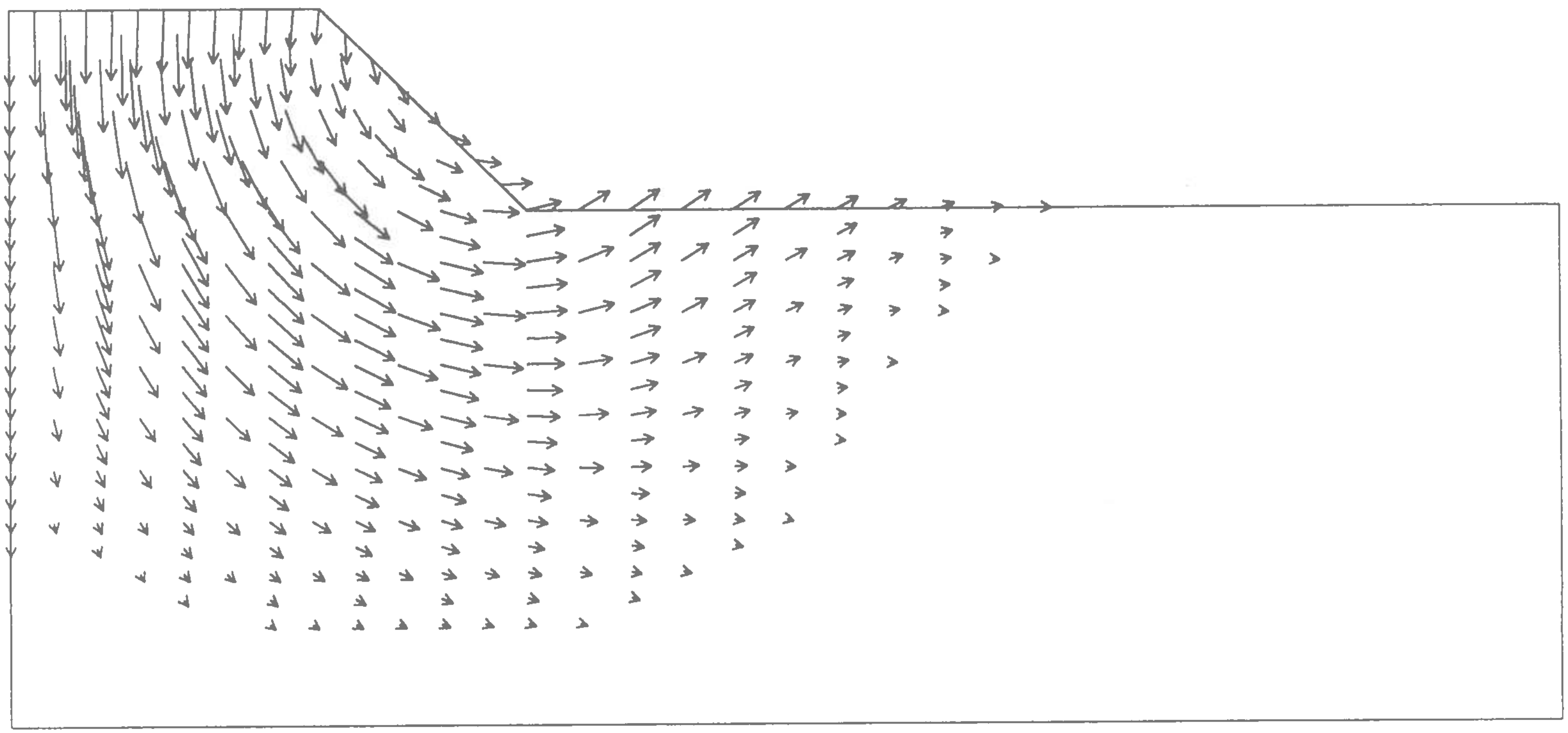
Section 13
Mesh



Section 13
Deformed Mesh



Section 13
Vector Trace



Triaxial Shear Results

Project: Ciniza Evaporation Lagoons

Project Number: 00-141

Sample #: 38631

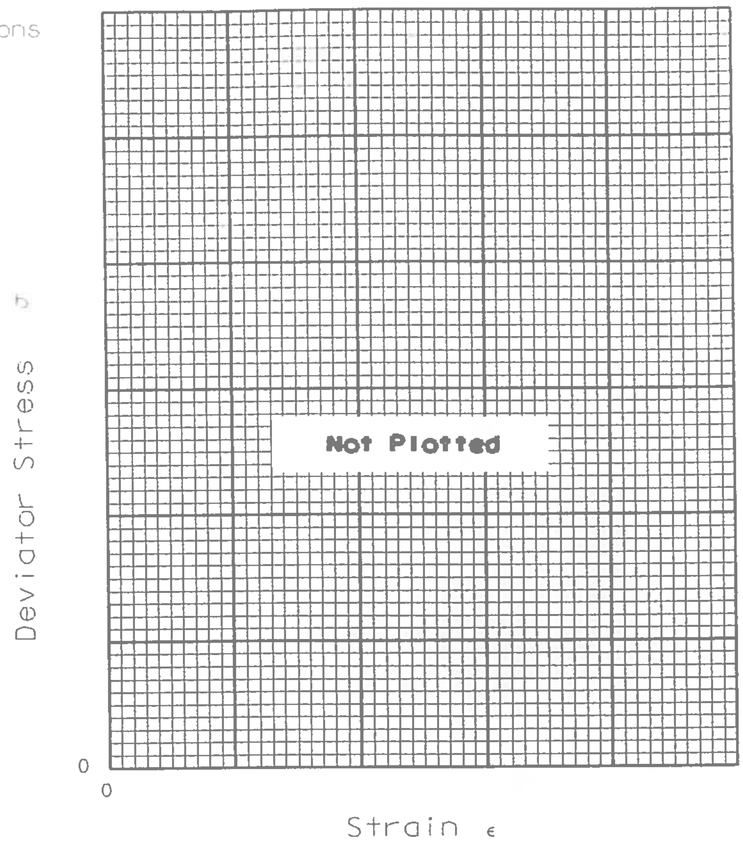
Unit Weight (pcf): 137.3 wet

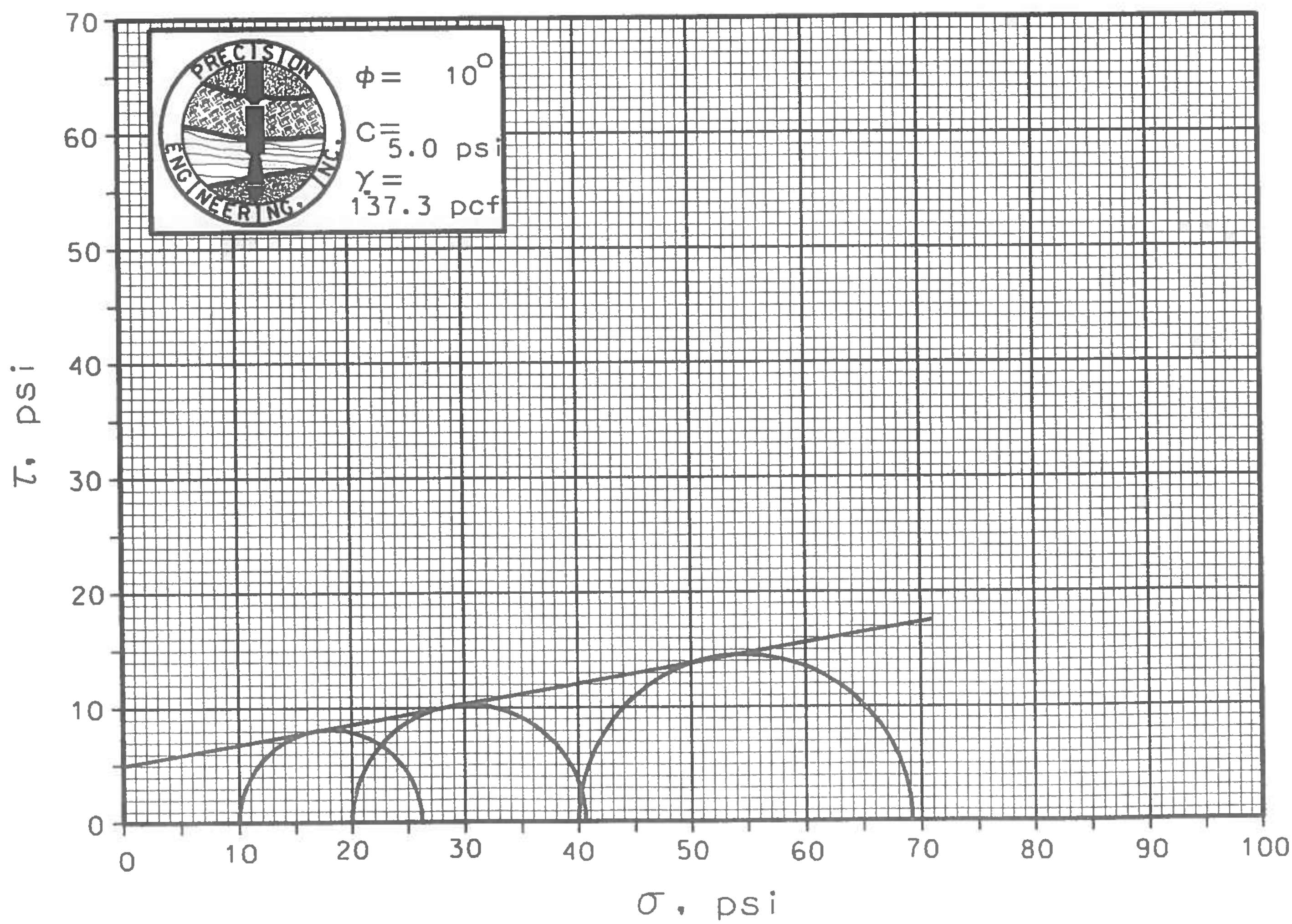
Lateral Pressure = σ_3

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

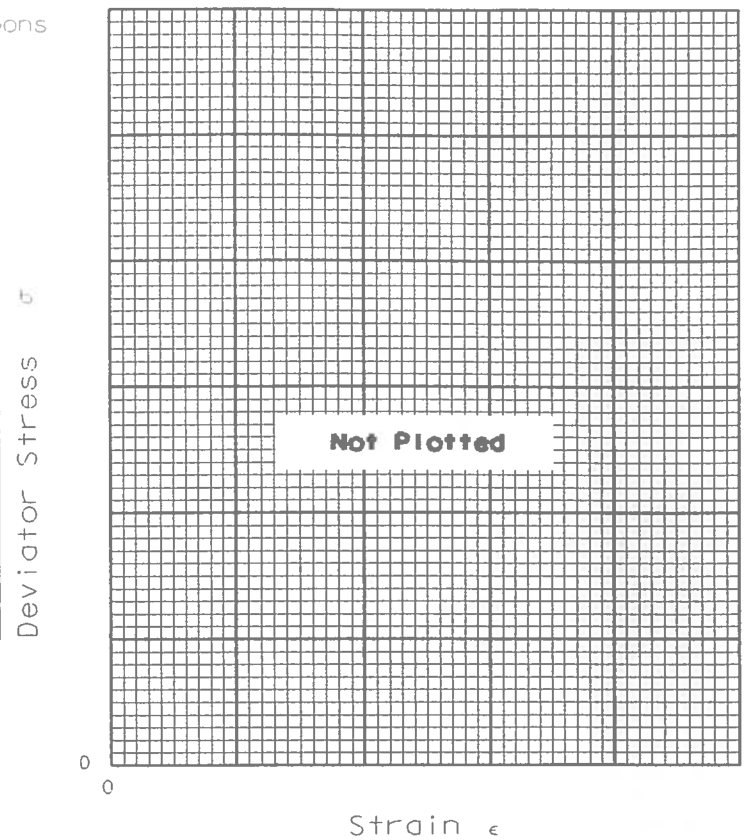
Unit Weight (pcf): 140.1 wet

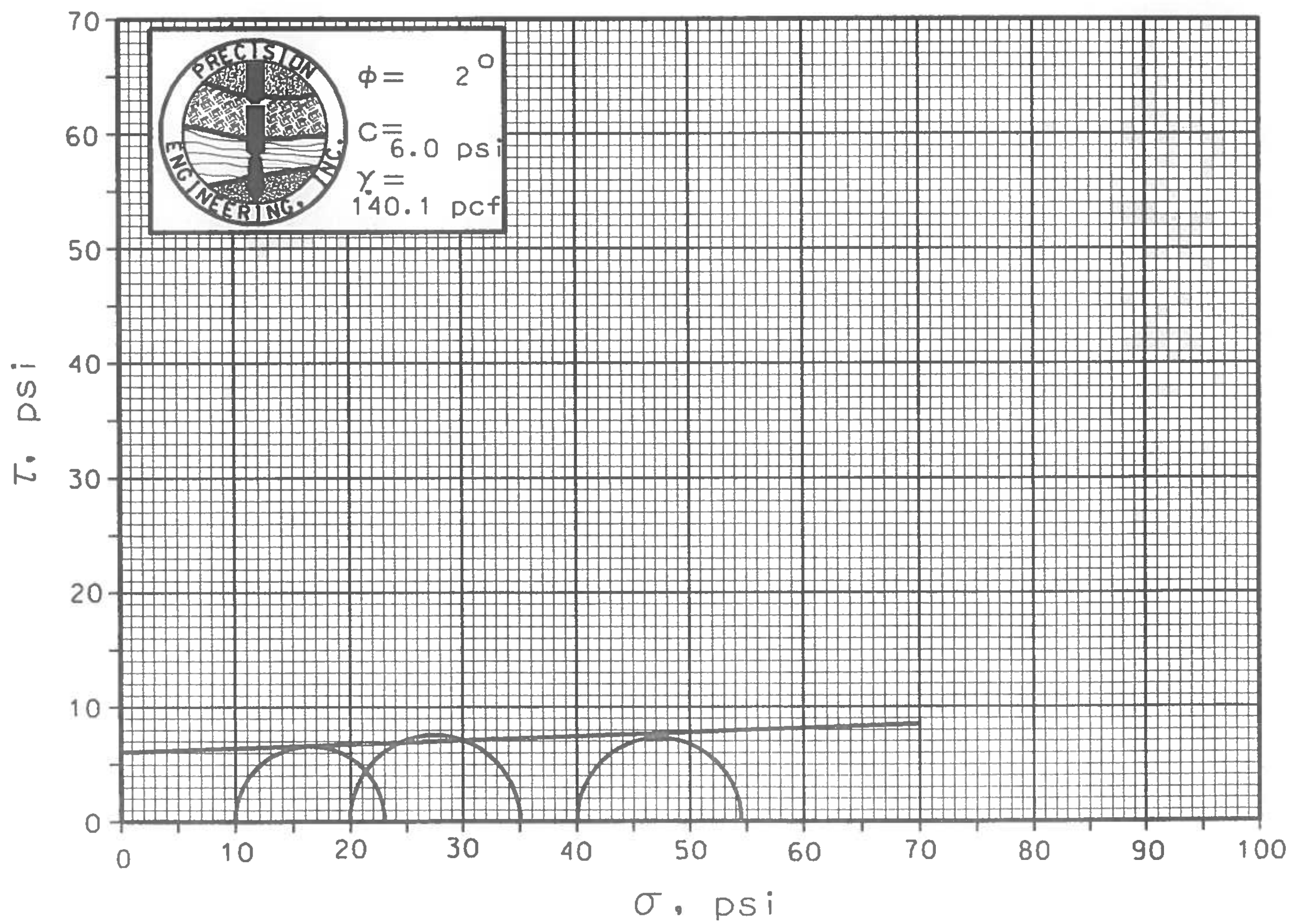
Lateral Pressure = σ_3

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

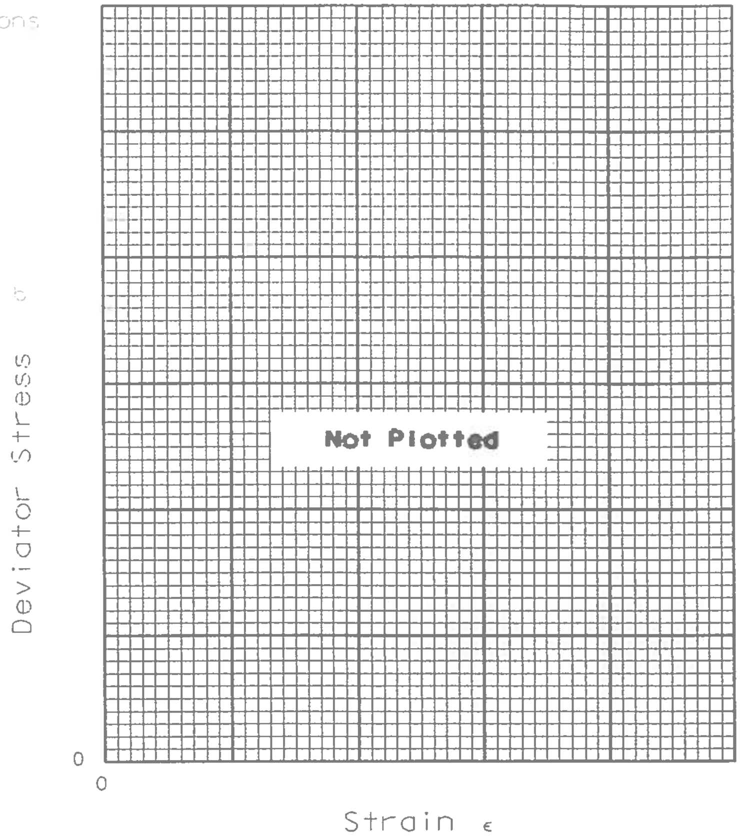
Unit Weight (pcf): 141.3 wet

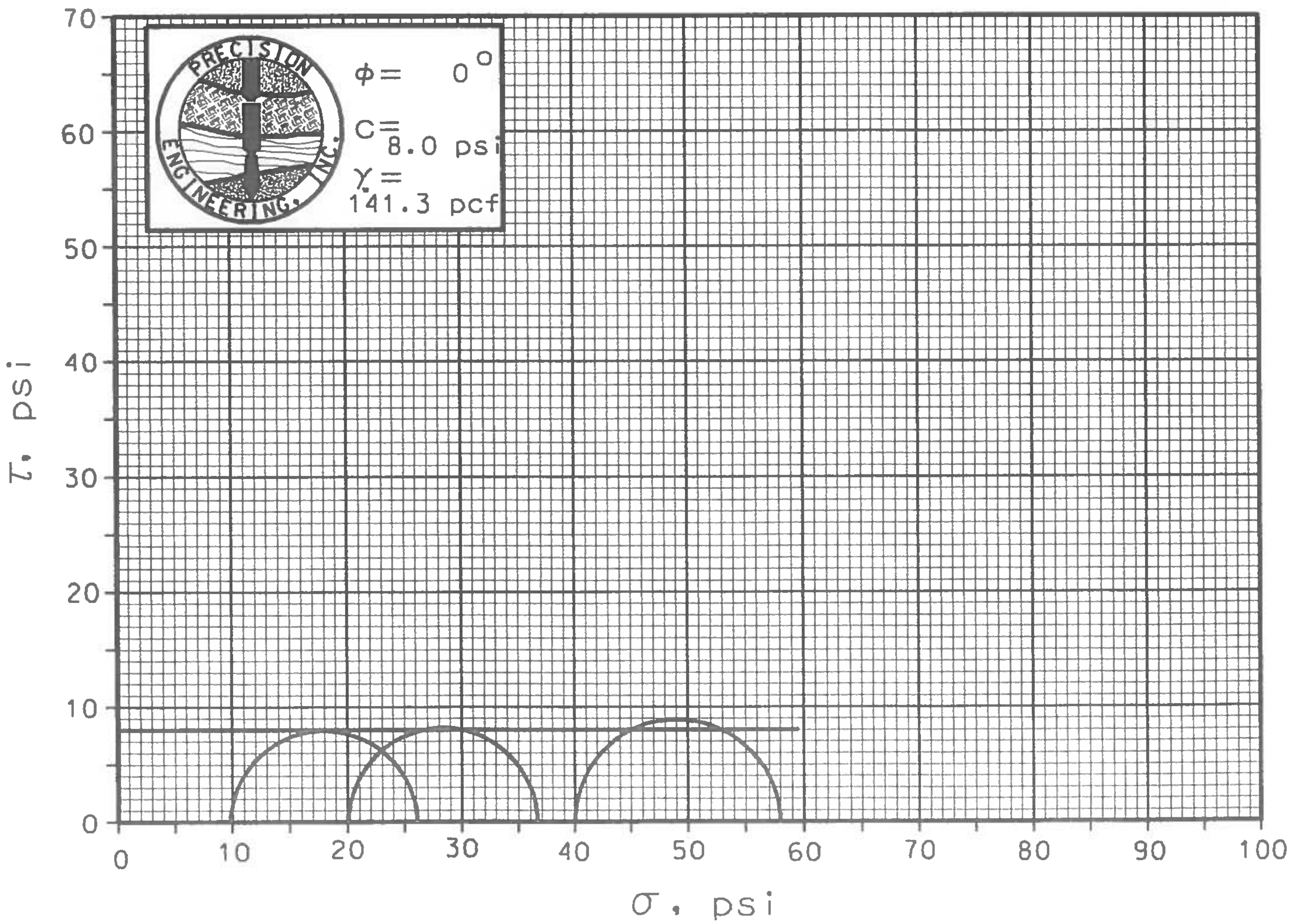
Lateral Pressure = σ_3

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

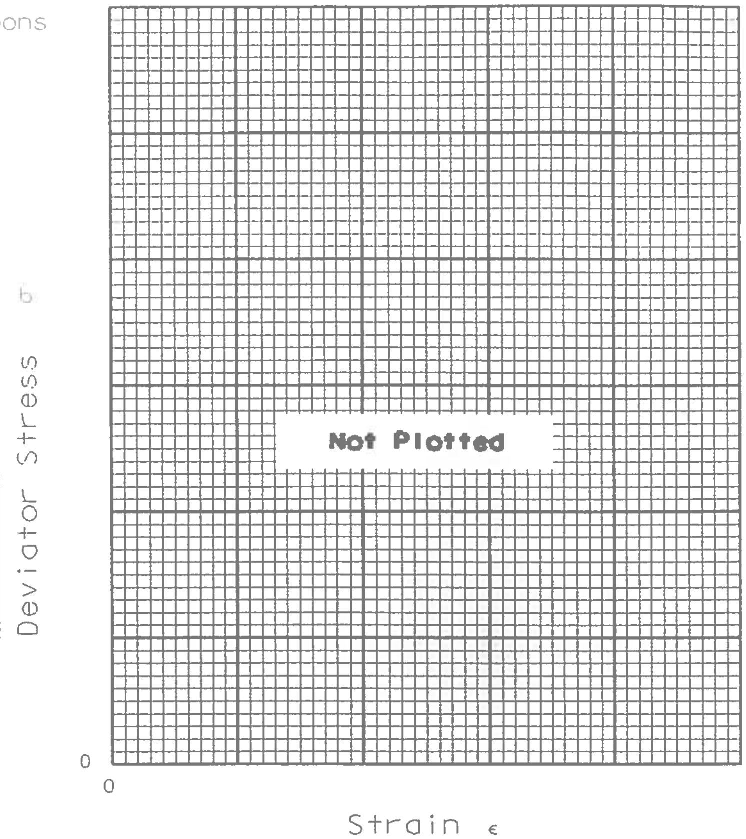
Unit Weight (pcf): 140.0 wet

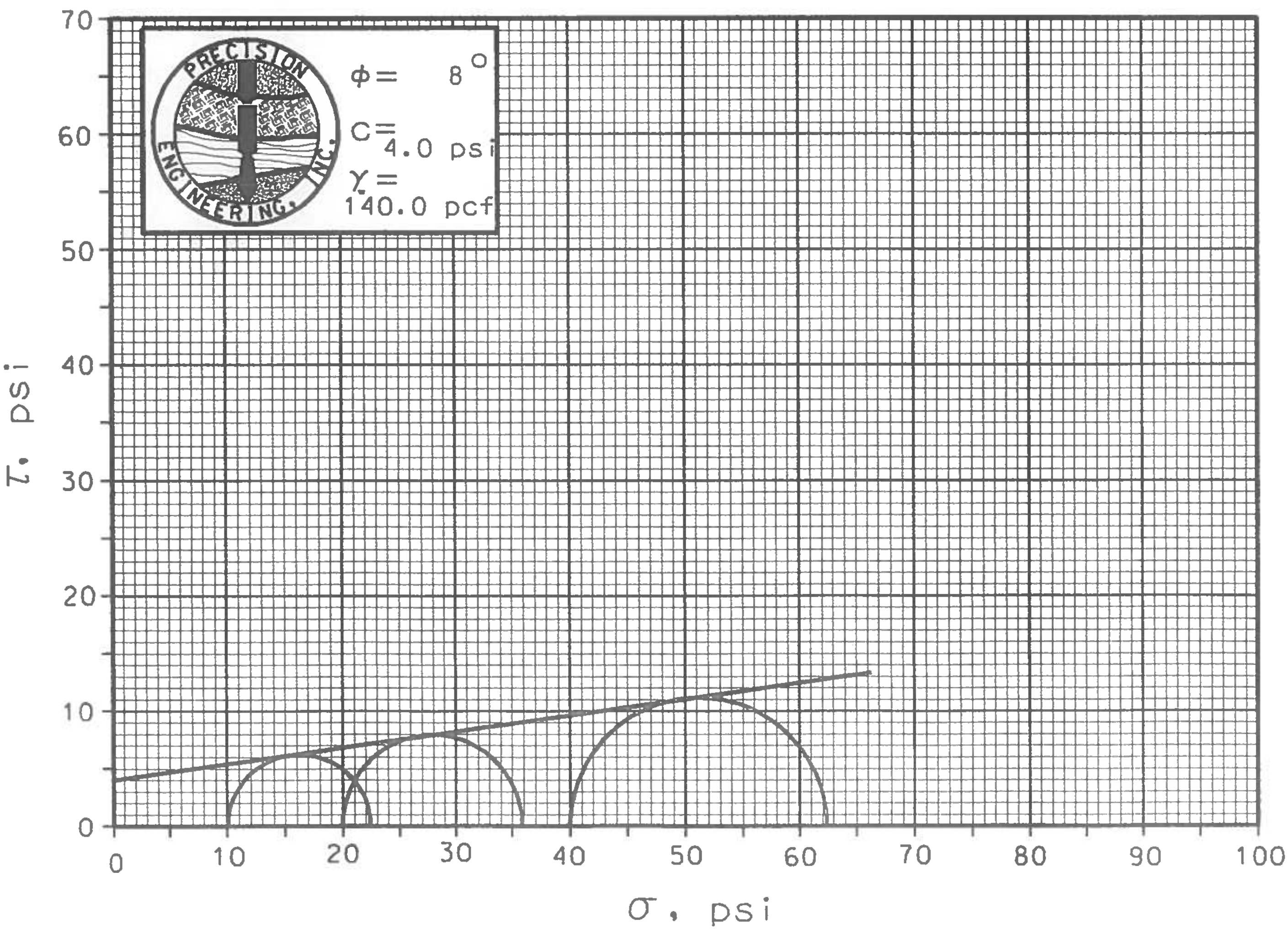
Lateral Pressure = σ_3

Max. Deviator Stress = σ

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

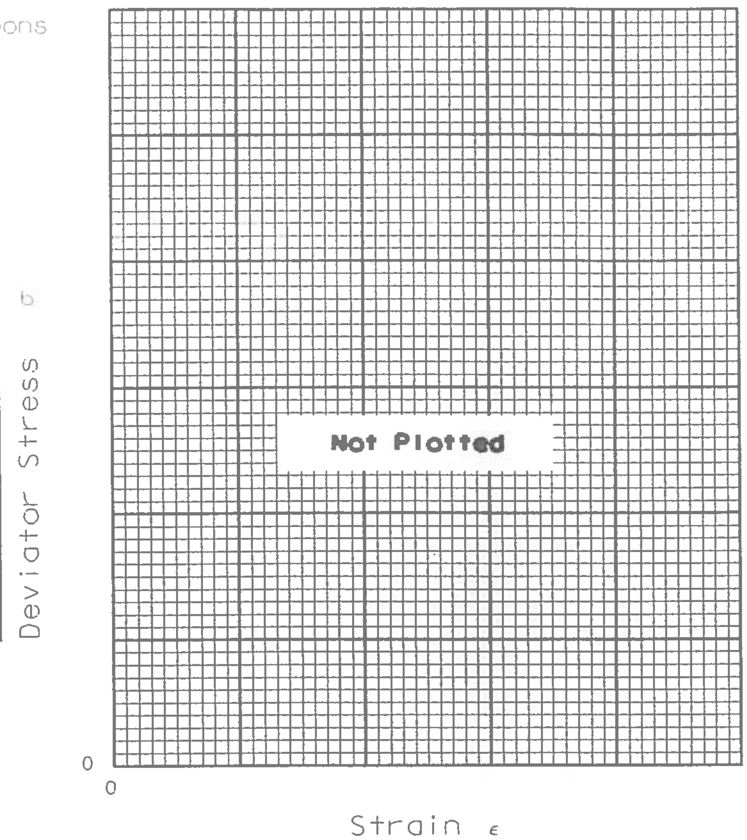
Unit Weight (pcf): 137.4 wet

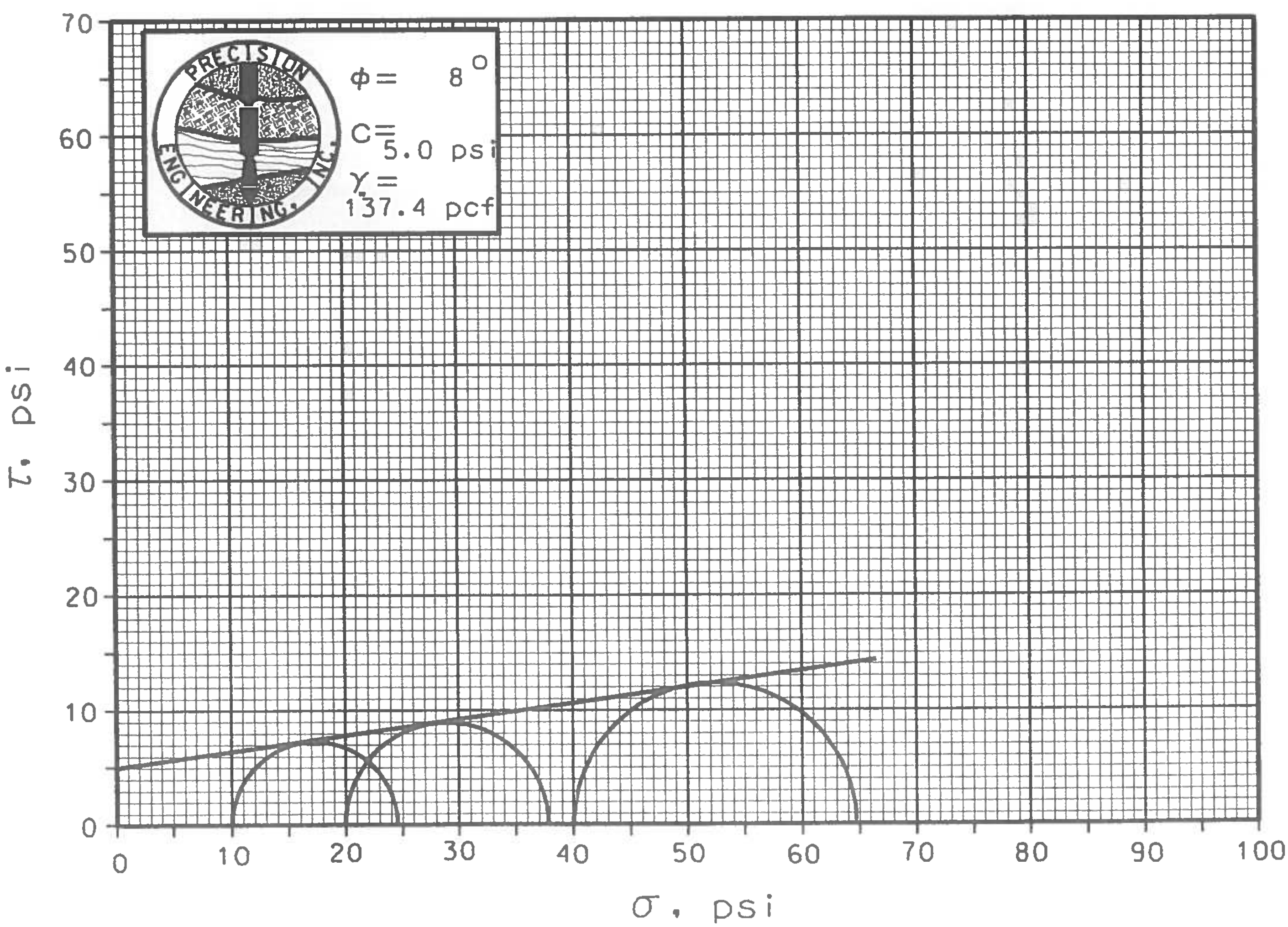
Lateral Pressure = σ_3

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

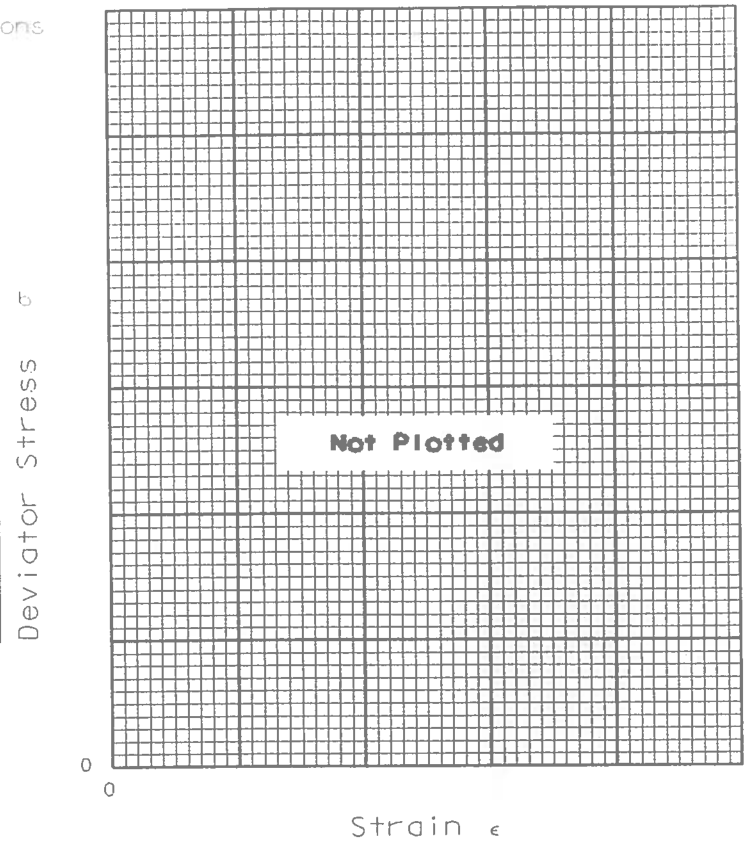
Unit Weight (pcf): 138.9 wet

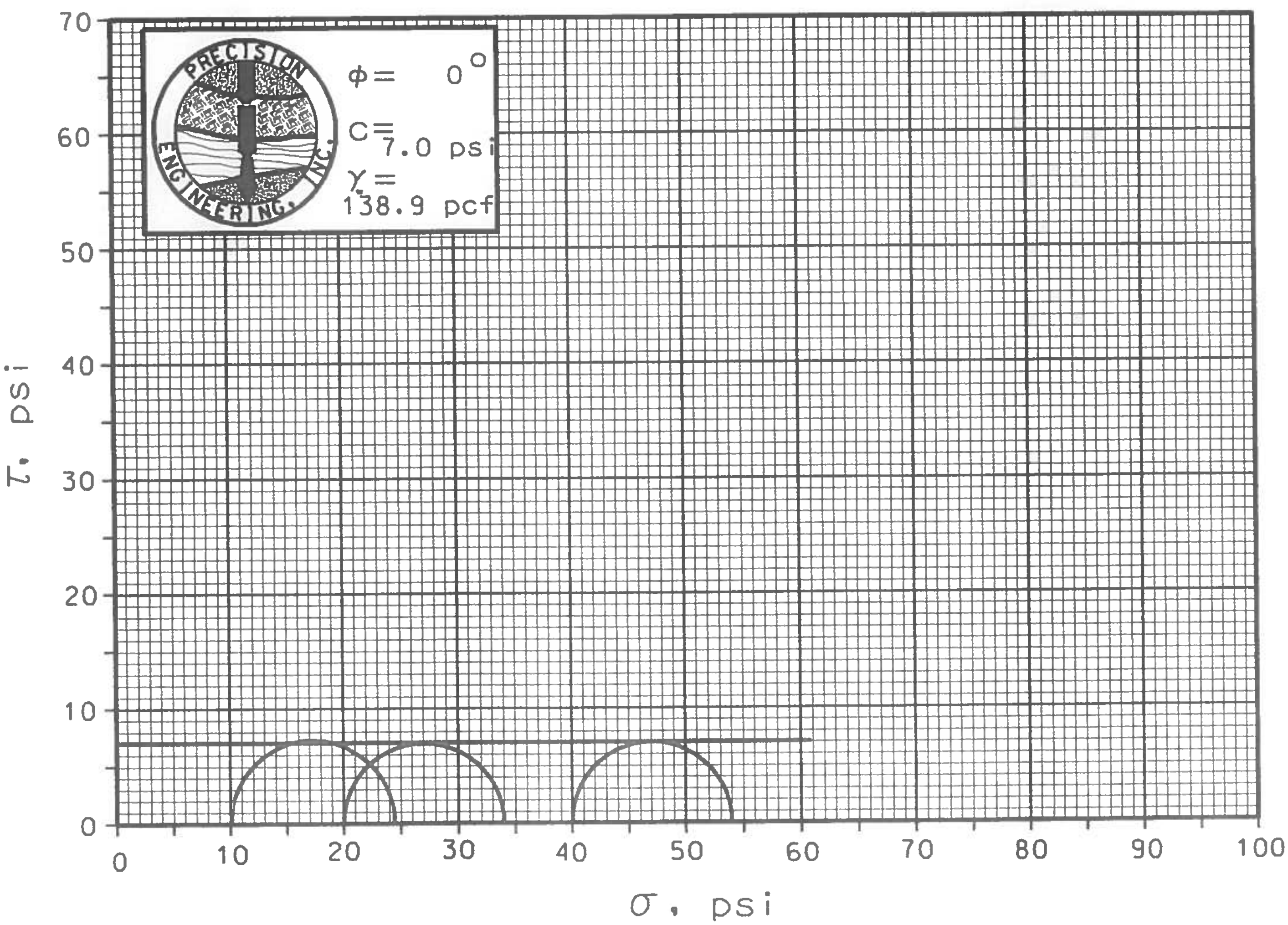
Lateral Pressure = σ_3

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

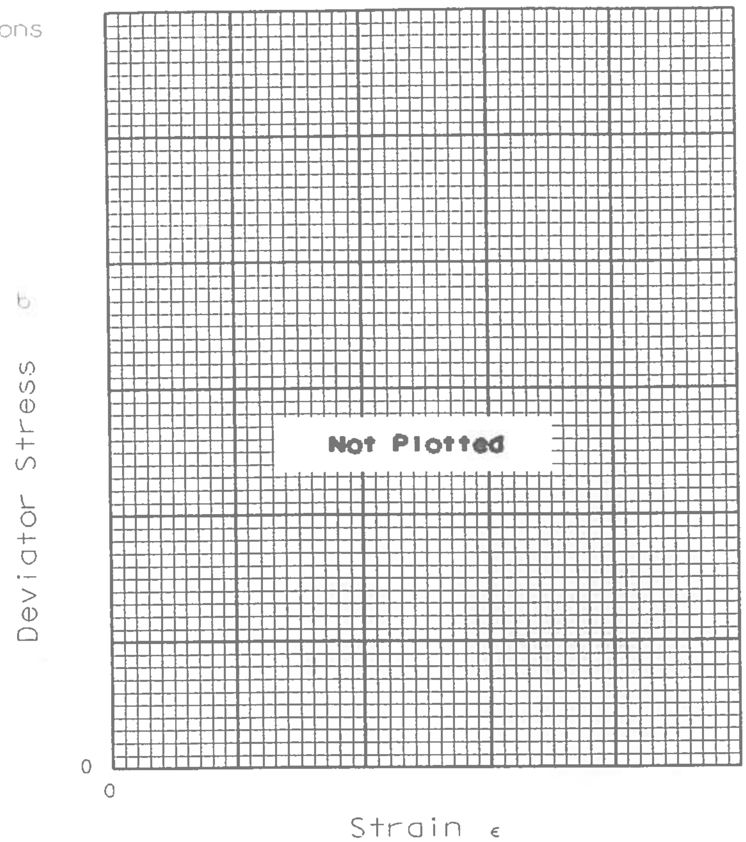
Unit Weight (pcf): 139.9 wet

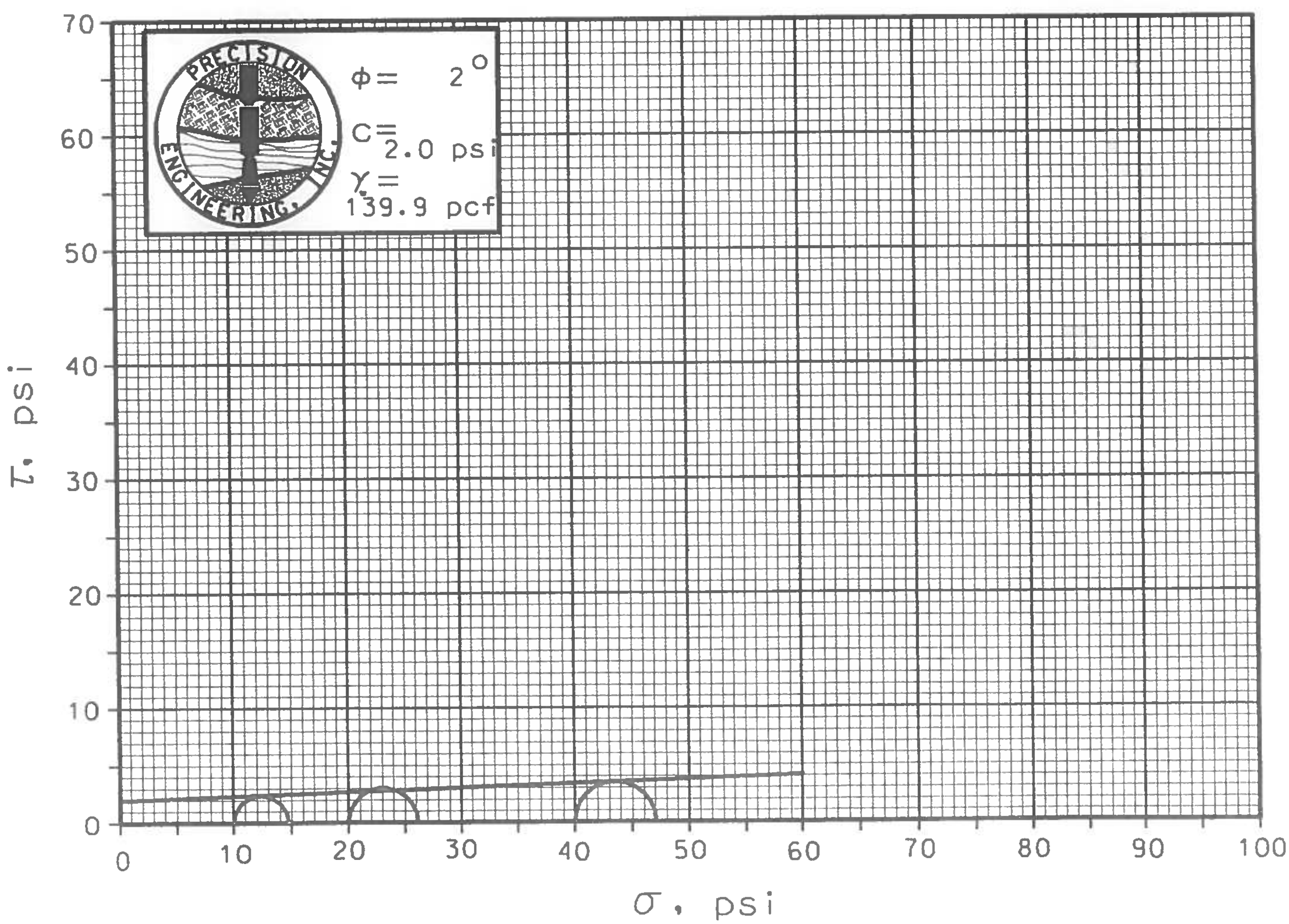
Lateral Pressure = σ_3

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

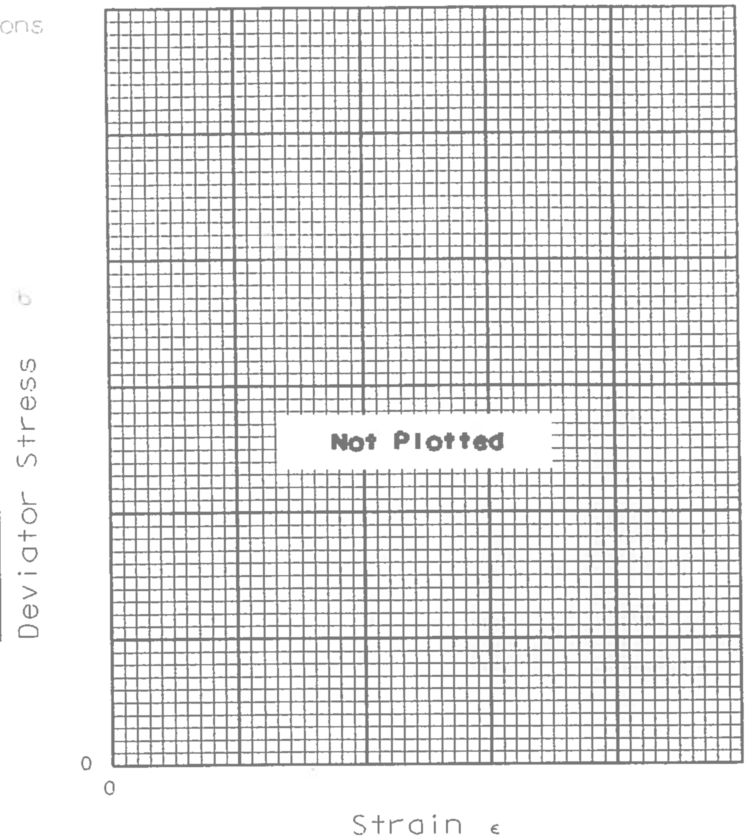
Unit Weight (pcf): 139.5 wet

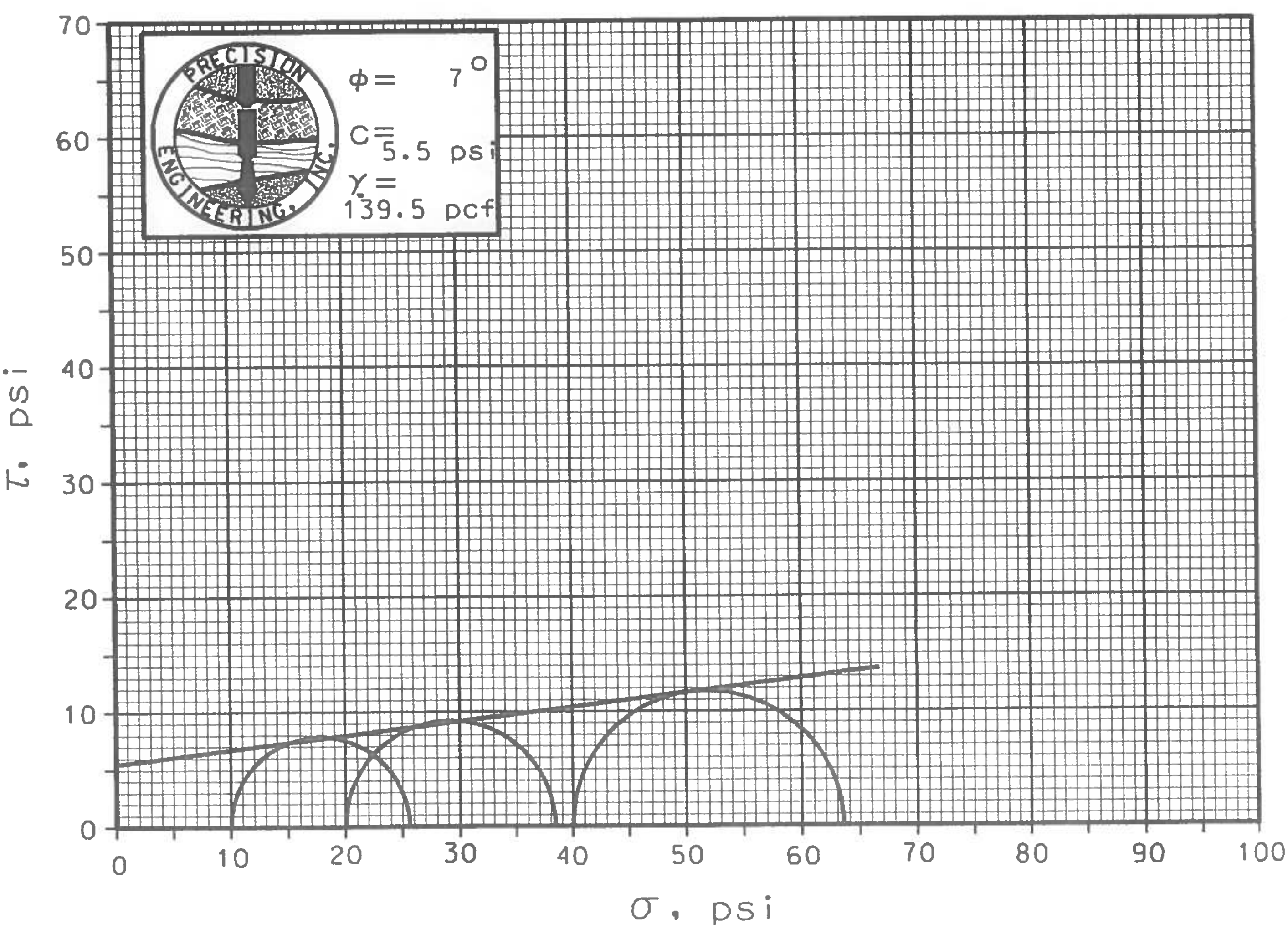
Lateral Pressure = σ_3

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

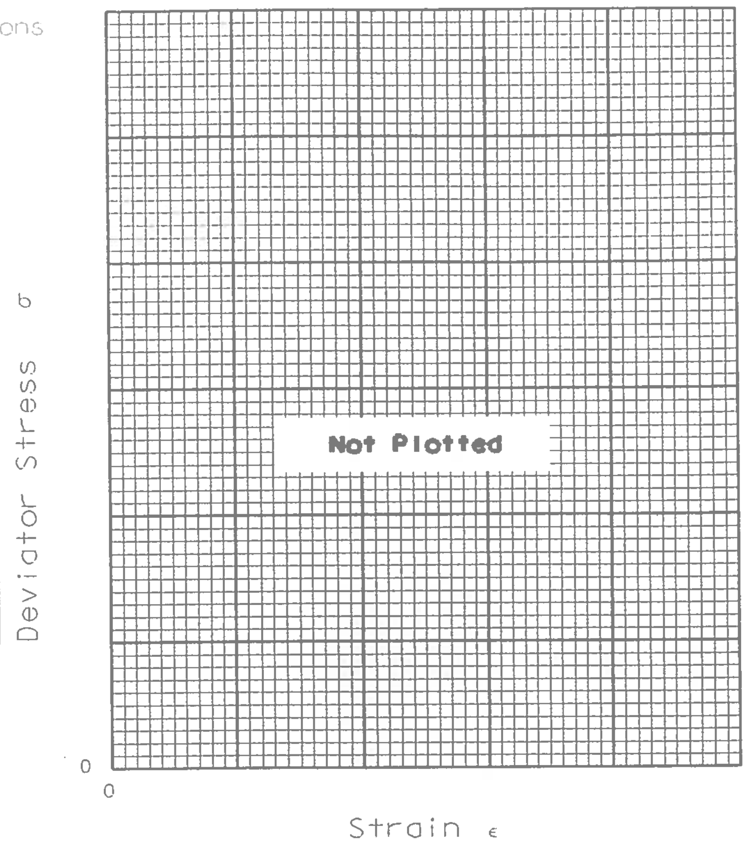
Unit Weight (pcf): 141.4 wet

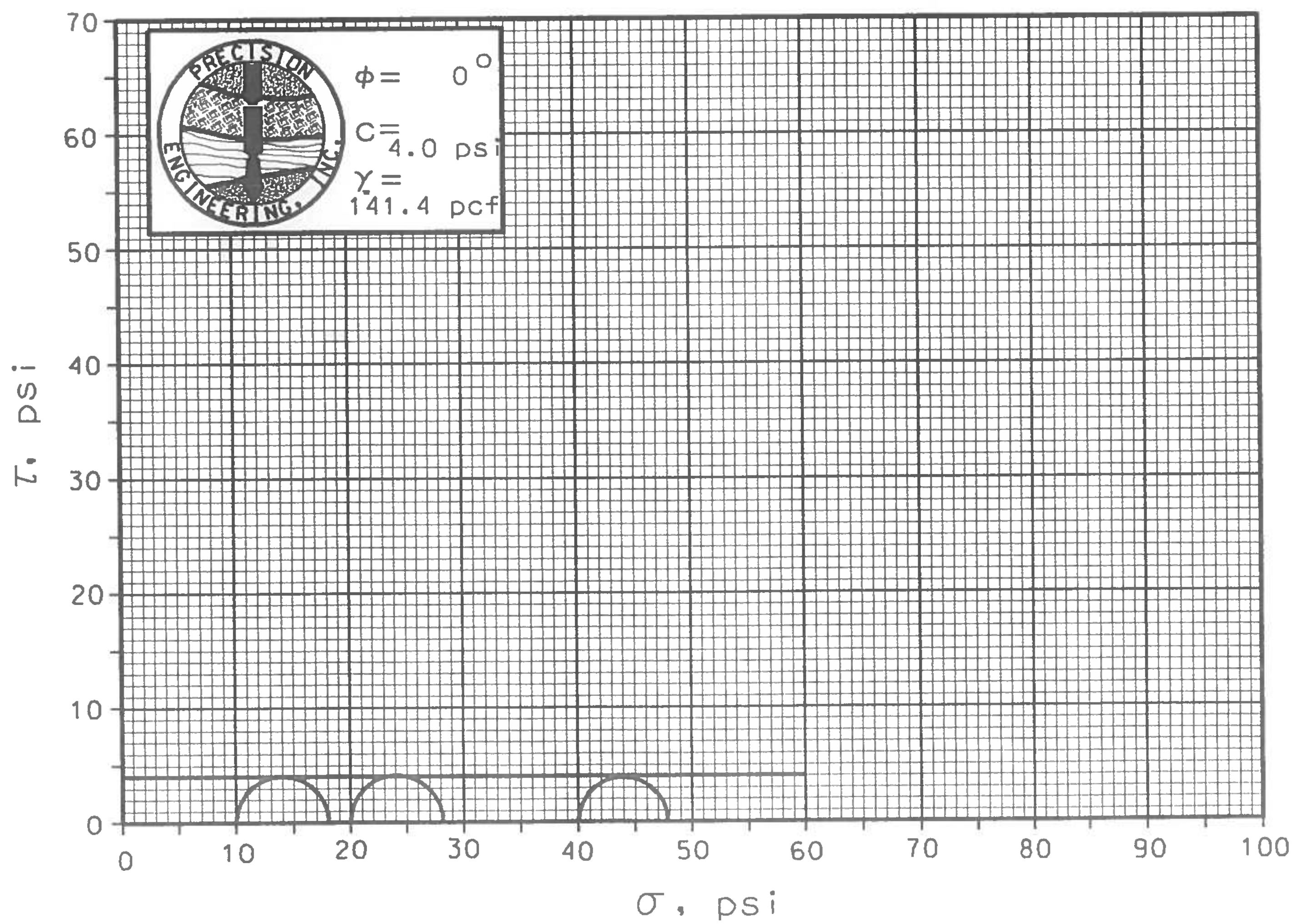
Lateral Pressure = σ_3

Max. Deviator Stress = σ

Max. Vertical Stress = σ_1

Sample	σ_3	σ	σ_1
1	10	8.0	18.0
2	20	8.2	28.2
3	40	7.9	47.9





PRECISION ENGINEERING INC.

GEOTECHNICAL & MATERIALS ENGINEERS

TESTING LABORATORY

(505) 523-7674 • P.O. BOX 422 • LAS CRUCES, NM 88004

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

<u>Descriptive Term</u> (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".

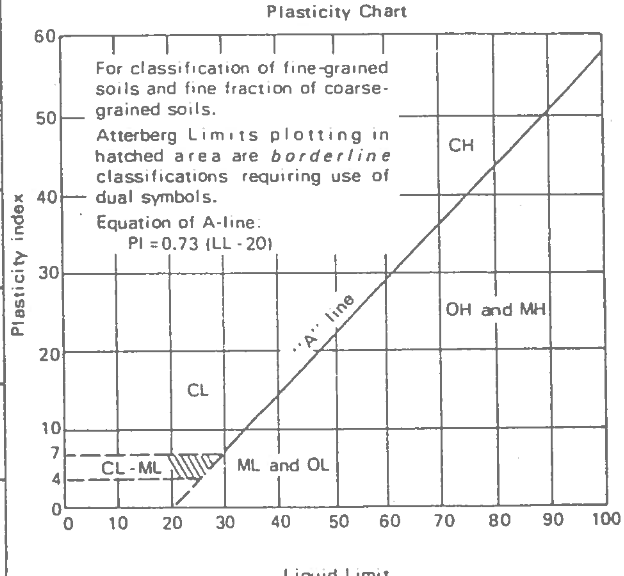
GEOTECHNICAL • MATERIALS • TESTING LABORATORY

Ph: (505) 523-7674 • FAX: (505) 523-7248

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.		

ENGINEERS & GEOLOGISTS • P.O. BOX 422 • LAS CRUCES, NM 88004

1101 West Mineral Avenue
Suite 102
Littleton, CO 80120
303.332.5757

February 16, 2017

Ed Riege
Remediation Manager
Western Refining Southwest, Inc.
92 Giant Crossing Road
Gallup, NM 87301

**Re: Responses to NMED Comments
Summary Report – Evaporation Pond Repairs
Western Gallup Refinery
Gallup, New Mexico**

Dear Ed:

At Western Refining Southwest's (Western's) request, this letter provides Axis Group Inc.'s (Axis') responses to New Mexico Environment Department's (NMED's) August 22, 2016 comments regarding the *Summary Report-Evaporation Pond Repairs* dated December 17, 2015. Responses to the NMED's comments have been incorporated into the Revised Summary Report, Evaporation Pond Repairs as appropriate.

Comment 1:

A: *In Section III (Miscellaneous), Part B (Pond Integrity), the Permittee states, "NMED's April 8, 2015 letter states 'seepage is likely occurring' and 'there is evidence that the berms are still in need of repair.' NMED notes that the basis for this observation is information from an August 2014 U.S. Environmental Protection Agency (EPA) RCRA compliance inspection. EPA's Inspection Report indicated that EPA had observed what it believed was moisture at a pond dike, and included several photographs, all of Pond 6.*

No response needed for Comment 1A.

B: *Western received EPA's Inspection Report in Fall 2014 and completed significant berm improvements on Pond 6 in March 2015, prior to receiving NMED's April 8th letter. Western also completed improvements to other pond dikes during this same time period.*

No response needed for Comment 1B.

C: *Section 2.4.3 (Pond 7/8 West Berm Soil Borings) describes the soils as "[t]he 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." Soil boring logs presented in Appendix D (Soil Boring Logs) indicate that there are "wet" layers in the soils within the evaporation pond berms along Ponds 7 and 8. Sand layers are also identified in the berm boring logs. The boring logs provided in Appendix C indicate water was present when those borings were installed in 2000.*

Response to Comment 1C:

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. No borings indicated wet soil or water. During the October 2015 boring program (Appendix D), four borings were installed on the Pond 7/8 west berm and 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.

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 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.

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

D: *For example Boring 8 (Southwest Corner of Pond 9A) indicates that the depth to water is 18 feet with a note "water bearing at 18', water rises to 6'2" after 24-hours and stabilizes." From 10 feet below the berm surface and down, the soil descriptions are "slightly sandy" at 10 feet, "very sandy" at 15 feet, and "sandy" at 20 feet. This is evidence that the evaporation pond berms allow water to seep through in spite of the calculated 1.9 X 10-7 cm/sec permeability. In the revised Report, discuss the permeability of the berms the sand layers, and whether or not the water observed in the borings presents a risk for berm failure. See also Comment 4.*

Response to Comment 1D:

Western does not agree with the interpretation of the boring log stated in the comment above. The log from the December 2000 program for Boring 8 at southwest corner of Pond 9 indicates “Clay” as the major descriptor with minor descriptors of various portions of sand (e.g. very sandy or slightly sandy).

Water encountered at a depth of 18-feet and then rising over 24-hours to a depth of 6-feet 2-inches is an indication of an artesian condition with water below a confining layer (i.e. clay). Western does not agree with NMED’s interpretation that this is evidence the evaporation pond berms allow water to seep through.

The 1.9 X 10-7 cm/sec permeability test result referred to in NMED’s comment is from a borrow sample taken during the October 2015 program and not from the Pond 9 soil obtained in the December 2000 program. The soil sample taken from the 2015 borrow pit was tested at a geotechnical laboratory for permeability using a flex-wall permeameter method described under ASTM 5084. Appendix B contains the geotechnical data and laboratory test results for the berm improvement activities.

Comment 2:

In Section III (Miscellaneous) point B, bullet I the Permittee discusses the placement of additional evaporation blowers to help in lowering the amount of water in the evaporation ponds. In the revised Report discuss the frequency (e.g., continuous, as needed) the blowers will be used.

Response to Comment 2:

The evaporation blowers operate continuously during the peak evaporation season (about April through October) except when the evaporation blowers are shut down for maintenance purposes or when the temperature makes evaporation inefficient. The evaporation blower operation is discussed in Section 5.2 of the Revised Summary Report.

Comment 3:

In Section III (Miscellaneous) point B, bullet 3 the Permittee discusses new staff gauges that were installed to measure current storage, remaining storage volume, and freeboard in the evaporation ponds. The Permittee must keep track of these measurements and report the data in table format in the annual Facility-wide Groundwater Monitoring Report. Additionally, the Permittee must also report on evaporation pond inspections, maintenance, *and/or repairs to the evaporation pond berms in the annual Facility Wide Groundwater Monitoring Report.*

Response to Comment 3:

Western will provide a staff-gage log in table format with the annual Facility-Wide Groundwater Monitoring Report. Western will also include copies of inspection records along with records of maintenance and improvements that have been conducted.

Comment 4:

In Section 2.4.4 the Permittee states, "[w]ater 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."

The piezometer logs indicate that surface water is entering the casing at the ground surface in a few of the piezometers (e.g., Pond 6, Piezometer E), ensure that the casing is constructed so that surface water cannot infiltrate the casing. Additionally, in the revised Report discuss how often water levels in the piezometer will be monitored and reference that the information will be reported in an annual status report (See Comment 3). Also, discuss whether or not the piezometric surface is below the potential or existing sliding surface or below the stability threshold for the berm slopes and discuss what measures will be taken if the water levels in the piezometers increase to the point where slope failure is possible.

Response to Comment 4:

Western continued improvements to the earth berms after the December 2015 Report was provided to NMED. The drive-point piezometers installed in the berms of Ponds 7, 8, and 9 during October 2015 were abandoned during these ongoing improvements.

Western will install new piezometers in the downstream 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 with casings and bentonite seals above the screen interval to prevent surface water intrusion. 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 (about three 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 reported in the Facility Wide Groundwater Report.

Due to the slopes and access constraints, 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

Western will also discuss the presence or absence of the phreatic surface, its relation to the theoretical slip circle identified in the slope stability output, and the potential effects on the numerical slope stability. Note however that Western does not believe that the water levels (as observed in the temporary drive-point piezometers) will rise to the point where the slope stability is in jeopardy. Western will provide the updated numerical slope stability evaluation in an addendum to the revised report.

Comment 5:

The stability of the embankment slopes was evaluated using total stress rather than effective stress analysis methods. Total stress analyses involve less sophisticated (and less costly) laboratory strength test methods than effective stress analyses and were in common usage thirty or more years ago. It has since become clear to the engineering profession that the strength behavior of soil is best characterized in terms of effective stresses, where the pressure of the water within the pores of the soil is explicitly accounted for. In total stress analyses, by comparison, pore water pressures are simply lumped into the soil strength value without quantification. The total stress method, because of the soil testing methodology employed, can potentially involve computations that involve artificially high values of soil cohesion, which, in turn, may lead to falsely high computed factors of safety (FS). Although the stability of the embankment slopes may indeed be satisfactory, that conclusion cannot reasonably be drawn from the data presented.

In order to assess whether the stability of each embankment lies within an acceptable range (for example, the FS = 1.5 for long term stability of the downstream face), all stability analyses must be repeated using the effective stress method in the context of the Bishop Method or the Morgenstern Price method. This requires retesting the soils to determine their effective stress shear strength parameters (Ø and c) using, for example, the direct shear method (a drained test) or the triaxial test (a drained test or, alternatively, an undrained test with pore pressure measurement). Provide a work plan proposing to collect additional soil data from the evaporation pond berms.

Response to Comment 5:

Western does not agree that total stress analysis is not applicable in the cases presented in the report. It is acceptable to use the total stress analysis for slope stability for the end-of-construction analysis and for partially saturated soil (refer to "EM 1110-2-1902", USACE 2003, "Geotechnical Engineering Techniques and Practices", Hunt 1986). Based on historical and current soil borings, the soil in the berms is best categorized as partially saturated.

Western updated the previous slope stability work conducted in December 2002 (Appendix C of the report) using the available soil strength data and applied the revised cross-sections after the new berm fill material was placed (through 2015). The updated slope stability work used the December 2002 slope stability triaxial sheer strength data (these were total stress parameters) to estimate the updated factor of safety.

Western used the Morgenstern Price method of analysis in the updated slope stability analysis in Appendix F of the December 2015 report. The updated slope stability analysis conducted on the revised berm cross-sections resulted in increased factors of safety in each updated analysis. The minimum factor of safety calculated for the updated cases was 4.5, clearly in excess of the minimum acceptable factor of safety of 1.5.

Note that the effective stress strength parameters on a clay soil typically result in a lower cohesion value (c value) and an increase in the internal angle of friction value. (Ø value) when compared to total stress strength parameters. While there are changes to be expected in the strength parameters between total stress and effective stress, Western does not expect the changes to be significant.

Western will install new piezometers in the downstream 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 with casings and bentonite seals above the screen interval to prevent surface water intrusion. Piezometers will be installed at selected cross-sections in the following earth berms:

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

Due to the slopes and access constraints, the borings used to install 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; and
- 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 evaluation. 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 (through 2016);
- 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).

Comment 6:

The slope stability analyses did not include an assessment of potential seismic loading conditions. A pseudo-seismic analysis must be performed for this purpose. As required by 40 CFR § 257.74(3)(e)(iv) and discussed in Seed, H.B. 1979. Geotechnique Vol. 29, No.3. An appropriate peak ground acceleration (PGA) should be applied to determine if the proposed slopes are stable under a seismic load. It is recommended that a PGA (2% over 50 years) of 0.081g based on current mapping be applied. The liquefaction potential of the berm material must also be evaluated.

Response to Comment 6:

The reference provided for a pseudo-seismic analysis is confusing. The reference provided [i.e. 40 CFR §257.74(3)(e)(iv)] appears to be for structural integrity criteria for new CCR surface impoundments and any lateral expansion of a CCR surface impoundment. The CCR referred to in the reference supplied is for Coal Combustion Residuals and does not apply to this facility. Also, the berms are not new and there is no lateral expansion being considered. Based on Western's review of this comment and the citation, a pseudo-seismic analysis is not required or warranted.

In addition, Western does not agree that the liquefaction potential for the berm material needs to be evaluated. Based on observations of the earth berms, there is insufficient flow or seepage at the toe of the downstream slope to require analysis for seepage forces and liquefaction potential.

Comment 7:

It is not clear how the water level was determined for the Pond 9 north rebuild section. It does not appear that piezometers were installed in the embankment. In addition, boring logs in the area seem to present conflicting information. Provide information regarding how the groundwater levels were determined for this section and to discuss the method used to measure the water level.

Response to Comment 7:

The Pond 9 north rebuild section is modeling the cross section from December 2002 slope stability work with no new additional soil or groundwater data.

However, work in 2016 added fill material to the Pond 9 north berm. The numerical slope stability of the Pond 9 north berm will be evaluated using the updated topography and soil strength parameters.

Comment 8:

A: *The Report does not provide information on how the strengths and unit weights for each soil type were determined, nor does it provide information as to how the delineations of soil materials were determined.*

Response to Comment 8A:

Section 2.4.5 in the Report provides a discussion of soil properties used. As discussed, soil unit weight and strength properties from the December 2002 slope stability analysis were used in the 2015 updated slope stability work. The purpose of the 2015 slope stability work was to update the 2002 slope stability analysis to include the new earth berm geometry. Based on a review of the boring logs and borrow soil sample data, it was determined that the soil classifications were sufficiently similar. Accordingly, the soil and strength properties from the December 2002 slope stability analysis were used (i.e. unit weight, cohesion, and internal friction angles). This information was also provided in tabular format in Table 1 of the Report. Average properties were determined for native material and berm fill.

Similarly, the discussion in Section 2.4.5 also indicated that the soil material delineations were based on historic topography and current topography survey data after additional fill material was added to the earth berm slopes.

B: *Boring logs from 2002 do not contain elevations and no geotechnical lab data were provided concerning the soil material used to complete repairs in 2013 and 2015. The analysis must include this information so that slope stability analyses are accurate and also so that a technical evaluation of the soils geotechnical information may be completed. If historic boring logs do not include elevations and geotechnical laboratory data, then the Permittee must provide a schedule to submit a work plan proposing to collect additional soil boring data.*

Response to Comment 8B:

Though the boring logs from 2002 engineering report do not contain elevations, the historic topography was discussed in Sections 2 and 3 and shown in cross-sections on Figure 6b of the Report. The geotechnical data for the December 2002 work was provided in Appendix C of the Report. In addition, geotechnical data from the 2013 and 2015 improvement work was provided in Appendix B of the Report. As shown on Table 1 of the Report, the soil properties do not vary greatly for the berm fill throughout the various earth berm sample locations.

Comment 9:

The Report does not specify whether rapid drawdown will be employed during site operations. If rapid drawdown is expected to occur, then a rapid drawdown analysis must be conducted to investigate the stability of interior slope faces of any pond embankment that is potentially subject to instances of abrupt lowering of the water level in the pond. Under such circumstances, the rate of dissipation of pore water pressures in the embankment soils, which have developed under long term steady state conditions, cannot keep pace with the lowering of the pond level. This results in excess pore pressures in the embankment that are likely to reduce embankment stability below that of long term steady state conditions. If the Permittee expects rapid drawdown at the evaporation ponds, then this analysis must be conducted. Please revise the Report accordingly.

Response to Comment 9:

A rapid drawdown analysis is not warranted since Western does not expect a rapid drawdown at the evaporation ponds.

Comment 10:

The Report does not specify whether loading to the berms is anticipated. The analyses were run assuming there would be no loadings on the berms (that is, no vehicular axle loadings and no dead loads). Traffic or high loadings on the berms must be included in the analysis if, in fact, such loadings are present or may occur.

Response to Comment 10:

Surcharge loading on the berms is not expected other than occasional light vehicle traffic. Should berm loading beyond light vehicle traffic be required, the loadings will be analyzed as appropriate.

Comment 11:

The graphical output profile of the Slope/W runs is confusing. Although the output file appears to provide a detailed summary of the specific run, the delineation of materials and zones is unclear. Also, in some runs, the critical failure plane is cut off and not within the limits of the profile. The graphical output must be portrayed at a scale that shows the full profile and is clear and understandable so that the stability of the slope can be confidently evaluated. Revise the Report accordingly.

Response to Comment 11:

The slip surfaces and the phreatic surface in the model output were displayed. However, additional detail will be added on the slope stability output for future slope stability evaluations. The additional detail will more clearly delineate the material type and properties used in each zone. In addition, the cross sections will provide sufficient vertical scale to illustrate the complete theoretical slope stability failure plane. Western expects to provide the updated numerical slope stability evaluation in an addendum to the Revised Summary Report, Evaporation Pond Repairs.

Comment 12:

In the revised Report, the following design scenarios must be evaluated in order to determine whether their inclusion would significantly impact embankment stability:

1. *Utilize a more conservative estimate of the groundwater elevation through the embankment for Pond 6 (west to east) and Pond 8 (south to north), using the November 11, 2015 readings from Piezometers A and E.*

Response to Comment 12 (1)

The November 2015 water levels from piezometers A and E were used to evaluate the phreatic surface in the 2015 numerical slope stability analysis. In a location where water was not detected, the phreatic surface was conservatively estimated to be at the bottom of the piezometer. Where surface water intrusion was encountered at the toe of the slope, the phreatic surface was estimated to be at the toe of the slope. The water levels used in the 2015 numerical slope stability analysis were obtained from temporary piezometers and that more permanent piezometers will be installed. Date from the new piezometers will be used in the future numerical slope stability analysis.

Please note the following:

- In Pond 6 North to South, piezometer A (middle of the crest) was dry for the last two measurements and piezometer E was initially dry but subject to surface water infiltration at the toe of the slope from a storm event and therefore not reliable.

- Similarly, for the Pond 8 South to North section, piezometer A (middle of the crest) was dry for the first two measurements and measured about 1.2 feet of water on the last measurement and piezometer E was initially dry but subject to surface water infiltration at the toe of the slope from a storm event and therefore not reliable.

2. *In the Slope/W runs, larger entry/exit ranges with more convergence/slip surfaces for each point must be utilized to increase confidence that the critical failure surface (that is, the surface with the lowest factor of safety) had, in fact, been identified.*

Response to Comment 12 (2)

In the updated 2015 slope stability analysis, entry/exit ranges were chosen that cover the entire length of the berm. This forced deeper slip surfaces in order to identify the critical potential failure surface.

3. *The Report does not explicitly state why the sections were cut where they were. Revise the Report to discuss the decision process. Additionally:*

a) move Section 6 to the southwest and extending Section 6 into the bottom of Pond 7 to enable a stability analysis of the interior slopes of Ponds 6 and 7, including a surcharge loading (as appropriate). [See Annotated Drawing 6a, note 5];

b) move Section 8 slightly to the west to capture the low point of the pond, corresponding to what appears to be the tallest and most appropriate embankment section for the analysis of stability. [See Annotated Drawing 6a, note 6]; and

c) extend Section 9A directly north into the Pond 6 bottom, so the stability analysis is performed of the interior slopes of Ponds 6 and 9, with the inclusion of surcharge loads, as appropriate. [See Annotated Drawing 6a, note 7]."

Response to Comment 12 (3)

Western selected the critical section for each pond system based on geometry, typically in a section with the greatest height for each pond system, and near the locations where the temporary drive-point piezometers were installed. In the future numerical slope stability work, the cross-sections will be adjusted as appropriate to address Comment 12.

Closing Remarks:

Axis Group Inc. appreciates the opportunity to continue working with Western on this important project. Please call me at 303-332-5757 with questions.

Regards,

John Billiard

John W. Billiard, P.E.
Technical Services Director