ENERGY FUELS NUCLEAR, INC.
RENO CREEK ISL PROJECT
INFORMATION AND DESIGN CRITERIA TO ACCOMPANY AN APPLICATION TO CONSTRUCT WASTEWATER FACILITIES

Prepared for:

Energy Fuels Nuclear, Inc.
One Tabor Center, Suite 2500
1200 17th Street
Denver, Colorado 80202

Submitted to:

Wyoming Department of
Environmental Quality
Water Quality Division

Prepared by:

WESTEC™
WELSH ENGINEERING SCIENCE & TECHNOLOGY INC

WESTEC Project No. 35701
Report 884

December 1993

40-9024

energy fuels nuclear, inc.

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December 29, 1993

DOCKETED
JAN 04 1994
USNRC
MAIL SECTION
DOCKET CLERK

'94 JAN -3 AM 8:28

URFO
RECEIVED

Mr. Ramon Hall
U. S. Nuclear Regulatory Agency
Uranium Recovery Field Office
Box 25325
Denver, CO 80225

RE: Reno Creek ISL Project Source Material License

Dear Mr. Hall:

Enclosed please find four copies of Energy Fuels Nuclear, Inc. (EFNI) Application for Permit to Construct Wastewater Facilities and supporting information associated with the Reno Creek ISL Project. The Application for Permit to Construct has been submitted to the Wyoming DEQ-WQD and describes site investigations and design of the barium chloride treatment ponds and irrigation reservoir associated with the project. The application does not include the Land Application permit for irrigation of in situ effluent. The Land Application permit will be submitted separately in January, 1994.

The design and operation of the Reno Creek ISL Project is described in the Application for Source Material License for Reno Creek submitted November 19, 1993 to NRC. Therefore, the attached information is supplied to provide more detail to this aspect of the operation.

Please call me if you have any questions regarding this matter.

Very truly yours,

William J. Almas

WJA/sju

Enclosures

cc: Wallace M. Mays
Harold R. Roberts
Terry V. Wetz

9405050245 1/3.

94-0165

40-9024
w/ 12/29/93 ltr.

ENERGY FUELS NUCLEAR, INC.
RENO CREEK ISL PROJECT
INFORMATION AND DESIGN CRITERIA TO ACCOMPANY AN APPLICATION TO CONSTRUCT WASTEWATER FACILITIES

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Energy Fuels Nuclear, Inc. One Tabor Center, Suite 2500 1200 17th Street Denver, Colorado 80202	Wyoming Department of Environmental Quality Water Quality Division

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CHAPTER III
APPLICATION FOR PERMIT TO CONSTRUCT, INSTALL, OR MODIFY WATER SUPPLIES, WASTEWATER FACILITIES, OR GROUNDWATER POLLUTION CONTROL SYSTEMS IN WYOMING

FOR USE BY DEQ/WQD ONLY

APPLICATION NO. ______

DATE RECEIVED ______

PROGRAM ASSIGNED ______

APPLICATION FORM

Application must contain three copies of the application form, plans, specifications, and pertinent design information.

Name of facility Reno Creek ISL Project Treatment Ponds

Owner, company, or corporation name Energy Fuels Nuclear, Inc.

Location of facility: County: Campbell

Township: 43N Range: 73W

Section: 29 ¼ Section: SE

Type of application:

X New permit*

___ As built approval

___ Revised permit*

___ Standard specification permit

___ Renewal of permit*

*Previous DEQ/WQD construction permit no(s). if applicable (modification, revision or renewal) ______

Type of Project (Mark all that apply)

___	201 Construction Grant Wastewater Treatment Plant (WWTP)	
___	State Revolving Fund (SRF) WWTP	
___	Public Water Supply (20 or more service connections)	including ground or surface water source, transmission line, treatment plant, chlorination or pumping system, storage facility, backflow prevention device, or laboratory
X	Wastewater Facility	including small wastewater facility (single unit, domestic sewage, less than 2,000 gallons), domestic sewage pond, disinfection, collection or pumping system, evaporative/containment pond, sedimentation pond, mechanical treatment plant, oil/water separator (external to a structure), sludge facility or laboratory
___	Monitoring wells	(groundwater contamination not determined) (P.E. not required)
___	Land Application System	including road application, land farming or one-time land application
___	Underground Storage Tank/Leaking Underground Storage Tank (UST/LUST)	
___	Site assessment/site characterization	including monitoring wells, borings, etc. (P.E. not required)
___	Groundwater remediation/treatment systems	including pump and treat, bioremediation, air sparging, soil vapor extraction, oil/water separator, recovery well, etc.
___	Groundwater Pollution Control (GPC) Program	
___	Site assessment/site characterization	including monitoring wells, borings, etc. (P.E. not required)
___	Groundwater and contamination containment systems	including physical, hydraulic, etc.
___	Groundwater remediation/treatment systems	including pump and treat, etc.
___	Monitoring wells	(groundwater contamination has been determined) (P.E. not required)
___	Deep anode beds	

TABLE OF CONTENTS

1.0 INTRODUCTION

Energy Fuels Nuclear, Inc. (EFNI) plans to permit and construct an in situ leach (ISL) uranium project at its Reno Creek site located approximately 10 miles southwest of Wright, Wyoming. Figure 1.1 illustrates the project location. The process consists of injecting a carbonate solution into the uranium ore body using injection wells and recovering the uranium enriched solution using recovery wells. The enriched solution will then be pumped to the processing plant for uranium extraction. A net surplus of extraction fluid will be pumped from the wellfields during operations to ensure a positive groundwater gradient towards the extraction wells. This prevents excursions of wellfield solution.

A net excess of 40 to 60 gpm of extraction flow has been estimated by EFNI for routing to the primary and secondary treatment ponds. The treatment ponds provide retention time for sedimentation to occur prior to release of the water to the storage reservoir. During the irrigation seasons, the water stored in the water storage reservoir will be pumped to a land application area for irrigation.

A groundwater sweep of leached ore bodies will commence following the fourth year of mining operations. Groundwater sweep for restoration purposes will be concurrent with leaching within other mining units as well as use of reverse osmosis for final restoration. The net excess fluid to be treated and contained will increase to 260 gpm in the fourth year. This will necessitate increasing the storage capacity of the reservoir by phased embankment construction. More detailed information describing the mining process, existing environment, and projected environmental impacts are contained in the Application for Amendment to Mine Permit #479 submitted to the Wyoming Department of Environmental Quality - Land Quality Division (WDEQ-LQD) in November 1993. Reference to portions of this document are made in this Application for Permit to Construct.

WESTEC was retained by EFNI to design the primary and secondary treatment ponds and the water storage reservoir, and WESTEC is responsible for only the design work. EFNI is responsible for all other aspects of the facility. These facilities will comply with the current

State of Wyoming DEQ Water Quality Division (WQD) and State Engineer's Office (SEO) regulations. A separate application is being prepared for submittal to the WDEQ-WQD to allow land application of treated wellfield solutions.

1.1 SITE LOCATION AND LAYOUT

The Reno Creek ISL Project is located in southern Campbell County, Wyoming about 40 air miles south southwest of Gillette. Figure 1.1, Project Location, shows the general location of the Reno Creek ISL Project. The permit area includes portions of Sections 21, 22, 27, 28, 29, 30, 31, 33 and 34, Township 43 North, Range 73 West. Access to the Reno Creek ISL Project is via Wyoming State Highway 387 which cuts through the project. Secondary access to the project is via local ranch roads and the existing gravel road to the pilot plant building originally owned by Rocky Mountain Energy.

The 3,613 acre mine permit area lies in the Belle Fourche and Cheyenne River drainages with the drainage divide occurring along the southern and eastern portions of the permit area. Figure 1.2, Site Plan, shows the permit area boundary, the planned mining areas, the irrigation site and the proposed satellite plant and water treatment locations. The existing pilot plant building constructed and used by Rocky Mountain Energy will be used as a warehouse facility during commercial operation. Figure 1.3, Process Area Layout, shows more detail in the area of the processing plant and water treatment installations.

The plant site and irrigation reservoir are located in the SE¼ of Section 29, T43NR73W. Two treatment ponds will be constructed to allow retention time and settling of the radium solids formed when radium has reacted with barium chloride. The ponds are designed to operate in series with gravity discharge to the irrigation reservoir.

1.2 OPERATOR INFORMATION

EFNI is a privately held Colorado corporation. EFNI will be the operator for Energy Fuels Limited, holder of all mineral claims in the area.

Energy Fuels Nuclear, Inc. address is as follows:

Energy Fuels Nuclear, Inc.
One Tabor Center, Suite 2500
1200 17th Street
Denver, Colorado 80202
Telephone: (303) 623-8317
Fax: (303) 534-7435

Individuals responsible for the permit application and construction/operation of the Reno Creek facility are listed below:

Wallace M. Mays, President
Terry V. Wetz, ISL Project Manager
William J. Almas, Manager of Environmental Affairs

Wallace M. Mays will be the individual signing all documents and will be considered the applicant.

1.3 GENERAL PROCESS DESCRIPTION

The uranium in situ leaching process proposed for Reno Creek has been successfully tested and proven at the Rocky Mountain Energy pilot project and at other ISL mining projects in Wyoming and Texas. This process, involving dissolution of uranium minerals from the host rock consists of two steps. First, the uranium must be oxidized from the tetravalent state to the hexavalent state with an oxidant such as gaseous oxygen. Second, a chemical compound, such as carbon dioxide, is used to complex the uranium in the solution. The uranium enriched solution is transferred from the production wells to the processing facility for extraction of uranium from the solution by using ion exchange resin.

The leaching solution, or lixiviant, is composed of native groundwater from the wellfield, fortified with the desired chemicals to achieve uranium solubilization and recovery. Barren lixiviant is injected with gaseous oxygen as oxidant and carbon dioxide to convert existing carbonate ions to bicarbonate ions. The natural bicarbonate levels, if required, will be supplemented by the addition of sodium bicarbonate, sodium hydroxide or potassium hydroxide.

The network of injection and recovery wells in the wellfields will be utilized to circulate and recover the uranium-bearing lixiviant as it removes the uranium mineralization from the host formation. The uranium-bearing solution will be pumped directly to the satellite plant for uranium recovery, refortification, and return back to the wellfield, Figure 1.4, Satellite Plant Process Flow Diagram. This cycle of circulation and uranium recovery will be continued until the formation is depleted of economically recoverable uranium.

The pregnant lixiviant from the wellfields will be passed through vessels containing a bed of ion exchange resin beads. This resin is selective to the uranium-bicarbonate complexed ion and removes the uranyl ions from the solution. When the resin is loaded with uranium, it will be removed from the vessel and processed to recover the uranium. Resin will be transferred to a resin hauling vehicle, the resin hauling vehicle will transport resin to an off site facility licensed for uranium recovery. After removal of the uranium, the resin will be returned to an ion exchange vessel for continuation of the recovery process.

A one percent to three percent bleed stream of the total 2000 gpm flow will be taken from the lixiviant stream after it passes through ion exchange. This bleed stream is taken to ensure that more water is recovered than injected in the operating wellfields. This will maintain a net inflow of water into the mining area to reduce the potential for horizontal and vertical excursions. The bleed stream will be treated to remove radium prior to disposal by surface irrigation. This process is described further in the Waste Water Treatment System section.

1.4 WASTE WATER TREATMENT SYSTEM

During the mining phase, the major waste stream generated will be the one to three percent bleed stream (20 to 60 gpm). A minor amount of liquids will be generated from plant wash down and from solutions used to flush and clean wells in the wellfield. In the groundwater restoration phase, the flow rate of waste solutions will be increased to approximately 200 gpm, thus making a maximum project total waste stream of approximately 260 gpm. These waste streams will be treated in the waste water treatment system, as shown on Figure 1.5, Waste Water Treatment System Process Flow Diagram. This is a closed system and the waste stream will only come to ambient atmospheric conditions as it is discharged into the radium removal settling ponds.

The bleed stream from the normal production stream passes through a separate ion exchange column. This final pass through ion exchange is done to remove any residual uranium not removed in the primary ion exchange circuit. The bleed stream then passes to the water treatment building Figure 1.6, Waste Water Treatment System. Restoration water from groundwater sweep and brine from reverse osmosis treatment also flow through the circuit as shown in Figure 1.5, Waste Water Treatment System Process Flow Diagram. After passing through the ion exchange column to remove residual uranium, the solution receives a flocculant prior to being treated with a barium chloride solution. The barium chloride solution is prepared in the waste water treatment building and is injected into the pipeline discharging to the first radium removal pond. Addition of barium chloride forms a radium precipitate.

The solutions entering the radium removal ponds traverse slowly from the first pond to the second. This allows the radium solids to settle in the lined treatment ponds before the clean water is decanted from the second pond and transferred to the irrigation reservoir prior to land application.

The radium removal ponds will be lined with 80-mil HDPE geomembrane. The geomembrane will be underlain by a leak detection and under drain collection system consisting of a sand blanket and collection piping. Beneath the leak detection system will be a minimum of one foot of reworked and compacted native clay, which will provide a secondary barrier in the unlikely event of a pond leak. Since the ponds will be kept full to properly operate the solid settling and water decontamination steps, opportunities for damage to the geomembrane liner are minimal. Drawings and construction specifications for the treatment ponds are included within Attachment 1.

The irrigation reservoir has been designed in two phases. The initial phase is designed to store solution from the bleed stream only. The second phase of the storage reservoir is designed to handle the combined flow (approximately 260 gpm maximum) from restoration activities and the bleed stream. The irrigation reservoir will not incorporate a geomembrane liner since the water it contains has already been treated for uranium and radium removal. The irrigation reservoir functions solely to store water to accommodate the seasonal land application by irrigation. Drawings and construction specifications for the irrigation reservoir are included within Attachment 1.

1.5 WASTE STREAM DESCRIPTION

Solutions to be land applied will originate from three waste streams. The solution streams are listed below:

- Bleed stream from producing wellfields
- Groundwater produced as part of groundwater sweep operations to restore the aquifer to its original use category.
- The reject solution from the reverse osmosis units used in the treatment of groundwater.

The quality of the water with respect to Total Dissolved Solids (TDS) and the concentrations of ions in wellfield solutions varies, depending on the solution stream. Most land application solutions can be expected to have a greater concentration of ions than found in groundwater in the area because of the effect of oxidation and subsequent increased solubility of the ions within the formation.

In order to estimate the water quality associated with solutions to be land applied, EFNI used water quality information gathered by Rocky Mountain Energy during the Pattern 2 pilot test for in situ leaching at the Reno Creek property.

On the basis of this water quality data, and the assumptions discussed herein, the worst case Sodium Adsorption Ratio (SAR) and electrical conductivities for the three solution streams are listed below.

Solution Stream	SAR	EC (dS/m)
Process Bleed	11.9	3.5
Groundwater Sweep	9.8	2.75
Reverse Osmosis Brine	10.2	4.25

Selenium and other trace metals may increase in concentration from the average baseline water quality. Selenium baseline averages 0.014 mg/liter across the mining area. Selenium concentrations have been assumed to triple to 0.06 mg/liter. More detail concerning assumptions for process chemistry is provided in Section 15.10 of the WDEQ-LQD Application for Amendment to Mine Permit.

2.0 PROJECT SCHEDULE

A discussion of the projected mine plan and schedule is presented in detail in Section 15 of the Application for Amendment to Mine Permit to the Land Quality Division of the WDEQ. The schedule itself is presented in Table 15.3 of this document. The project life is ten years in total. As described in the design report prepared by WESTEC (Attachment 1), the reservoir design is two phased. The first three years assumes no restoration stream to the reservoir, only process bleed. Since the bleed stream is only projected at approximately 40 gpm, only 96.68 acre-feet of storage is needed during the first four years of the project. Thereafter, the dam will be raised to accommodate a design inflow of 260 gpm for the remaining six years of the project. The 260 gpm stream includes groundwater sweep, reverse osmosis brine and process bleed solutions.

Water will be withdrawn from the reservoir at a rate of 400 to 500 gallons per minute (gpm) during the 7 month irrigation season. Since input to the reservoir will be less than the irrigation rate every month during the life of the project, the reservoir will be drawn down to the 5125 msl elevation level each year. Surface area of the reservoir at this elevation will be 0.4 acres.

3.0 ENVIRONMENTAL IMPACTS

Impacts to the environment are expected to be limited to impacts on the groundwater and soils. These impacts are described below. No radiological impacts of significance are anticipated since the water stored in the irrigation reservoir will be treated for radium and uranium prior to storage. The radium treatment ponds are double lined with a leak detection system. Radium solids will be retained within the lined ponds. Radionuclide concentrations will be less than effluent discharge limitations established in 10 CFR 20 as presented in Table 16.4 of the WDEQ-LQD Application for Amendment to Mine Permit.

Groundwater - Hydro-Engineering of Casper, Wyoming performed an analysis of the projected impacts to the groundwater in the vicinity of the irrigation reservoir. Hydro-Engineering's analysis is reproduced below.

Three drill holes exist on the northern edge of the irrigation reservoir. These drill holes are RN-3874, RN-3876, and RN-3878. The lithology of these drill holes indicate that the Upper Aquifer consists of a mudstone and some silty sandstone. The Upper Aquifer exists between 105'-110' below land surface at these three drill holes. The majority of the lithology between the land surface and the Upper Aquifer is mudstone with a few feet of interbedded sands. On the average, 80' of mudstone exists between the irrigation reservoir and the Upper Aquifer, therefore seepage rates to the Upper Aquifer will be low, and movement of water will take a very long time. The reservoir will be operated at varying levels during each of the nine irrigation years due to the use of water from the reservoir for irrigation. Table 15.2 (WDEQ-LQD Application for Amendment to Mine Permit) presents the water balance for the irrigation system and shows that the storage of water in the reservoir will vary greatly with time. A minimum of five feet of water is planned to be retained in the bottom of the irrigation reservoir. Therefore, a small area of approximately two acres will be covered with water most of the time. The maximum stage of the reservoir is planned for an elevation of 5154 ft-msl. This equates to 17.5 acres.

Seepage from the irrigation reservoir will probably saturate the upper portions of sediments beneath the reservoir. A rough estimate of the seepage rates was made by assuming saturated flow and using Darcy's equation. A vertical permeability of 1 x 10^{-6} cm/sec is thought to be representative of the type of material in the bottom of the irrigation reservoir. Permeability is based on knowledge of this type of material in the area. An average area of ten acres and a conservative gradient of 1 ft/ft was used for this calculation. These parameters indicate that an average seepage rate of 6.4 gpm will discharge from the irrigation reservoir to the groundwater. Movement through the mudstone down through the Upper Aquifer is estimated to take 38 years. This is based on a vertical permeability of 1E^{-7} cm/sec for the mudstone material, a unit gradient of 1 ft/ft, and an effective porosity of 0.05.

This analysis indicates little impact to the Upper Aquifer below the irrigation reservoir. Any contribution of salts or trace metals to groundwater would be over a period of time at least equal to the life of the reservoir (ten years). Contribution would be to a marginal groundwater resource from a quantity and quality standpoint. Refer to Section 10 of the WDEQ-LQD Application for Amendment to Mine Permit for a complete description of the hydrogeologic environment. No exceedence of Class 3 groundwater standards is expected.

Soils - As described in Section 15.12 of the WDEQ-LQD Application for Amendment to Mine Permit, A and B horizon material will be stripped from the irrigation reservoir prior to construction. Additionally, the material used to construct the dam itself will be subsoil materials from the reservoir basin. These materials will be held in reserve and used as the reclamation cover after the project is completed. The remaining near surface subsoil material will be saturated with saline irrigation solutions over the course of the 10 year life of project. Irrigation waters are expected to be saline and slightly sodic, as described in Section 15.10 of the WDEQ-LQD Application for Amendment to Mine Permit. Near surface material will come into equilibrium with irrigation solutions. This will result in soil salinity increasing slightly in subsoil material. This will be a temporary effect to material not proposed as reclamation top dressing.

4.0 ENVIRONMENTAL MONITORING

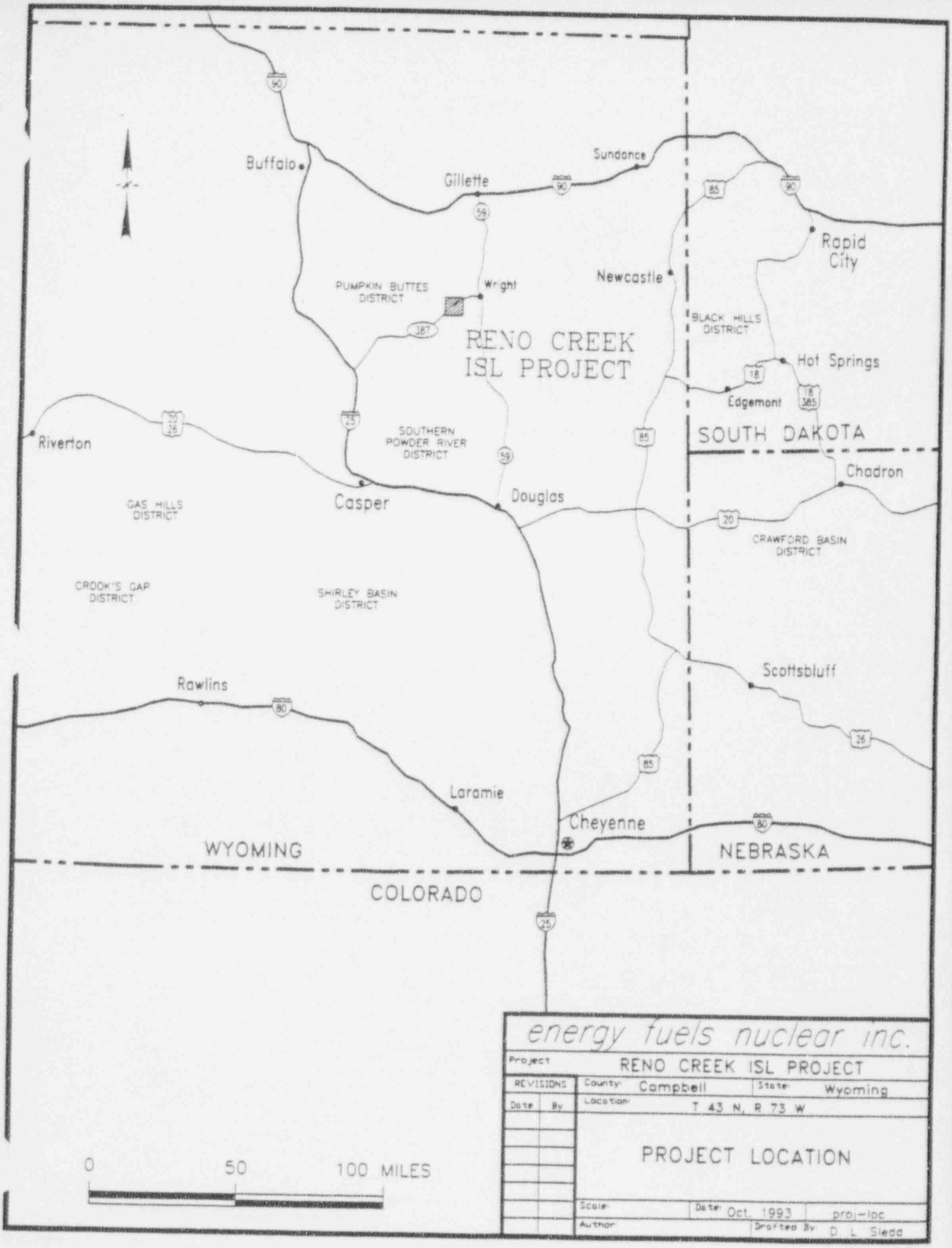
In order to assess the extent of environmental impacts associated with the irrigation reservoir, EFNI has already proposed, as a regional baseline well, RI-30U for groundwater monitoring on a semi annual basis. This well is completed in the Upper Aquifer and is located approximately 1000 feet from the proposed dam site. The well is hydrologically down gradient from the reservoir. The well will be sampled for the parameters listed in Table 10.5-6 found in Section 10 of the WDEQ-LQD Application for Amendment to Mine Permit. The purpose of the monitoring well is to detect and quantify any changes in groundwater quality attributable to mining or water disposal operations.

Additionally, at the conclusion of mining, earthen material within four feet of the surface will be tested for the list of parameters contained in Table I-3 of WDEQ-LQD Guideline 1, Topsoil and Overburden to determine the suitability of material for reclamation. Soil samples will be taken on a 500 foot grid across the area affected by the reservoir. If excess salts or toxic substances such as selenium are found in concentrations in excess of baseline and established limits, a remediation plan will be developed and implemented. Remediation could be in the form of additional soil leaching with freshwater and/or the addition of amendments to the soil.

The leak detection system for the radium treatment ponds will be monitored weekly as described in Section 16.1.3 for the WDEQ-LQD Application for Amendment to Mine Permit.

5.0 RECLAMATION

Section 17 of the WDEQ-LQD Application for Amendment to Mine Permit describes reclamation for areas affected by mining operations. At the conclusion of mining, the dam structure will be removed, available subsoil from the dam and topsoil stockpile will be spread over the area as a growth media, and the entire area reseeded with native grasses. Reclamation procedures will be modified to incorporate a remediation plan for the affected area, if one should be necessary based on soil analytical information.

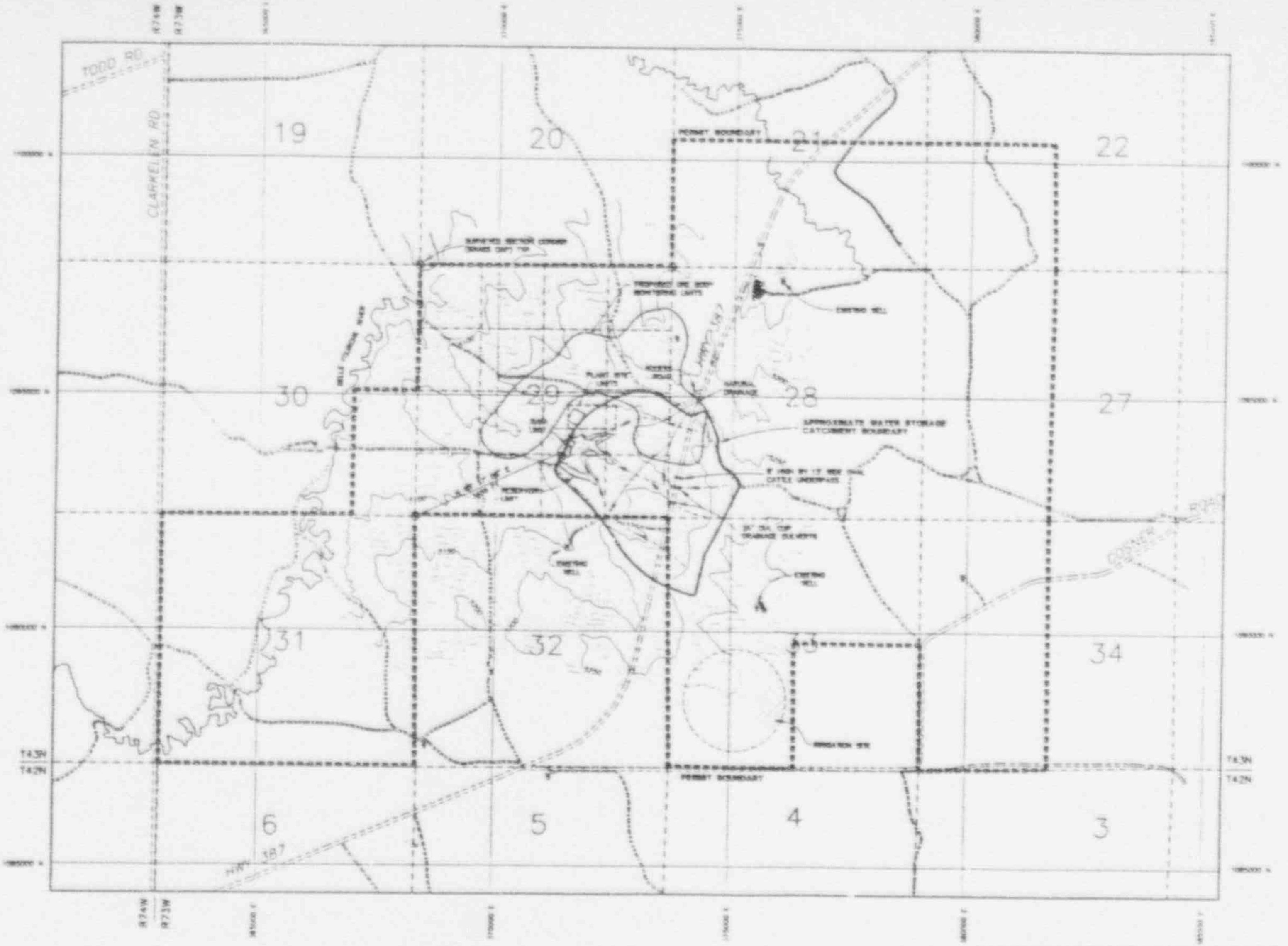


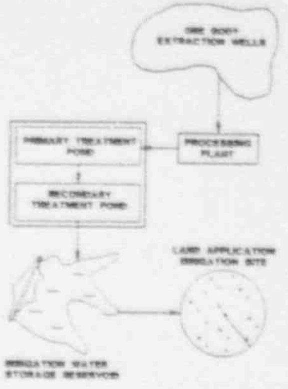
energy fuels nuclear inc.

Project: RENO CREEK ISL PROJECT

REVISIONS		County: Campbell	State: Wyoming
Date	By	Location: T 43 N, R 73 W	
		PROJECT LOCATION	
		Scale:	Date: Oct. 1993 proj-loc
		Author:	Drafted By: D L Siedd

Figure 1.1





SCHEMATIC OF WATER TREATMENT AND STORAGE FACILITIES

SCALE IN FEET

NO.	DESCRIPTION	BY	CK	APPR'D	DATE
	ISSUED DRAFT FOR REVIEW			L.L.B.	6/93
	ISSUED FOR PERMITTING				

PREPARED FOR:

ENERGY FUELS NUCLEAR INC.
RENO CREEK ISL PROJECT

TITLE:

GENERAL
FACILITIES LAYOUT

PREPARED BY:

WESTEC

SCALE: 1" = 1000'

DRAWING No.: 35701-02

REVISION: 1

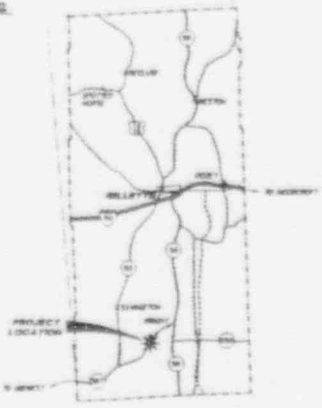
ENGINEER

DESIGN PLANS FOR THE

RENO CREEK ISL PROJECT
TREATMENT PONDS & IRRIGATION
WATER STORAGE FACILITIES

ENERGY FUELS NUCLEAR INC.
CAMPBELL COUNTY, WYOMING

STATE OF WYOMING
(NOT TO SCALE)



CAMPBELL COUNTY, WYOMING

0 7.5 15 30
APPROX. SCALE IN MILES

LIST OF DRAWINGS

DRAWING No.	TITLE	REVISION
35701-01	TITLE SHEET AND PROJECT LOCATION MAP	△1
35701-02	GENERAL FACILITIES LAYOUT	△1
J5701-03	TREATMENT POND FACILITIES LAYOUT AND EXPLORATION SUMMARY LOGS	△1
35701-04	TREATMENT POND CROSS SECTIONS & DETAILS	△1
35701-05	IRRIGATION RESERVOIR FACILITIES LAYOUT	△1
35701-06	IRRIGATION RESERVOIR CROSS SECTIONS AND DETAILS	△1

STATE APPROVAL

WYOMING

I HEREBY CERTIFY THAT THE DRAWINGS FOR THE DESIGN OF THE RENO CREEK ISL PROJECT TREATMENT PONDS & IRRIGATION WATER STORAGE FACILITIES WERE PREPARED UNDER MY DIRECTION BY WELSH ENGINEERING SCIENCE AND TECHNOLOGY, INC. (WESTEC) FOR ENERGY FUELS NUCLEAR INC.

GENERAL NOTE

DESIGN DRAWINGS SHOW STATE COORDINATES FOR THE LOCATION OF THE PROPOSED TREATMENT PONDS AND DAM EMBANKMENT CENTERLINES. AUTOCAD WAS USED TO DETERMINE THE APPROXIMATE DISTANCE AND BEARING FROM THE S.W. CORNER OF SECTION 29, T. 43 N., R. 73 W. TO THE DAM CENTROID (CENTER OF VALLEY), BASED ON TOPOGRAPHIC MAPS PROVIDED BY ENERGY FUELS NUCLEAR, INC. THE PROPOSED DAM CENTROID WAS USED FOR TIE-IN LOCATION TO THE SECTION CORNER, SINCE THE DAM DOES NOT HAVE A PLANNED OUTLET STRUCTURE THROUGH THE EMBANKMENT.

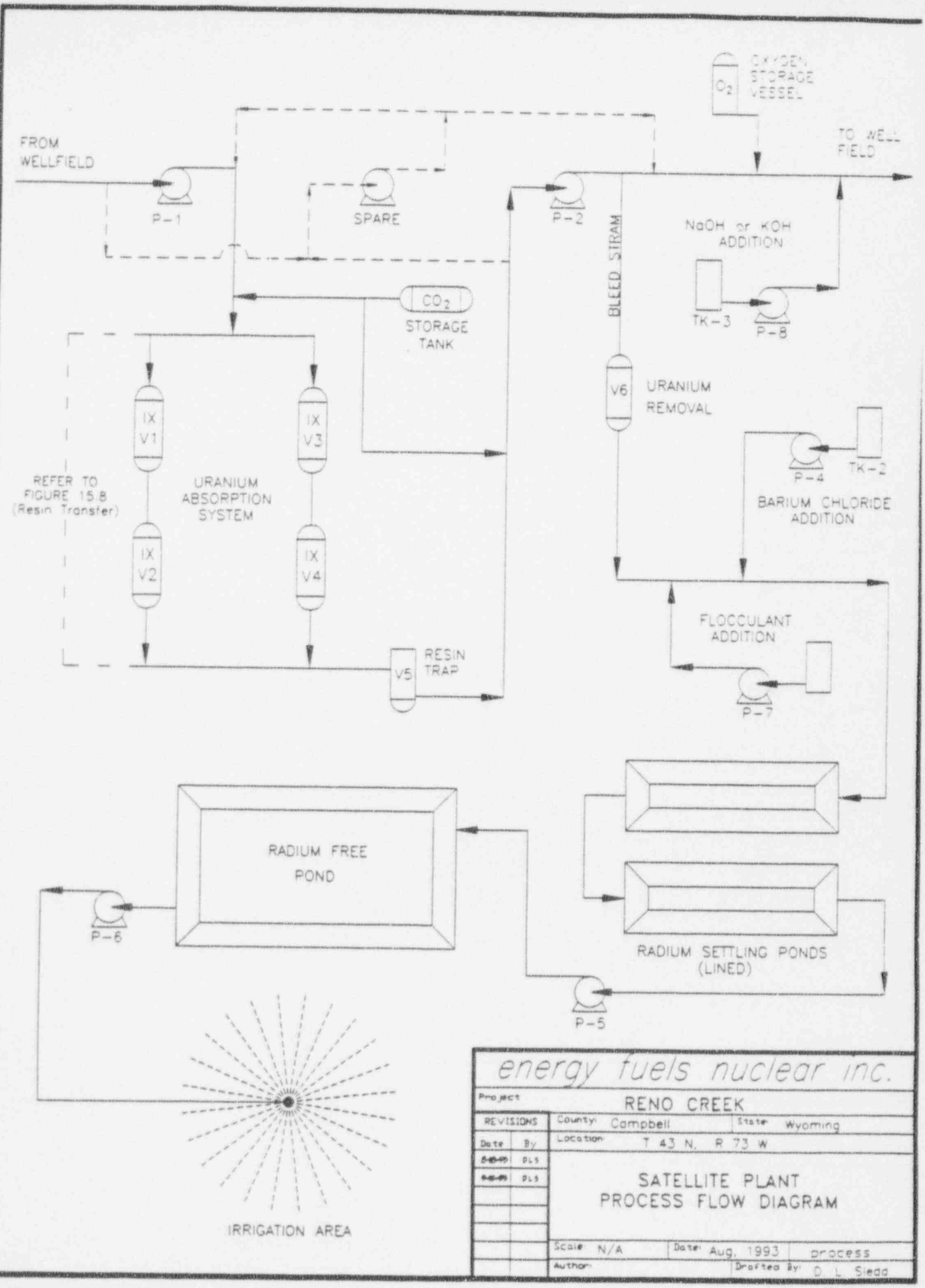
PREPARED FOR

ENERGY FUELS NUCLEAR INC.

PREPARED BY

WESTEC
WELSH ENGINEERING SCIENCE & TECHNOLOGY, INC.
5800 S. QUEBEC STREET, SUITE 319-B
ENGLEWOOD, COLORADO 80111
(303) 290-9717

TITLE SHEET DRAWING NO. 35701-01



energy fuels nuclear inc.

Project RENO CREEK

REVISIONS

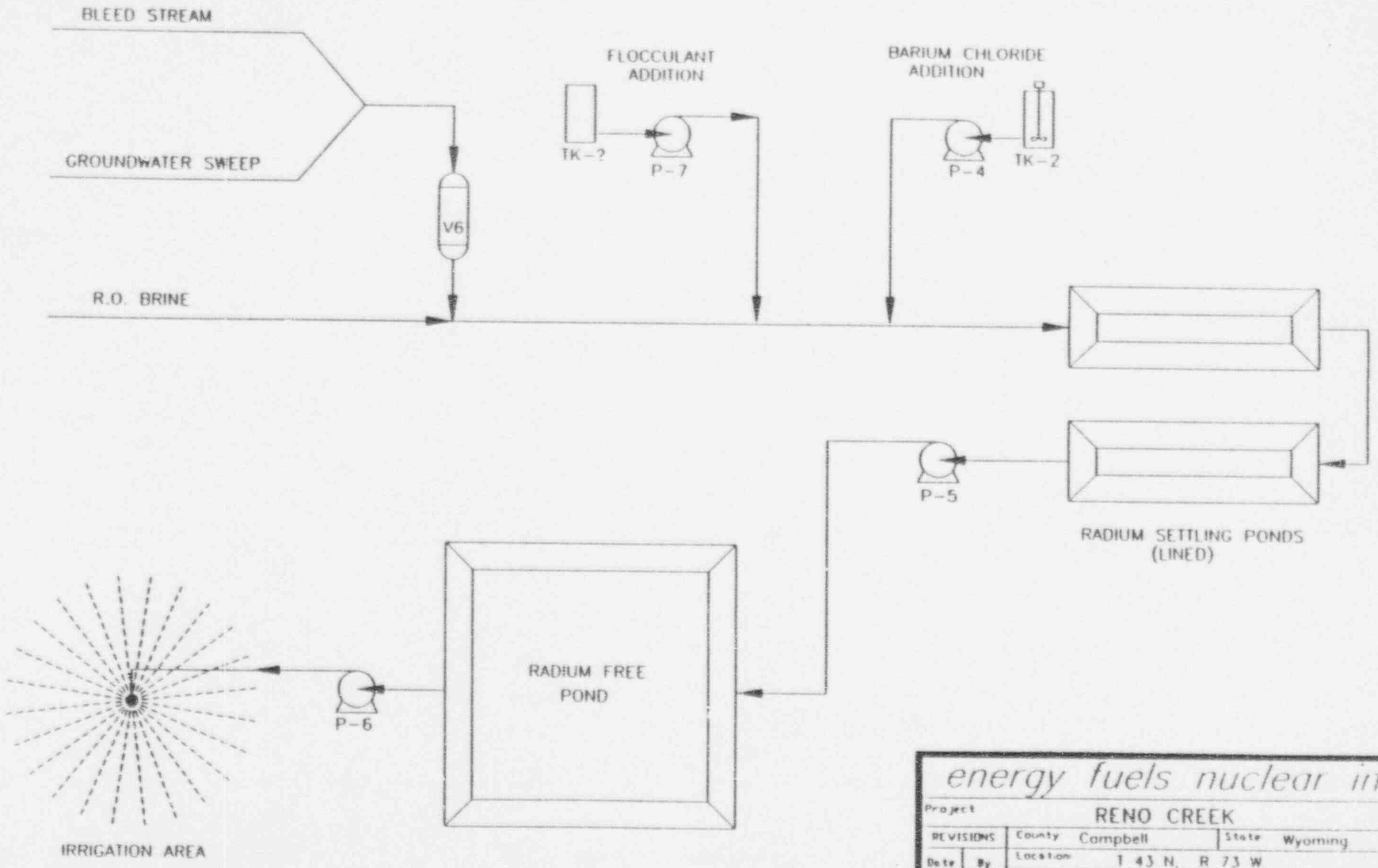
Date	By
[illegible]	DLS
[illegible]	DLS

County: Campbell
State: Wyoming
Location: T 43 N, R 73 W

SATELLITE PLANT
PROCESS FLOW DIAGRAM

Scale: N/A
Date: Aug, 1993
process
Author:
Drafted By: D. L. Siedd

Figure 1.4



energy fuels nuclear inc.

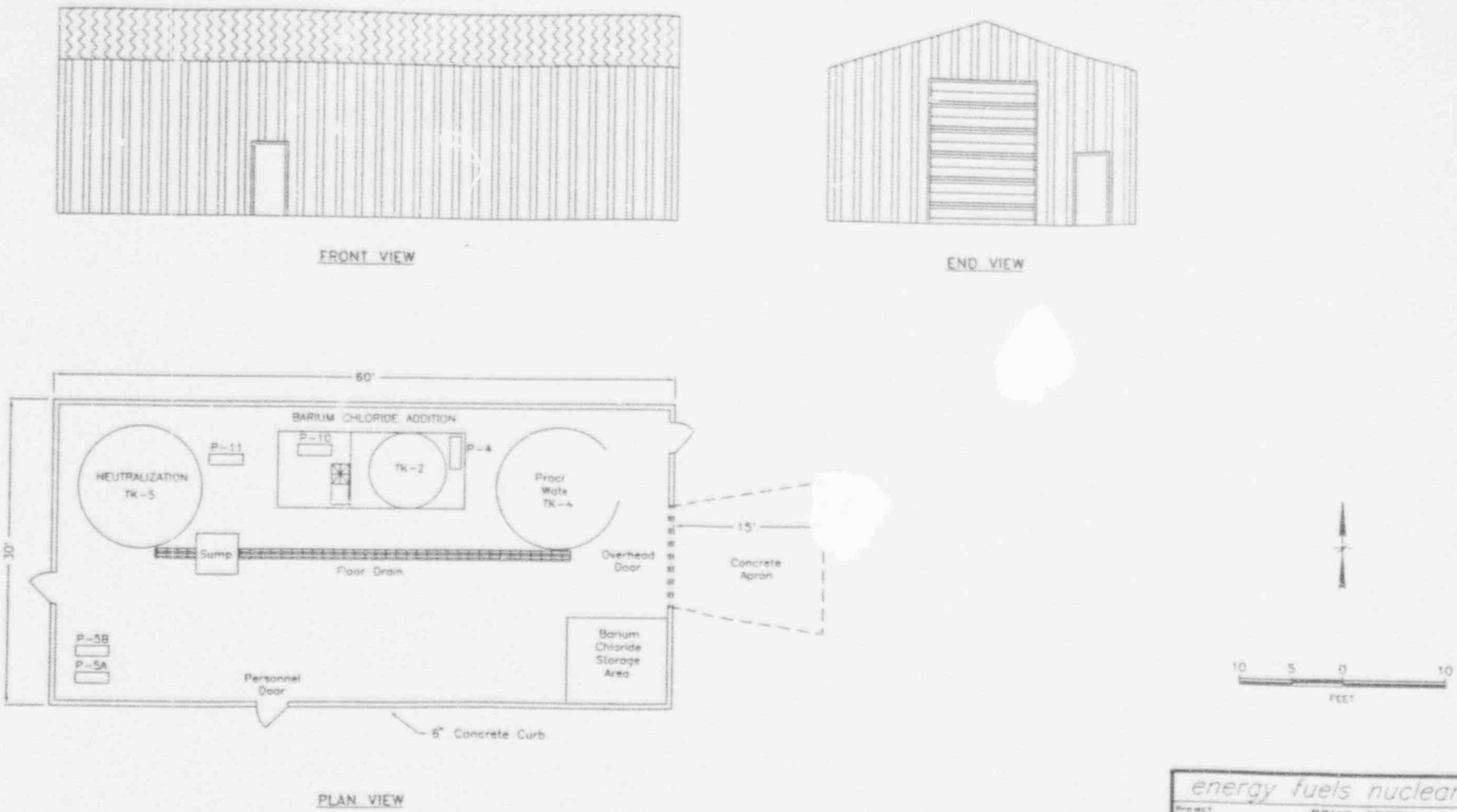
Project RENO CREEK

REVISIONS		County Campbell	State Wyoming
Date	By	Location T 43 N, R 73 W	
[illegible]	PLS		
[illegible]	PLS		

WASTE WATER TREATMENT SYSTEM
PROCESS FLOW DIAGRAM

Scale: N/A | Date: July, 1993 | [illegible]
Author: | Draftsman [illegible]

Figure 1.5



energy fuels nuclear inc.

Project: RENO CREEK

REVISIONS

County: Campbell

State: Wyoming

Location: T 43 N, R 73 N

Date | By

WASTE WATER TREATMENT SYSTEM

Scale: 1" = 10'

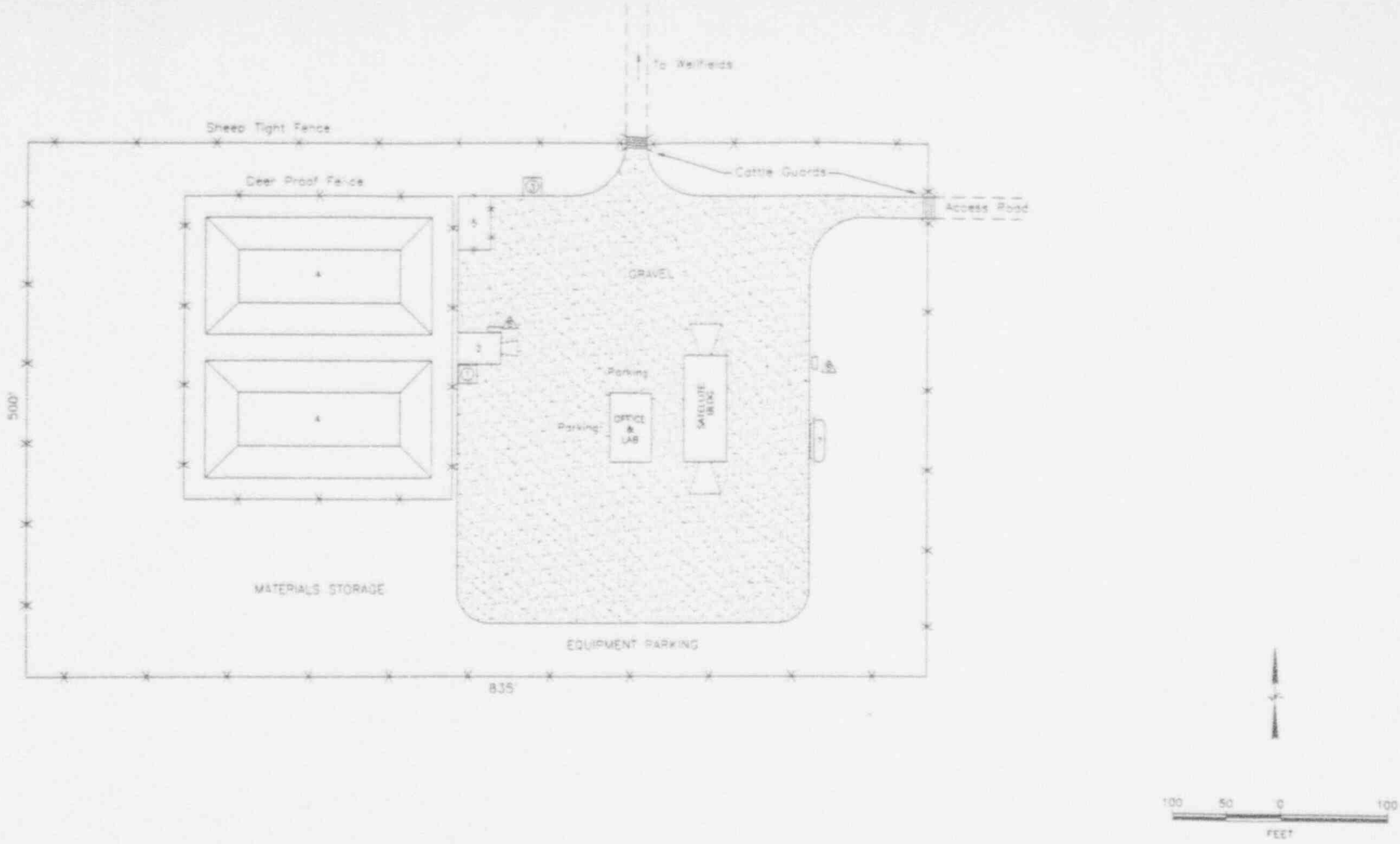
Date: July, 1993

wtrsh

Author:

Draftsman: DL Sh

Figure 1.8



LEGEND

1	Caustic Soda Strorage Tank
2	Waste Water Treatmant
3	Hydrochloric Acid Storage Tank
4	Lined Radium Removal Ponds
5	Gas, Diesel & Propane Storage Area
6	Electrical Transformer
7	Carbon Dioxide Storage Vessel

energy fuels nuclear inc.

Project RENO CREEK

County Campbell   State Wyoming

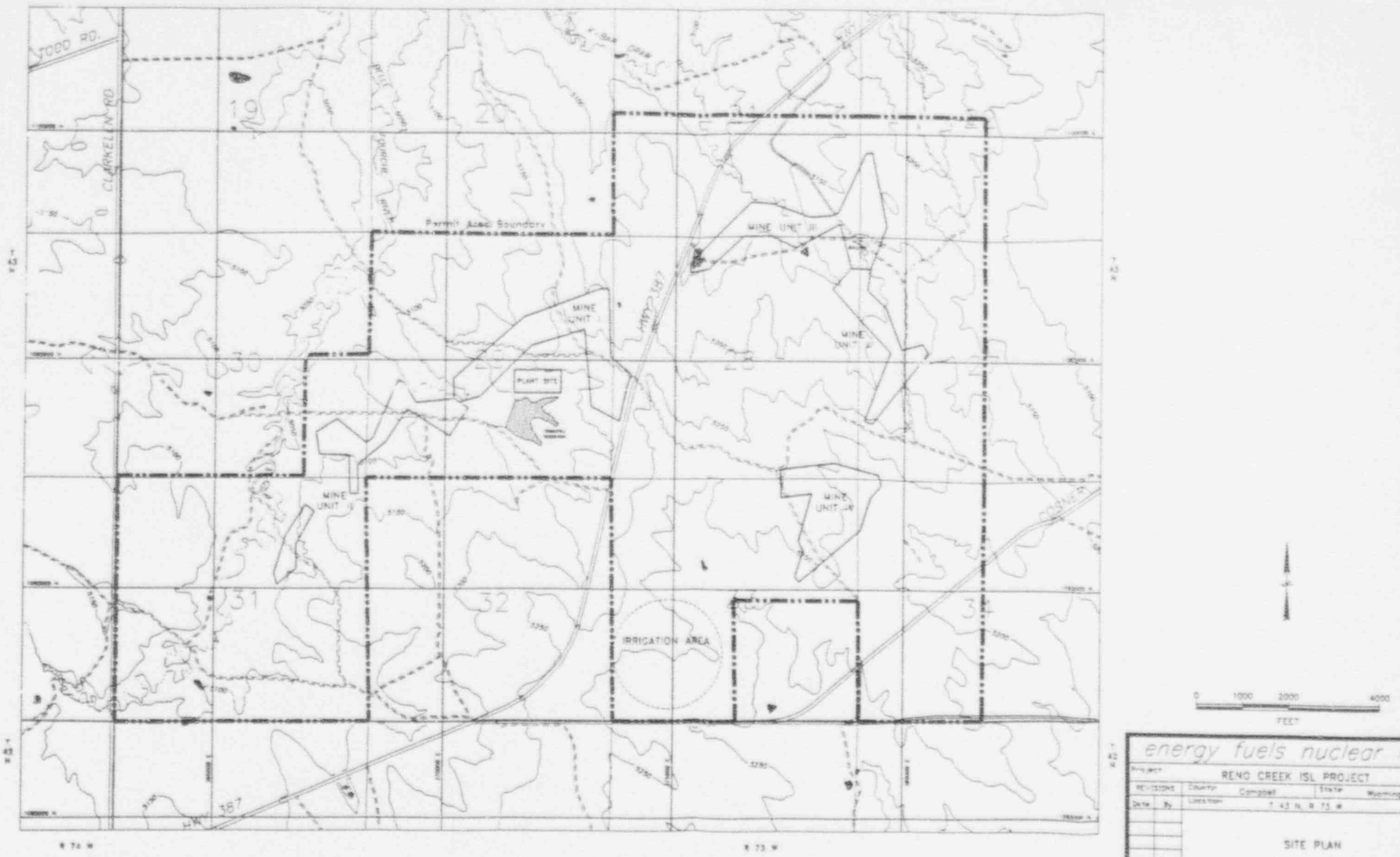
Location T 43 N, R 73 W

PROCESS AREA LAYOUT

Scale 1" = 100'   Date July, 1993

Draftsman D.L. Stead

Figure 1.3



energy fuels nuclear inc.

Project RENO CREEK ISL PROJECT

REVISIONS		County Campbell	State Wyoming
Date	By	Location T 43 N, R 73 W	

SITE PLAN

Scale 1"=2000' Date October 1993

Author Draftsman DL Stead

Figure 1.2

APPENDIX A

CLIMATIC DATA

TABLE A.1
PRECIPITATION DATA - CASPER, WYOMING

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1980	0.81	0.63	1.19	0.35	2.82	0.10	0.85	0.65	0.10	0.64	0.74	0.37	9.25
1981	0.46	0.23	0.77	1.56	3.51	0.37	1.27	0.50	0.23	0.76	0.75	0.43	10.84
1982	0.41	0.33	0.60	1.25	2.10	4.15	1.92	0.88	3.40	1.18	0.55	3.71	20.48
1983	0.42	0.35	2.29	2.28	1.40	3.76	2.61	0.78	0.20	0.88	2.72	0.78	18.41
1984	1.19	0.48	1.59	2.23	1.33	1.34	2.26	0.25	0.50	0.71	0.70	0.78	13.36
1985	0.79	0.61	0.52	1.25	1.37	1.32	1.57	0.09	1.09	0.46	1.56	1.05	11.68
1986	0.36	0.89	0.55	1.89	1.33	4.06	0.88	0.27	1.31	2.63	1.48	0.27	15.92
1987	1.42	1.42	1.43	0.35	1.40	0.70	1.93	1.80	0.59	0.55	0.77	0.63	12.99
1988	0.28	0.79	0.71	0.71	1.24	0.28	0.55	0.16	0.74	0.12	0.48	0.50	6.56
1989	0.16	1.37	0.49	0.72	2.77	1.95	0.28	1.00	3.22	1.17	0.34	0.31	13.78
1990	0.27	0.70	1.13	1.35	1.09	0.66	2.15	1.89	0.52	0.90	1.27	0.61	12.54
AVG	0.60	0.71	1.02	1.27	1.85	1.70	1.48	0.75	1.08	0.91	1.03	0.86	13.26

TABLE A.2
PRECIPITATION DATA - GILLETTE, WYOMING

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1981	0.28	0.57	1.27	0.48	4.54	1.38	2.82	2.32	0.27	0.93	0.25	0.67	15.78
1982	0.75	0.27	1.82	1.73	4.82	3.65	3.34	4.39	4.38	2.15	0.54	1.78	29.62
1983	0.27	0.25	1.35	1.30	2.30	1.27	0.38	1.92	0.40	2.35	1.35	1.01	14.15
1984	0.65	0.30	1.40	3.75	1.75	3.30	0.25	0.36	0.45	0.30	1.25	0.31	13.07
1985	0.33	0.02	0.54	0.76	3.24	2.62	2.15	0.90	1.91	0.10	1.12	0.38	14.07
1986	0.31	0.52	0.92	2.01	1.93	2.10	0.70	0.33	4.41	2.79	1.11	0.22	17.35
1987	0.14	0.99	0.87	0.24	3.76	2.94	2.91	2.10	1.16	0.74	0.43	0.52	16.50
1988	0.23	0.56	0.66	0.33	1.37	1.79	2.70	1.30	1.32	0.88	0.90	0.95	12.56
1989	0.07	0.34	0.95	1.25	4.07	2.29	1.16	0.80	2.04	1.01	0.38	0.41	15.31
1990	0.28	0.26	0.68	2.55	1.17	0.82	2.28	2.35	0.80	0.75	0.37	0.05	12.72
1991	0.08	0.74	0.71	2.24	4.06	2.03	1.80	0.64	0.85	0.87	0.81	0.61	14.88
AVG	0.31	0.44	1.02	1.51	3.00	2.20	1.86	1.58	1.64	1.17	.77	.63	16.00

TABLE A.3
PRECIPITATION DATA - KAYCEE, WYOMING

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1981	0.30	0.33	1.25	0.52	4.91	1.13	1.12	0.84	0.37	0.81	0.46	0.55	12.69
1982	0.49	0.12	1.27	1.11	2.54	4.34	2.80	0.60	3.74	1.51	0.24	1.04	19.80
1983	0.12	0.11	0.90	0.95	2.23	1.87	0.57	1.58	0.20	1.73	1.29	0.89	12.44
1984	0.86	0.26	0.70	1.40	0.88	2.77	0.96	0.36	0.51	0.51	0.72	0.17	10.10
1985	0.45	0.42	0.67	1.11	3.40	1.30	0.41	0.12	1.66	0.30	1.04	0.28	11.22
1986	0.27	0.85	0.41	2.22	2.12	1.10	1.30	0.57	1.14	--	--	0.10	--
1987	0.70	0.70	0.59	2.88	2.88	1.90	2.14	0.99	1.57	0.41	1.18	0.07	16.01
1988	0.18	0.21	0.54	0.90	1.15	0.49	0.56	0.25	0.83	0.23	0.41	0.34	6.09
1989	0.15	0.38	0.81	1.88	2.87	1.48	--	0.45	2.03	1.36	0.25	0.26	--
1990	0.21	0.23	0.55	0.84	1.02	1.42	1.39	0.56	0.61	1.21	0.43	0.36	8.83
1991	0.20	0.25	0.91	2.66	3.58	2.52	1.05	0.29	1.42	0.61	0.29	0.14	13.92
AVG	0.36	0.35	0.78	1.51	2.51	1.85	1.23	0.60	1.28	0.87	0.63	0.38	12.34

TABLE A.4
PRECIPITATION DATA - MIDWEST, WYOMING

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1981	0.36	0.48	1.34	0.73	4.58	0.24	2.27	0.38	0.56	0.95	0.65	0.38	12.92
1982	0.39	0.29	1.64	1.39	--	--	2.18	1.07	3.64	1.82	--	--	--
1983	--	--	--	--	--	--	--	--	--	1.51	1.63	0.85	--
1984	0.65	0.40	0.68	2.10	1.18	0.67	1.40	0.22	0.21	--	0.15	0.21	--
1985	0.29	0.48	--	--	1.08	1.94	1.33	--	1.13	0.78	--	--	--
1986	0.02	0.13	1.23	1.41	1.44	2.82	0.04	0.00	0.15	2.68	0.79	0.73	--
1987	--	1.50	2.27	0.14	3.01	3.46	2.57	--	--	--	--	0.95	--
1988	0.30	0.50	0.09	0.04	0.90	0.74	0.11	0.37	1.94	1.44	0.69	0.41	12.17
1989	0.22	0.16	0.30	1.25	2.58	1.59	0.92	0.60	2.36	1.21	0.03	0.07	11.29
1990	0.36	0.08	0.41	1.16	1.32	0.73	0.71	0.35	0.33	0.02	0.92	0.22	6.61
1991	0.08	0.61	1.09	3.69	2.67	1.02	1.11	0.27	0.48	0.21	0.60	0.25	14.34
AVG	0.30	0.46	1.01	1.32	2.08	1.08	1.26	0.41	1.20	1.18	0.68	0.45	11.47

TABLE A.5
MAXIMUM SNOWFALL AMOUNTS (INCHES) - CASPER, WYOMING
(FOR MONTHLY AND 24 HOUR PERIOD)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
MONTHLY	22.1	22.7	27.7	33.6	15.7	T	T	T	11.5	16.1	37.1	62.8	62.8
YEAR	1980	1987	1983	1984	1980	1990	1990	1990	1982	1986	1983	1982	1982
HOUR (24)	7.6	9.8	9.2	9.8	8.1	T	T	T	6.8	13.1	14.3	31.1	31.1
YEAR	1980	1990	1987	1985	1980	1990	1990	1990	1982	1986	1983	1982	1982

TABLE A.6
AVERAGE RELATIVE HUMIDITY (%) - CASPER, WYOMING
(FOR 1990)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
HOUR 05	66	66	78	81	82	68	75	74	67	62	59	62	70
HOUR 11	51	51	52	50	41	32	34	30	32	39	48	54	43
HOUR 17	51	48	46	49	41	26	28	28	27	38	53	55	41
HOUR 23	65	64	74	76	70	59	61	58	51	62	58	51	63

TABLE A.7
TEMPERATURE DATA - CASPER, WYOMING

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1980	16.4	27.5	31.0	44.2	51.6	64.4	72.2	66.4	59.7	46.5	33.8	34.2	45.7
1981	31.4	29.9	38.0	48.3	51.4	64.3	71.8	69.2	62.0	44.4	39.0	27.3	48.1
1982	20.1	25.7	36.6	41.1	51.1	60.3	70.2	73.7	56.9	45.2	32.2	23.3	44.7
1983	31.2	31.5	36.3	38.0	48.4	50.4	71.2	74.8	60.2	49.7	31.2	10.9	45.3
1984	21.9	27.5	34.4	39.1	54.5	61.5	70.4	71.2	52.5	40.1	34.8	22.9	44.2
1985	16.1	19.7	33.3	45.5	55.3	61.3	71.6	66.7	53.4	45.3	20.3	21.3	42.5
1986	31.6	28.5	42.8	44.4	50.9	67.4	69.0	69.3	55.5	45.9	32.0	26.2	47.0
1987	23.1	28.4	32.4	49.7	57.5	64.8	70.7	66.2	58.7	46.7	35.5	23.8	46.5
1988	20.3	27.4	32.0	46.0	54.2	72.6	73.5	69.8	58.0	49.8	34.0	26.3	47.0
1989	26.1	11.9	35.6	44.9	54.0	61.2	73.4	69.0	48.2	46.3	37.3	24.1	45.2
1990	29.1	27.9	35.4	44.3	50.5	64.6	69.8	68.5	63.2	46.3	36.9	15.8	46.0
AVG	24.3	26.0	35.3	44.1	52.7	63.0	71.2	69.5	58.0	46.0	33.4	23.3	45.7

TABLE A.8
TEMPERATURE DATA - GILLETTE, WYOMING

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1981	31.4	29.9	38.0	48.3	51.4	64.3	71.8	69.2	62.0	44.4	39.0	27.3	48.1
1982	15.4	24.6	32.0	39.5	49.2	57.7	68.1	70.2	55.3	44.5	30.7	23.3	42.5
1983	30.6	34.6	36.5	39.7	49.0	62.0	72.8	76.3	59.8	49.7	32.9	7.3	45.9
1984	24.6	31.2	34.2	39.9	50.9	61.3	71.8	73.2	55.2	42.7	36.2	20.7	45.2
1985	18.8	21.6	34.4	48.7	57.4	60.9	72.5	67.3	54.3	46.1	17.1	20.6	43.3
1986	30.0	24.8	42.8	43.1	52.7	67.8	70.9	70.6	54.0	47.6	29.0	25.5	46.6
1987	25.5	30.8	31.8	49.5	58.2	64.3	69.3	63.8	57.9	45.4	37.1	25.2	46.6
1988	20.0	24.4	32.6	45.1	56.5	73.0	74.0	69.9	57.8	48.3	32.1	26.8	46.7
1989	25.2	11.2	30.8	42.9	52.2	60.7	73.2	69.6	56.8	45.8	34.7	18.9	43.5
1990	26.4	25.8	33.8	42.2	50.5	63.5	69.4	70.0	64.7	44.7	37.3	14.2	45.2
1991	17.0	34.7	35.8	41.5	52.4	63.5	70.4	72.3	58.9	42.8	28.3	27.8	45.5
AVG	22.4	26.7	34.8	43.7	52.8	63.5	71.3	70.2	57.9	45.6	3.22	21.6	45.4

TABLE A.9
TEMPERATURE DATA - KAYCEE, WYOMING

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1981	32.3	29.7	38.6	49.0	52.9	63.6	73.3	69.5	61.8	46.0	39.7	27.0	58.6
1982	17.8	27.8	36.1	41.6	51.0	59.5	69.5	72.9	56.0	45.6	32.9	26.1	44.7
1983	32.2	33.7	37.7	39.9	49.5	62.2	71.3	74.1	59.9	50.2	33.1	8.5	46.0
1984	24.6	31.0	35.8	40.7	55.0	63.0	72.6	72.1	54.8	42.6	36.0	22.9	45.9
1985	16.4	22.9	34.8	47.7	57.1	63.0	71.6	67.5	53.4	45.9	16.7	20.9	43.2
1986	32.9	27.8	43.8	45.8	52.2	68.3	--	69.5	55.8	--	--	26.4	--
1987	25.1	30.7	34.7	48.7	57.6	65.7	69.9	66.0	58.9	47.3	38.1	25.6	47.4
1988	21.2	27.6	34.4	45.6	56.2	72.8	74.5	70.3	57.6	49.3	33.4	26.5	47.5
1989	24.8	11.1	45.5	46.7	54.6	62.7	--	69.3	58.2	45.8	37.1	22.4	--
1990	31.1	27.4	36.0	42.5	51.1	65.0	71.7	70.5	63.4	45.3	37.2	14.1	46.3
1991	16.8	36.4	36.3	41.4	52.3	65.6	70.6	70.7	57.7	43.0	28.2	28.4	45.6
AVG	25.0	27.8	36.7	44.5	53.5	64.7	71.7	70.2	57.9	46.1	33.2	22.6	46.1

TABLE A.10
TEMPERATURE DATA - MIDWEST, WYOMING

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1981	33.3	31.1	39.7	20.9	54.0	66.1	73.6	70.2	63.8	47.0	40.6	29.0	49.9
1982	20.8	28.6	37.7	43.9	--	-	72.3	75.8	58.1	47.8	--	--	--
1983	--	--	--	--	--	--	--	--	--	51.7	33.9	10.4	--
1984	23.2	28.6	35.8	41.1	55.7	63.9	72.6	73.0	57.3	--	37.2	24.2	--
1985	20.6	23.9	37.3	--	58.4	63.4	73.3	--	55.9	48.5	16.7	21.4	--
1986	31.8	26.7	43.3	44.8	52.9	70.0	70.9	72.4	57.0	47.5	33.9	36.9	49.0
1987	27.7	33.8	35.7	53.2	61.6	67.3	71.5	--	--	--	--	24.7	--
1988	20.0	23.5	33.4	46.4	56.0	73.5	74.8	69.1	56.9	50.7	33.0	26.0	47.4
1989	25.8	13.2	37.0	44.6	55.1	62.0	73.6	69.3	57.3	47.3	36.3	22.8	45.4
1990	31.8	28.6	37.2	43.3	52.0	64.9	70.3	70.7	63.8	45.8	35.5	11.6	46.3
1991	18.1	34.3	37.8	41.0	52.5	64.7	70.8	71.3	60.2	44.3	30.5	27.8	46.1
AVG	25.3	27.7	37.5	42.1	55.4	66.2	72.4	71.5	58.9	47.8	33.1	23.5	47.4

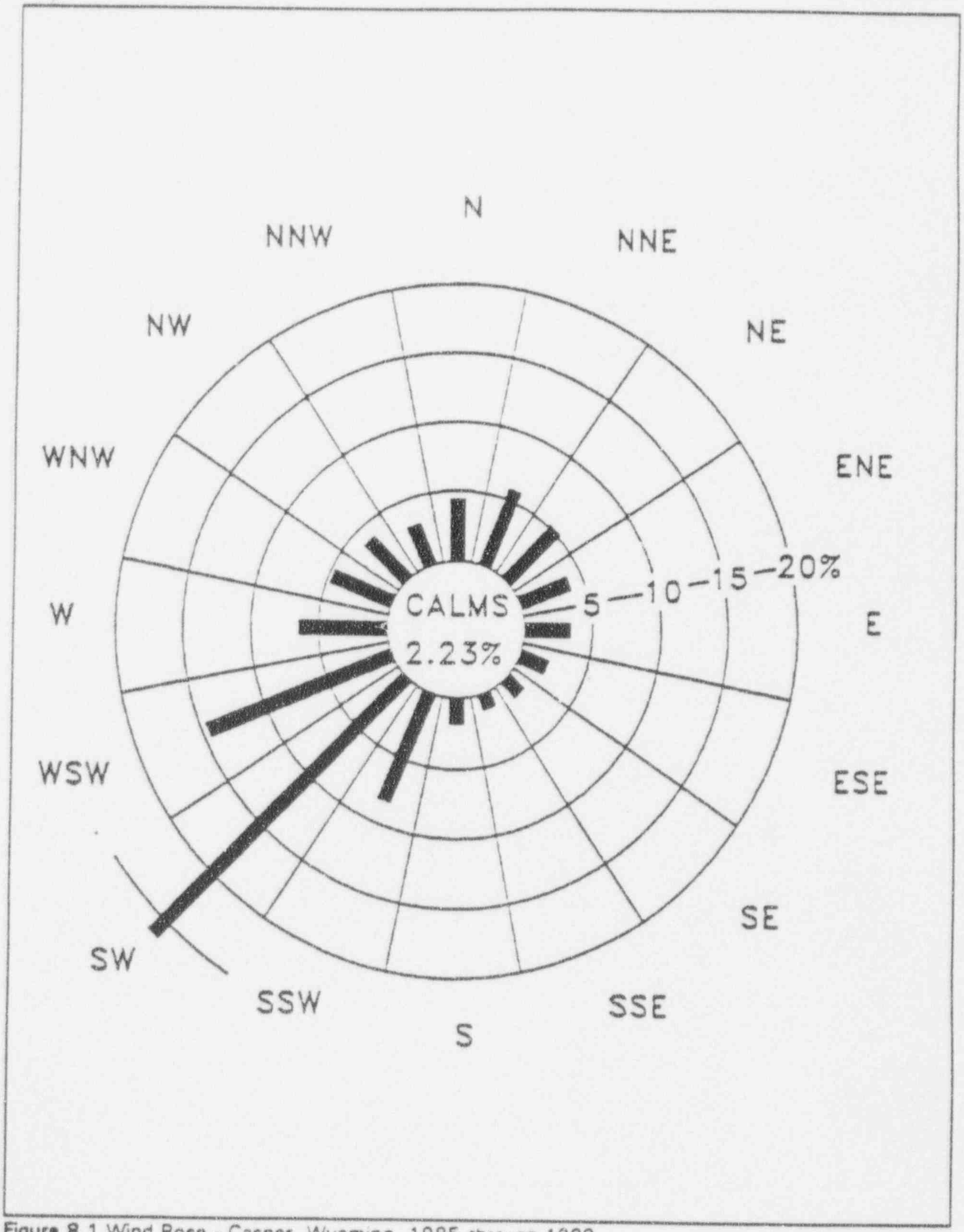


Figure 8.1 Wind Rose - Casper, Wyoming, 1985 through 1989

APPENDIX B

GEOTECHNICAL DATA

APPENDIX B.1

TEST PIT LOGS

LOG OF TEST PIT NO. WTP-1

LOCATION Collection Ponds - West Side (300 ft W. of BH 3877)

SURFACE CONDITIONS Grass and Sage Brush (all sites) ELEVATION: ____

DEPTH IN FEET	SAMPLE	MOISTURE CONTENT-%	LITHOLOGY	DESCRIPTION	SYMBOL	REMARKS
1	1'			Topsoil, Clayey, Organics, Dry to Moist, Dark to Light Brown	1'	
2 3 4 5 6	BAG 6.5'			Clay (weathered claystone), Sandy, Easily Excavates to Sand and Clay Sizes, Stiff to Very Stiff, Slightly Moist, Brown (CL) (Residual Soil) NOTE: Case 580C Backhoe.	6.5'	
7 8				Claystone, Hard to Very Hard, Silty and Sandy, Excavates to Sand, Gravel and Cobble Sizes, Moist, Gray (Bedrock).	7.8'	

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FIGURE B-1

LOG OF TEST PIT NO. WTP-2

LOCATION Collection Ponds - East Side (200 ft E. of WTP-1)

SURFACE CONDITIONS ____________ ELEVATION: ________

DEPTH IN FEET	SAMPLE	MOISTURE CONTENT-%	LITHOLOGY	DESCRIPTION	SYMBOL	REMARKS
				Topsoil (see WTP-1)		
1	BAG	1'		Clay, Stiff to Very Stiff, Silty, Slightly Moist, Light Brown (CL) (Residual Soil)	1'	
2						
3						
	BAG	3.5'		Claystone, Hard to Very Hard, Silty and Sandy, Moist, Gray (Bedrock) (Gradually Harder to Excavate with Depth)	3.5'	
4						
5						
6						
7		7'			7'	
8						

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FIGURE B-2

LOG OF TEST PIT NO. WTP-3

LOCATION Collection Ponds - North Side (100 ft E. and 100 ft N. of WTP-1)

SURFACE CONDITIONS

ELEVATION:

DEPTH IN FEET	SAMPLE	MOISTURE CONTENT-%	LITHOLOGY	DESCRIPTION	SYMBOL	REMARKS
0 – 1.2				Topsoil	1.2'	
1.2 – 3.5				Sand, Medium Dense, Silty and Clayey, Fine Grained, 6" Calcareous Layer (White) at 2' Depth, Slightly Moist, Brown (SM)	3.5'	
3.5 – 6.5				Claystone with Siltstone and Sandstone Lenses, Medium Hard to Very Hard with Depth, Slightly Moist to Moist, Gray, Brown (Bedrock)	6.5'	

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FIGURE B-3

LOG OF TEST PIT NO. WTP-4

LOCATION Dam Site Left Abutment 200' S. of WTP-5 on Ridgeline

SURFACE CONDITIONS ____________ ELEVATION: ________

DEPTH IN FEET	SAMPLE	MOISTURE CONTENT-%	LITHOLOGY	DESCRIPTION	SYMBOL	REMARKS
				Topsoil		
1		1'		Clay, Medium Stiff to Stiff, Slightly Moist to Moist, Sandy, Brown, Gray (CL)	1'	
2						
3						
4	BAG					
5						
6						
7						
8		8.5'			8.5'	

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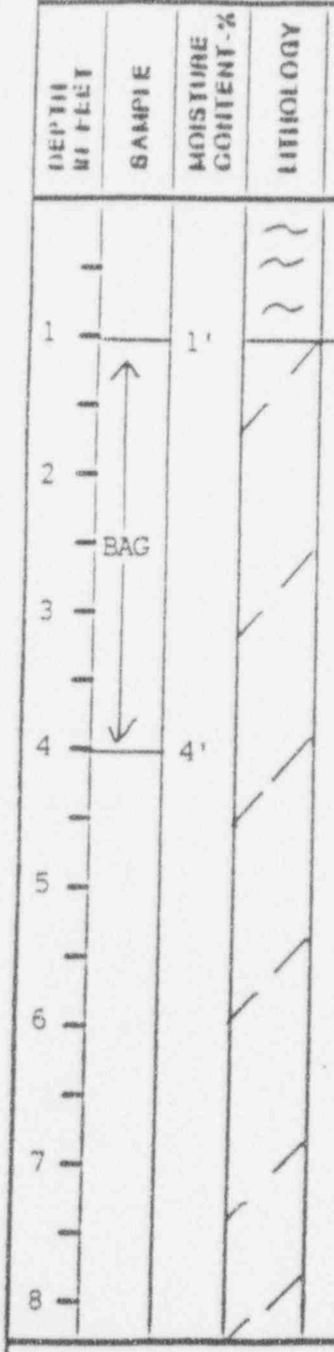
FIGURE

B-4

LOG OF TEST PIT NO. WTP-5

LOCATION Dam Site Valley Bottom at Dam Axis

SURFACE CONDITIONS ____________________ ELEVATION: __________



DESCRIPTION	SYMBOL	REMARKS
Topsoil	1'	
Clay, Medium Stiff to Stiff, Sandy, Mixture of Transported Bedrock Pieces, Moist to Very Moist with Depth, Gray, Brown (CL)	9'	

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FIGURE
B-5

LOG OF TEST PIT NO. WTP-6

LOCATION Dam Site - Right Abutment At Dam Axis on Ridgeline (50 ft E. of BH 3876)

SURFACE CONDITIONS ______________ ELEVATION: ______

DEPTH IN FEET	SAMPLE	MOISTURE CONTENT-%	LITHOLOGY	DESCRIPTION	SYMBOL	REMARKS
1				Topsoil	1'	
2 3				Sand, Medium Dense to Dense, Silty (Residual Soil), Slightly Moist, Gradual Transition to Bedrock, Brown (SM)	3'	
4 5 6 7 8				Sandstone, Medium Hard to Hard, Silty with Siltstone Lenses, Crumbles in Hand to Sand and Silt Sizes, Fine Grained, Moist, Brown (Bedrock)	8'	

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FIGURE B-6

LOG OF TEST PIT NO. WTP-7

LOCATION 500 ft SE of WTP-4 on Left Ridge of Reservoir

SURFACE CONDITIONS ______________ ELEVATION: ________

DEPTH IN FEET	SAMPLE	MOISTURE CONTENT-%	LITHOLOGY	DESCRIPTION	SYMBOL	REMARKS
				Topsoil	1'	
				Sand, Medium Dense, Silty, Clay Lenses, Fine Grained, Slightly Moist, Tan, Brown (Residual Soil) (SM)	5'	
				Claystone, Hard to Very Hard, Sandstone and Siltstone Lenses, Moist, Gray, Brown, Tan (Bedrock)	7.5'	

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FIGURE

B-7

LOG OF TEST PIT NO. WTP-8

LOCATION Reservoir Upper End of Left Drainage at 1,000 ft Upstream of WTP-4

SURFACE CONDITIONS ________________ ELEVATION: ________

DEPTH IN FEET	SAMPLE	MOISTURE CONTENT-%	LITHOLOGY	DESCRIPTION	SYMBOL	REMARKS
				Topsoil		
1		1'		Clay, Medium Stiff to Stiff, Silty, Moist to Very Moist, Brown, Gray (CL)	1'	
2						
3	BAG					
4						
5						
6		6'				
7						
8					9'	

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FIGURE

B-8

LOG OF TEST PIT NO. WTP-9

LOCATION Reservoir Middle Ridgeline at 500 ft Upstream of WTP-5 to SE

SURFACE CONDITIONS

ELEVATION:

DEPTH IN FEET	SAMPLE	MOISTURE CONTENT-%	LITHOLOGY	DESCRIPTION	SYMBOL	REMARKS
				Topsoil	0.5'	
1				Clay, Medium Stiff to Stiff, Silty, Residual Soil, Brown, Gray (CL)	2'	
2 3 4 5				Claystone with Siltstone Lenses, Hard to Very Hard, Moist, Gray, Brown (Bedrock)	6'	
6 7 8						

WESTEC

Job No. 35701

Engr. AJB

Date 8/19/93

FIGURE B-9

LOG OF TEST PIT NO. WTP-10

LOCATION Reservoir Right Side Valley Drainage at 1,000 ft± Upstream of WTP-5

SURFACE CONDITIONS

ELEVATION:

DEPTH IN FEET	SAMPLE	MOISTURE CONTENT-%	LITHOLOGY	DESCRIPTION	SYMBOL	REMARKS
0–1			~	Topsoil	1'	
1–8			/	Clay, Medium Stiff to Very Stiff, Sandy, Moist, Gray, Brown (CL)	8'	

WESTEC

Job No. 35701

Engr. AJB

Date 8/19/93

FIGURE B-10

LOG OF TEST PIT NO. WTP-11

LOCATION Reservoir Right Side Valley Drainage at 100 ft W. of BH 3878

SURFACE CONDITIONS ____________ ELEVATION: ________

DEPTH IN FEET	SAMPLE	MOISTURE CONTENT-%	LITHOLOGY	DESCRIPTION	SYMBOL	REMARKS
				Topsoil		
1					1'	
				Clay, Medium Stiff to Very Stiff, Sandy, Moist, Brown, Gray (CL)		
2						
3						
4						
5						
6						
7						
8					8'	

WESTEC

Job No. 35701

Engr. AJB

Date 8/19/93

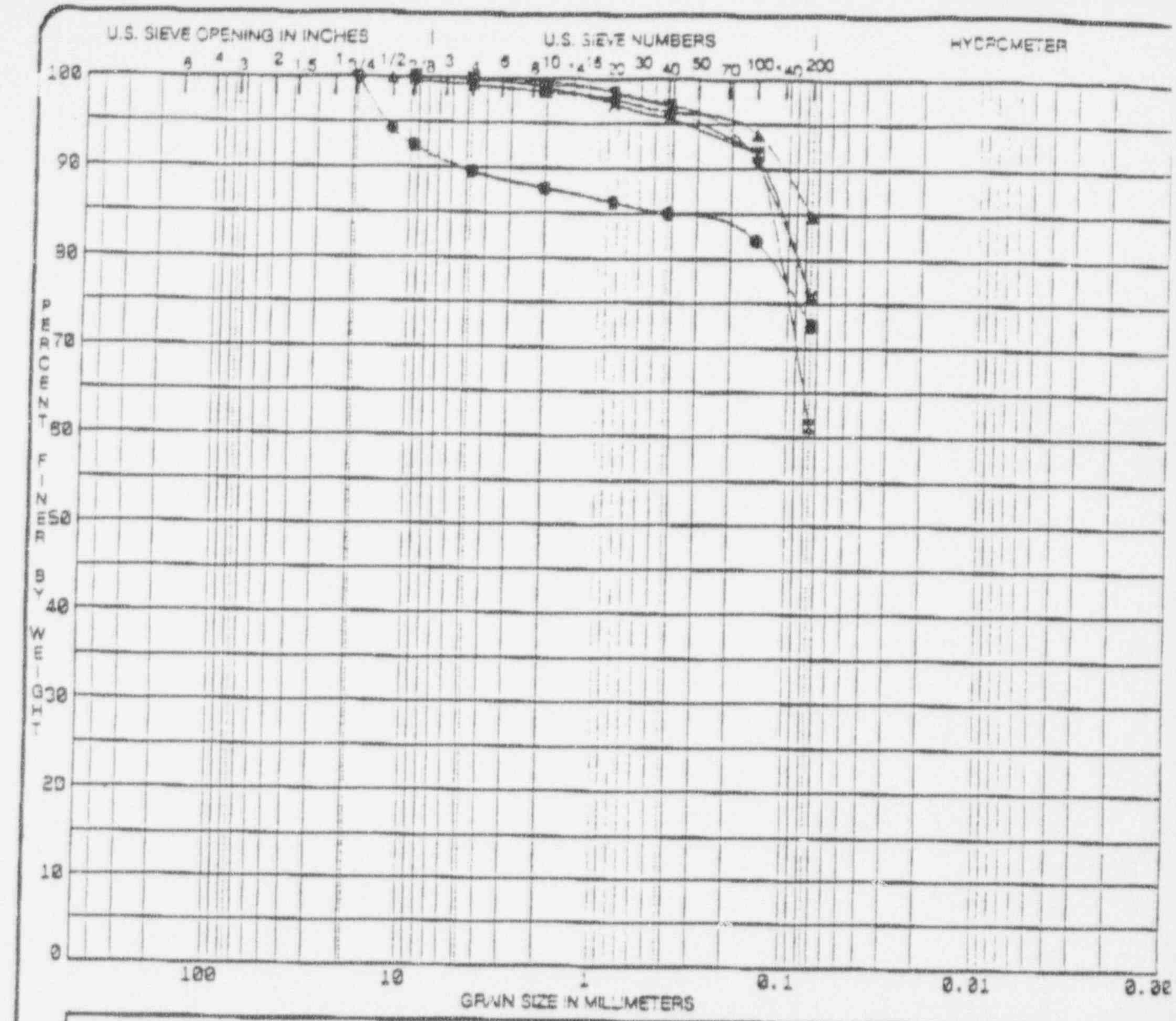
FIGURE B-11

APPENDIX B.2

LABORATORY TEST RESULTS

APPENDIX B.2.1

WESTEC LABORATORY RESULTS



<table>
<tr><td rowspan="2">COBBLES</td><td colspan="2">GRAVEL</td><td colspan="3">SAND</td><td rowspan="2">SILT OR CLAY</td></tr>
<tr><td>coarse</td><td>fine</td><td>coarse</td><td>medium</td><td>fine</td></tr>
</table>

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WTP-1	1.0 -6.5	LEAN CLAY with SAND CL		33	19	14		
⊠	WTP-2	1.0 -3.5	SANDY LEAN CLAY CL		31	21	10		
▲	WTP-4	1.0 -8.5	LEAN CLAY with SAND CL		40	19	21		
★	WTP-5	1.0 -4.0	LEAN CLAY with SAND CL		36	17	19		
☒	WTP-8	1.0 -6.0	LEAN CLAY with SAND CL		33	17	16		

Specimen identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WTP-1	1.0	19.00				10.5	17.0	72.5	
⊠	WTP-2	1.0	9.50				0.2	38.6	61.2	
▲	WTP-4	1.0	12.50				0.8	14.4	84.8	
★	WTP-5	1.0	4.75				0.0	24.5	75.5	
☒	WTP-8	1.0	9.50				0.1	24.1	75.8	

PROJECT ENERGY FUELS NUCLEAR, INC. RENO CREEK PROJECT

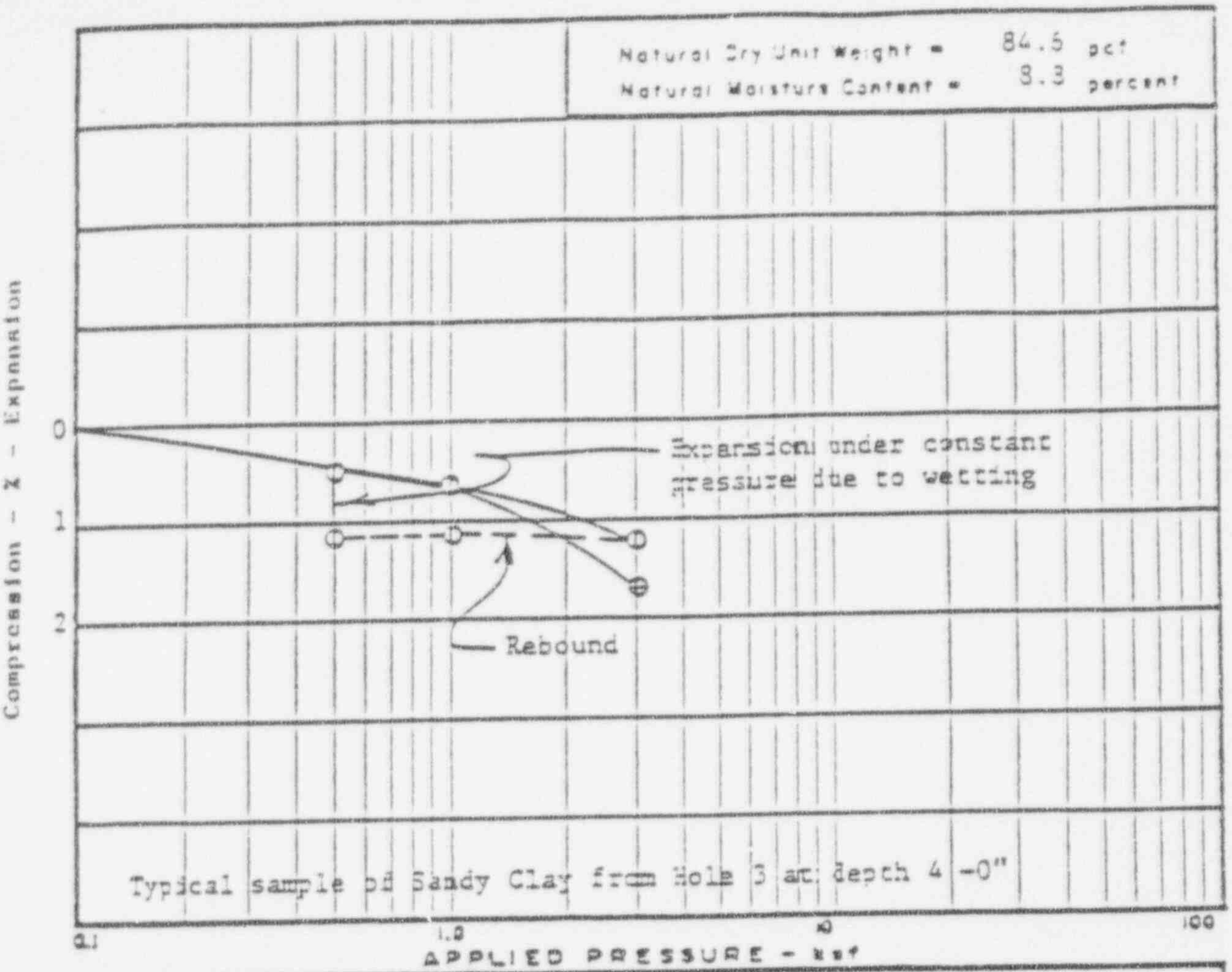
JOB NO. 35701
DATE 9/1/93

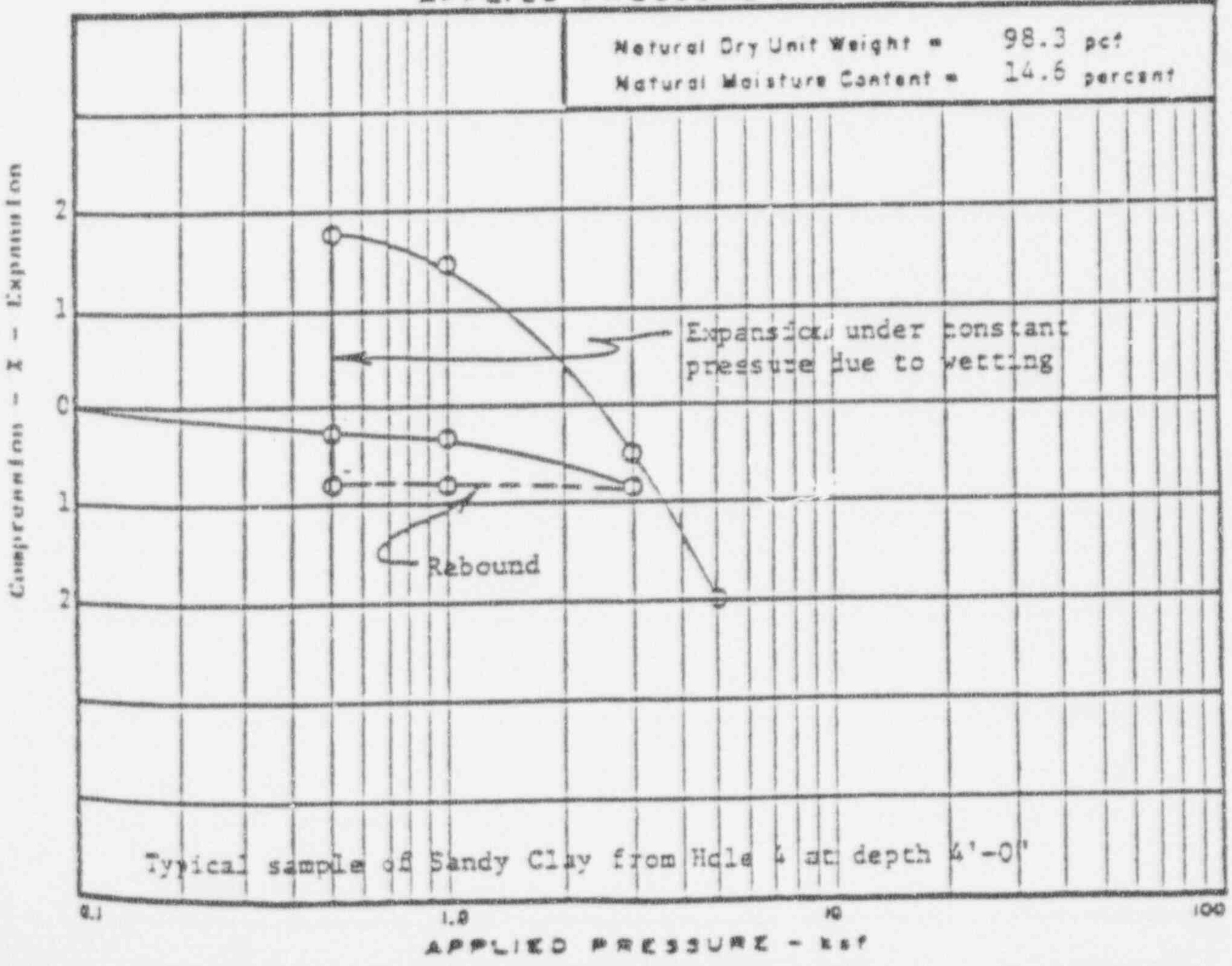
WESTEC™
Welsh Engineering Science & Technology, Inc.
Reno, Nevada

GRAIN SIZE DISTRIBUTION
FIGURE 1

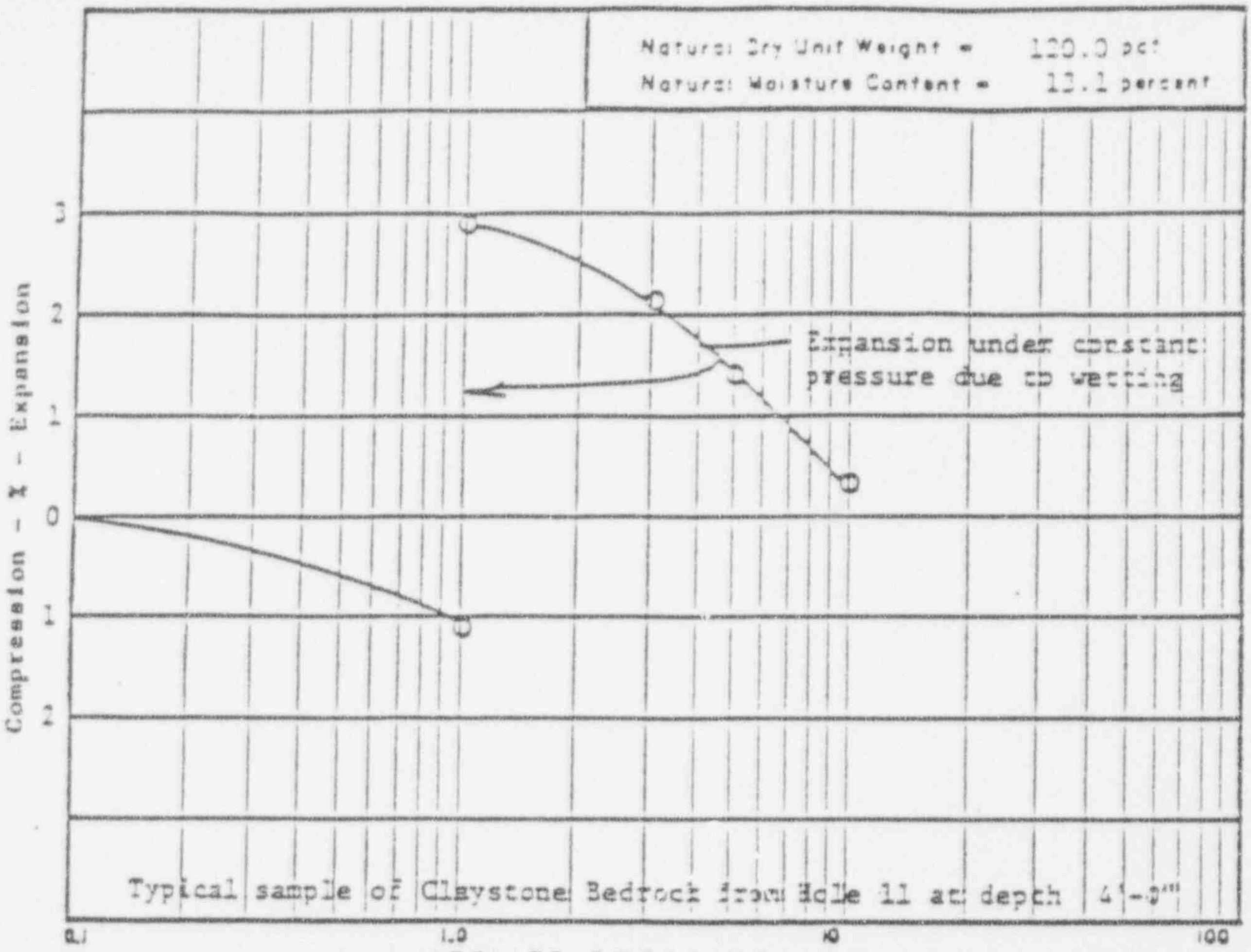
APPENDIX B.2.2

PREVIOUS LABORATORY RESULTS BY OTHERS



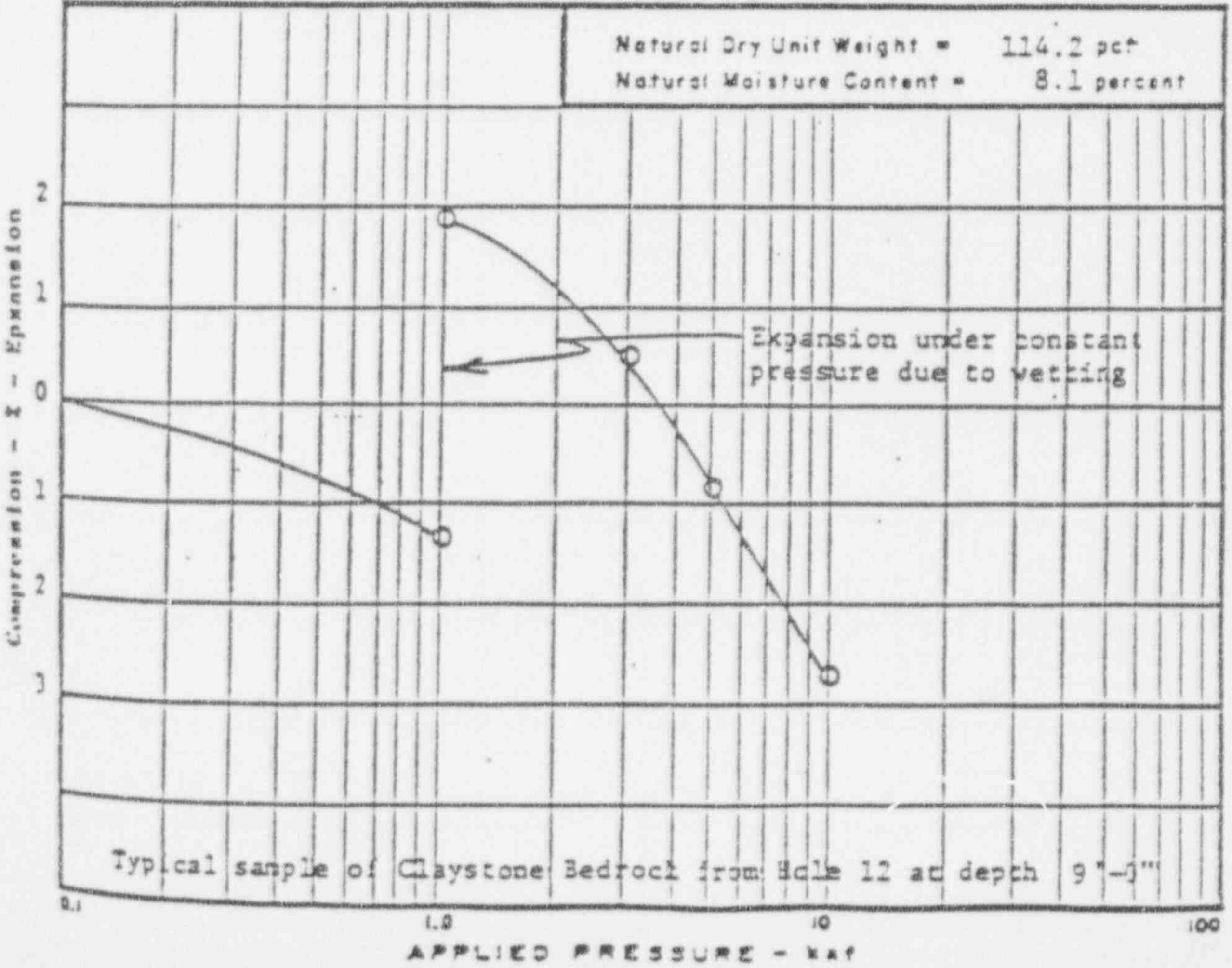


Swell-Consolidation Test Results



Natural Dry Unit Weight = 120.0 pcf
Natural Moisture Content = 13.1 percent

Typical sample of Claystone Bedrock from Hole 11 at depth 4'-0"

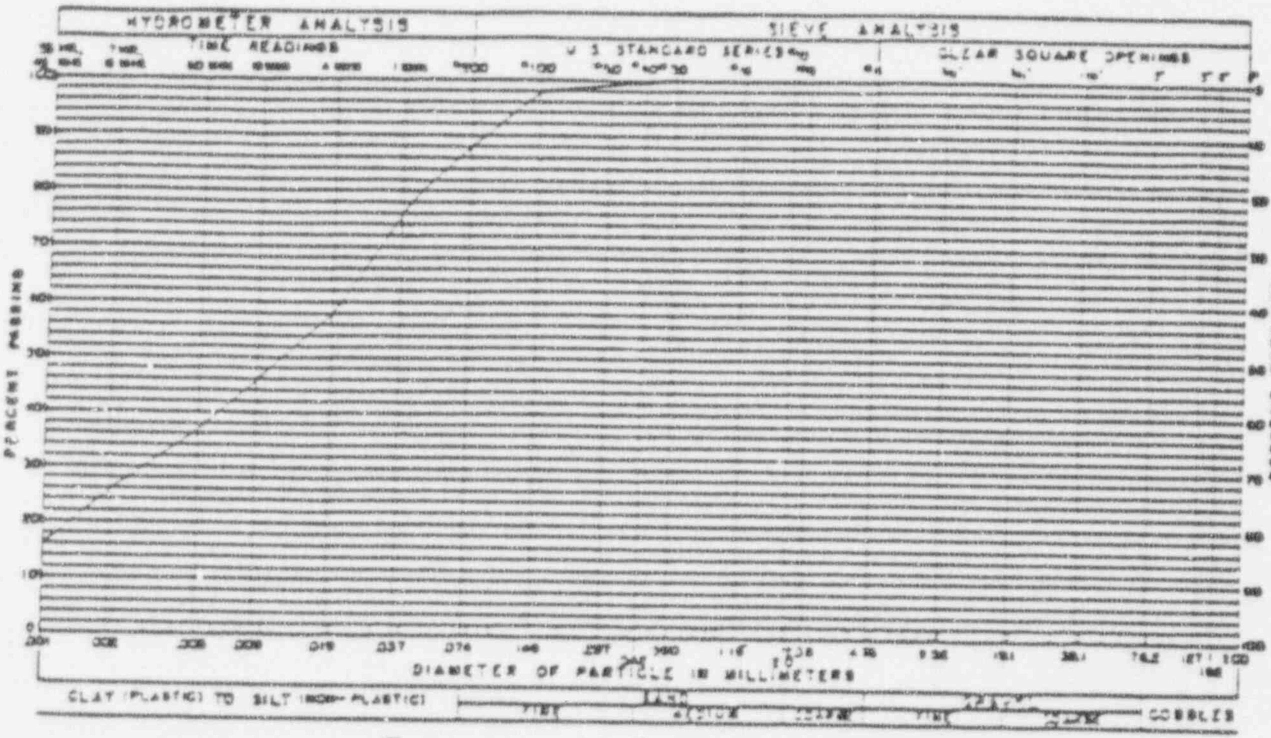


Natural Dry Unit Weight = 114.2 pcf
Natural Moisture Content = 8.1 percent

Typical sample of Claystone Bedrock from Hole 12 at depth 9'-0"

CHEN AND ASSOCIATES

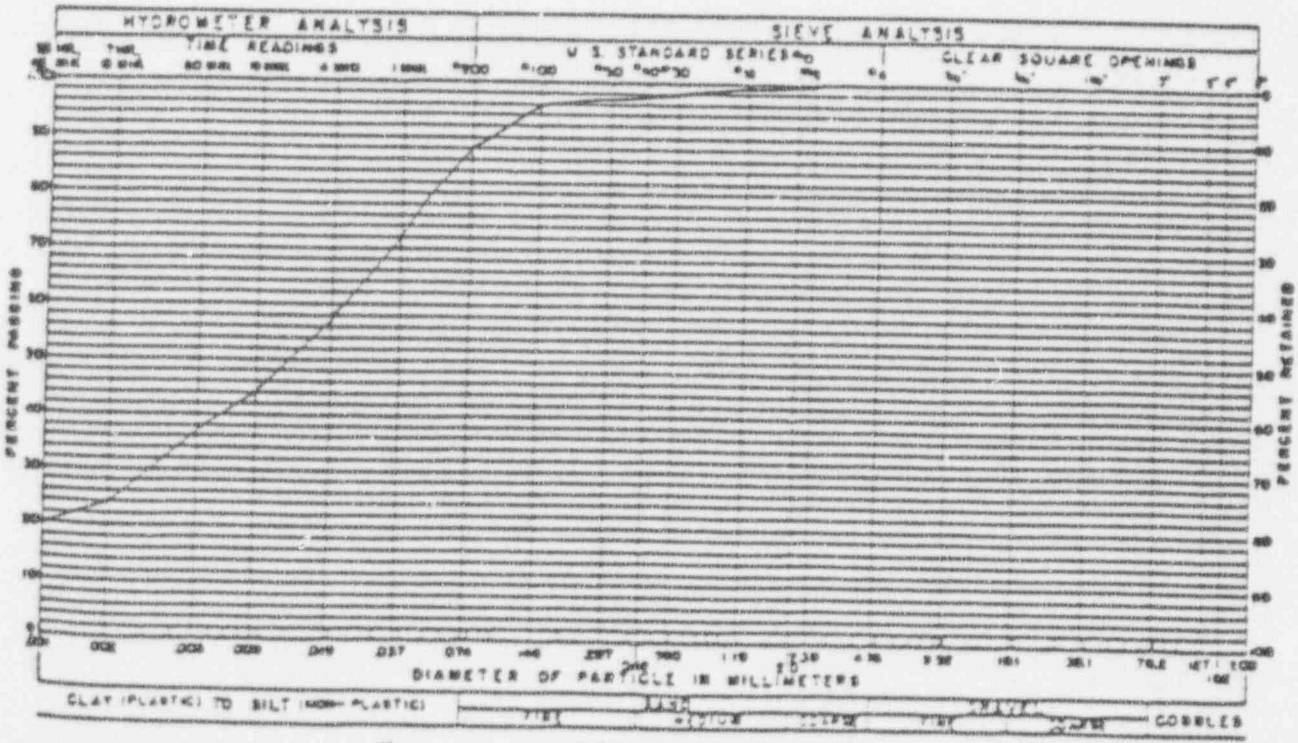
Consulting Soil and Foundation Engineers



GRAVEL % SAND 12 % SILT AND CLAY 88 %

LIQUID LIMIT 35 % PLASTICITY INDEX 12%

SAMPLE OF Sandy Clay FROM Hole 1 at depth 4'-0"

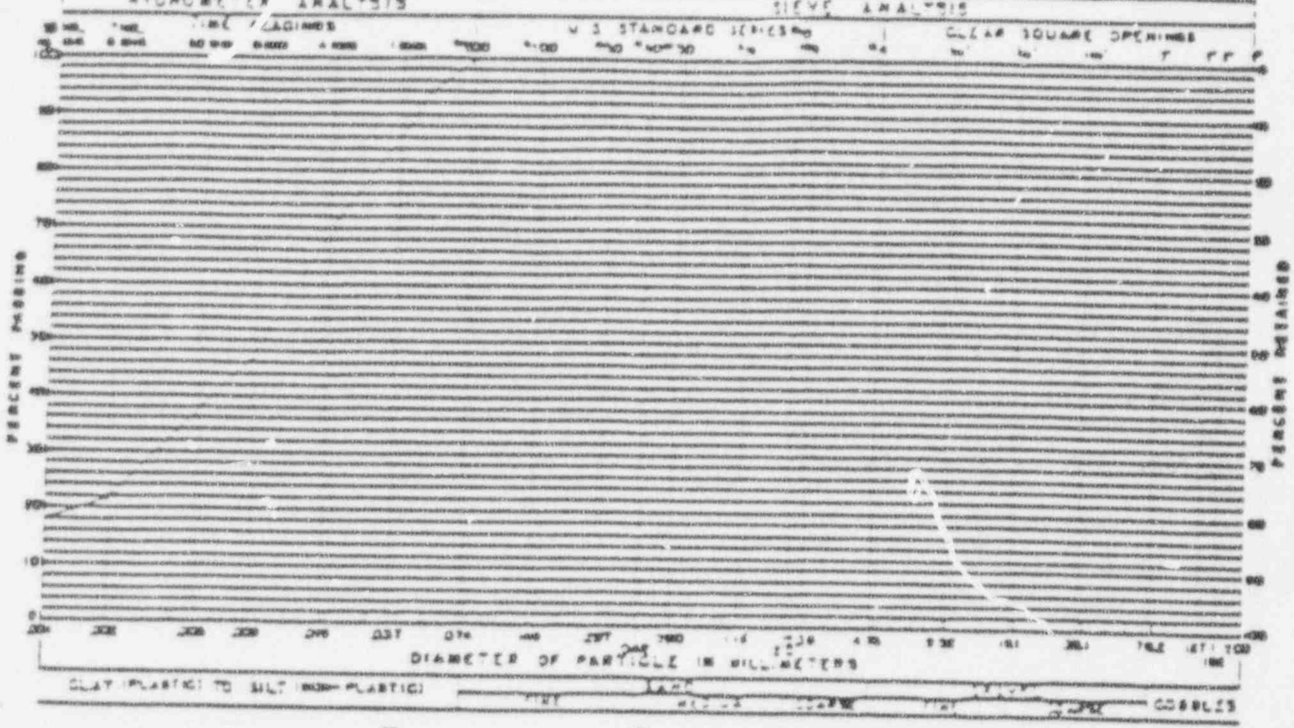


GRAVEL % SAND 12 % SILT AND CLAY 88%

LIQUID LIMIT 34 % PLASTICITY INDEX 12 %

CHEN AND ASSOCIATES

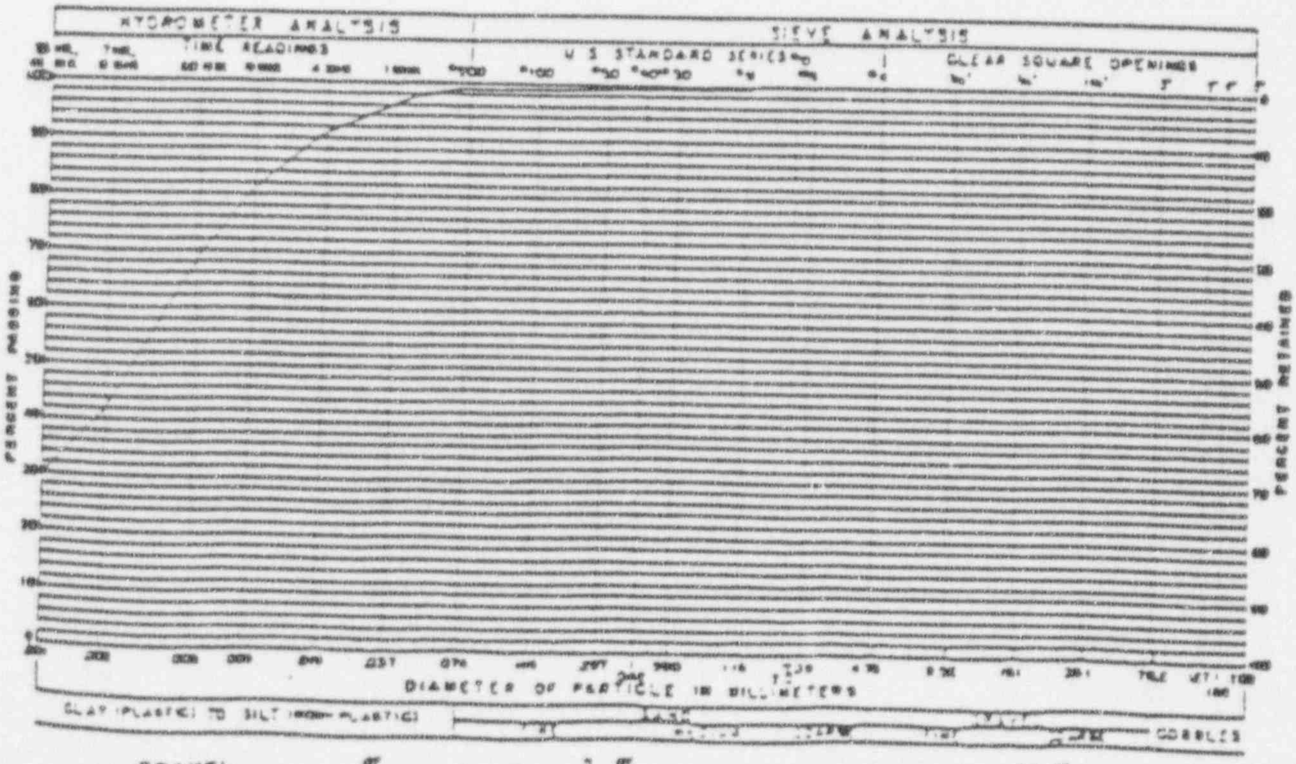
Consulting Soil and Foundation Engineers



GRAVEL %　SAND %　SILT AND CLAY 100 %

LIQUID LIMIT 37 %　PLASTICITY INDEX 13 %

SAMPLE OF Clay　FROM Hole 4 at depth 4'-0"



GRAVEL %　SAND 1 %　SILT AND CLAY 99 %

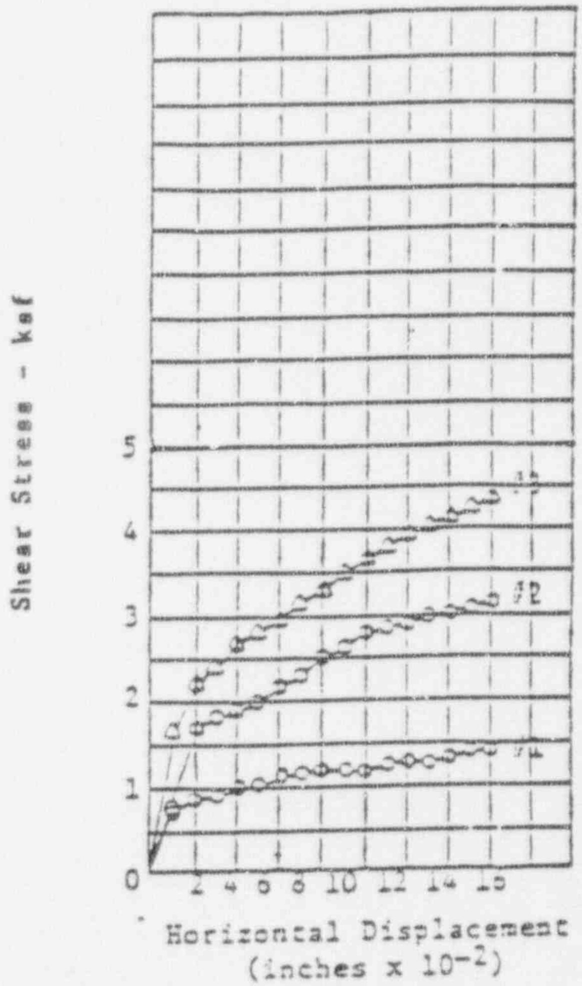
LIQUID LIMIT 71 %　PLASTICITY INDEX 39 %

TEST NUMBER	1	2	3
LOCATION	TH3 at 4'-0"	TH3 at 4'-0"	TH3 at 4'-0"
HEIGHT - INCH	1.0	1.0	1.0
DIAMETER - INCH	1.94	1.94	1.94
WATER CONTENT - %	8.8	8.8	8.3
DRY DENSITY - pcf	84.6	84.6	86.6
CONSOL. LOAD - ksf	2	4	6
NORMAL LOAD - ksf	2	4	6
SHEAR STRESS - ksf	1.1	2.2	3.0

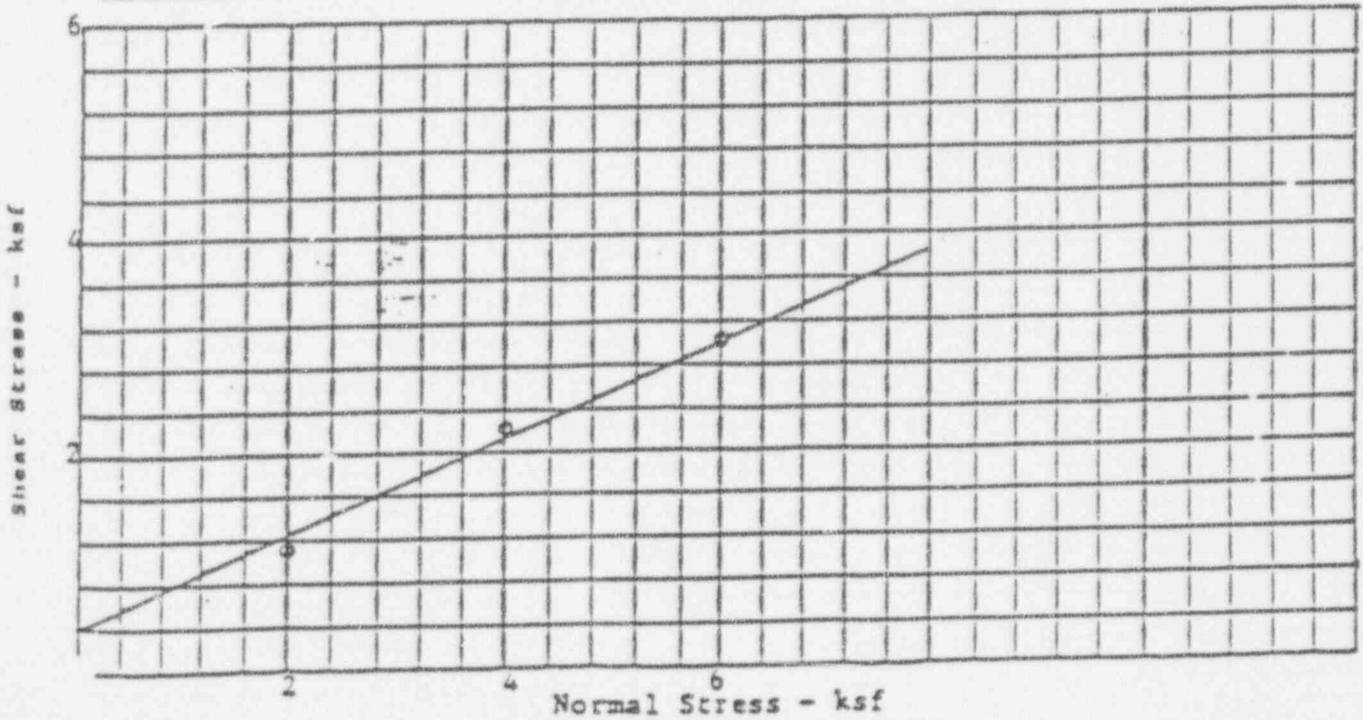
TYPE OF SPECIMEN Undisturbed

SOIL DESCRIPTION Clay

TYPE OF TEST Consolidated-Undrained

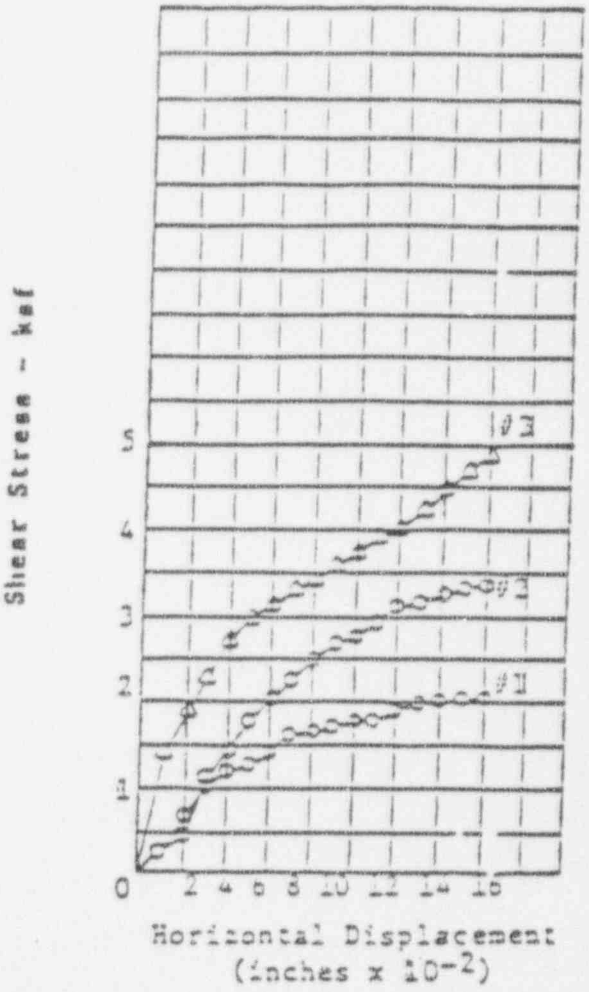


TAN Ø 0.445 Ø 24° COHESION - ksf 0.5



DIRECT SHEAR TEST RESULTS

TEST NUMBER	1	2	3
LOCATION	TH4 at 4'-0"	TH4 at 4'-0"	TH4 at 4'-0"
HEIGHT - INCH	1.0	1.0	1.0
DIAMETER - INCH	1.94	1.94	1.94
WATER CONTENT - %	13.4	13.4	14.6
DRY DENSITY - pcf	99.6	99.6	98.3
CONSOL. LOAD - ksf	2	4	6
NORMAL LOAD - ksf	2	4	6
SHEAR STRESS - ksf	1.6	2.5	3.5

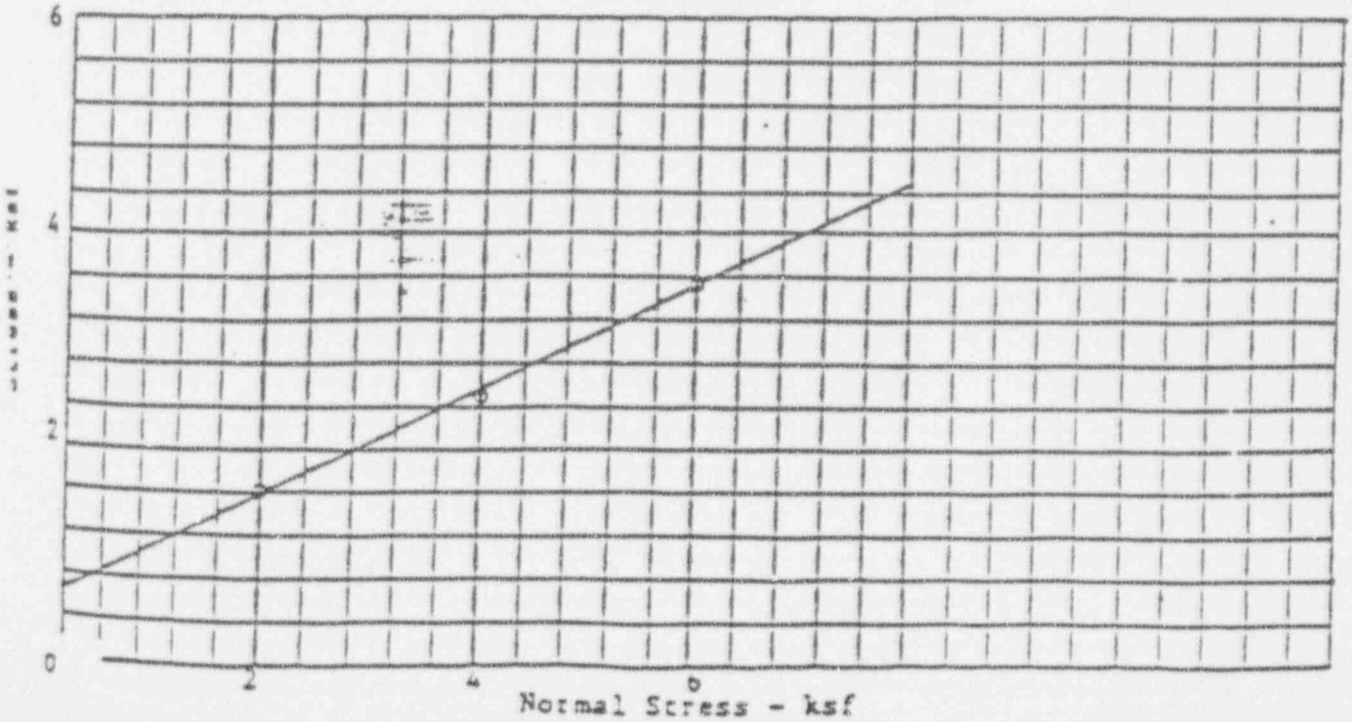


TYPE OF SPECIMEN Undisturbed

SOIL DESCRIPTION Clay

TYPE OF TEST Consolidated-Undrained

TAN Ø 0.466 Ø 25° COHESION - ksf 0.7



DIRECT SHEAR TEST RESULTS

CHEN AND ASSOCIATES

TA .E I

SUMMARY OF LABORATORY TEST RESULTS

LE	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		SPECIFIC GRAVITY (%)	WATER SOLUBLE SULFATE (%)	GRADATION ANALYSIS			SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)			+#4 (%)	-#4 +#200(%)	-#200 (%)	
	4	8.9	86.5	35	12	2.69		0	12	88	Sandy Clay
	4	8.8	84.6	34	12	2.67		0	12	88	Sandy Clay
	4	13.4	99.6	37	13	2.65		0	0	100	Clay
	4	16.4	110.4	71	39	2.72		0	1	99	Claystone Bedrock
	4	13.1	120.0				0.50				Claystone Bedrock
	9	8.1	114.2				0.02				Claystone Bedrock

TABLE II

SUMMARY OF SHEAR STRENGTH PARAMETERS

Material	Dry Density (pcf)	Friction Angle (^{o})	Cohesive (ksf)	Type of Test	Sample Type	Hole and Depth (ft.)
Clay	85.2	24	0.3	CU	Undisturbed	3 @ 4'-0"
Clay	99.2	25	0.7	CU	Undisturbed	4 @ 4'-0"

CHEN and ASSOCIATES, INC.

JOB NO. 3625W

TABLE III

PERCOLATION TEST RESULTS

HOLE NO.	HOLE DEPTH (In.)	LENGTH OF INTERVAL (Min.)	WATER DEPTH AT START OF INTERVAL (Inches)	WATER DEPTH AT END OF INTERVAL (Inches)	DROP IN WATER LEVEL (Inches)	AVERAGE PERCOLATION RATE (Min./Inch.)
rc No. 1	28 3/4	30	8 1/8	3 9/16	4 9/16	
		30	8 5/16	6	2 5/16	
		30	6	5	1	
		30	5	4 3/8	5/8	
		30	4 3/8	3 15/16	7/16	
		30	3 15/16	3 9/16	3/8	
		30	6 5/16	5 7/8	7/16	
		30	5 7/8	5 9/16	5/16	96.7 Min./Inch
rc No. 2	29 1/16	30	7 1/8	1 13/16	5 5/16	
		30	7 15/16	5 3/16	2 3/4	
		30	5 3/16	3 7/8	1 5/16	
		30	3 7/8	3	7/8	
		30	3	2 5/16	11/16	
		30	7 11/16	6 9/16	1 1/8	
		30	6 9/16	5 7/8	11/16	
		30	5 7/8	5 3/8	1/2	60.0 Min./Inch
rc No. 3	25 1/8	30	6 1/2	2 13/16	3 11/16	
		30	7 13/16	5 3/16	2 5/8	
		30	5 3/16	4	1 3/16	
		30	4	3 5/16	11/16	
		30	3 5/16	2 11/16	5/8	
		30	8	6 1/2	1 1/2	
		30	6 1/2	5 9/16	15/16	
		30	5 9/16	4 15/16	5/8	47.6 Min./Inch
rc No. 4	28 9/16	30	8 1/2	6 5/8	1 7/8	
		30	6 5/8	6 1/16	9 1/6	
		30	6 1/16	5 5/8	7/16	
		30	5 5/8	5 5/16	5/16	
		30	5 5/16	5 3/16	1/8	
		30	5 3/16	5	3/16	
		30	5	4 7/8	1/8	
		30	4 7/8	4 5/8	1/4	120.0 Min./Inch

CHEN and ASSOCIATES, INC.

JOB NO. 5626W

TABLE III

PERCOLATION TEST RESULTS

HOLE NO.	HOLE DEPTH (In.)	LENGTH OF INTERVAL (Min.)	WATER DEPTH AT START OF INTERVAL (Inches)	WATER DEPTH AT END OF INTERVAL (Inches)	DROP IN WATER LEVEL (Inches)	AVERAGE PERCOLATION RA (Min./Inch.)
rc No. 5	28 9/16	30	6 7/16	3 1/16	3 3/8	
		30	7 11/16	5 5/16	2 3/8	
		30	5 5/16	4 5/16	1	
		30	4 5/16	3 1/2	13/16	
		30	3 1/2	3 3/16	5/16	
		30	3 3/16	2 3/4	7/16	
		30	6 1/2	5 11/16	13/16	
		30	5 11/16	5 1/8	9/16	53.6 Min./In
rc No. 6	30 1/4	30	6 1/8	3 1/16	3 1/16	
		30	8 1/4	6 1/2	1 3/4	
		30	6 1/2	5 11/16	13/16	
		30	5 11/16	4 15/16	3/4	
		30	4 15/16	4 1/4	11/16	
		30	4 1/4	3 11/16	9/16	
		30	3 11/16	3 1/4	7/16	
		30	3 1/4	2 13/16	7/16	68.2 Min./In

APPENDIX C

STABILITY ANALYSIS

```
                          ** PCSTABL5M **

                                by
                          Purdue University
    ------------------------------------------------------------------------

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


          Run Date:                    09-16-93
          Time of Run:                 4:26pm
          Run By:                      ANDY WALSH
          Input Data Filename:         C:EFN.1
          Output Filename:             C:EFN.OUT
          Plotted Output Filename:     C:EFN.PLT



          PROBLEM DESCRIPTION   DOWNSTREAM EMB.ANALYSIS, CIRCL2, STATIC





          BOUNDARY COORDINATES

              6 Top   Boundaries
              8 Total Boundaries

          Boundary      X-Left     Y-Left     X-Right     Y-Right     Soil Type
             No.         (ft)       (ft)        (ft)        (ft)      Below Bnd

              1            .00      38.00      100.00       40.00         2
              2         100.00      40.00      180.00       80.00         1
              3         180.00      80.00      205.00       80.00         1
              4         205.00      80.00      214.00       77.00         1
              5         214.00      77.00      302.00       48.00         1
              6         302.00      48.00      380.00       54.00         2
              7         100.00      40.00      245.00       43.00         2
              8         245.00      43.00      302.00       48.00         2
    ------------------------------------------------------------------------


         ISOTROPIC SOIL PARAMETERS


          2 Type(s) of Soil


         Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
         Type Unit Wt. Unit Wt. Intercept  Angle  Pressure Constant  Surface
          No.  (pcf)    (pcf)     (psf)    (deg)   Param.    (psf)     No.

          1   105.0    110.0     300.0     24.0     .00        .0       1
```

```
        2   115.0     120.0      500.0      30.0      .00          .0      2
--------------------------------------------------------------------------------

     2 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED


     Unit Weight of Water =  62.40


     Piezometric Surface No.  1 Specified by  6 Coordinate Points

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

         1            .00        38.00
         2         100.00        40.00
         3         120.00        40.50
         4         140.00        50.00
         5         214.00        77.00
         6         380.00        77.00


     Piezometric Surface No.  2 Specified by  5 Coordinate Points

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

         1            .00        38.00
         2         100.00        40.00
         3         245.00        43.00
         4         302.00        48.00
         5         380.00        54.00
--------------------------------------------------------------------------------

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


     200 Trial Surfaces Have Been Generated.


      10 Surfaces Initiate From Each Of 20 Points Equally Spaced
     Along The Ground Surface Between  X = 100.00 ft.
                                     and  X = 130.00 ft.


     Each Surface Terminates Between    X = 170.00 ft.
                                    and    X = 190.00 ft.


     Unless Further Limitations Were Imposed, The Minimum Elevation
     At Which A Surface Extends Is  Y = 40.00 ft.
```

```
          5.00 ft. Line Segments Define Each Trial Failure Surface.

-------------------------------------------------------------------------------

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

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


         Failure Surface Specified By 21 Coordinate Points


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

            1          106.32         43.16
            2          111.20         42.07
            3          116.14         41.33
            4          121.13         40.95
            5          126.13         40.92
            6          131.12         41.24
            7          136.07         41.92
            8          140.96         42.95
            9          145.77         44.33
           10          150.47         46.05
           11          155.03         48.09
           12          159.43         50.45
           13          163.66         53.13
           14          167.69         56.09
           15          171.49         59.33
           16          175.06         62.84
           17          178.36         66.59
           18          181.39         70.57
           19          184.13         74.75
           20          186.57         79.12
           21          186.98         80.00

         Circle Center At X =  124.0 ; Y =  111.1  and Radius,   70.2

               ***     1.641    ***


              Individual data on the    24  slices

                         Water  Water     Tie      Tie      Earthquake
                         Force  Force    Force    Force        Force   Surcharge
Slice  Width    Weight    Top    Bot     Norm      Tan     Hor      Ver     Load
```

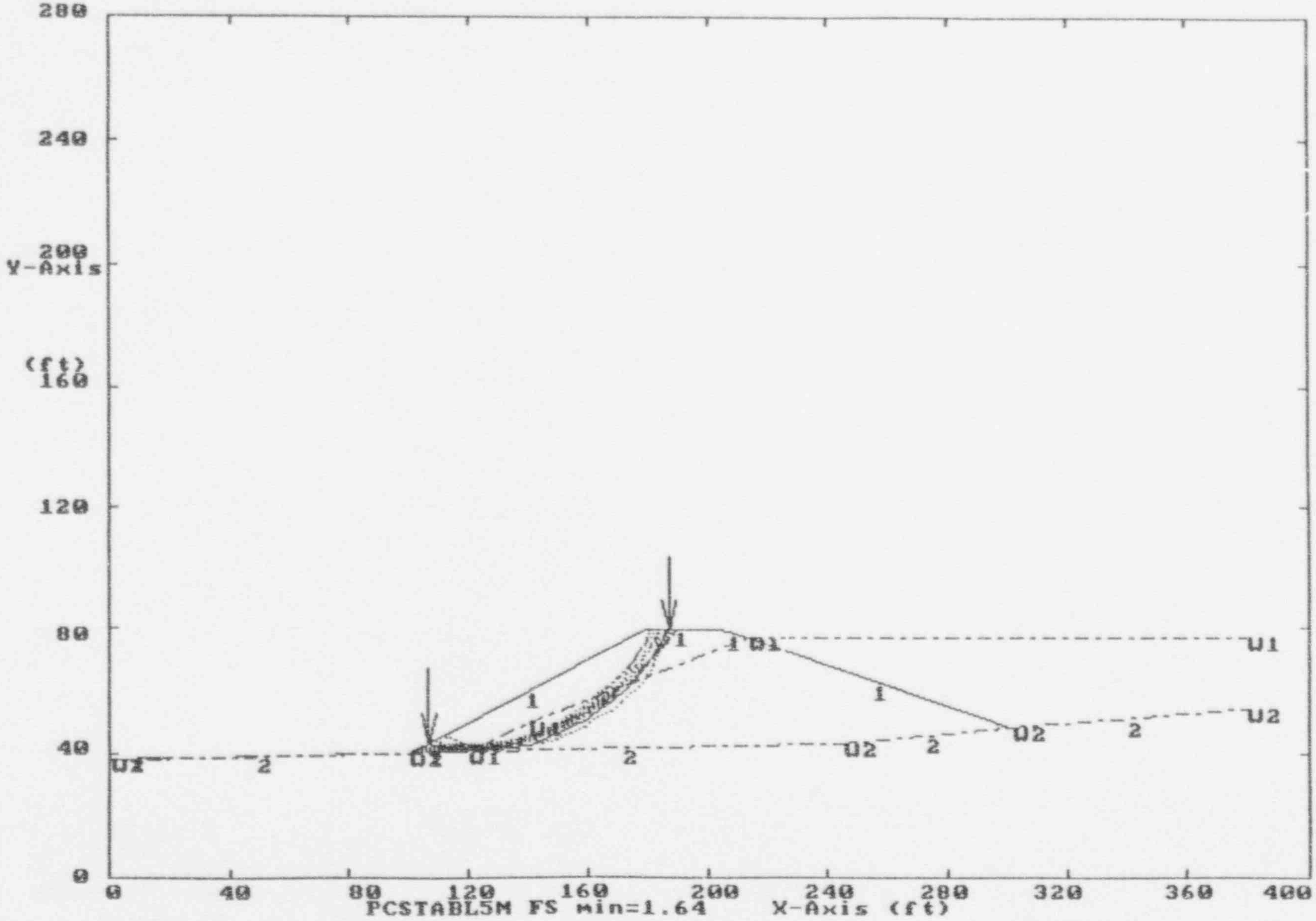
```
 No.    Ft(m)    Lbs(kg) Lbs(kg) Lbs(kg) Lbs(kg) Lbs(kg) Lbs(kg) Lbs(kg) Lbs(kg)
  1       4.9     904.0      .0      .0      .0      .0      .0      .0      .0
  2       4.9    2665.9      .0      .0      .0      .0      .0      .0      .0
  3       4.8    4118.6      .0      .0      .0      .0      .0      .0      .0
  4        .2     162.5      .0      .4      .0      .0      .0      .0      .0
  5       5.0    5742.3      .0   365.9      .0      .0      .0      .0      .0
  6       5.0    7011.1      .0   995.9      .0      .0      .0      .0      .0
  7       5.0    8033.6      .0  1522.2      .0      .0      .0      .0      .0
  8       3.9    7004.2      .0  1531.5      .0      .0      .0      .0      .0
  9       1.0    1789.4      .0   422.8      .0      .0      .0      .0      .0
 10       4.8    9276.9      .0  2227.7      .0      .0      .0      .0      .0
 11       4.7    9478.0      .0  2282.9      .0      .0      .0      .0      .0
 12       4.6    9412.3      .0  2227.0      .0      .0      .0      .0      .0
 13       4.4    9094.2      .0  2060.2      .0      .0      .0      .0      .0
 14       4.2    8545.7      .0  1783.3      .0      .0      .0      .0      .0
 15       4.0    7795.7      .0  1397.7      .0      .0      .0      .0      .0
 16       3.8    6879.3      .0   905.5      .0      .0      .0      .0      .0
 17       3.5    5710.4      .0   309.2      .0      .0      .0      .0      .0
 18        .1     126.4      .0      .0      .0      .0      .0      .0      .0
 19       3.3    4733.7      .0      .0      .0      .0      .0      .0      .0
 20       1.6    2051.4      .0      .0      .0      .0      .0      .0      .0
 21       1.4    1511.9      .0      .0      .0      .0      .0      .0      .0
 22       2.7    2111.6      .0      .0      .0      .0      .0      .0      .0
 23       2.4     783.9      .0      .0      .0      .0      .0      .0      .0
 24        .4      19.1      .0      .0      .0      .0      .0      .0      .0

          Failure Surface Specified By 21 Coordinate Points


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

              1         106.32        43.16
              2         111.18        42.00
              3         116.12        41.21
              4         121.10        40.78
              5         126.10        40.72
```

DOWNSTREAM EMB.ANALYSIS, CIRCL2, STATIC,
Ten Most Critical. C:EFN.PLT By: ANDY WALSH 09-16-93 4:26pm



```
                        ** PCSTABL5M **

                              by
                        Purdue University
  --------------------------------------------------------------------------------

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

          Run Date:                   09-16-93
          Time of Run:                4:33pm
          Run By:                     ANDY WALSH
          Input Data Filename:        C:EFN.2
          Output Filename:            C:EFN.OUT
          Plotted Output Filename:    C:EFN.PLT


          PROBLEM DESCRIPTION   DOWNSTREAM EMB.ANALYSIS, CIRCL2, PSEUDO



          BOUNDARY COORDINATES

              6 Top   Boundaries
              8 Total Boundaries

          Boundary     X-Left     Y-Left    X-Right    Y-Right     Soil Type
             No.        (ft)       (ft)       (ft)       (ft)      Below Bnd

              1          .00      38.00     100.00      40.00          2
              2       100.00      40.00     180.00      80.00          1
              3       180.00      80.00     205.00      80.00          1
              4       205.00      80.00     214.00      77.00          1
              5       214.00      77.00     302.00      48.00          1
              6       302.00      48.00     380.00      54.00          2
              7       100.00      40.00     245.00      43.00          2
              8       245.00      43.00     302.00      48.00          2
  --------------------------------------------------------------------------------


         ISOTROPIC SOIL PARAMETERS

          2 Type(s) of Soil

          Soil  Total  Saturated  Cohesion Friction   Pore    Pressure   Piez.
          Type Unit Wt. Unit Wt. Intercept  Angle  Pressure Constant Surface
           No.  (pcf)    (pcf)     (psf)    (deg)   Param.    (psf)     No.

            1   105.0    110.0     300.0     24.0     .00        .0      1
```

```
        2   115.0    120.0     500.0     30.0     .00        .0      2
-----------------------------------------------------------------------------


      2 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED


      Unit Weight of Water =  62.40


      Piezometric Surface No.  1 Specified by  6 Coordinate Points

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

          1           .00       38.00
          2        100.00       40.00
          3        120.00       40.50
          4        140.00       50.00
          5        214.00       77.00
          6        380.00       77.00


      Piezometric Surface No.  2 Specified by  5 Coordinate Points

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

          1           .00       38.00
          2        100.00       40.00
          3        245.00       43.00
          4        302.00       48.00
          5        380.00       54.00


     A Horizontal Earthquake Loading Coefficient
     Of .050 Has Been Assigned

     A Vertical Earthquake Loading Coefficient
     Of .000 Has Been Assigned

     Cavitation Pressure =      .0 psf
-----------------------------------------------------------------------------


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


     200 Trial Surfaces Have Been Generated.


      10 Surfaces Initiate From Each Of 20 Points Equally Spaced
```

```
    Along The Ground Surface Between  X = 100.00 ft.
                                 and  X = 130.00 ft.


    Each Surface Terminates Between   X = 170.00 ft.
                                and   X = 190.00 ft.


    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y = 40.00 ft.


     5.00 ft. Line Segments Define Each Trial Failure Surface.

-------------------------------------------------------------------------------

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


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



    Failure Surface Specified By 21 Coordinate Points


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

        1          106.32         43.16
        2          111.20         42.07
        3          116.14         41.33
        4          121.13         40.95
        5          126.13         40.92
        6          131.12         41.24
        7          136.07         41.92
        8          140.96         42.95
        9          145.77         44.33
       10          150.47         46.05
       11          155.03         48.09
       12          159.43         50.45
       13          163.66         53.13
       14          167.69         56.09
       15          171.49         59.33
       16          175.06         62.84
       17          178.36         66.59
       18          181.39         70.57
       19          184.13         74.75
       20          186.57         79.12
       21          186.98         80.00

   Circle Center At X =  124.0 ; Y =  111.1  and Radius,   70.2


         ***      1.470    ***
```

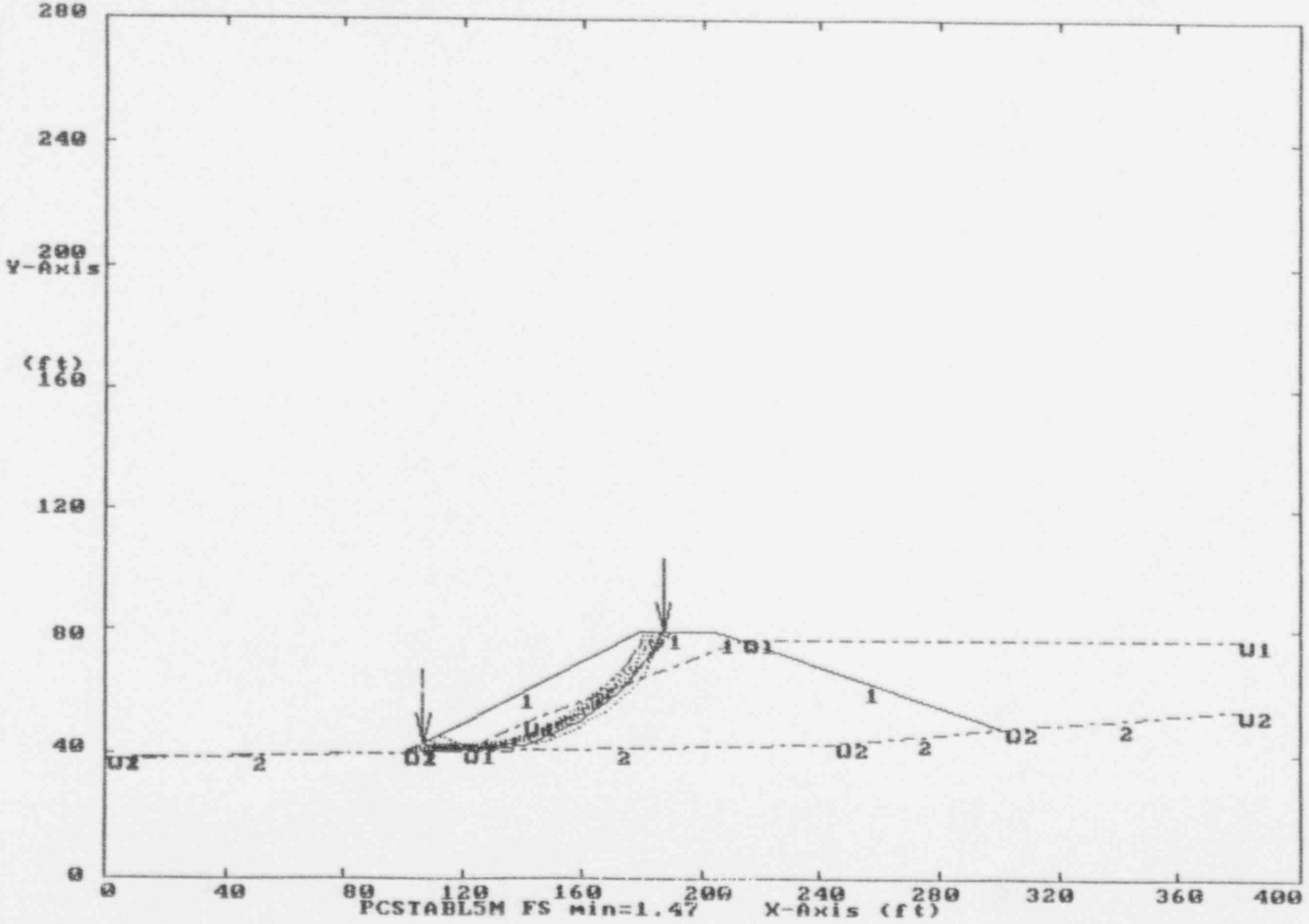
```
               Individual data on the    24  slices


                            Water    Water      Tie      Tie    Earthquake
                            Force    Force    Force    Force       Force   Surcharge
Slice   Width     Weight      Top      Bot     Norm      Tan      Hor      Ver     Load
 No.    Ft(m)    Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)
   1      4.9      904.0       .0       .0       .0       .0     45.2       .0       .0
   2      4.9     2665.9       .0       .0       .0       .0    133.3       .0       .0
   3      4.8     4118.6       .0       .0       .0       .0    205.9       .0       .0
   4       .2      162.5       .0       .4       .0       .0      8.1       .0       .0
   5      5.0     5742.3       .0    365.9       .0       .0    287.1       .0       .0
   6      5.0     7011.1       .0    995.9       .0       .0    350.6       .0       .0
   7      5.0     8033.6       .0   1522.2       .0       .0    401.7       .0       .0
   8      3.9     7004.2       .0   1531.5       .0       .0    350.2       .0       .0
   9      1.0     1789.4       .0    422.8       .0       .0     89.5       .0       .0
  10      4.8     9276.9       .0   2227.7       .0       .0    463.8       .0       .0
  11      4.7     9478.0       .0   2282.9       .0       .0    473.9       .0       .0
  12      4.6     9412.3       .0   2227.0       .0       .0    470.6       .0       .0
  13      4.4     9094.2       .0   2060.2       .0       .0    454.7       .0       .0
  14      4.2     8545.7       .0   1783.3       .0       .0    427.3       .0       .0
  15      4.0     7795.7       .0   1397.7       .0       .0    389.8       .0       .0
  16      3.8     6879.3       .0    905.5       .0       .0    344.0       .0       .0
  17      3.5     5710.4       .0    309.2       .0       .0    285.5       .0       .0
  18       .1      126.4       .0       .0       .0       .0      6.3       .0       .0
  19      3.3     4733.7       .0       .0       .0       .0    236.7       .0       .0
  20      1.6     2051.4       .0       .0       .0       .0    102.6       .0       .0
  21      1.4     1511.9       .0       .0       .0       .0     75.6       .0       .0
  22      2.7     2111.6       .0       .0       .0       .0    105.6       .0       .0
  23      2.4      783.9       .0       .0       .0       .0     39.2       .0       .0
  24       .4       19.1       .0       .0       .0       .0      1.0       .0       .0

         Failure Surface Specified By 21 Coordinate Points


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

DOWNSTREAM EMB.ANALYSIS, CIRCL2, PSEUDO,
Ten Most Critical. C:EFN.PLT By: ANDY WALSH 09-16-93 4:33pm



```
                    ** PCSTABL5M **

                          by
                   Purdue University
--------------------------------------------------------------------------

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

      Run Date:                  09-16-93
      Time of Run:               5:20pm
      Run By:                    ANDY WALSH
      Input Data Filename:       C:EFN.3
      Output Filename:           C:EFN.OUT
      Plotted Output Filename:   C:EFN.PLT


      PROBLEM DESCRIPTION   DOWNSTREAM EMB.ANALYSIS, CIRCL2, STATIC,



      BOUNDARY COORDINATES

          6 Top   Boundaries
          8 Total Boundaries

      Boundary     X-Left     Y-Left     X-Right     Y-Right     Soil Type
         No.        (ft)       (ft)        (ft)        (ft)      Below Bnd

          1           .00      38.00      100.00       40.00         2
          2        100.00      40.00      180.00       80.00         1
          3        180.00      80.00      205.00       80.00         1
          4        205.00      80.00      214.00       77.00         1
          5        214.00      77.00      302.00       48.00         1
          6        302.00      48.00      380.00       54.00         2
          7        100.00      40.00      245.00       43.00         2
          8        245.00      43.00      302.00       48.00         2
--------------------------------------------------------------------------

     ISOTROPIC SOIL PARAMETERS


      2 Type(s) of Soil


     Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
     Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
      No.  (pcf)    (pcf)     (psf)     (deg)   Param.    (psf)     No.

       1   105.0    110.0     300.0     24.0     .00        .0       1
```

```
       2   115.0    120.0      500.0      30.0      .00          .0      2
--------------------------------------------------------------------------------


         2 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED


         Unit Weight of Water =  62.40


         Piezometric Surface No.  1 Specified by  6 Coordinate Points

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

             1            .00        38.00
             2         100.00        40.00
             3         120.00        40.50
             4         140.00        50.00
             5         214.00        77.00
             6         380.00        77.00


         Piezometric Surface No.  2 Specified by  5 Coordinate Points

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

             1            .00        38.00
             2         100.00        40.00
             3         245.00        43.00
             4         302.00        48.00
             5         380.00        54.00
--------------------------------------------------------------------------------


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


        200 Trial Surfaces Have Been Generated.


         10 Surfaces Initiate From Each Of 20 Points Equally Spaced
        Along The Ground Surface Between  X =  70.00 ft.
                                     and  X =  90.00 ft.


        Each Surface Terminates Between   X = 200.00 ft.
                                     and  X = 220.00 ft.


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

```
     5.00 ft. Line Segments Define Each Trial Failure Surface.

--------------------------------------------------------------------------------

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

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

         Failure Surface Specified By 28 Coordinate Points

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

             1           88.95         39.78
             2           93.85         38.80
             3           98.79         38.03
             4          103.76         37.46
             5          108.75         37.09
             6          113.74         36.93
             7          118.74         36.97
             8          123.74         37.23
             9          128.72         37.68
            10          133.67         38.34
            11          138.60         39.20
            12          143.48         40.27
            13          148.32         41.53
            14          153.10         42.99
            15          157.82         44.65
            16          162.46         46.50
            17          167.03         48.54
            18          171.51         50.77
            19          175.89         53.18
            20          180.17         55.76
            21          184.34         58.52
            22          188.39         61.45
            23          192.32         64.54
            24          196.12         67.79
            25          199.78         71.20
            26          203.30         74.75
            27          206.67         78.45
            28          207.32         79.23

        Circle Center At X =  115.2 ; Y =  158.5  and Radius,  121.5

             ***     1.924    ***
```

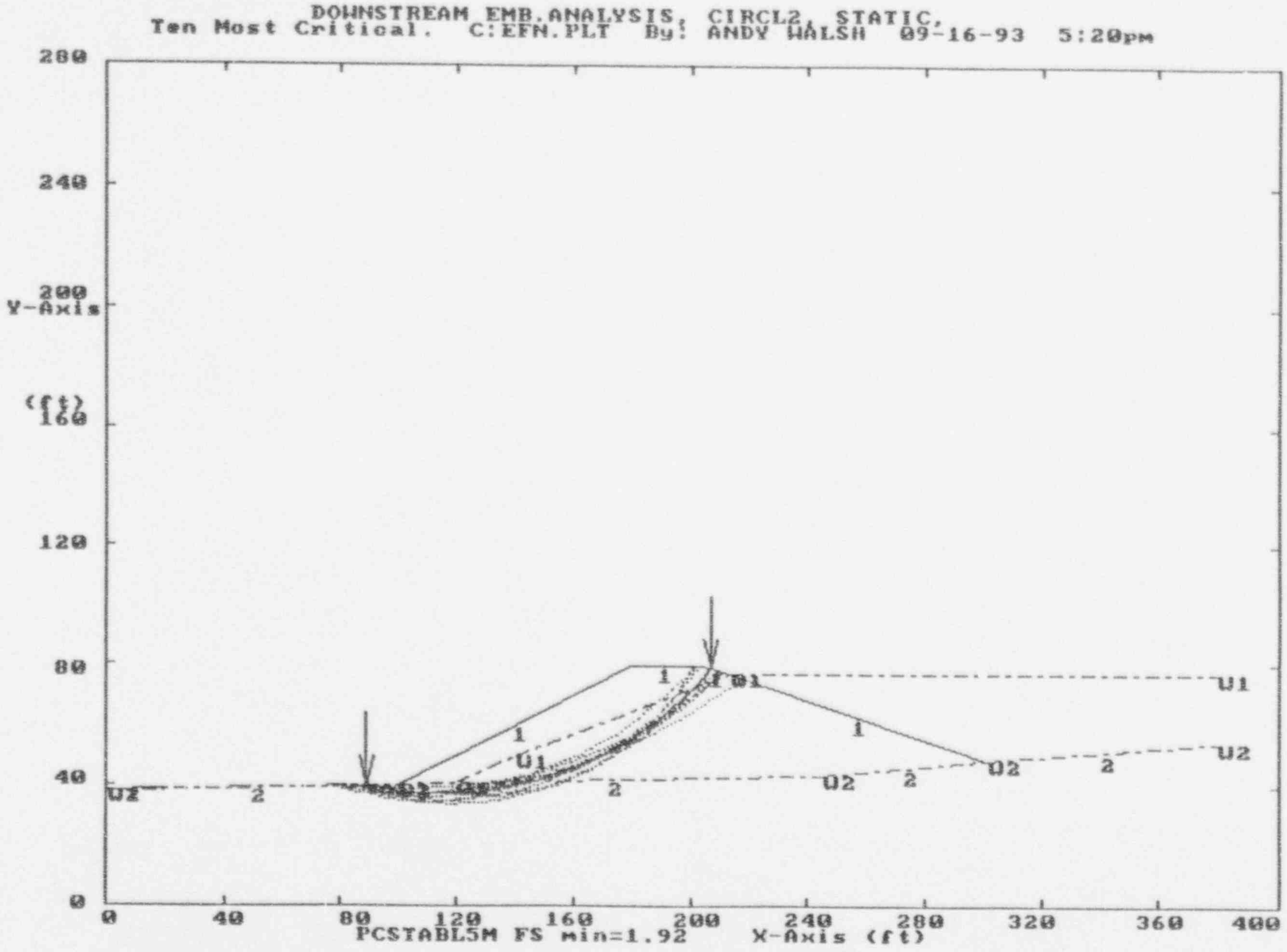
```
               Individual data on the    34  slices

                              Water   Water     Tie       Tie     Earthquake
                              Force   Force    Force     Force       Force   Surcharge
Slice   Width     Weight       Top     Bot      Norm      Tan      Hor      Ver      Load
 No.    Ft(m)    Lbs(kg)   Lbs(kg) Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)
  1      4.9      316.3       .0    167.7       .0       .0       .0       .0       .0
  2      4.9      896.0       .0    471.5       .0       .0       .0       .0       .0
  3      1.2      294.4       .0    154.1       .0       .0       .0       .0       .0
  4      3.8     1422.8       .0    558.5       .0       .0       .0       .0       .0
  5      5.0     3278.3       .0    890.7       .0       .0       .0       .0       .0
  6      5.0     4761.4       .0   1005.1       .0       .0       .0       .0       .0
  7      5.0     6118.8       .0   1055.4       .0       .0       .0       .0       .0
  8      1.3     1738.9       .0    266.7       .0       .0       .0       .0       .0
  9      3.7     5610.8       .0    775.0       .0       .0       .0       .0       .0
 10      5.0     8476.9       .0    963.8       .0       .0       .0       .0       .0
 11      5.0     9458.3       .0    821.9       .0       .0       .0       .0       .0
 12      4.9    10285.3       .0    616.3       .0       .0       .0       .0       .0
 13      1.4     3076.5       .0    130.6       .0       .0       .0       .0       .0
 14      3.5     7881.1       .0    216.8       .0       .0       .0       .0       .0
 15      2.6     6150.1       .0     53.5       .0       .0       .0       .0       .0
 16      2.2     5314.4       .0   1529.8       .0       .0       .0       .0       .0
 17      4.8    11855.0       .0   3419.6       .0       .0       .0       .0       .0
 18      4.7    12103.3       .0   3470.3       .0       .0       .0       .0       .0
 19      4.6    12203.3       .0   3456.8       .0       .0       .0       .0       .0
 20      4.6    12158.9       .0   3379.1       .0       .0       .0       .0       .0
 21      4.5    11975.4       .0   3237.3       .0       .0       .0       .0       .0
 22      4.4    11659.3       .0   3031.6       .0       .0       .0       .0       .0
 23      4.1    10784.8       .0   2660.2       .0       .0       .0       .0       .0
 24       .2      433.1       .0    102.2       .0       .0       .0       .0       .0
 25      4.2    10170.1       .0   2430.2       .0       .0       .0       .0       .0
 26      4.1     8648.9       .0   2035.5       .0       .0       .0       .0       .0
 27      3.9     7114.0       .0   1578.9       .0       .0       .0       .0       .0
 28      3.8     5581.1       .0   1061.3       .0       .0       .0       .0       .0
 29      3.7     4066.5       .0    483.6       .0       .0       .0       .0       .0
 30       .9      830.7       .0     24.2       .0       .0       .0       .0       .0
 31      2.6     1765.9       .0       .0       .0       .0       .0       .0       .0
 32      1.7      772.0       .0       .0       .0       .0       .0       .0       .0
 33      1.7      382.9       .0       .0       .0       .0       .0       .0       .0
 34       .7       34.4       .0       .0       .0       .0       .0       .0       .0

          Failure Surface Specified By 29 Coordinate Points


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

              1          85.79         39.72
```


DOWNSTREAM EMB.ANALYSIS, CIRCL2, STATIC.
Ten Most Critical. C:EFN.PLT By: ANDY WALSH 09-16-93 5:20pm
280
240
200
Y-Axis
(ft)
160
120
80
40
0
0
40
80
120
160
200
240
280
320
360
400
PCSTABL5M FS min=1.92
X-Axis (ft)
1
U1
2
U2
W2
W1

```
                               ** PCSTABL5M **

                                     by
                              Purdue University
   ------------------------------------------------------------------------------

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


          Run Date:                    09-16-93
          Time of Run:                 5:04pm
          Run By:                      ANDY WALSH
          Input Data Filename:         C:EFN.4
          Output Filename:             C:EFN.OUT
          Plotted Output Filename:     C:EFN.PLT



          PROBLEM DESCRIPTION    DOWNSTREAM EMB.ANALYSIS, CIRCL2, PSEUDO,




          BOUNDARY COORDINATES

              6 Top   Boundaries
              8 Total Boundaries

          Boundary     X-Left     Y-Left     X-Right     Y-Right    Soil Type
             No.        (ft)       (ft)       (ft)        (ft)      Below Bnd

              1            .00      38.00      100.00      40.00           2
              2        100.00      40.00      180.00      80.00           1
              3        180.00      80.00      205.00      80.00           1
              4        205.00      80.00      214.00      77.00           1
              5        214.00      77.00      302.00      48.00           1
              6        302.00      48.00      380.00      54.00           2
              7        100.00      40.00      245.00      43.00           2
              8        245.00      43.00      302.00      48.00           2
---------------------------------------------------------------------------------


         ISOTROPIC SOIL PARAMETERS


           2 Type(s) of Soil


          Soil  Total  Saturated  Cohesion Friction   Pore    Pressure   Piez.
          Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
           No.  (pcf)    (pcf)     (psf)     (deg)   Param.     (psf)    No.

            1   105.0    110.0     300.0     24.0     .00         .0      1
```

```
     2   115.0    120.0     500.0     30.0     .00         .0      2
--------------------------------------------------------------------------------


   2 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED


   Unit Weight of Water =  62.40


   Piezometric Surface No.  1 Specified by  6 Coordinate Points

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

       1           .00       38.00
       2         100.00      40.00
       3         120.00      40.50
       4         140.00      50.00
       5         214.00      77.00
       6         380.00      77.00


   Piezometric Surface No.  2 Specified by  5 Coordinate Points

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

       1           .00       38.00
       2         100.00      40.00
       3         245.00      43.00
       4         302.00      48.00
       5         380.00      54.00


   A Horizontal Earthquake Loading Coefficient
   Of .050 Has Been Assigned

   A Vertical Earthquake Loading Coefficient
   Of .000 Has Been Assigned

   Cavitation Pressure =     .0 psf
--------------------------------------------------------------------------------


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


   200 Trial Surfaces Have Been Generated.


    10 Surfaces Initiate From Each Of 20 Points Equally Spaced
```

```
Along The Ground Surface Between  X =  70.00 ft.
                             and  X =  90.00 ft.


Each Surface Terminates Between   X = 200.00 ft.
                            and   X = 220.00 ft.


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


 5.00 ft. Line Segments Define Each Trial Failure Surface.


---------------------------------------------------------------------------------

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


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



Failure Surface Specified By 29 Coordinate Points


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

    1        85.79       39.72
    2        90.76       39.18
    3        95.75       38.79
    4       100.74       38.56
    5       105.74       38.49
    6       110.74       38.56
    7       115.73       38.79
    8       120.72       39.18
    9       125.69       39.72
   10       130.64       40.41
   11       135.57       41.25
   12       140.47       42.25
   13       145.34       43.39
   14       150.17       44.69
   15       154.95       46.13
   16       159.70       47.72
   17       164.38       49.46
   18       169.02       51.33
   19       173.59       53.35
   20       178.10       55.52
   21       182.54       57.81
   22       186.91       60.25
   23       191.20       62.82
   24       195.41       65.51
   25       199.53       68.34
   26       203.57       71.29
```

```
           27         207.51         74.37
           28         211.36         77.56
           29         211.62         77.79

        Circle Center At X =  105.7 ; Y =  200.8  and Radius,  162.3


              ***     1.685    ***



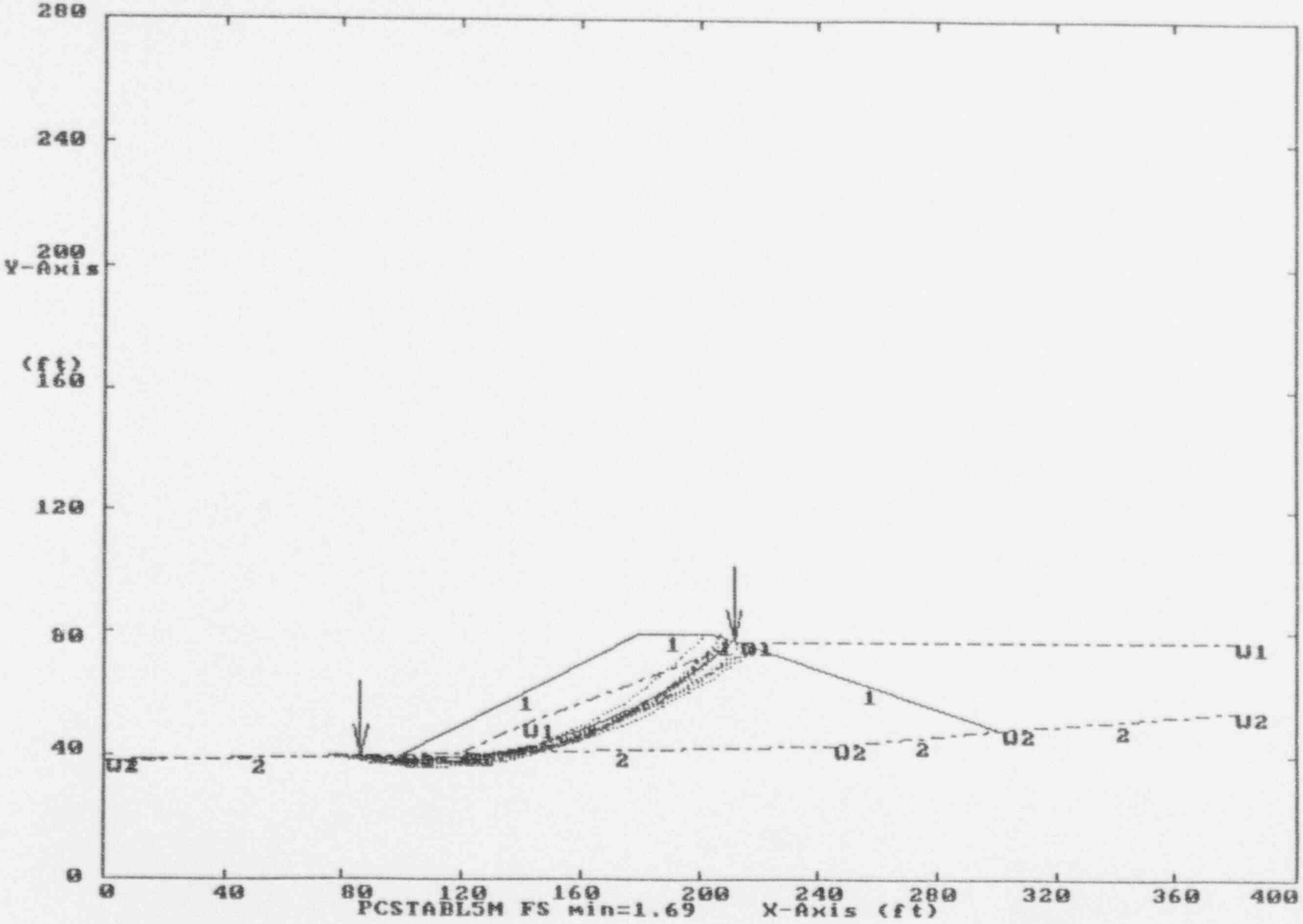

            Individual data on the    35  slices


                            Water   Water     Tie      Tie      Earthquake
                            Force   Force    Force    Force       Force    Surcharge
 Slice  Width    Weight      Top     Bot      Norm     Tan       Hor     Ver      Load
  No.   Ft(m)   Lbs(kg)  Lbs(kg) Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg) Lbs(kg)  Lbs(kg)
   1     5.0     190.1       .0     99.4       .0       .0      9.5      .0       .0
   2     5.0     526.1       .0    274.3       .0       .0     26.3      .0       .0
   3     4.3     644.4       .0    335.4       .0       .0     32.2      .0       .0
   4      .7     140.8       .0     66.1       .0       .0      7.0      .0       .0
   5     5.0    1741.3       .0    481.3       .0       .0     87.1      .0       .0
   6     5.0    3061.6       .0    513.5       .0       .0    153.1      .0       .0
   7     5.0    4284.9       .0    497.6       .0       .0    214.2      .0       .0
   8     4.3    4559.4       .0    376.5       .0       .0    228.0      .0       .0
   9      .7     847.3       .0     57.2       .0       .0     42.4      .0       .0
  10     5.0    6453.1       .0    321.8       .0       .0    322.7      .0       .0
  11     5.0    7412.5       .0    162.0       .0       .0    370.6      .0       .0
  12     1.5    2418.4       .0     10.6       .0       .0    120.9      .0       .0
  13     3.4    5851.2       .0   1208.0       .0       .0    292.6      .0       .0
  14     4.4    8140.5       .0   1855.4       .0       .0    407.0      .0       .0
  15      .5     903.1       .0    222.5       .0       .0     45.2      .0       .0
  16     4.9    9710.4       .0   2419.7       .0       .0    485.5      .0       .0
  17     4.8   10258.4       .0   2580.9       .0       .0    512.9      .0       .0
  18     4.8   10697.9       .0   2694.1       .0       .0    534.9      .0       .0
  19     4.7   11029.3       .0   2759.3       .0       .0    551.5      .0       .0
  20     4.7   11253.6       .0   2776.3       .0       .0    562.7      .0       .0
  21     4.6   11372.5       .0   2745.1       .0       .0    568.6      .0       .0
  22     4.6   11388.4       .0   2665.8       .0       .0    569.4      .0       .0
  23     4.5   11304.1       .0   2538.5       .0       .0    565.2      .0       .0
  24     1.9    4764.1       .0   1035.3       .0       .0    238.2      .0       .0
  25     2.5    6189.5       .0   1328.0       .0       .0    309.5      .0       .0
  26     4.4    9766.2       .0   2140.3       .0       .0    488.3      .0       .0
  27     4.3    8448.7       .0   1869.7       .0       .0    422.4      .0       .0
  28     4.2    7103.7       .0   1551.9       .0       .0    355.2      .0       .0
  29     4.1    5739.6       .0   1187.0       .0       .0    287.0      .0       .0
  30     4.0    4364.7       .0    775.5       .0       .0    218.2      .0       .0
  31     1.4    1236.2       .0    171.1       .0       .0     61.8      .0       .0
  32     2.5    1641.2       .0    146.7       .0       .0     82.1      .0       .0
  33      .6     265.6       .0      5.7       .0       .0     13.3      .0       .0
  34     3.3     767.0       .0       .0       .0       .0     38.3      .0       .0
  35      .3       4.3       .0       .0       .0       .0       .2      .0       .0

       Failure Surface Specified By 28 Coordinate Points
```

Point No.	X-Surf (ft)	Y-Surf (ft)
1	87.90	39.76
2	92.84	38.99
3	97.80	38.40

DOWNSTREAM EMB.ANALYSIS, CIRCL2, PSEUDO,
Ten Most Critical. C:EFN.PLT By: ANDY WALSH 09-16-93 5:04pm



```
                         ** PCSTABL5M **

                               by
                        Purdue University
--------------------------------------------------------------------------

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


        Run Date:                    10-13-93
        Time of Run:                 9:07am
        Run By:                      ANDY WALSH
        Input Data Filename:         C:EFN10.IN
        Output Filename:             C:EFN10.OUT
        Plotted Output Filename:     C:EFN10.PLT



        PROBLEM DESCRIPTION   UPSTREAM EMBANKMENT ANALYSIS, CIRCL2,
                              STATIC, R=0.30, RAPID DRAINDOWN ANALYSIS



        BOUNDARY COORDINATES

            6 Top   Boundaries
            8 Total Boundaries

        Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
          No.         (ft)       (ft)       (ft)       (ft)     Below Bnd

           1            .00      52.00      58.00      48.00        2
           2          58.00      48.00     146.00      77.00        1
           3         146.00      77.00     155.00      80.00        1
           4         155.00      80.00     180.00      80.00        1
           5         180.00      80.00     260.00      40.00        1
           6         260.00      40.00     360.00      38.00        2
           7          58.00      48.00     114.00      43.00        2
           8         114.00      43.00     260.00      40.00        2
--------------------------------------------------------------------------


       ISOTROPIC SOIL PARAMETERS


        2 Type(s) of Soil


        Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
        Type Unit Wt. Unit Wt.  Intercept  Angle  Pressure Constant Surface
        No.   (pcf)    (pcf)     (psf)    (deg)   Param.    (psf)     No.

         1    105.0    110.0     300.0     24.0     .30        .0       1
```

```
      2   115.0    120.0      500.0      30.0      .00          .0       2
------------------------------------------------------------------------------------


        2 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED


        Unit Weight of Water =  62.40


        Piezometric Surface No.  1 Specified by  7 Coordinate Points

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

            1            .00        52.00
            2          58.00        48.00
            3         146.00        77.00
            4         220.00        50.00
            5         240.00        40.50
            6         260.00        40.00
            7         360.00        38.00


        Piezometric Surface No.  2 Specified by  5 Coordinate Points

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

            1            .00        52.00
            2          58.00        48.00
            3         114.00        43.00
            4         260.00        40.00
            5         360.00        38.00
------------------------------------------------------------------------------------


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


        200 Trial Surfaces Have Been Generated.


         10 Surfaces Initiate From Each Of 20 Points Equally Spaced
        Along The Ground Surface Between  X =  60.00 ft.
                                     and  X =  80.00 ft.


        Each Surface Terminates Between    X = 150.00 ft.
                                     and   X = 170.00 ft.


        Unless Further Limitations Were Imposed, The Minimum Elevation
```

```
      At Which A Surface Extends Is  Y = 43.00 ft.


       5.00 ft. Line Segments Define Each Trial Failure Surface.


-----------------------------------------------------------------------------

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


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



      Failure Surface Specified By 22 Coordinate Points


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

          1          70.53        52.13
          2          75.08        50.07
          3          79.78        48.35
          4          84.59        46.99
          5          89.49        45.98
          6          94.45        45.34
          7          99.44        45.07
          8         104.44        45.17
          9         109.42        45.63
         10         114.35        46.46
         11         119.20        47.66
         12         123.96        49.21
         13         128.58        51.10
         14         133.06        53.33
         15         137.36        55.89
         16         141.45        58.75
         17         145.33        61.92
         18         148.96        65.35
         19         152.32        69.05
         20         155.41        72.99
         21         158.19        77.14
         22         159.82        80.00

      Circle Center At X =  100.6 ; Y =  112.7  and Radius,   67.6

            ***     1.086    ***



        Individual data on the    24  slices


                         Water  Water     Tie      Tie     Earthquake
```

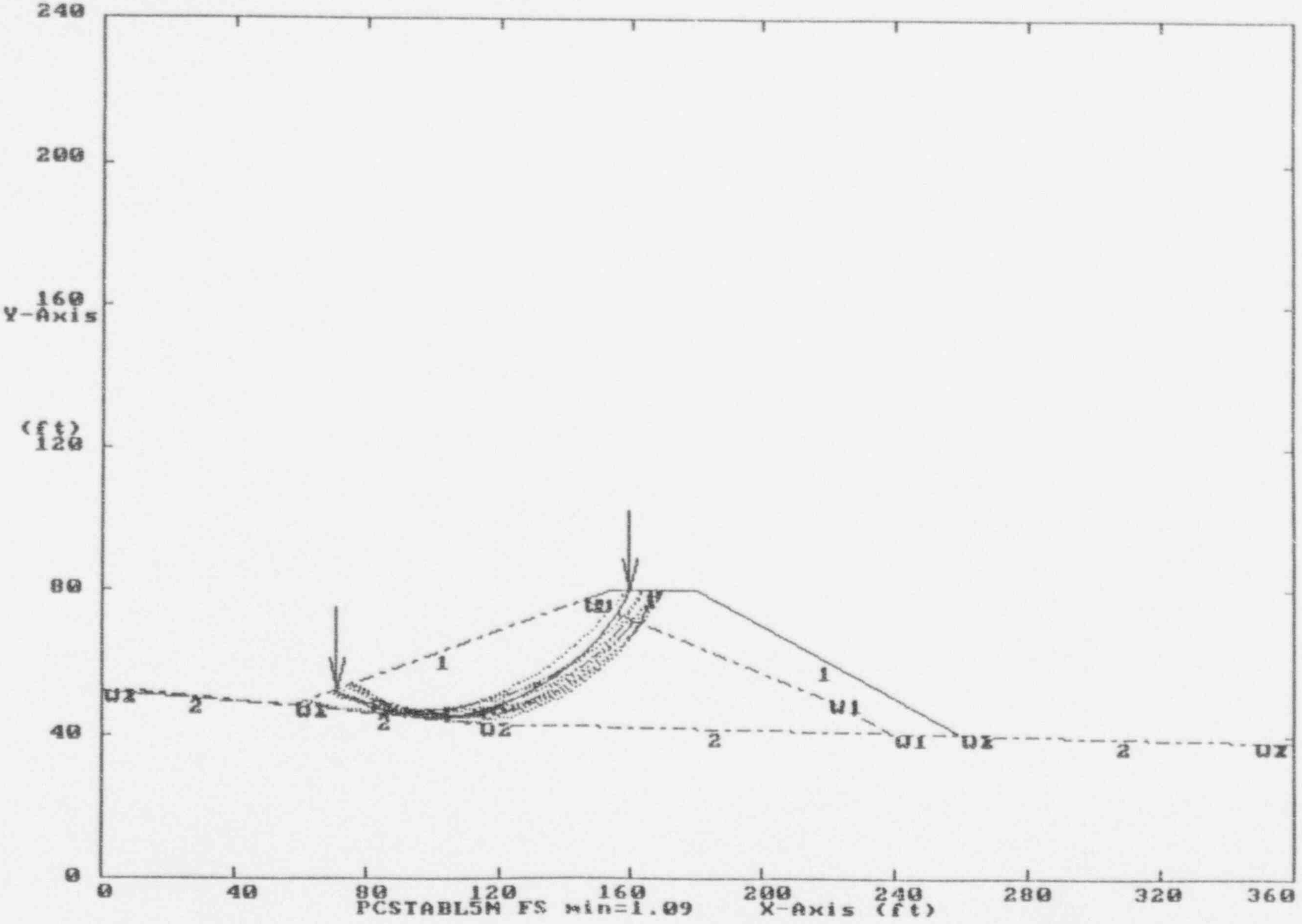
```
                              Force   Force     Force    Force        Force    Surcharge
Slice  Width     Weight        Top     Bot       Norm      Tan      Hor       Ver      Load
 No.   Ft(m)    Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)
  1      4.6      890.1       .0    821.1        .0       .0       .0       .0       .0
  2      4.7     2675.9       .0   2395.0        .0       .0       .0       .0       .0
  3      4.8     4380.8       .0   3828.2        .0       .0       .0       .0       .0
  4      4.9     5957.4       .0   5112.8        .0       .0       .0       .0       .0
  5      5.0     7363.4       .0   6241.9        .0       .0       .0       .0       .0
  6      5.0     8562.5       .0   7209.2        .0       .0       .0       .0       .0
  7      5.0     9525.6       .0   8009.6        .0       .0       .0       .0       .0
  8      5.0    10230.9       .0   8638.5        .0       .0       .0       .0       .0
  9      4.9    10665.1       .0   9092.7        .0       .0       .0       .0       .0
 10      4.9    10823.1       .0   9369.5        .0       .0       .0       .0       .0
 11      4.8    10708.1       .0   9467.6        .0       .0       .0       .0       .0
 12      4.6    10331.9       .0   9386.4        .0       .0       .0       .0       .0
 13      4.5     9714.3       .0   9126.2        .0       .0       .0       .0       .0
 14      4.3     8882.6       .0   8688.6        .0       .0       .0       .0       .0
 15      4.1     7871.1       .0   8075.9        .0       .0       .0       .0       .0
 16      3.9     6720.1       .0   7291.5        .0       .0       .0       .0       .0
 17       .7     1083.4       .0   1254.6        .0       .0       .0       .0       .0
 18      3.0     4376.9       .0   4800.0        .0       .0       .0       .0       .0
 19      3.4     4138.0       .0   4224.0        .0       .0       .0       .0       .0
 20      2.7     2515.7       .0   2101.9        .0       .0       .0       .0       .0
 21       .4      312.4       .0    187.4        .0       .0       .0       .0       .0
 22       .3      223.4       .0    129.9        .0       .0       .0       .0       .0
 23      2.5     1220.8       .0    657.5        .0       .0       .0       .0       .0
 24      1.6      244.3       .0    148.3        .0       .0       .0       .0       .0

           Failure Surface Specified By 24 Coordinate Points


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

               1          71.58         52.48
```

UPSTREAM EMBANKMENT ANALYSIS, CIRCL2, STATIC, R=0.30, RAPID DRAINDOWN ANALYSIS
Ten Most Critical. C:EFN10.PLT By: ANDY WALSH 10-13-93 9:07am



PCSTABL5M FS min=1.09

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                          ** PCSTABL5M **

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

       Run Date:                    10-13-93
       Time of Run:                 9:16am
           By:                      ANDY WALSH
       Input Data Filename:         C:EFN13.IN
       Output Filename:             C:EFN13.OUT
       Plotted Output Filename:     C:EFN13.PLT



       PROBLEM DESCRIPTION   UPSTREAM EMBANKMENT ANALYSIS, CIRCL2,
                             STATIC, R=0.30, FDN, RAPID DRAINDOWN ANL



       BOUNDARY COORDINATES

           6 Top   Boundaries
           8 Total Boundaries

       Boundary     X-Left      Y-Left     X-Right     Y-Right     Soil Type
          No.        (ft)        (ft)        (ft)        (ft)      Below Bnd

           1           .00       52.00       58.00       48.00         2
           2         58.00       48.00      146.00       77.00         1
           3        146.00       77.00      155.00       80.00         1
           4        155.00       80.00      180.00       80.00         1
           5        180.00       80.00      260.00       40.00         1
           6        260.00       40.00      360.00       38.00         2
           7         58.00       48.00      114.00       43.00         2
           8        114.00       43.00      260.00       40.00         2
--------------------------------------------------------------------------------


      ISOTROPIC SOIL PARAMETERS

       2 Type(s) of Soil


       Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
       Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
        No.  (pcf)    (pcf)     (psf)     (deg)   Param.    (psf)     No.

         1   105.0    110.0     300.0     24.0     .30        .0       1
```

```
          2   115.0     120.0      500.0      30.0      .00           .0         2
-------------------------------------------------------------------------------


       2 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED


       Unit Weight of Water =  62.40


       Piezometric Surface No.  1 Specified by  7 Coordinate Points

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

           1             .00        52.00
           2           58.00        48.00
           3          146.00        77.00
           4          220.00        50.00
           5          240.00        40.50
           6          260.00        40.00
           7          360.00        38.00


       Piezometric Surface No.  2 Specified by  5 Coordinate Points

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

           1             .00        52.00
           2           58.00        48.00
           3          114.00        43.00
           4          260.00        40.00
           5          360.00        38.00
-------------------------------------------------------------------------------


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


      200 Trial Surfaces Have Been Generated.


       10 Surfaces Initiate From Each Of 20 Points Equally Spaced
      Along The Ground Surface Between  X =  60.00 ft.
                                      and  X =  80.00 ft.


      Each Surface Terminates Between    X = 160.00 ft.
                                      and    X = 180.00 ft.


      Unless Further Limitations Were Imposed, The Minimum Elevation
```

```
      At Which A Surface Extends Is  Y =    .00 ft.


       5.00 ft. Line Segments Define Each Trial Failure Surface.


-------------------------------------------------------------------------------

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


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



      Failure Surface Specified By 24 Coordinate Points


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

          1         65.26        50.39
          2         70.02        48.84
          3         74.85        47.55
          4         79.74        46.52
          5         84.68        45.76
          6         89.66        45.28
          7         94.65        45.07
          8         99.65        45.13
          9        104.64        45.47
         10        109.60        46.07
         11        114.53        46.95
         12        119.39        48.10
         13        124.19        49.51
         14        128.90        51.18
         15        133.52        53.11
         16        138.02        55.29
         17        142.39        57.71
         18        146.63        60.37
         19        150.71        63.25
         20        154.63        66.36
         21        158.37        69.67
         22        161.93        73.18
         23        165.29        76.89
         24        167.82        80.00

     Circle Center At X =    96.0 ; Y =  136.3  and Radius,    91.2


           ***      1.076    ***



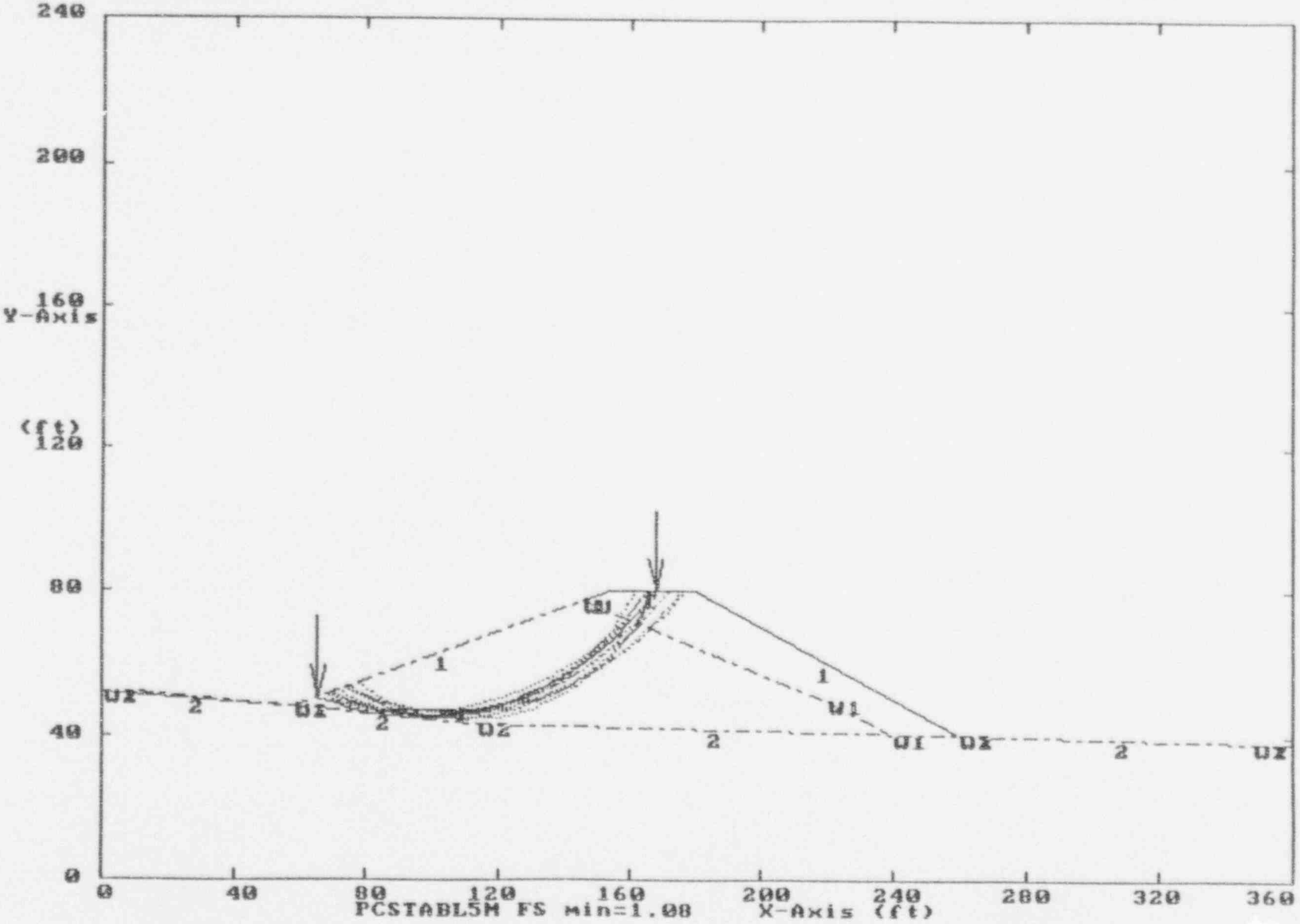
           Individual data on the    26  slices
```

```
                          Water    Water     Tie      Tie     Earthquake
                          Force    Force    Force    Force       Force     Surcharge
Slice  Width    Weight     Top      Bot      Norm     Tan      Hor      Ver      Load
 No.   Ft(m)   Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)
  1     4.8     813.9      .0     719.9      .0       .0       .0       .0       .0
  2     4.8    2419.0      .0    2105.2      .0       .0       .0       .0       .0
  3     4.9    3934.0      .0    3379.2      .0       .0       .0       .0       .0
  4     4.9    5335.9      .0    4538.1      .0       .0       .0       .0       .0
  5     5.0    6604.3      .0    5578.5      .0       .0       .0       .0       .0
  6     5.0    7721.5      .0    6497.2      .0       .0       .0       .0       .0
  7     5.0    8672.6      .0    7291.5      .0       .0       .0       .0       .0
  8     5.0    9445.9      .0    7959.0      .0       .0       .0       .0       .0
  9     5.0   10032.9      .0    8497.7      .0       .0       .0       .0       .0
 10     4.9   10428.6      .0    8906.0      .0       .0       .0       .0       .0
 11     4.9   10631.2      .0    9182.6      .0       .0       .0       .0       .0
 12     4.8   10642.6      .0    9326.8      .0       .0       .0       .0       .0
 13     4.7   10467.6      .0    9338.0      .0       .0       .0       .0       .0
 14     4.6   10115.0      .0    9216.3      .0       .0       .0       .0       .0
 15     4.5    9596.1      .0    8962.1      .0       .0       .0       .0       .0
 16     4.4    8925.7      .0    8576.0      .0       .0       .0       .0       .0
 17     3.6    6956.5      .0    6903.5      .0       .0       .0       .0       .0
 18      .6    1163.5      .0    1138.3      .0       .0       .0       .0       .0
 19     4.1    7168.1      .0    6807.6      .0       .0       .0       .0       .0
 20     3.9    6114.6      .0    5206.4      .0       .0       .0       .0       .0
 21      .4     533.2      .0     424.2      .0       .0       .0       .0       .0
 22     3.4    4267.2      .0    3012.7      .0       .0       .0       .0       .0
 23     2.1    2045.5      .0    1104.3      .0       .0       .0       .0       .0
 24     1.5    1169.8      .0     493.3      .0       .0       .0       .0       .0
 25     3.4    1750.7      .0     781.7      .0       .0       .0       .0       .0
 26     2.5     412.7      .0     196.4      .0       .0       .0       .0       .0

          Failure Surface Specified By 22 Coordinate Points


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

UPSTREAM EMBANKMENT ANALYSIS, CIRCL2, STATIC, R=0.30, FDN, RAPID DRAINDOWN ANL
Ten Most Critical.   C:EFN13.PLT   By: ANDY WALSH   10-13-93   9:16am



```
                        ** PCSTABL5M **

                              by
                       Purdue University
--------------------------------------------------------------------------------

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


        Run Date:                  09-17-93
        Time of Run:               11:09am
        Run By:                    ANDY WALSH
        Input Data Filename:       C:EFN11.IN
        Output Filename:           C:EFN11.OUT
        Plotted Output Filename:   C:EFN11.PLT



        PROBLEM DESCRIPTION   UPSTREAM EMBANKMENT ANALYSIS, CIRCL2,
                              STATIC



        BOUNDARY COORDINATES

            6 Top   Boundaries
            8 Total Boundaries

        Boundary     X-Left     Y-Left     X-Right     Y-Right     Soil Type
          No.         (ft)       (ft)        (ft)        (ft)      Below Bnd

           1           .00      52.00       58.00       48.00          2
           2         58.00      48.00      146.00       77.00          1
           3        146.00      77.00      155.00       80.00          1
           4        155.00      80.00      180.00       80.00          1
           5        180.00      80.00      260.00       40.00          1
           6        260.00      40.00      360.00       38.00          2
           7         58.00      48.00      114.00       43.00          2
           8        114.00      43.00      260.00       40.00          2
--------------------------------------------------------------------------------


       ISOTROPIC SOIL PARAMETERS


        2 Type(s) of Soil


        Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
        Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant  Surface
         No.  (pcf)    (pcf)     (psf)     (deg)   Param.    (psf)     No.

          1   105.0    110.0     300.0     24.0     .00        .0       1
```

```
      2   115.0     120.0      500.0      30.0      .00          .0       2
-------------------------------------------------------------------------------


         2 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED


         Unit Weight of Water =  62.40


         Piezometric Surface No.  1 Specified by  6 Coordinate Points

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

             1           .00       77.00
             2        146.00       77.00
             3        220.00       50.00
             4        240.00       40.50
             5        260.00       40.00
             6        360.00       38.00


         Piezometric Surface No.  2 Specified by  5 Coordinate Points

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

             1           .00       52.00
             2         58.00       48.00
             3        114.00       43.00
             4        260.00       40.00
             5        360.00       38.00
-------------------------------------------------------------------------------


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


         200 Trial Surfaces Have Been Generated.


          10 Surfaces Initiate From Each Of 20 Points Equally Spaced
         Along The Ground Surface Between  X =  58.00 ft.
                                      and  X =  70.00 ft.


         Each Surface Terminates Between    X = 160.00 ft.
                                     and    X = 180.00 ft.


         Unless Further Limitations Were Imposed, The Minimum Elevation
         At Which A Surface Extends Is  Y = 43.00 ft.
```

```
  5.00 ft. Line Segments Define Each Trial Failure Surface.

-------------------------------------------------------------------------------

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


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



   Failure Surface Specified By 24 Coordinate Points


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

       1          64.32       50.08
       2          69.09       48.59
       3          73.94       47.37
       4          78.85       46.42
       5          83.80       45.73
       6          88.78       45.33
       7          93.78       45.19
       8          98.78       45.33
       9         103.76       45.74
      10         108.71       46.43
      11         113.62       47.39
      12         118.47       48.62
      13         123.24       50.11
      14         127.92       51.86
      15         132.50       53.86
      16         136.97       56.12
      17         141.30       58.61
      18         145.49       61.34
      19         149.52       64.30
      20         153.38       67.47
      21         157.07       70.86
      22         160.56       74.43
      23         163.85       78.20
      24         165.26       80.00

  Circle Center At X =    93.7 ; Y =  136.0  and Radius,    90.9

        ***     3.485    ***

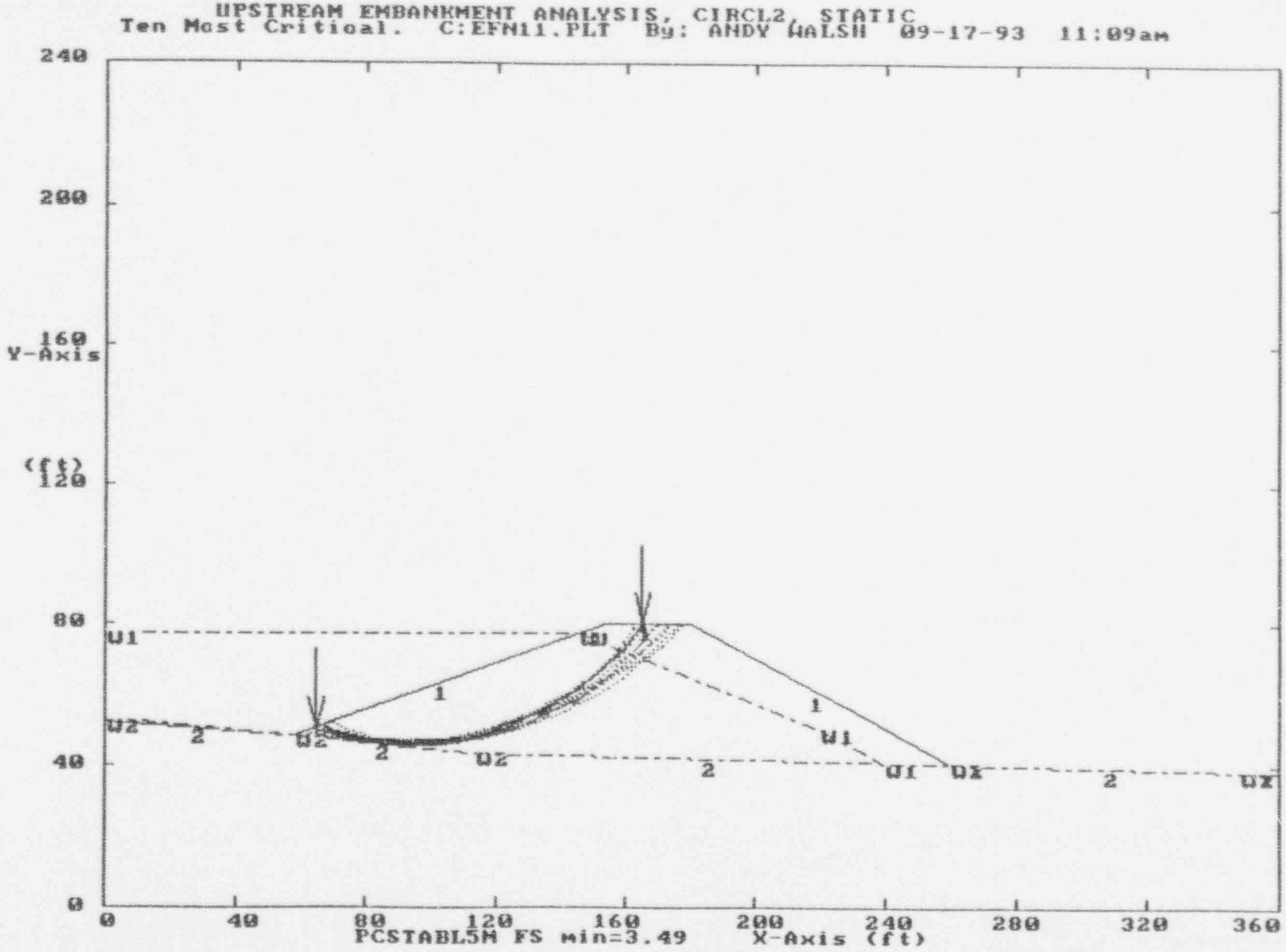


        Individual data on the    26  slices
```

```
                          Water    Water      Tie       Tie      Earthquake
                          Force    Force     Force     Force       Force    Surcharge
Slice   Width    Weight    Top      Bot      Norm       Tan      Hor       Ver      Load
 No.    Ft(m)   Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)   Lbs(kg)  Lbs(kg)   Lbs(kg)  Lbs(kg)
  1      4.8     803.5   8196.0   8630.5       .0        .0       .0        .0       .0
  2      4.8    2384.0   7818.9   9053.2       .0        .0       .0        .0       .0
  3      4.9    3868.9   7397.1   9392.8       .0        .0       .0        .0       .0
  4      5.0    5235.7   6936.1   9648.2       .0        .0       .0        .0       .0
  5      5.0    6464.4   6442.2   9818.6       .0        .0       .0        .0       .0
  6      5.0    7538.0   5921.5   9903.7       .0        .0       .0        .0       .0
  7      5.0    8442.2   5380.5   9903.0       .0        .0       .0        .0       .0
  8      5.0    9166.2   4825.7   9816.7       .0        .0       .0        .0       .0
  9      5.0    9702.4   4263.7   9644.9       .0        .0       .0        .0       .0
 10      4.9   10046.7   3700.9   9388.2       .0        .0       .0        .0       .0
 11      4.8   10198.2   3143.7   9047.4       .0        .0       .0        .0       .0
 12      4.8   10159.8   2598.3   8623.4       .0        .0       .0        .0       .0
 13      4.7    9937.6   2070.3   8117.7       .0        .0       .0        .0       .0
 14      4.6    9541.1   1565.3   7531.6       .0        .0       .0        .0       .0
 15      4.5    8982.9   1088.4   6867.1       .0        .0       .0        .0       .0
 16      4.3    8278.6    644.0   6126.0       .0        .0       .0        .0       .0
 17      4.2    7446.8    236.3   5310.6       .0        .0       .0        .0       .0
 18       .5     865.2      2.8    612.0       .0        .0       .0        .0       .0
 19      3.5    5610.2       .0   3422.8       .0        .0       .0        .0       .0
 20      3.9    5411.4       .0   2679.2       .0        .0       .0        .0       .0
 21      1.6    1997.2       .0    746.4       .0        .0       .0        .0       .0
 22      2.1    2225.1       .0    566.0       .0        .0       .0        .0       .0
 23      1.5    1339.2       .0    134.2       .0        .0       .0        .0       .0
 24      2.0    1365.2       .0       .0       .0        .0       .0        .0       .0
 25      3.3    1272.5       .0       .0       .0        .0       .0        .0       .0
 26      1.4     133.0       .0       .0       .0        .0       .0        .0       .0

           Failure Surface Specified By 24 Coordinate Points


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



UPSTREAM EMBANKMENT ANALYSIS, CIRCL2, STATIC
Ten Most Critical. C:EFN11.PLT By: ANDY WALSH 09-17-93 11:09am

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                         ** PCSTABL5M **

                               by
                        Purdue University
--------------------------------------------------------------------------

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


       Run Date:                  09-17-93
       Time of Run:               11:27am
       Run By:                    ANDY WALSH
       Input Data Filename:       C:EFN12.IN
       Output Filename:           C:EFN12.OUT
       Plotted Output Filename:   C:EFN12.PLT



       PROBLEM DESCRIPTION   UPSTREAM EMBANKMENT ANALYSIS, CIRCL2,
                             PSEUDO



       BOUNDARY COORDINATES

           6 Top   Boundaries
           8 Total Boundaries

       Boundary     X-Left     Y-Left    X-Right     Y-Right     Soil Type
         No.         (ft)       (ft)       (ft)        (ft)      Below Bnd

          1           .00      52.00      58.00       48.00          2
          2         58.00      48.00     146.00       77.00          1
          3        146.00      77.00     155.00       80.00          1
          4        155.00      80.00     180.00       80.00          1
          5        180.00      80.00     260.00       40.00          1
          6        260.00      40.00     360.00       38.00          2
          7         58.00      48.00     114.00       43.00          2
          8        114.00      43.00     260.00       40.00          2
--------------------------------------------------------------------------

      ISOTROPIC SOIL PARAMETERS


       2 Type(s) of Soil


      Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
      Type Unit Wt. Unit Wt. Intercept  Angle  Pressure Constant Surface
       No.  (pcf)    (pcf)     (psf)    (deg)   Param.    (psf)     No.

       1   105.0    110.0     300.0     24.0     .00        .0       1
```

```
     2   115.0    120.0     500.0      30.0     .00          .0       2
--------------------------------------------------------------------------------


          2 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED


          Unit Weight of Water =  62.40


          Piezometric Surface No.  1 Specified by  6 Coordinate Points

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

              1             .00        77.00
              2          146.00        77.00
              3          220.00        50.00
              4          240.00        40.50
              5          260.00        40.00
              6          360.00        38.00


          Piezometric Surface No.  2 Specified by  5 Coordinate Points

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

              1             .00        52.00
              2           58.00        48.00
              3          114.00        43.00
              4          260.00        40.00
              5          360.00        38.00


          A Horizontal Earthquake Loading Coefficient
          Of .050 Has Been Assigned

          A Vertical Earthquake Loading Coefficient
          Of .000 Has Been Assigned

          Cavitation Pressure =      .0 psf
--------------------------------------------------------------------------------


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


          200 Trial Surfaces Have Been Generated.


           10 Surfaces Initiate From Each Of 20 Points Equally Spaced
```

```
Along The Ground Surface Between  X =  58.00 ft.
                             and  X =  70.00 ft.


Each Surface Terminates Between   X = 160.00 ft.
                            and   X = 180.00 ft.


Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is  Y = 43.00 ft.


 5.00 ft. Line Segments Define Each Trial Failure Surface.

--------------------------------------------------------------------------------

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


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



Failure Surface Specified By 24 Coordinate Points


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

    1          66.84         50.91
    2          71.59         49.36
    3          76.42         48.06
    4          81.32         47.03
    5          86.26         46.26
    6          91.23         45.76
    7          96.23         45.53
    8         101.23         45.58
    9         106.22         45.89
   10         111.18         46.47
   11         116.11         47.32
   12         120.98         48.44
   13         125.79         49.82
   14         130.51         51.46
   15         135.14         53.35
   16         139.66         55.49
   17         144.06         57.87
   18         148.32         60.48
   19         152.43         63.33
   20         156.39         66.39
   21         160.17         69.66
   22         163.77         73.13
   23         167.17         76.79
   24         169.85         80.00

Circle Center At X =   97.9 ; Y =  137.8  and Radius,   92.2
```

```
          ***     2.575    ***



            Individual data on the    26  slices

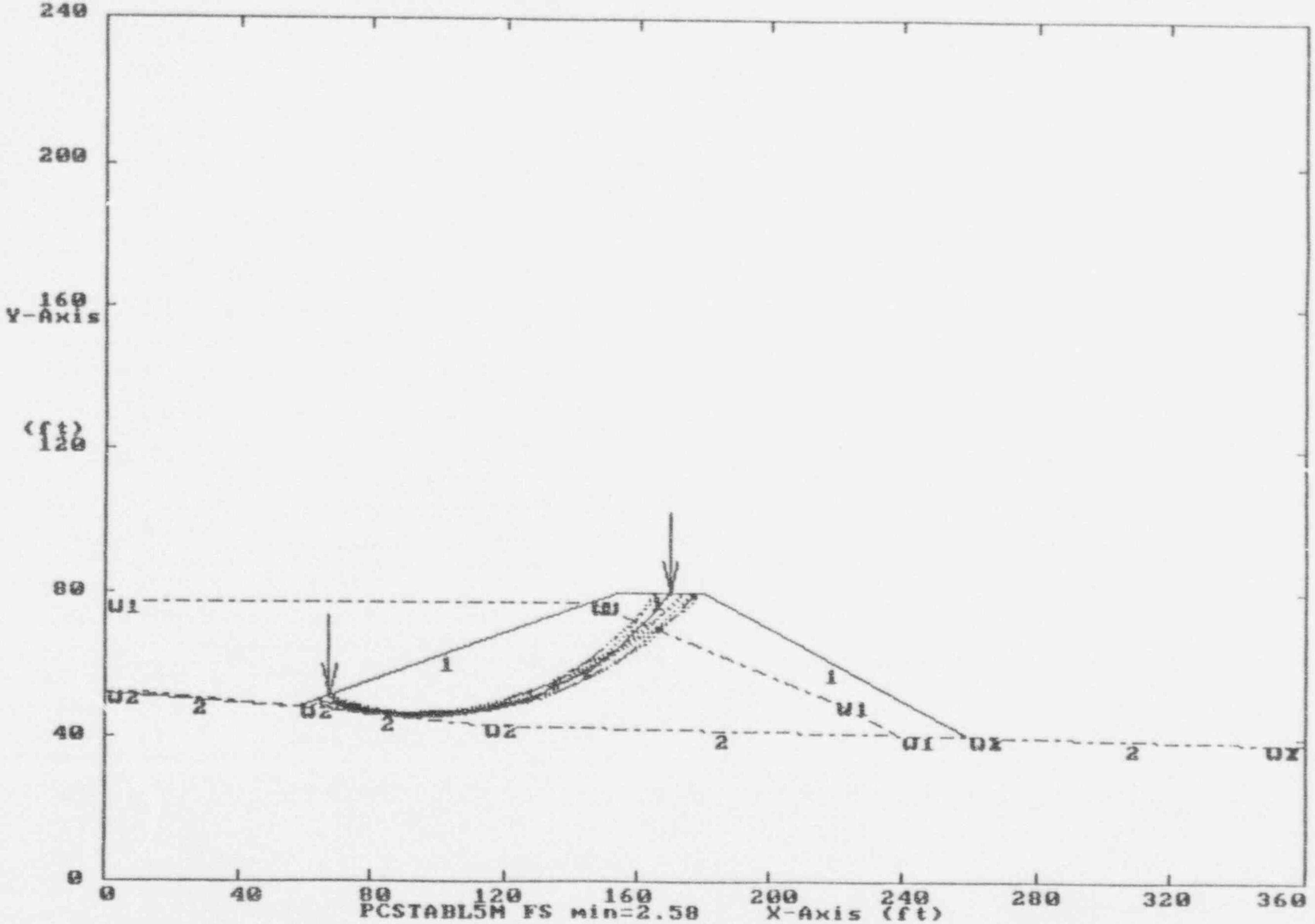
                                Water   Water      Tie       Tie      Earthquake
                                Force   Force     Force     Force        Force   Surcharge
Slice   Width     Weight         Top     Bot       Norm      Tan       Hor      Ver     Load
 No.    Ft(m)    Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)
  1      4.8      816.0   7899.1   8381.6       .0        .0     40.8       .0       .0
  2      4.8     2425.6   7526.9   8826.8       .0        .0    121.3       .0       .0
  3      4.9     3946.3   7110.5   9190.3       .0        .0    197.3       .0       .0
  4      4.9     5355.5   6655.5   9471.2       .0        .0    267.8       .0       .0
  5      5.0     6633.1   6167.6   9668.6       .0        .0    331.7       .0       .0
  6      5.0     7761.5   5652.9   9781.9       .0        .0    388.1       .0       .0
  7      5.0     8726.0   5117.6   9810.8       .0        .0    436.3       .0       .0
  8      5.0     9514.9   4568.0   9755.3       .0        .0    475.7       .0       .0
  9      5.0    10119.8   4010.6   9615.4       .0        .0    506.0       .0       .0
 10      4.9    10535.2   3451.5   9391.6       .0        .0    526.8       .0       .0
 11      4.9    10759.3   2897.1   9084.5       .0        .0    538.0       .0       .0
 12      4.8    10793.3   2353.2   8695.1       .0        .0    539.7       .0       .0
 13      4.7    10641.9   1825.8   8224.5       .0        .0    532.1       .0       .0
 14      4.6    10312.8   1320.2   7674.0       .0        .0    515.6       .0       .0
 15      4.5     9817.1    841.4   7045.3       .0        .0    490.9       .0       .0
 16      4.4     9168.7    394.2   6340.3       .0        .0    458.4       .0       .0
 17      1.9     3892.3     40.9   2636.1       .0        .0    194.6       .0       .0
 18      2.3     4472.2       .0   2685.4       .0        .0    223.6       .0       .0
 19      4.1     7411.3       .0   3964.1       .0        .0    370.6       .0       .0
 20      2.6     4230.8       .0   1881.2       .0        .0    211.5       .0       .0
 21      1.4     2109.2       .0    783.9       .0        .0    105.5       .0       .0
 22      3.8     4836.7       .0   1321.0       .0        .0    241.8       .0       .0
 23      1.6     1648.6       .0    144.9       .0        .0     82.4       .0       .0
 24      2.0     1612.8       .0       .0       .0        .0     80.6       .0       .0
 25      3.4     1803.2       .0       .0       .0        .0     90.2       .0       .0
 26      2.7      451.8       .0       .0       .0        .0     22.6       .0       .0

        Failure Surface Specified By 26 Coordinate Points


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

            1         63.68        49.87
            2         68.51        48.58
```

UPSTREAM EMBANKMENT ANALYSIS, CIRCL2, PSEUDO
Ten Most Critical.   C:EFN12.PLT   By: ANDY WALSH   09-17-93   11:27am



PCSTABL5M FS min=2.58

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                    ** PCSTABL5M **

                          by
                   Purdue University
----------------------------------------------------------------------------

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

     Run Date:                   09-17-93
     Time of Run:                11:52am
     Run By:                     ANDY WALSH
     Input Data Filename:        C:EFN14.IN
     Output Filename:            C:EFN14.OUT
     Plotted Output Filename:    C:EFN14.PLT


     PROBLEM DESCRIPTION   UPSTREAM EMBANKMENT ANALYSIS, CIRCL2,
                           STATIC, FOUNDATION


     BOUNDARY COORDINATES

        6 Top   Boundaries
        8 Total Boundaries

     Boundary    X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd

        1          .00      52.00      58.00      48.00         2
        2        58.00      48.00     146.00      77.00         1
        3       146.00      77.00     155.00      80.00         1
        4       155.00      80.00     180.00      80.00         1
        5       180.00      80.00     260.00      40.00         1
        6       260.00      40.00     360.00      38.00         2
        7        58.00      48.00     114.00      43.00         2
        8       114.00      43.00     260.00      40.00         2
----------------------------------------------------------------------------

    ISOTROPIC SOIL PARAMETERS


     2 Type(s) of Soil


    Soil  Total  Saturated  Cohesion Friction   Pore    Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept  Angle   Pressure Constant  Surface
     No.  (pcf)    (pcf)     (psf)    (deg)    Param.    (psf)     No.

      1   105.0    110.0     300.0     24.0     .00        .0       1
```

```
     2   115.0     120.0      500.0      30.0      .00          .0      2
--------------------------------------------------------------------------------

    2 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED


    Unit Weight of Water =  62.40


    Piezometric Surface No.  1 Specified by  6 Coordinate Points

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

        1            .00       77.00
        2         146.00       77.00
        3         220.00       50.00
        4         240.00       40.50
        5         260.00       40.00
        6         360.00       38.00


    Piezometric Surface No.  2 Specified by  5 Coordinate Points

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

        1            .00       52.00
        2          58.00       48.00
        3         114.00       43.00
        4         260.00       40.00
        5         360.00       38.00
--------------------------------------------------------------------------------


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


    200 Trial Surfaces Have Been Generated.


     10 Surfaces Initiate From Each Of 20 Points Equally Spaced
    Along The Ground Surface Between  X =  60.00 ft.
                                and  X =  80.00 ft.


    Each Surface Terminates Between   X = 160.00 ft.
                               and   X = 180.00 ft.


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

```
     5.00 ft. Line Segments Define Each Trial Failure Surface.

-------------------------------------------------------------------------------

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


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


    Failure Surface Specified By 24 Coordinate Points


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

        1          65.26         50.39
        2          70.02         48.84
        3          74.85         47.55
        4          79.74         46.52
        5          84.68         45.76
        6          89.66         45.28
        7          94.65         45.07
        8          99.65         45.13
        9         104.64         45.47
       10         109.60         46.07
       11         114.53         46.95
       12         119.39         48.10
       13         124.19         49.51
       14         128.90         51.18
       15         133.52         53.11
       16         138.02         55.29
       17         142.39         57.71
       18         146.63         60.37
       19         150.71         63.25
       20         154.63         66.36
       21         158.37         69.67
       22         161.93         73.18
       23         165.29         76.89
       24         167.82         80.00

   Circle Center At X =   96.0 ; Y =  136.3  and Radius,   91.2

         ***     3.473   ***


         Individual data on the    26  slices
```

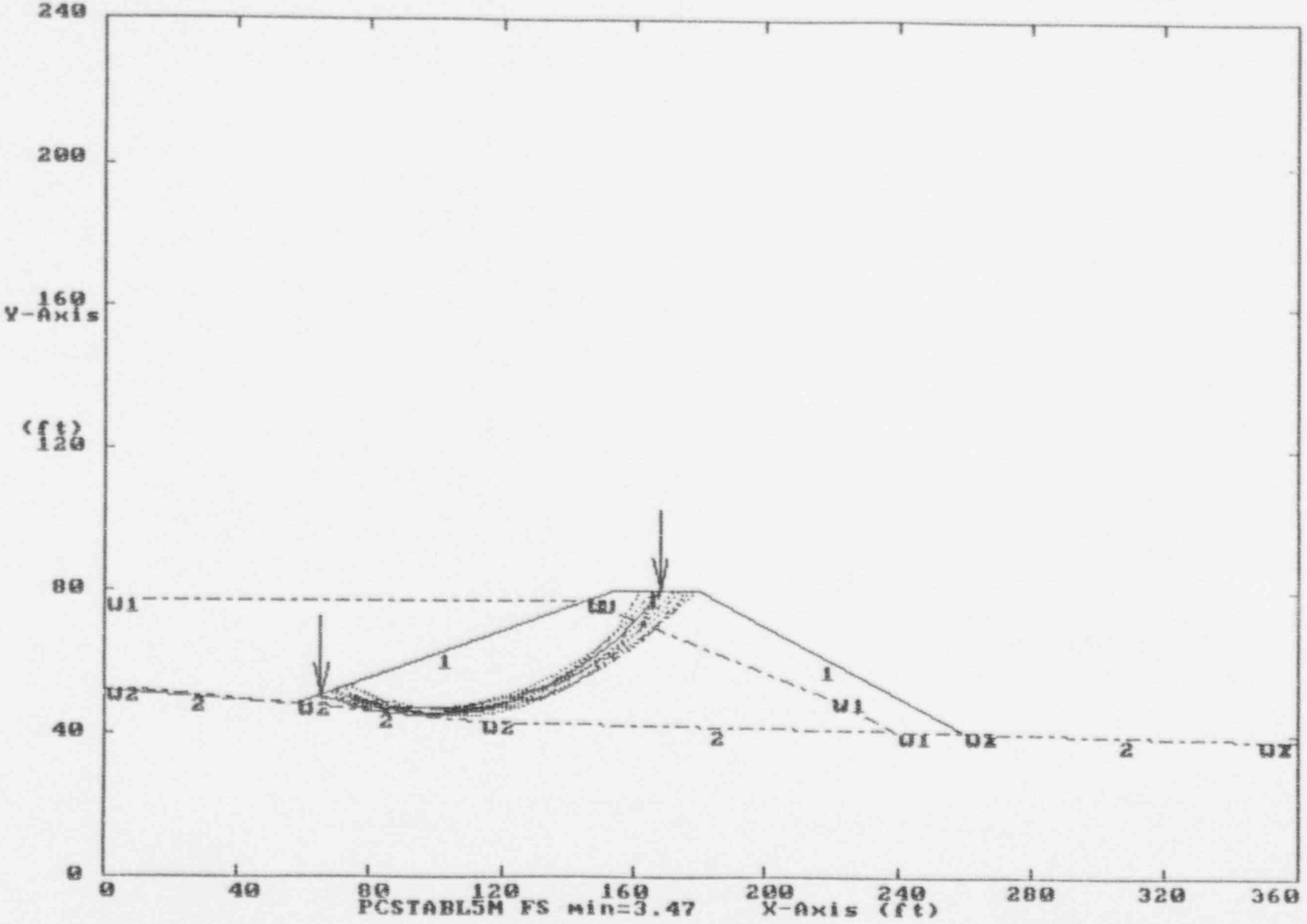
```
                          Water    Water      Tie       Tie      Earthquake
                          Force    Force     Force     Force       Force     Surcharge
Slice  Width    Weight     Top      Bot      Norm       Tan       Hor        Ver       Load
 No.   Ft(m)   Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)
  1     4.8      815.7   8062.4   8543.7       .0       .0       .0       .0       .0
  2     4.8     2424.4   7693.7   8987.9       .0       .0       .0       .0       .0
  3     4.9     3942.7   7279.8   9349.6       .0       .0       .0       .0       .0
  4     4.9     5347.8   6826.1   9627.7       .0       .0       .0       .0       .0
  5     5.0     6619.1   6338.8   9821.4       .0       .0       .0       .0       .0
  6     5.0     7738.7   5823.8   9930.0       .0       .0       .0       .0       .0
  7     5.0     8691.9   5287.6   9953.4       .0       .0       .0       .0       .0
  8     5.0     9466.9   4736.6   9891.3       .0       .0       .0       .0       .0
  9     5.0    10055.3   4177.4   9744.0       .0       .0       .0       .0       .0
 10     4.9    10451.9   3616.4   9511.9       .0       .0       .0       .0       .0
 11     4.9    10654.9   3059.9   9195.8       .0       .0       .0       .0       .0
 12     4.8    10666.3   2514.0   8796.5       .0       .0       .0       .0       .0
 13     4.7    10491.0   1984.7   8315.3       .0       .0       .0       .0       .0
 14     4.6    10137.5   1477.4   7753.6       .0       .0       .0       .0       .0
 15     4.5     9617.5    997.3   7113.1       .0       .0       .0       .0       .0
 16     4.4     8945.6    549.1   6395.7       .0       .0       .0       .0       .0
 17     3.6     6972.0    141.0   4826.8       .0       .0       .0       .0       .0
 18      .6     1163.5       .0    726.2       .0       .0       .0       .0       .0
 19     4.1     7168.1       .0   4174.8       .0       .0       .0       .0       .0
 20     3.9     6114.6       .0   2866.6       .0       .0       .0       .0       .0
 21      .4      533.2       .0    210.5       .0       .0       .0       .0       .0
 22     3.4     4267.2       .0   1303.1       .0       .0       .0       .0       .0
 23     2.1     2045.5       .0    241.7       .0       .0       .0       .0       .0
 24     1.5     1169.8       .0       .0       .0       .0       .0       .0       .0
 25     3.4     1750.7       .0       .0       .0       .0       .0       .0       .0
 26     2.5      412.7       .0       .0       .0       .0       .0       .0       .0

         Failure Surface Specified By 25 Coordinate Points


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

             1          67.37         51.09
             2          72.12         49.53
```

UPSTREAM EMBANKMENT ANALYSIS, CIRCL2, STATIC, FOUNDATION
Ten Most Critical. C:EFN14.PLT By: ANDY WALSH 09-17-93 11:52am



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                        ** PCSTABL5M **

                              by
                       Purdue University
--------------------------------------------------------------------------

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


      Run Date:                    09-17-93
      Time of Run:                 12:01pm
      Run By:                      ANDY WALSH
      Input Data Filename:         C:EFN15.IN
      Output Filename:             C:EFN15.OUT
      Plotted Output Filename:     C:EFN15.PLT




      PROBLEM DESCRIPTION   UPSTREAM EMBANKMENT ANALYSIS, CIRCL2,
                            PSEUDO, FOUNDATION



      BOUNDARY COORDINATES

         6 Top   Boundaries
         8 Total Boundaries


      Boundary    X-Left     Y-Left    X-Right    Y-Right    Soil Type
         No.       (ft)       (ft)       (ft)       (ft)     Below Bnd

          1          .00      52.00      58.00      48.00        2
          2        58.00      48.00     146.00      77.00        1
          3       146.00      77.00     155.00      80.00        1
          4       155.00      80.00     180.00      80.00        1
          5       180.00      80.00     260.00      40.00        1
          6       260.00      40.00     360.00      38.00        2
          7        58.00      48.00     114.00      43.00        2
          8       114.00      43.00     260.00      40.00        2
--------------------------------------------------------------------------

     ISOTROPIC SOIL PARAMETERS


      2 Type(s) of Soil


      Soil  Total  Saturated  Cohesion Friction   Pore    Pressure   Piez.
      Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant  Surface
       No.  (pcf)    (pcf)     (psf)     (deg)   Param.    (psf)     No.

        1   105.0    110.0     300.0     24.0     .00        .0       1
```

```
          2   115.0    120.0      500.0      30.0     .00          .0       2
--------------------------------------------------------------------------------


          2 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED


          Unit Weight of Water =  62.40


          Piezometric Surface No.  1 Specified by  6 Coordinate Points

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

              1            .00        77.00
              2         146.00        77.00
              3         220.00        50.00
              4         240.00        40.50
              5         260.00        40.00
              6         360.00        38.00


          Piezometric Surface No.  2 Specified by  5 Coordinate Points

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

              1            .00        52.00
              2          58.00        48.00
              3         114.00        43.00
              4         260.00        40.00
              5         360.00        38.00


          A Horizontal Earthquake Loading Coefficient
          Of .050 Has Been Assigned

          A Vertical Earthquake Loading Coefficient
          Of .000 Has Been Assigned

          Cavitation Pressure =      .0 psf
--------------------------------------------------------------------------------


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


          200 Trial Surfaces Have Been Generated.


           10 Surfaces Initiate From Each Of 20 Points Equally Spaced
```

```
        Along The Ground Surface Between  X =  60.00 ft.
                                     and  X =  80.00 ft.


        Each Surface Terminates Between   X = 160.00 ft.
                                    and   X = 180.00 ft.


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


         5.00 ft. Line Segments Define Each Trial Failure Surface.

-----------------------------------------------------------------------------

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


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


        Failure Surface Specified By 24 Coordinate Points


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

            1         65.26        50.39
            2         70.02        48.84
            3         74.85        47.55
            4         79.74        46.52
            5         84.68        45.76
            6         89.66        45.28
            7         94.65        45.07
            8         99.65        45.13
            9        104.64        45.47
           10        109.60        46.07
           11        114.53        46.95
           12        119.39        48.10
           13        124.19        49.51
           14        128.90        51.18
           15        133.52        53.11
           16        138.02        55.29
           17        142.39        57.71
           18        146.63        60.37
           19        150.71        63.25
           20        154.63        66.36
           21        158.37        69.67
           22        161.93        73.18
           23        165.29        76.89
           24        167.82        80.00

        Circle Center At X =   96.0 ; Y =  136.3  and Radius,    91.2
```

```
          ***     2.562    ***



         Individual data on the    26  slices

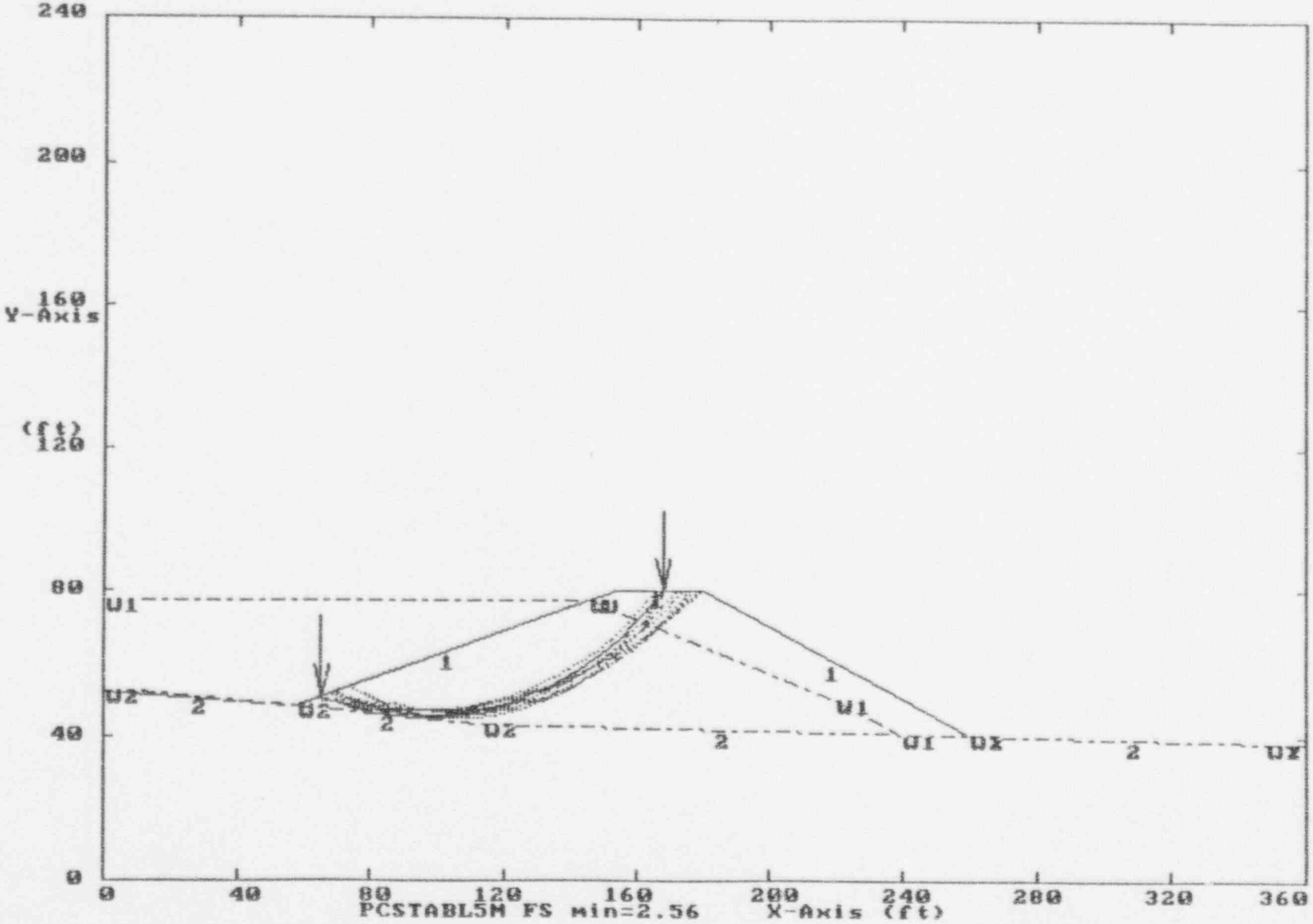
                              Water   Water      Tie      Tie      Earthquake
                              Force   Force     Force    Force       Force    Surcharge
 Slice   Width    Weight       Top     Bot      Norm      Tan      Hor      Ver      Load
  No.    Ft(m)   Lbs(kg)   Lbs(kg) Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)  Lbs(kg)
   1      4.8     815.7    8062.4  8543.7       .0       .0     40.8       .0       .0
   2      4.8    2424.4    7693.7  8987.9       .0       .0    121.2       .0       .0
   3      4.9    3942.7    7279.8  9349.6       .0       .0    197.1       .0       .0
   4      4.9    5347.8    6826.1  9627.7       .0       .0    267.4       .0       .0
   5      5.0    6619.1    6338.8  9821.4       .0       .0    331.0       .0       .0
   6      5.0    7738.7    5823.8  9930.0       .0       .0    386.9       .0       .0
   7      5.0    8691.9    5287.6  9953.4       .0       .0    434.6       .0       .0
   8      5.0    9466.9    4736.6  9891.3       .0       .0    473.3       .0       .0
   9      5.0   10055.3    4177.4  9744.0       .0       .0    502.8       .0       .0
  10      4.9   10451.9    3616.4  9511.9       .0       .0    522.6       .0       .0
  11      4.9   10654.9    3059.9  9195.8       .0       .0    532.7       .0       .0
  12      4.8   10666.3    2514.0  8796.5       .0       .0    533.3       .0       .0
  13      4.7   10491.0    1984.7  8315.3       .0       .0    524.6       .0       .0
  14      4.6   10137.5    1477.4  7753.6       .0       .0    506.9       .0       .0
  15      4.5    9617.5     997.3  7113.1       .0       .0    480.9       .0       .0
  16      4.4    8945.6     549.1  6395.7       .0       .0    447.3       .0       .0
  17      3.6    6972.0     141.0  4826.8       .0       .0    348.6       .0       .0
  18       .6    1163.5        .0   726.2       .0       .0     58.2       .0       .0
  19      4.1    7168.1        .0  4174.8       .0       .0    358.4       .0       .0
  20      3.9    6114.6        .0  2866.6       .0       .0    305.7       .0       .0
  21       .4     533.2        .0   210.5       .0       .0     26.7       .0       .0
  22      3.4    4267.2        .0  1303.1       .0       .0    213.4       .0       .0
  23      2.1    2045.5        .0   241.7       .0       .0    102.3       .0       .0
  24      1.5    1169.8        .0      .0       .0       .0     58.5       .0       .0
  25      3.4    1750.7        .0      .0       .0       .0     87.5       .0       .0
  26      2.5     412.7        .0      .0       .0       .0     20.6       .0       .0

        Failure Surface Specified By 25 Coordinate Points


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

            1          67.37         51.09
            2          72.12         49.53
            3          76.95         48.23
```

UPSTREAM EMBANKMENT ANALYSIS, CIRCL2, PSEUDO, FOUNDATION
Ten Most Critical. C:EFN15.PLT By: ANDY WALSH 09-17-93 12:01pm



APPENDIX D

DESIGN DRAWINGS

APPENDIX E

TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

1.0 SITE PREPARATION

1.1 GENERAL

Site preparation includes clearing, grubbing, stripping, borrow development, required excavations, and foundation preparation within the various work areas for their designated purpose. In general, these work areas include the Treatment Pond and Plant facilities, Irrigation Water Storage facilities, diversion ditches and berms, designated access road corridors, and borrow areas.

The intent of these Specifications is to minimize ground disturbance beyond required work limits. Unless otherwise noted on the Drawings, grubbing and stripping shall extend 5 feet beyond the required excavation and fill limits.

1.2 CLEARING AND GRUBBING

No clearing and grubbing of vegetation is required at this site. The grass-cover vegetation shall be removed as part of stripping.

1.3 STRIPPING

Stripping includes removal of vegetation and organic soils (soil cover), as determined by the Engineer. Depth of stripping shall not exceed 12 inches from the original ground surface, unless otherwise directed by the Engineer. Material removed from stripping operations shall be placed in designated soil cover stockpile areas for subsequent reclamation operations in locations indicated by the Owner.

Soil cover stockpile limits shall be graded to prevent ponding of water. Exterior stockpile slopes shall be trimmed to reasonably regular lines and stable slopes of 2H:1V or flatter.

1.4 BORROW DEVELOPMENT

The Contractor shall liaise with the Owner, as needed, to schedule and coordinate the production and/or stockpiling of acceptable borrow materials from the borrow pit area and other sources on and off site for the execution of the Contractor's work.

Acceptable borrow areas shall be stripped in stages, as approved by the Owner/Engineer, to minimize ground disturbance. Each stage of stripping shall be sufficient in areal extent for the Contractor to operate conventional earthwork equipment for conditioning and excavating materials acceptable for fill placement. Stripped cover soil shall be temporarily stockpiled for final borrow surface reclamation by the Contractor, as approved by the Owner, or placed in designated soil cover stockpile areas for final reclamation by the Owner.

The final surfaces of all borrow areas developed by the Contractor shall be left in reasonably smooth, even conditions and graded to drain for long-term stability. Final surface grading shall be by dozer or grader blade operations, as approved by the Engineer. Final cut slopes shall be no steeper than 2H:1V. The Contractor shall replace stripped cover soil over the final borrow cuts, unless otherwise approved by the Owner.

1.5 EXCAVATION

Insofar as is practical in the permanent construction, the Contractor shall use materials obtained from on-site required excavations and the Owner's stockpiles which meet applicable fill specifications. All open-cut excavations shall be performed in accordance with the Specifications to the lines, grades, and dimensions shown on the Drawings or as established by the Engineer. Assumed site leveling or structure excavation lines are shown on the Drawings, but the final excavation may vary to suit field conditions.

1.6 FOUNDATION PREPARATION

The intent of these Specifications is to prepare a subbase for the placement of fill for site grading and foundation structures. At the completion of the required foundation stripping operations and removal of unsuitable foundation material, the final site grading cut surface of the treatment ponds and the foundation subgrade area for the water storage reservoir embankment shall be scarified to a minimum depth of 6 inches, moisture conditioned to within 2 percent of optimum moisture content, and recompacted to at least 95 percent of maximum density (ASTM D-698). No fill shall be placed until the stripped and reworked fill foundation areas have been inspected and approved by the Engineer.

Foundation preparation for geomembrane liner placement in final cut or fill areas includes select borrow or in-place materials for liner fill, as specified in Section 2.0.

2.0 FILL PLACEMENT

2.1 GENERAL

The work covered by this section of the Specifications shall include, but is not limited to: fill placement for the irrigation water storage embankment area, treatment ponds, berms, drains, liner anchor, and runoff diversion ditches; reworking in-place foundation materials; and earthwork incident thereto. The procedures for the construction of required fills shall be discussed with and approved by the Engineer prior to fill placement. Fill placement shall include the following material types specified herein: compacted fill; liner fill; drain fill; general fill; and structural fill. General placement, moisture control, and compaction guidelines are discussed herein.

The distribution of materials shall be such that the fill is free from lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. The combined borrow excavation and fill placement operation shall be such that the materials, when compacted in the fill, will be blended sufficiently to secure the best practicable distribution of the material, subject to the approval of the Engineer.

During compaction operations, the borrow and reworked in-place materials requiring moisture conditioning shall be maintained within the moisture content range required to permit proper compaction to the specified density with the equipment being used. The moisture content of the earth fill material prior to and during compaction shall be uniform throughout the material.

Wherever necessary, after fill material has been placed and spread, or reworked in-place and moisture conditioned as specified, the layer shall be compacted by passing compaction equipment over the entire surface of the layer a sufficient number of times to obtain the required density, as determined by the Engineer on the basis of field density tests and his observation of the fill operations.

The Engineer shall continuously evaluate the Contractor's equipment and methods. If such equipment or methods are found unsatisfactory for the intended use, the Engineer will require the Contractor to replace the unsatisfactory equipment with other types or adjust methods until proper compaction is achieved.

The Contractor shall maintain and protect fills in a condition satisfactory to the Engineer at all times until the final completion and acceptance of the work.

2.2 COMPACTED FILL

Compacted fill shall be used to construct the irrigation water storage embankment as shown on the Drawings. Compacted fill shall consist of inorganic soils and rock from approved borrow areas and required excavations.

Compacted fill with less than 30 percent rock particles retained on the 3/4-inch sieve size and a maximum 6-inch rock size shall be moisture conditioned to within 2 percent of optimum moisture content, placed in 9-inch maximum loose lifts and compacted to a minimum 95 percent of maximum density (ASTM D-698).

Oversized rock for the compacted soil fill shall be raked to the outside fill slopes or stockpiled for use as rip rap material.

2.3 SOIL LINER FILL

Liner fill shall be used as a prepared soil foundation placed in two 6-inch compacted lifts to inhibit seepage and provide secondary containment system for the treatment ponds. The soil liner fill will be compacted to meet 1×10^{-7} cm/sec permeability requirements.

Reworked in-place natural soils and weathered bedrock meeting liner fill gradation, moisture and compaction requirements specified herein shall be acceptable as reworked soil liner fill. Soil liner fill shall consist of the finer inorganic soils available from Engineer approved borrow areas or in-place soils with a 3/4-inch maximum rock size adjacent to the geomembrane liner material, a minimum 30 percent fines passing the No. 200 sieve size, and a minimum plasticity index of 10. Non-plastic soils with a minimum 50 percent fines passing the No. 200 sieve size, or other equivalent low permeability soils shall be acceptable, as approved by the Engineer.

Soil liner fill shall be moisture conditioned to within 2 percent of optimum moisture content, placed in maximum 9-inch loose lifts, and compacted to a minimum 95 percent of maximum density (ASTM D-698).

The Contractor shall selectively borrow, transport, and place fill as meets the Specification from approved borrow areas within the project area. The finished soil liner fill surface shall be smooth, compacted, and free from irregular surface changes to the satisfaction of the Engineer. Oversized rock greater than 3/4-inch in size shall be removed from the exposed surface fill prior to smoothing and compaction. The degree of smoothing shall be that ordinarily obtained from blade grader operations. The prepared surface shall be graded to drain so that ponding does not occur.

2.4 GENERAL FILL

General fill shall be used to construct controlled grades for miscellaneous lightly loaded or non-critical structures and subgrades for roadways and lined pond berms, as shown on the Drawings. General fill shall consist of inorganic soils and rock from Engineer approved borrow areas, moisture conditioned to within 2 percent of optimum moisture content, placed in 12-inch maximum loose lifts, and compacted to a minimum 90 percent of maximum density (ASTM D-698).

2.5 STRUCTURAL FILL

Structural fill shall be used to construct the foundation support for heavily loaded or critical plant structures requiring low foundation movement tolerances. Structural fill shall consist of inorganic soils and rock from Engineer approved borrow areas, moisture conditioned to within 2 percent of optimum moisture content, placed in 8-inch maximum loose lifts, and compacted to a minimum 98 percent of maximum density (ASTM D-1557).

2.6 DRAIN FILL

The drain fill material shall be placed in the water storage embankment downstream drain blanket and in the treatment pond leak detection sand layer, as shown on the Drawings. Drain fill shall consist of relatively clean sand and gravel from an off site source with a 3/4-inch maximum size, 40 to 70 percent passing the No. 4 sieve size, and a maximum 5 percent passing the No. 200 sieve size. The drain fill shall not require any compaction, moisture or lift thickness specifications and shall be placed in a manner to prevent direct dumping on the pond leak detection drain pipes. The drain blanket layer for the water storage embankment shall be 20 feet wide by 40 feet long by 1-foot thick beneath the downstream toe of the Phase 1 embankment in the valley bottom. The drain blanket shall be extended downstream to the Phase 2 toe at 20 feet wide by 31 feet long by 1-foot thick.

Prior approval of the drain material by the Engineer will be required before the drain material is delivered to site.

2.7 RANDOM FILL

Random fill shall be placed for the liner anchor trench and other areas outside of structure limits, as shown on the Drawings. Random fill shall include inorganic soil and rock with no lift thickness, moisture conditioning, or compaction requirements in the trench. The final surface shall be wheel rolled by a rubber-tired front-end loader with loaded bucket, or equivalent compaction approved by the Engineer. The final random fill surface shall be graded to drain.

3.0 GEOMEMBRANE LINER MATERIAL

3.1 GENERAL

The Contractor shall furnish and install geomembrane liner materials and miscellaneous materials incident thereto in accordance with the manufacturer's recommendations. The intent of design is to provide flexible high density polyethylene liners for the primary treatment pond containment systems. The high density polyethylene liners are specified for their resistance to sunlight degradation (UV-light) and long-term exposure durability. Alignments, lengths, and areas are shown on the Drawings. Exact locations and lengths may be varied to suit conditions encountered in the field, as approved by the Engineer.

Direct vehicular contact with the liners shall not be allowed in order to prevent damage to the liners.

In addition to field seam testing specified herein, the Contractor shall water test the top liner for the treatment ponds with a minimum 5 feet of ponded fresh water (8 feet above the sump bottom level) with no leaks in 48 hours prior to acceptance by the Owner. If leaks occur, the Contractor shall find and repair the leaks for a retest as before. The Owner shall provide the source of water for testing.

3.2 MATERIALS

The geomembrane liners shall be placed over the leak detection sand and wick drain material in the treatment ponds to provide an uninterrupted impervious liner seepage barrier. Liner materials for feasibility design include 80-mil high density polyethylene (HDPE) or an Engineer approved equivalent. The liners shall have the following minimum requirements as shown on Table 4.1, or as approved by the Engineer:

TABLE 3.1

MINIMUM REQUIREMENTS FOR LINER

PROPERTIES	TEST METHODS	MINIMUM TEST VALUES
		80-mil HDPE
Minimum thickness (mil)	ASTM D1593	76
Puncture resistance (lb)	FTMS 101-2065	105
Tear resistance initiation (lb)	ASTM D1004-Die C	55
Tensile strength at break (lb/in)	ASTM D638	320
Tensile strength at yield (lb/in)	ASTM D638	190
Elongation at break (%)	ASTM D638	700

3.3 PLACEMENT

The geomembrane shall be installed by crews experienced in the placement of the particular type of liner to be installed on projects of similar size and type, according to the manufacturer's recommendations. Experience records of the liner manufacturer and installer shall be submitted to the Owner for review. Approval of the manufacturer and installer shall be obtained from the Owner prior to purchase of material or mobilization of the installer.

The Contractor shall visually inspect all delivered liner materials on arrival at the job site for damage and identification. Any damage to the liner panels caused by shipment, handling, and placement shall be rejected. Liner panels shall remain in the shipping containers or shall be covered and protected from the elements until ready for installation. Only liner panels for each day's seaming shall be placed.

The liner panels shall be oriented in such a manner as to minimize stress on the factory and field seams. To this end, liner panels shall be placed with factory seams and long field seams oriented longitudinally with the slopes (positioned up and down slopes).

The liner panels shall be temporarily anchored and held in place with sandbags, or other approved methods until completion of field seaming. Anchoring at the edge of the liner shall be as shown on the Drawings. Care shall be taken to ensure that the liner panels are positioned in a slackened condition for conforming to the subgrade without being taut. The liner panels shall be placed and smoothed so that the direct contact with the liner fill is maximized.

Sheets shall be of maximum width produced by the manufacturer. Before the adoption of a particular seaming technique, the Contractor shall supply the Engineer with written details of the method and equipment to be used. Operating criteria and specifications for the seaming technique and equipment shall be submitted. Approval of the seaming technique shall be obtained from the Engineer prior to its use. Such approval shall not relieve the Contractor of the responsibility of producing the required seam. Lining sheets shall be seamed by a fusion method according to the manufacturer's recommendations.

3.4 SEAMING

The two sheets of liner shall be overlapped to the minimum manufacturer's specification with the two sheets pulled tightly to keep the seamed edges smooth and wrinkle free. If the area to be seamed is not fresh and clean and free of dirt, the area shall be cleaned with trichloroethane or other manufacturer approved cleaner. No seaming shall be performed when moisture resulting from either condensation or precipitation exists at the seam in quantities sufficient to reduce the effectiveness of the seaming technique.

3.5 TESTING AND FIELD INSPECTION

The Contractor shall provide the Engineer with a copy of the manufacturer's quality control testing for roll of each shipment or partial shipment of liner, if the entire shipment is not covered by the testing. Such testing shall include data on the melt index (ASTM D-1238), density (ASTM D-1504), tensile and elongation (ASTM D-638), thickness (ASTM D-1593), and carbon black content (ASTM D-1603).

The test data shall be referenced to a shipment number. Upon placement, the Contractor shall indicate by a plan the exact location at which the liner shipment is installed.

The Contractor shall be responsible for providing his own quality control personnel and testing equipment. The Engineer will perform his own testing independent of the Contractor's testing. At the end of each shift, the Contractor shall submit to the Engineer a written notice indicating the areas of installation completed during that shift.

Field quality control testing shall involve both nondestructive and destructive testing. The nondestructive testing shall determine "water tightness" of the seam, whereas the destructive testing shall determine the strength and integrity of the seam.

Destructive testing shall be performed on dumb-bells cut with the seam centrally located within the test specimen. Both shear and peel testing shall be performed.

A sample seam shall be made twice during each shift with each seaming machine. Samples from the weld shall be tested in shear and peel, and no seaming equipment may start work until the seaming weld has been visually approved by the Engineer.

A visual examination of all seams shall be performed. Any suspect areas, breaks, or holes in the weld shall be recorded and marked for repair.

In addition to or concurrent with the visual inspection, the Contractor shall test all seams with the use of a vacuum box, pressurized double-wedge air channel, or other standard techniques. Details of the method of nondestructive seam testing to be adopted shall be submitted to the Engineer for approval prior to its use. Any holes detected in the seam shall be recorded and marked for repair. All repaired areas shall be retested upon completion of the repair.

Vacuum testing for the extrusion or fusion welded liners shall involve the use of a glass-faced suction box, typically 3 feet long and wide enough to cover the weld, placed over a section of the seam which has been wetted with a soap solution. Suction shall be applied to the seam at 5 psi, as indicated on a pressure gauge mounted to the box with a sensitivity to the nearest 1 psi. Any leaks demonstrated by the formation of bubbles shall be marked for repair and retested.

Non-destructive testing of a double wedge weld consists of pressurizing a continuous open air channel between the double welds for leaks. First, air is blown throughout the air channel to check for continuity or blockage. Blocked air channels shall require weld vacuum testing as specified above. Second, the ends of the continuous air channel seam are sealed and the air channel pressurized with an air pump and a sharp hollow needle or other approved pressure feed device to a specified pressure of typically 40 psi. Third, the air pressure is maintained over a specified time interval, typically 2 minutes, with allowance for expansion of the liner material under pressure. Further, if the seam does not hold pressure within liner expansion tolerance, the leak is located and repaired (normally found by the sound of hissing from the defect). Once isolated, the remainder of the seam is retested and the defective area recorded and marked for repair. If the leak cannot be located, vacuum box testing shall be done along the entire length of seam.

For double wedge testing the Contractor shall have an air pump with valves, mounted on a cushion to protect the liner, and capable of generating and sustaining 45 psi of pressure. The air pump shall be equipped with a pressure gauge accurate to the nearest 1 psi sensitivity for testing. Acceptable expansion tolerance for each type of liner shall be as specified by the manufacturer and approved by the Engineer.

4.0 PIPE MATERIAL

4.1 GENERAL

Corrugated polyethylene (PE) drain pipes with perforations, Schedule 80 Polyvinyl Chloride (PVC) pipe, and wick drains shall be used for leak detection in the primary and secondary treatment ponds, as shown on the Drawings. High density polyethylene (HDPE) pipe or equivalent decant/siphon spillway pipe shall be installed from the Treatment Ponds to the irrigation water storage reservoir, as directed by the Owner.

The Contractor shall furnish and install the pipe, wick drains, and miscellaneous materials incident thereto, in accordance with the manufacturer's instructions and recommendations. Layouts, elevations, and lengths of pipe and drain materials are shown on the Drawings. Exact locations, lengths, slopes, and alignment of drains may vary to suit field conditions, as approved by the Engineer.

Construction equipment shall not cross over installed pipelines and wick drains. If pipeline materials are damaged by the Contractor's methods of installation and construction, and not suitable for use in permanent construction, as determined by the Owner/Engineer, the damaged material shall be replaced by the Contractor at no expense to the Owner.

4.2 PE DRAIN PIPE

The treatment pond leak detection pipes shall be located in the pond bottoms to detect leakage through the primary 80-mil HDPE geomembrane liner, as shown on the Drawings. The drain pipes shall be corrugated and perforated PE pipe. The 4-inch PE pipes shall be heavy duty highway grade pipe meeting AASHTO M-294 standards. The pipes shall be interconnected with manufactured joints as recommended by the manufacturer and shall be fitted with a polypropylene filter sock.

The manufactured drain pipe perforations shall be a minimum of 10 percent open area. Perforations shall be evenly placed around the inner pipe corrugation for minimum reduction in pipe strength.

4.3 PVC PIPE

The leak detection wells placed on the pond side slopes beneath the 80-mil HDPE liner shall consist of solid 4-inch diameter Schedule 80 PVC pipe with the bottom section slotted within the leak detection sump areas in the pond bottoms. The top and bottom of the pipe shall be capped (manufactured caps) and a 1/4-inch air vent hole installed below the top cap. Couplings shall be solvent welded (glued) and the top cap shall be threaded for ready access to the detection system. The fabricated slotted section shall have 3 rows of slots spaced at 120 degrees on maximum 1/2-inch centers, or approved equivalent. The slot widths shall be between 0.02 to 0.05 inches.

The top section of the leak detection well PVC pipes shall be caulked and clamped to the top 80-mil HDPE liner utilizing an HDPE liner boot for a water tight seal. The top of the pipe shall extend a minimum of 2 feet above the pond liner crest level.

4.4 HDPE PIPE

The HDPE for the treatment pond inlet/outlet pipes shall be Driscopipe 1000 Grade SDR 32.5, or equivalent approved by the Engineer. The outlet area extending through the pond liner shall be welded to HDPE pipe boots for a water tight seal. An optional decant/siphoning system may be provided by the Owner.

4.5 WICK DRAINS

Wick drains shall be placed on the pond slopes beneath the 80-mil HDPE pond liner on 20-foot centers at a 45 degree angle to the slope direction and at all pond corners for leak detection. Wick drain materials shall be placed and anchored, as approved by the Engineer, to prevent movement during geomembrane liner placement.

The Contractor shall furnish and install 4-inch wide fabric-enclosed wick drains, as produced by American Wick Drain Corporation, or an equivalent approved by the Engineer. The wick drains are capable of passing 1.5 gpm each of flow under low hydraulic heads and shall daylight to the drain fill in the pond bottom for leak detection.

5.0 QUALITY ASSURANCE

5.1 GENERAL

The following are guidelines for CQA testing by the Engineer and his Quality Assurance Team for the earthwork construction of the treatment ponds and the water storage reservoir and related facilities. Geomembrane liner testing and inspection are specified in Section 3. To the extent possible, CQA testing shall be conducted so as not to interfere with normal construction operations. However, if required for any reason, the Contractor shall stop work in the area being tested until the testing is complete or approval to proceed has been given by the Engineer or his appointed representative. The results shall be used to document and verify the quality of work and the extent to which the earthwork and installations have been completed as set forth in the Specifications and permits for the construction and operation of the structure.

The guidelines do not relieve the Contractor of any of his responsibilities to conduct his own daily quality control testing or to complete in a timely manner the work agreed to under the Specifications.

5.2 BORROW AREA CONTROL

The Contractor shall be responsible for development and/or processing of borrow materials to meet Specifications. Representative moisture and gradation tests may be conducted by the Engineer on borrow materials to determine the suitability of new borrow material used as fill. It shall be the Contractor's responsibility to notify the Engineer of changes in borrow source locations in advance of development to allow time for representative testing without unduly interrupting construction activities. Should the material prove to be unsuitable, a new borrow source location shall be designated by the Engineer and/or Contractor's processing operations adjusted to produce acceptable fill materials.

5.3 TESTING

Testing of fill materials shall be necessary for the Engineer to verify the suitability of materials, moisture-density relations and degree of compaction being obtained. Testing may include gradation and Atterberg Limit analyses, moisture content, permeability, compaction, and field density determination by the Sand Cone or Nuclear Gauge Method.

APPENDIX F

DIVERSION DITCH CALCULATIONS

TABLE F.1 HYDROLOGIC PARAMETERS FOR DIVERSION DITCH SIZING

Diversion Ditch No.	Catchment Area (sq.mi.)	*Time of Concentration,Tc (Hrs)	Max. Length of Travel,L (ft)	Average Slope,S (%)	Runoff Curve Number,Cn
1	0.095	0.89	2,900	4.1	70
2	0.140	0.77	2,700	4.1	70
3	0.118	0.93	3,400	3.5	70

✱ Time of concentration (hrs), $T_c = 1.67\ T_{lag}$

Lag time (hrs), $T_{lag} = L^{0.8} * \{(\frac{1000}{CN} - 10) + 1\}^{0.7}/[1900 * S^{0.5}]$

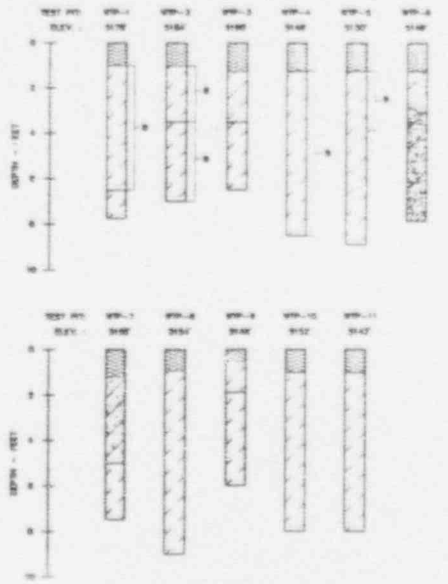
where, L is the length of the stream channel (in feet)

S is the average watershed land slope in percent

CN = SCS Runoff Curve Number (Meadows, Good Condition, Hydrologic Group Type

LEGEND:

▨	Organic soil, sandy clay and silty sand, loose, some organics, dry to moist, dark brown (TOPSOIL)
▨	Clay, sandy, silty, stiff to very stiff, residual soil (highly weathered bedrock or transported soil) with occasional claystone fragments, moist, brown, gray (CL)
▨	Sand, silty, medium dense, residual soil (highly weathered bedrock), slightly moist, brown (SM)
▨	Sandstone, interstratified with siltstone and claystone lenses, medium hard to hard, calcite cemented, slightly moist, brown to yellow brown to yellow (BEDROCK)
▨	Claystone, occasional sandstone lenses, hard to very hard, moist, brown to gray (BEDROCK)
☐	Indicates a small bag sample was taken at the depth interval shown
☐	Indicates gradual change in strata



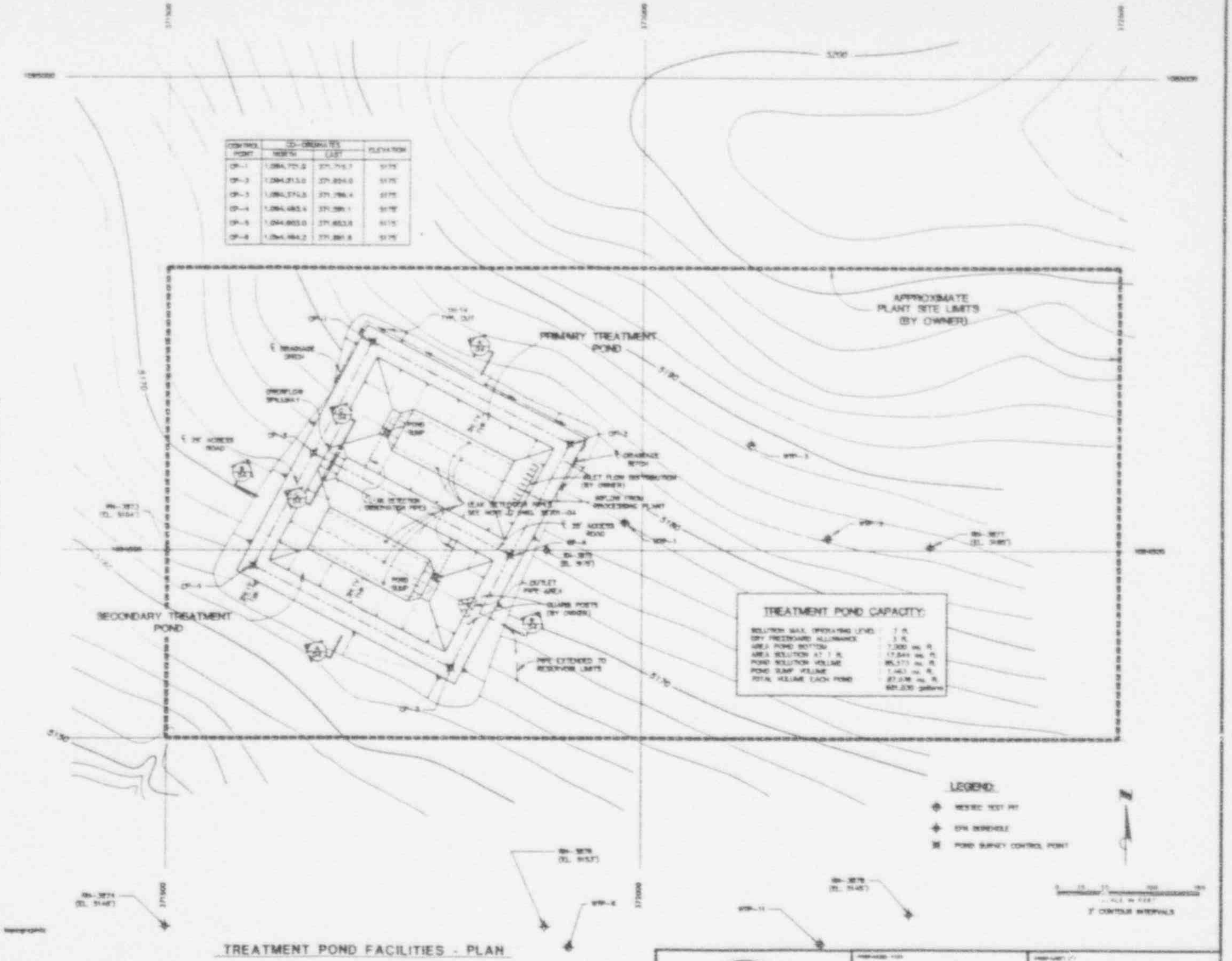
GENERAL NOTES:

1) Test pits were excavated on August 18, 1993 using a Case Model 580C Backhoe.

2) Test pit locations and elevations were field located based on USGS 10-ft. contour topographic maps and existing surveyed borehole locations provided by the Owner.

3) No free water was encountered in the test pits at the time of excavation.

4) These test pit logs summarize subsurface conditions for formulating the preliminary design criteria presented in this report. The test pit explorations were not made to define conditions for construction, nor is the information presented herein for that purpose.



TREATMENT POND CAPACITY:

SOLUTION MAX. OPERATING LEVEL	7 ft.
DRY FREEBOARD ALLOWANCE	3 ft.
AREA POND BOTTOM	7,300 sq. ft.
AREA SOLUTION AT 7 ft.	17,844 sq. ft.
POND SOLUTION VOLUME	85,573 cu. ft.
POND SUMP VOLUME	1,463 cu. ft.
TOTAL VOLUME EACH POND	87,036 cu. ft. 651,030 gallons

CONTROL POINT	CO-ORDINATES		ELEVATION
	NORTH	EAST	
CP-1	1,084,771.8	371,714.7	5175
CP-2	1,084,813.0	371,854.0	5175
CP-3	1,084,574.5	371,786.4	5175
CP-4	1,084,483.4	371,599.1	5175
CP-5	1,084,893.0	371,653.8	5175
CP-6	1,084,464.2	371,881.8	5175

TREATMENT POND FACILITIES - PLAN

NO.	DESCRIPTION	BY	CK	APPRVD	DATE
A	ISSUED DRAFT FOR REVIEW			A.J.B.	8/93
B	ISSUED FOR PERMITTING				

DESIGNED	A.J.B.	8/93
DRAWN	M.A.B.	8/93
CHECKED		
APPROVED		
APPROVED		
APPROVED		

WYOMING

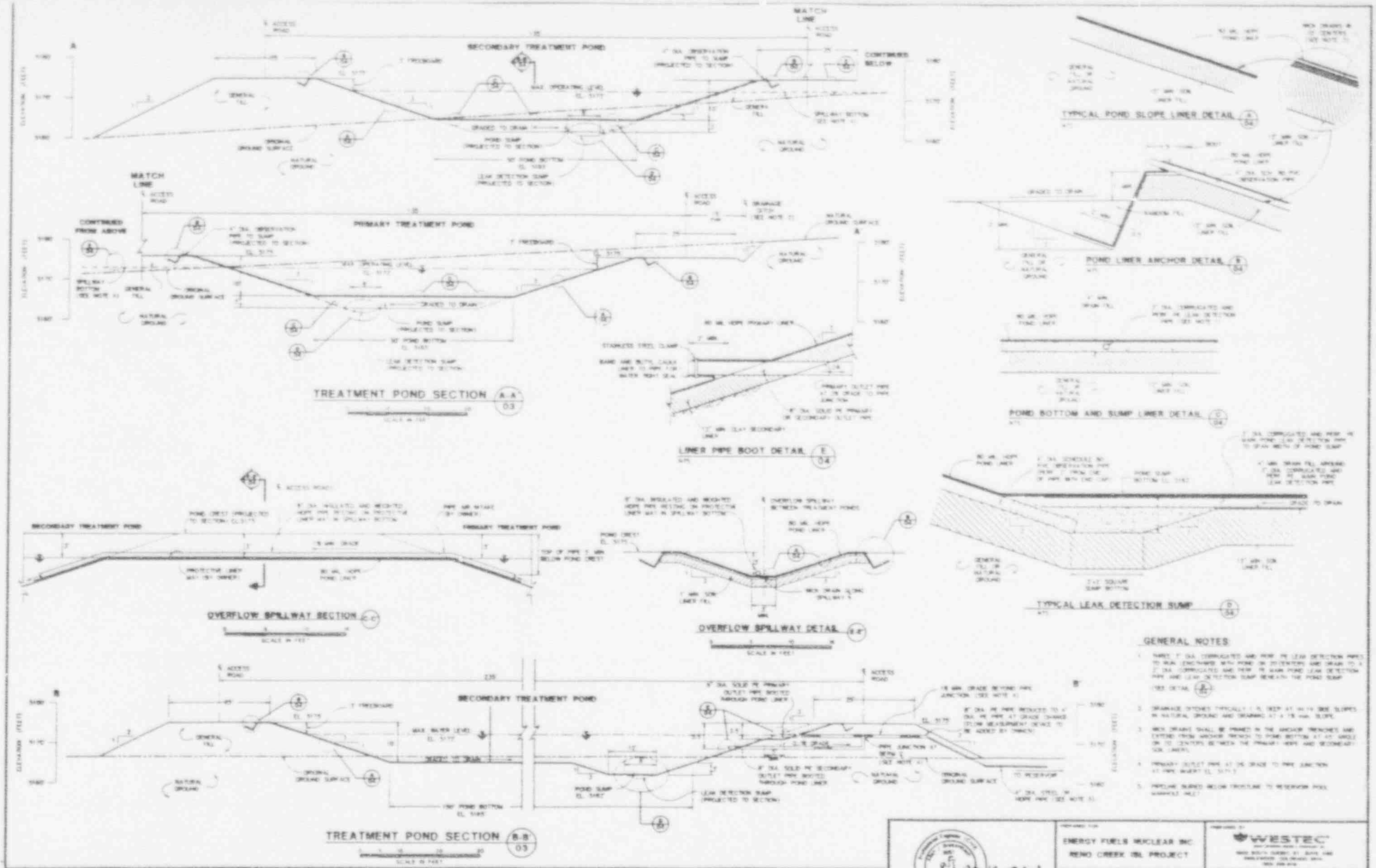
ENGINEER

PREPARED FOR:
ENERGY FUELS NUCLEAR INC.
RENO CREEK ISL PROJECT

TITLE:
TREATMENT POND
FACILITIES LAYOUT AND
EXPLORATION SUMMARY LOGS

PREPARED BY:
WESTEC

SCALE: 1"=50'
DRAWING NO.: 35701-03
REVISION: 1



GENERAL NOTES

1. THREE 1" DIA. CORRUGATED AND PERF. PE LEAK DETECTION PIPES TO RUN LENGTHWISE WITH POND ON 20' CENTERS AND DRAIN TO A 2" DIA. CORRUGATED AND PERF. PE MAIN POND LEAK DETECTION PIPE AND LEAK DETECTION SUMP BENEATH THE POND SUMP (SEE DETAIL D/04).
2. DRAINAGE DITCHES TYPICALLY 1 FT. DEEP AT 1H:1V SIDE SLOPES IN NATURAL GROUND AND DRAINING AT A 1% min. SLOPE.
3. WICK DRAINS SHALL BE PINNED IN THE ANCHOR TRENCHES AND EXTEND FROM ANCHOR TRENCH TO POND BOTTOM AT 45° ANGLE ON 10' CENTERS BETWEEN THE PRIMARY HDPE AND SECONDARY SOIL LINERS.
4. PRIMARY OUTLET PIPE AT 1% GRADE TO PIPE JUNCTION AT PIPE INVERT EL. 5171.5
5. PIPELINE BURIED BELOW FROSTLINE TO RESERVOIR POOL MANHOLE INLET.

NO.	DESCRIPTION	BY	CH	APPRVD	DATE
A	ISSUED DRAFT FOR REVIEW			A.J.B.	5/93
1	ISSUED FOR PERMITTING				

WYOMING

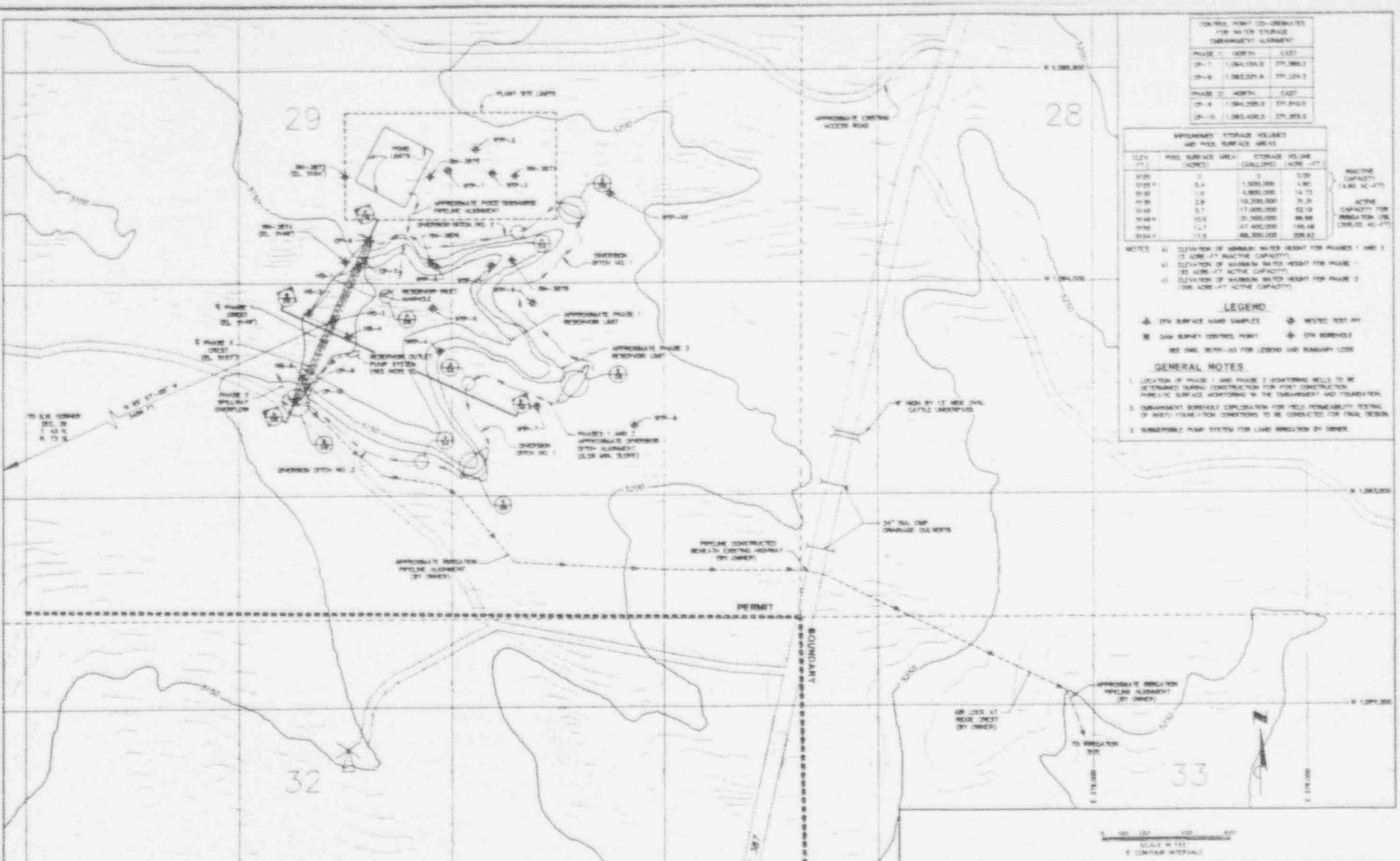
ENGINEER

PREPARED FOR
ENERGY FUELS NUCLEAR INC
RENO CREEK ISL PROJECT

PREPARED BY
WESTEC

TITLE
TREATMENT POND
CROSS SECTIONS AND DETAILS

SCALE AS SHOWN
DRAWING No. 35701-04
REVISION 1



CONTROL POINT CO-ORDINATES FOR WATER STORAGE EMBANKMENT ALIGNMENT

PHASE 1	NORTH	EAST
CP-7	1,084,104.0	371,380.2
CP-8	1,083,521.8	371,324.3
PHASE 2	NORTH	EAST
CP-9	1,084,255.0	371,910.0
CP-10	1,083,456.0	371,355.0

IMPOUNDMENT STORAGE VOLUMES AND POOL SURFACE AREAS

ELEV. (FT)	POOL SURFACE AREA (ACRES)	STORAGE VOLUME (GALLONS)	STORAGE VOLUME (ACRE-FT)	
5125	0	0	0.00	INACTIVE CAPACITY (4.60 AC-FT)
5128.5 a)	0.4	1,500,000	4.60	
5130	1.0	4,800,000	14.73	ACTIVE CAPACITY FOR IRRIGATION (TB (205.02 AC-FT)
5135	2.8	10,200,000	31.31	
5140	5.7	17,000,000	52.10	
5148.6 b)	10.0	31,300,000	96.06	
5150	12.7	47,400,000	145.46	
5154 c)	17.5	68,300,000	209.62	

NOTES:
a) ELEVATION OF MINIMUM WATER HEIGHT FOR PHASES 1 AND 2 (5 ACRE-FT INACTIVE CAPACITY)
b) ELEVATION OF MAXIMUM WATER HEIGHT FOR PHASE 1 (92 ACRE-FT ACTIVE CAPACITY)
c) ELEVATION OF MAXIMUM WATER HEIGHT FOR PHASE 2 (205 ACRE-FT ACTIVE CAPACITY)

LEGEND

⊕ EFN SURFACE HAND SAMPLES	⊕ WESTEC TEST PIT
▣ DAW SURVEY CONTROL POINT	✦ EFN BOREHOLE

SEE DWG. 35701-03 FOR LEGEND AND SUMMARY LOGS

GENERAL NOTES

1. LOCATION OF PHASE 1 AND PHASE 2 MONITORING WELLS TO BE DETERMINED DURING CONSTRUCTION FOR POST CONSTRUCTION PHREATIC SURFACE MONITORING IN THE EMBANKMENT AND FOUNDATION.
2. EMBANKMENT BOREHOLE EXPLORATION FOR FIELD PERMEABILITY TESTING OF INSITU FOUNDATION CONDITIONS TO BE CONDUCTED FOR FINAL DESIGN.
3. SUBMERSIBLE PUMP SYSTEM FOR LAND IRRIGATION BY OWNER.

NO.	DESCRIPTION	BY	CH	APPRVD	DATE
A	ISSUED DRAFT FOR REVIEW			A.J.B.	5/93
1	ISSUED FOR PERMITTING				

DESIGNED	A.J.B.	5/93
DRAWN	M.E.B.	5/93
CHECKED		
APPROVED		
APPROVED		
APPROVED		

WYOMING

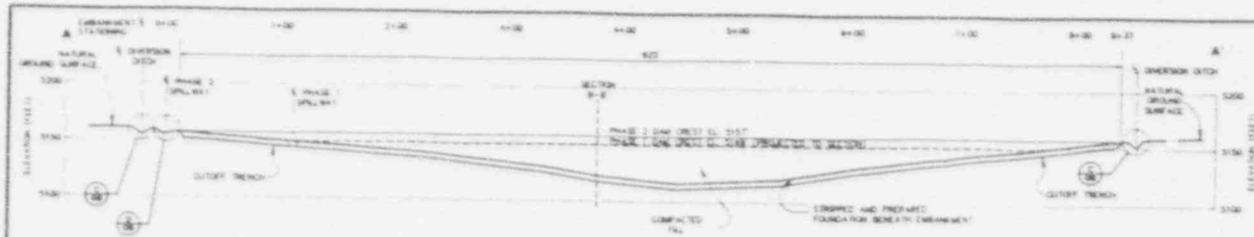
ENGINEER

PREPARED FOR
ENERGY FUELS NUCLEAR INC
RENO CREEK ISL PROJECT

TITLE
IRRIGATION RESERVOIR FACILITIES LAYOUT

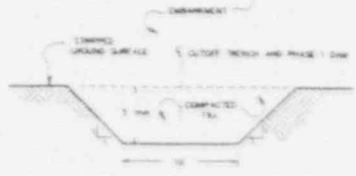
PREPARED BY
WESTEC
ENGLEWOOD, COLORADO

SCALE 1:200
DRAWING NO. 35701-05
REVISION 1



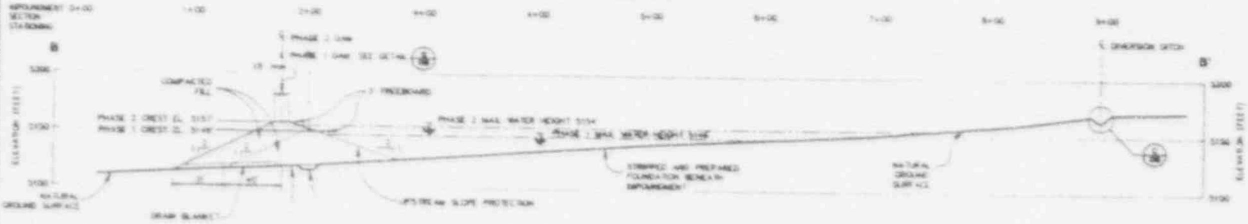
DAM EMBANKMENT PROFILE (A-A' / 05)

SCALE IN FEET



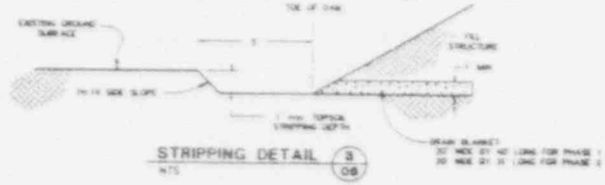
CUTOFF TRENCH DETAIL (A / 06)

NTS



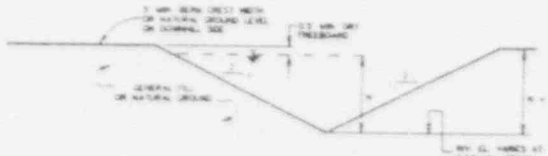
DAM IMPOUNDMENT PROFILE (B-B' / 05)

SCALE IN FEET



STRIPPING DETAIL (B / 06)

NTS



DIVERSION DITCH DETAIL (C / 06)

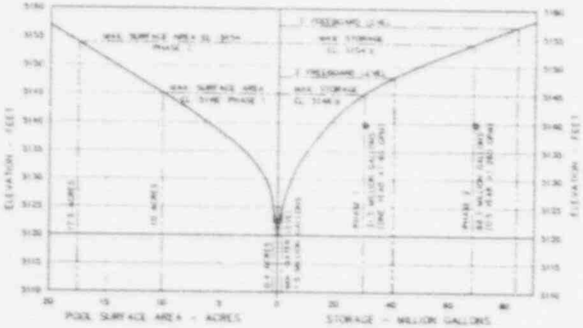
NTS

DIVERSION DITCH NO.	MAXIMUM FLOW DEPTH (H)	ESTIMATED DESIGN DEPTH (H + 0.5')	DITCH FLOW CAPACITY * (CFS)	REQUIRED DESIGN FLOW (CFS)
1	2.2	2.7	41.30	38.67
2	3.0	3.5	94.13	88.41
3	3.1	3.6	102.66	96.23

* PERMANENT DIVERSION DITCHES ARE SIZED FOR THE 100-YR, 24-HR DESIGN STORM EVENT OF 4.2 INCHES USING THE SOIL CONSERVATION SERVICE TR-20 COMPUTER PROGRAM TO MODEL PEAK RUNOFF FLOWS. MANNINGS n = 0.035

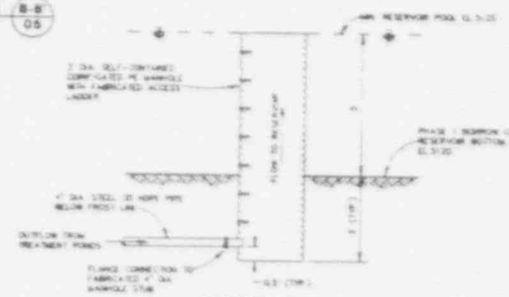
DIVERSION DITCH NO.	CATCHMENT AREA (SQ. MILES)	TIME OF CONCENTRATION (HRS)	MAX. LENGTH OF TRAVEL, L (FT)	AVERAGE SLOPE, S (%)	RUNOFF CURVE NUMBER, CN **
1	0.285	0.68	2866	4.1	78
2	0.140	0.77	2750	4.1	78
3	0.118	0.83	3408	3.5	78

** RUNOFF CURVE NUMBERS BASED ON MEADOW TYPE SURFACE, GOOD CONDITION, HYDROLOGIC GROUP TYPE C (100-YR, 24-HR STORM EVENT IS 4.2 INCHES)



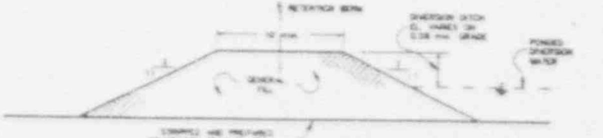
IMPOUNDMENT STORAGE VOLUMES AND POOL SURFACE AREA VS ELEVATION

* STORAGE VOLUMES BASED ON OBTAINING EMBANKMENT BORROW MATERIAL FROM THE IMPOUNDMENT. ASSUME FINAL BORROW CUT AT EL. 5120 LEVEL.



RESERVOIR INLET DETAIL (F / 06)

NTS

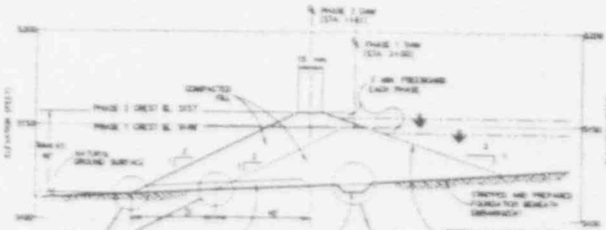


TYPICAL RETENTION BERM DETAIL (E / 06)

NTS

OVERFLOW SPILLWAY DETAIL (D / 06)

NTS



PHASED DAM EMBANKMENT DETAIL (G / 05)

SCALE IN FEET

ENGINEER

PREPARED FOR
ENERGY FUELS NUCLEAR INC
RENO CREEK ISL PROJECT

PREPARED BY
WESTEC

TITLE
IRRIGATION RESERVOIR
CROSS SECTIONS AND DETAILS

SCALE AS SHOWN

DRAWING NO. 35701-06

REVISION 1

FILE

DITCH NO. 1

```
1
******************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY******************

 JOB TR-20            ECON                                 SUMMARY   NOPLOTS
 TITLE 001 RENO CREEK CATCHMENT ANAL FOR DIVERSION DITCH SIZING-TRIAL 1
   3 STRUCT       01
   9 ENDTBL
   6 RUNOFF 1 001        1 .07          70.          .77          1 1   1   1
     ENDATA
   7 INCREM 6             .05
   7 COMPUT 7 001    001   0.           4.2          1.           2 2  01  01
     ENDCMP 1
     ENDJOB 2
0*'*******************************END OF 80-80 LIST*******************************

 EXECUTIVE CONTROL OPERATION INCREM
+                                      MAIN TIME INCREMENT =   .05 HOURS

 EXECUTIVE CONTROL OPERATION COMPUT                                                            RECORD ID
+                                      FROM XSECTION   1
+                                                          TO XSECTION   1
        STARTING TIME =    .00     RAIN DEPTH =  4.20    RAIN DURATION=  1.00    RAIN TABLE NO.= 2    ANT. MOIST. COND= 2
        ALTERNATE NO.= 1           STORM NO.= 1    MAIN TIME INCREMENT =   .05 HOURS

 OPERATION RUNOFF   CROSS SECTION   1

           PEAK TIME(HRS)                PEAK DISCHARGE(CFS)            PEAK ELEVATION(FEET)
             12.41                              39.07                          (RUNOFF)

 TIME(HRS)          FIRST HYDROGRAPH POINT =    .00 HOURS      TIME INCREMENT =  .05 HOURS      DRAINAGE AREA =     .07 SQ.MI.
   10.50    DISCHG           .00       .00       .00       .00       .00       .01       .01       .02       .04       .05
   11.00    DISCHG           .08       .11       .15       .20       .25       .32       .39       .47       .56       .66
   11.50    DISCHG           .77       .91      1.12      1.40      1.81      2.38      3.24      4.54      6.38      8.88
   12.00    DISCHG         12.16     16.17     20.68     25.39     29.94     33.85     36.74     38.45     39.06     38.74
   12.50    DISCHG         37.66     35.92     33.69     31.20     28.62     26.12     23.88     21.97     20.32     18.85
   13.00    DISCHG         17.53     16.35     15.27     14.30     13.42     12.64     11.91     11.25     10.65     10.11
   13.50    DISCHG          9.61      9.17      8.76      8.38      8.03      7.71      7.41      7.13      6.87      6.63
   14.00    DISCHG          6.41      6.20      6.00      5.82      5.64      5.48      5.32      5.17      5.03      4.91
   14.50    DISCHG          4.79      4.68      4.57      4.47      4.37      4.27      4.18      4.08      4.00      3.91

  RUNOFF VOLUME ABOVE BASEFLOW =  1.01 WATERSHED INCHES,     45.73 CFS-HRS,     3.78 ACRE-FEET;   BASEFLOW =    .00 CFS

 EXECUTIVE CONTROL OPERATION ENDCMP                                                            RECORD ID
+                                      COMPUTATIONS COMPLETED FOR PASS   1



                                                                                               RECORD ID
```

F - 2

```
 EXECUTIVE CONTROL OPERATION ENDJOB
1


 TR20 XEQ 12-15-93  03:48       RENO CREEK CATCHMENT ANAL FOR DIVERSION DITCH SIZING-TRIAL 1                JOB  1   SUMMARY
      REV PC 09/83(.2)                                                                                               PAGE   1


 SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
                   (A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
                    A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

 SECTION/     STANDARD                  RAIN  ANTEC  MAIN          PRECIPITATION                            PEAK DISCHARGE
 STRUCTURE     CONTROL    DRAINAGE     TABLE  MOIST  TIME   -------------------------  RUNOFF   ----------------------------------------
    ID        OPERATION     AREA         #     COND  INCREM  BEGIN    AMOUNT  DURATION  AMOUNT    ELEVATION   TIME        RATE       RATE
                          (SQ MI)                    (HR)   (HR)     (IN)     (HR)     (IN)        (FT)     (HR)        (CFS)      (CSM)


    ALTERNATE    1   STORM    1
+
 XSECTION    1  RUNOFF       .07         2      2     .05      .0     4.20    24.00     1.01        ---     12.41       39.07      558.1
1


 TR20 XEQ 12-15-93  03:48       RENO CREEK CATCHMENT ANAL FOR DIVERSION DITCH SIZING-TRIAL 1                JOB  1   SUMMARY
      REV PC 09/83(.2)


 SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AN

 XSECTION/                  DRAINAGE
 STRUCTURE                    AREA        STORM NUMBERS..........
   ID                       (SQ MI)              1

0 XSECTION    1               .07
+
    ALTERNATE     1                             39.07
1END OF  1 JOBS IN THIS RUN
```

F -3

DITCH NO. 2

```
1

******************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*****************

JOB TR-20            ECON                              SUMMARY   NOPLOTS
TITLE 003 RENO CREEK CATCHMENT ANAL FOR DIVERSION DITCH SIZING-TRIAL 3
 2 XSECTN    001          1.0
 8                        0.          0.0         0.0
 8                        1.          5.25        2.
 8                        2.          32.29       8.
 8                        3.          94.13       18.
 9 ENDTBL
 6 RUNOFF 1 001        1 .07          70.         .77          1 1   1   1
 2 XSECTN    002          1.
 8                        0.          0.0         0.0
 8                        1.          5.25        2.
 8                        2.          32.29       8.
 8                        3.          94.13       18.
 9 ENDTBL
 6 REACH  3 002    1   2 110C.                                 1 1       1
 6 RUNOFF 1 002        3 .095         70.         .89          1 1   1   1
 6 ADDHYD 4 002    2 3 4                                       1 1   1   1
   ENDATA
 7 INCREM 6               .05
 7 COMPUT - 001    002    0.          4.2         1.           2 2  01  01
   ENDCMP 1
   ENDJOB 2
0******** -*********************END OF 80-80 LIST******************************


EXECUTIVE CONTROL OPERATION INCREM
+                                    MAIN TIME INCREMENT =   .05 HOURS


EXECUTIVE CONTROL OPERATION COMPUT
+                                    FROM XSECTION   1
+                                                        TO XSECTION   2
        STARTING TIME =   .00     RAIN DEPTH =  4.20    RAIN DURATION=  1.00
        ALTERNATE NO.= 1          STORM NO.= 1     MAIN TIME INCREMENT =   .05 HOURS


OPERATION RUNOFF    CROSS SECTION   1

          PEAK TIME(HRS)                PEAK DISCHARGE(CFS)            PEAK ELEVATION(FEET)
             12.41                            39.07                          (RUNOFF)

TIME(HRS)          FIRST HYDROGRAPH POINT =    .00 HOURS      TIME INCREMENT =  .05 HOURS      DRAINAGE AREA =    .07 SQ.MI.
  10.50    DISCHG        .00       .00       .00       .00       .00       .01       .01       .02       .04       .05
  11.00    DISCHG        .08       .11       .15       .20       .25       .32       .39       .47       .56       .66
  11.50    DISCHG        .77       .91      1.12      1.40      1.81      2.38      3.24      4.54      6.38      8.88
  12.00    DISCHG      12.16     16.17     20.68     25.39     29.94     33.85     36.74     38.45     39.06     38.74
  12.50    DISCHG      37.66     35.92     33.69     31.20     28.62     26.12     23.88     21.97     20.32     18.85
  13.00    DISCHG      17.53     16.35     15.27     14.30     13.42     12.64     11.91     11.25     10.65     10.11
```

```
  13.50    DISCHG       9.61      9.17      8.76      8.38      8.03      7.71      7.41      7.13      6.87      6.63
  14.00    DISCHG       6.41      6.20      6.00      5.82      5.64      5.48      5.32      5.17      5.03      4.91
  14.50    DISCHG       4.79      4.68      4.57      4.47      4.37      4.27      4.18      4.08      4.00      3.91

   RUNOFF VOLUME ABOVE BASEFLOW =  1.01 WATERSHED INCHES,     45.73 CFS-HRS,     3.78 ACRE-FEET;   BASEFLOW =    .00 CFS
0     *** WARNING - REACH   2 INFLOW HYDROGRAPH VOLUME TRUNCATED ABOVE BASEFLOW AT       3.91 CFS.  10.02 % OF PEAK.

 OPERATION REACH    CROSS SECTION   2

          PEAK TIME(HRS)             PEAK DISCHARGE(CFS)          PEAK ELEVATION(FEET)
             12.49                         38.59                          2.10

 TIME(HRS)          FIRST HYDROGRAPH POINT =   .00 HOURS     TIME INCREMENT =  .05 HOURS      DRAINAGE AREA =    .07 SQ.MI.
   10.50    DISCHG        .00       .00       .00       .00       .00       .00       .00       .01       .02       .03
   11.00    DISCHG        .04       .07       .09       .13       .17       .22       .28       .35       .42       .51
   11.50    DISCHG        .60       .71       .83      1.01      1.25      1.60      2.08      2.80      3.89      5.44
   12.00    DISCHG       7.59     10.44     14.01     18.17     22.68     27.21     31.35     34.72     37.04     38.30
   12.50    DISCHG      38.57     38.00     36.70     34.82     32.56     30.10     27.62     25.28     23.22     21.41
   13.00    DISCHG      19.81     18.39     17.11     15.96     14.92     13.99     13.14     12.37     11.67     11.04
   13.50    DISCHG      10.46      9.93      9.45      9.02      8.62      8.25      7.92      7.60      7.31      7.04
   14.00    DISCHG       6.78      6.55      6.33      6.12      5.93      5.75      5.58      5.42      5.26      5.12
   14.50    DISCHG       4.99      4.86      4.75      4.64      4.53      4.43      4.33      4.23      4.14      4.05

 OPERATION RUNOFF   CROSS SECTION   2
1

 TR20 XEQ 12-15-93   22:18       RENO CREEK CATCHMENT ANAL FOR DIVERSION DITCH SIZING-TRIAL 3                     JOB  1    PASS
     REV PC 09/83(.2)                                                                                                       PAGE


          PEAK TIME(HRS)             PEAK DISCHARGE(CFS)          PEAK ELEVATION(FEET)
             12.50                         47.82                       (RUNOFF)

 TIME(HRS)          FIRST HYDROGRAPH POINT =   .00 HOURS     TIME INCREMENT =  .05 HOURS      DRAINAGE AREA =    .09 SQ.MI.
   10.50    DISCHG        .00       .00       .00       .00       .00       .01       .01       .02       .03       .05
   11.00    DISCHG        .08       .11       .15       .20       .25       .32       .40       .49       .59       .71
   11.50    DISCHG        .84      1.00      1.23      1.53      1.95      2.52      3.37      4.64      6.45      8.92
   12.00    DISCHG      12.13     16.06     20.60     25.58     30.76     35.77     40.20     43.68     46.10     47.45
   12.50    DISCHG      47.82     47.36     46.19     44.40     42.17     39.62     36.90     34.15     31.56     29.27
   13.00    DISCHG      27.28     25.51     23.89     22.42     21.08     19.85     18.70     17.65     16.70     15.82
   13.50    DISCHG      15.02     14.27     13.58     12.95     12.36     11.83     11.34     10.88     10.45     10.05
   14.00    DISCHG       9.68      9.33      9.00      8.70      8.42      8.16      7.92      7.68      7.47      7.27
   14.50    DISCHG       7.07      6.88      6.70      6.52      6.35      6.18      6.02      5.87      5.73      5.60

   RUNOFF VOLUME ABOVE BASEFLOW =  1.00 WATERSHED INCHES,     61.45 CFS-HRS,     5.08 ACRE-FEET;   BASEFLOW =    .00 CFS

 OPERATION ADDHYD   CROSS SECTION   2

          PEAK TIME(HRS)             PEAK DISCHARGE(CFS)          PEAK ELEVATION(FEET)
```

F-5

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              12.49                              86.41                              2.88

  TIME(HRS)            FIRST HYDROGRAPH POINT =    .00 HOURS       TIME INCREMENT =  .05 HOURS       DRAINAGE AREA =     .16 SQ.MI.
    10.50      DISCHG          .00         .00         .00         .00         .00         .01         .01         .03         .05         .08
    11.00      DISCHG          .12         .17         .24         .33         .43         .55         .68         .84        1.02        1.22
    11.50      DISCHG         1.44        1.71        2.06        2.54        3.20        4.12        5.46        7.45       10.34       14.36
    12.00      DISCHG        19.72       26.49       34.61       43.76       53.43       62.98       71.55       78.40       83.14       85.75
    12.50      DISCHG        86.40       85.36       82.89       79.22       74.73       69.73       64.52       59.44       54.77       50.68
    13.00      DISCHG        47.10       43.90       41.01       38.38       36.00       33.83       31.84       30.03       28.37       26.86
    13.50      DISCHG        25.48       24.20       23.03       21.96       20.98       20.08       19.25       18.48       17.75       17.08
    14.00      DISCHG        16.46       15.88       15.33       14.82       14.35       13.91       13.50       13.10       12.73       12.39
    14.50      DISCHG        12.06       11.75       11.45       11.16       10.88       10.61       10.35       10.10        9.87        9.65

    RUNOFF VOLUME ABOVE BASEFLOW =  1.00 WATERSHED INCHES,     106.86 CFS-HRS,      8.83 ACRE-FEET;   BASEFLOW =     .00 CFS

  EXECUTIVE CONTROL OPERATION ENDCMP                                                                                 RECORD ID
 +                                      COMPUTATIONS COMPLETED FOR PASS    1



  EXECUTIVE CONTROL OPERATION ENDJOB
 1


  TR20 XEQ 12-15-93  22:18        RENO CREEK CATCHMENT ANAL FOR DIVERSION DITCH SIZING-TRIAL 3                    JOB  1   SUMMARY
       REV PC 09/83(.2)                                                                                                    PAGE    2


  SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
                    (A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
                     A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

  SECTION/     STANDARD                   RAIN  ANTEC  MAIN          PRECIPITATION                                     PEAK DISCHARGE
  STRUCTURE     CONTROL     DRAINAGE  TABLE  MOIST  TIME   --------------------------  RUNOFF   --------------------------------------
     ID        OPERATION      AREA       #    COND  INCREM  BEGIN    AMOUNT  DURATION  AMOUNT    ELEVATION   TIME          RATE          RATE
                            (SQ MI)                  (HR)   (HR)      (IN)     (HR)     (IN)        (FT)      (HR)         (CFS)         (CSM)

     ALTERNATE     1    STORM     1
 +   ___________________________
  XSECTION    1  RUNOFF       .07       2      2     .05      .0      4.20     24.00     1.01         ---      12.41         39.07         558.1
  XSECTION    2  REACH        .07       2      2     .05      .0      4.20     24.00     1.01        2.10      12.49         38.59         551.2
  XSECTION    2  RUNOFF       .09       2      2     .05      .0      4.20     24.00     1.00         ---      12.50         47.82         503.4
  XSECTION    2  ADDHYD       .16       2      2     .05      .0      4.20     24.00     1.00        2.88      12.49         86.41         523.7
 1


  TR20 XEQ 12-15-93  22:18        RENO CREEK CATCHMENT ANAL FOR DIVERSION DITCH SI
       REV PC 09/83(.2)
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SUMMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
             (A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK
              A QUESTION MARK(?) AFTER COEFF.(C) INDICATES PARAMETERS OUTSIDE ACCEPTABLE LIMITS, SEE PREVIOUS WARNINGS)

                          HYDROGRAPH INFORMATION                                   ROUTING PARAMETERS                        PEAK
+                ________  ____________________________  _________________________________________________________________________
                                    OUTFLOW+              VOLUME  MAIN  ITER-  Q AND A             PEAK   S/Q   ATT- TRAVEL TIME
+
XSEC REACH     INFLOW       OUTFLOW     INTERV.AREA  BASE-  ABOVE  TIME  ATION  EQUATION    LENGTH  RATIO  @PEAK  KIN  STOR- KINE-
+
  ID LENGTH   PEAK  TIME   PEAK  TIME   PEAK  TIME   FLOW   BASE   INCR   #    COEFF POWER FACTOR  O/I    (K)   COEFF  AGE  MATIC
      (FT)   (CFS)  (HR)  (CFS)  (HR)  (CFS)  (HR)  (CFS)   (IN)   (HR)         (X)   (M)   (K*)   (Q*)  (SEC)  (C)   (HR)  (HR)

   ALTERNATE    1   STORM    1
+   ______________________________
                                                                         2.11
+  2   1100      39  12.4     39  12.5                0     1.01*   .05    1       1.31   .026   .988    198  .62    .10   .06
+                                          86  12.5
1


TR20 XEQ 12-15-93   22:18       RENO CREEK CATCHMENT ANAL FOR DIVERSION DITCH SI
     REV PC 09/83(.2)


SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AN

XSECTION/          DRAINAGE
STRUCTURE            AREA       STORM NUMBERS..........
  ID               (SQ MI)           1

0 XSECTION    1          .07
+________________________________
   ALTERNATE    1                  39.07
0 XSECTION    2          .16
+________________________________
   ALTERNATE    1                  86.41
1END OF  1 JOBS IN THIS RUN
```

F-7

```
1


        DITCH NO. 3
 ******************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*****************

 JOB TR-20           ECON                            SUMMARY   NOPLOTS
 TITLE 002 RENO CREEK CATCHMENT ANAL FOR DIVERSION DITCH SIZING-TRIAL 2
  2 XSECTN   001           1.0
  8                        0.          0.0         0.0
  8                        1.          5.25        2.
  8                        2.          32.29       8.
  8                        3.          94.13       18.
  9 ENDTBL
  6 RUNOFF 1 001         1 .07         70.         .77         1 1   1   1
  2 XSECTN   002           1.
  8                        0.          0.0         0.0
  8                        1.          5.25        2.
  8                        2.          32.29       8.
  8                        3.          94.13       18.
  9 ENDTBL
  6 REACH  3 002    1    2 800.                                1 1       1
  6 RUNOFF 1 002         3 .118        70.         .97         1 1   1   1
  6 ADDHYD 4 002    2 3 4                                      1 1   1   1
    ENDATA
  7 INCREM 6               .05
  7 COMPUT 7 001    002    0.          4.2         1.          2 2  01  01
    ENDCMP 1
    ENDJOB 2
0********************************END OF 80-80 LIST*********************************


 EXECUTIVE CONTROL OPERATION INCREM
+                                          MAIN TIME INCREMENT =   .05 HOURS


 EXECUTIVE CONTROL OPERATION COMPUT
+                                          FROM XSECTION   1
+                                                             TO XSECTION   2
        STARTING TIME =   .00    RAIN DEPTH =  4.20   RAIN DURATION=  1.00    RAIN TABLE NO.= 2    ANT. MOIST. COND= 2
        ALTERNATE NO.= 1         STORM NO.= 1    MAIN TIME INCREMENT =   .05 HOURS


 OPERATION RUNOFF   CROSS SECTION   1

           PEAK TIME(HRS)                PEAK DISCHARGE(CFS)           PEAK ELEVATION(FEET)
              12.41                            39.07                         (RUNOFF)

 TIME(HRS)           FIRST HYDROGRAPH POINT =    .00 HOURS      TIME INCREMENT =  .05 HOURS       DRAINAGE AREA =    .07 SQ.MI.
   10.50     DISCHG          .00        .00        .00        .00        .00        .01        .01        .02        .04        .05
   11.00     DISCHG          .08        .11        .15        .20        .25        .32        .39        .47        .56        .66
   11.50     DISCHG          .77        .91       1.12       1.40       1.81       2.38       3.24       4.54       6.38       8.88
   12.00     DISCHG        12.16      16.17      20.68      25.39      29.94      33.85      36.74      38.45      39.06      38.74
   12.50     DISCHG        37.66      35.92      33.69      31.20      28.62      26.12      23.88      21.97      20.32      18.85
   13.00     DISCHG        17.53      16.35      15.27      14.30      13.42      12.64      11.91      11.25      10.65      10.11
```

```
   13.50    DISCHG         9.61       9.17       8.76       8.38       8.03       7.71       7.41       7.13       6.87       6.63
   14.00    DISCHG         6.41       6.20       6.00       5.82       5.64       5.48       5.32       5.17       5.03       4.91
   14.50    DISCHG         4.79       4.68       4.57       4.47       4.37       4.27       4.18       4.08       4.00       3.91

   RUNOFF VOLUME ABOVE BASEFLOW =  1.01 WATERSHED INCHES,     45.73 CFS-HRS,     3.78 ACRE-FEET;   BASEFLOW =    .00 CFS

      ***  WARNING  REACH   2 ATT-KIN COEFF.(C) GREATER THAN 0.667, CONSIDER REDUCING MAIN TIME INCREMENT  ***
0     *** WARNING - REACH   2 INFLOW HYDROGRAPH VOLUME TRUNCATED ABOVE BASEFLOW AT       3.91 CFS,  10.02 % OF PEAK.

 OPERATION REACH     CROSS SECTION   2

           PEAK TIME(HRS)                PEAK DISCHARGE(CFS)            PEAK ELEVATION(FEET)
              12.47                            38.88                           2.11

 TIME(HRS)           FIRST HYDROGRAPH POINT =    .00 HOURS      TIME INCREMENT =  .05 HOURS      DRAINAGE AREA =    .07 SQ.MI.
   10.50    DISCHG          .00        .00        .00        .00        .00        .00        .00        .01        .02        .03
   11.00    DISCHG          .05        .07        .10        .14        .19        .24        .30        .37        .45        .53
   11.50    DISCHG          .63        .74        .87       1.06       1.32       1.70       2.22       3.00       4.18       5.87
   12.00    DISCHG         8.18      11.23      15.02      19.37      23.99      28.56      32.62      35.79      37.83      38.77
   12.50    DISCHG        38.75      37.91      36.38      34.31      31.92      29.39      26.88      24.57      22.57      20.84
   13.00    DISCHG        19.31      17.94      16.72      15.60      14.60      13.69      12.88      12.14      11.46      10.84
   13.50    DISCHG        10.28       9.77       9.31       8.88       8.50       8.14       7.81       7.51       7.22       6.95
   14.00    DISCHG         6.70       6.47       6.26       6.06       5.87       5.70       5.53       5.37       5.22       5.08
   14.50    DISCHG         4.95       4.82       4.71       4.60       4.50       4.40       4.30       4.20       4.11       4.02
1


 TR20 XEQ 12-15-93  05:21        RENO CREEK CATCHMENT ANAL FOR DIVERSION DITCH SIZING-TRIAL 2                        JOB  1   PASS
      REV PC 09/83(.2)                                                                                                        PAGE



 OPERATION RUNOFF    CROSS SECTION   2

           PEAK TIME(HRS)                PEAK DISCHARGE(CFS)            PEAK ELEVATION(FEET)
              12.52                            57.61                         (RUNOFF)

 TIME(HRS)           FIRST HYDROGRAPH POINT =    .00 HOURS      TIME INCREMENT =  .05 HOURS      DRAINAGE AREA =    .12 SQ.MI.
   10.50    DISCHG          .00        .00        .00        .00        .00        .01        .01        .02        .04        .06
   11.00    DISCHG          .08        .12        .17        .22        .29        .37        .46        .56        .68        .81
   11.50    DISCHG          .97       1.16       1.42       1.78       2.26       2.92       3.88       5.32       7.37      10.16
   12.00    DISCHG        13.79      18.22      23.35      29.05      35.07      41.04      46.52      51.03      54.39      56.52
   12.50    DISCHG        57.50      57.47      56.58      54.95      52.72      50.04      47.05      43.89      40.74      37.81
   13.00    DISCHG        35.22      32.93      30.87      28.99      27.28      25.71      24.26      22.90      21.66      20.52
   13.50    DISCHG        19.47      18.51      17.61      16.77      16.00      15.30      14.64      14.03      13.47      12.94
   14.00    DISCHG        12.45      12.00      11.57      11.17      10.80      10.46      10.13       9.83       9.54       9.27
   14.50    DISCHG         9.02       8.78       8.55       8.33       8.11       7.89       7.69       7.48       7.29       7.11

   RUNOFF VOLUME ABOVE BASEFLOW =  1.00 WATERSHED INCHES,     76.09 CFS-HRS,     6.29 ACRE-FEET;   BASEFLOW =    .00 CFS

 OPERATION ADDHYD    CROSS SECTION   2
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          PEAK TIME(HRS)                  PEAK DISCHARGE(CFS)            PEAK ELEVATION(FEET)
             12.50                             96.25                          3.03

   TIME(HRS)           FIRST HYDROGRAPH POINT =    .00 HOURS        TIME INCREMENT =  .05 HOURS       DRAINAGE AREA =    .19 SQ.MI.
     10.50     DISCHG          .00         .00         .00         .00         .00         .01         .01         .03         .05         .09
     11.00     DISCHG          .13         .19         .27         .36         .47         .60         .76         .93        1.13        1.35
     11.50     DISCHG         1.60        1.90        2.29        2.84        3.58        4.61        6.10        8.32       11.55       16.03
     12.00     DISCHG        21.97       29.45       38.38       48.42       59.06       69.60       79.15       86.82       92.22       95.29
     12.50     DISCHG        96.25       95.38       92.96       89.26       84.64       79.43       73.93       68.46       63.31       58.66
     13.00     DISCHG        54.53       50.88       47.59       44.60       41.88       39.41       37.14       35.04       33.11       31.35
     13.50     DISCHG        29.75       28.27       26.91       25.66       24.50       23.44       22.45       21.54       20.69       19.89
     14.00     DISCHG        19.16       18.48       17.83       17.24       16.68       16.15       15.66       15.20       14.76       14.35
     14.50     DISCHG        13.97       13.61       13.26       12.93       12.61       12.29       11.99       11.69       11.40       11.13

     RUNOFF VOLUME ABOVE BASEFLOW =  1.00 WATERSHED INCHES,     121.57 CFS-HRS,     10.05 ACRE-FEET;   BASEFLOW =    .00 CFS


   EXECUTIVE CONTROL OPERATION ENDCMP
  +                                        COMPUTATIONS COMPLETED FOR PASS    1




   EXECUTIVE CONTROL OPERATION ENDJOB                                                                               RECORD
  1



   TR20 XEQ 12-15-93  05:21        RENO CREEK CATCHMENT ANAL FOR DIVERSION DITCH SIZING-TRIAL 2                    JOB
        REV PC 09/83(.2)



   SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
                     (A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
                      A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

   SECTION/     STANDARD                  RAIN  ANTEC  MAIN           PRECIPITATION                              PEAK DISCHARGE
   STRUCTURE     CONTROL    DRAINAGE   TABLE  MOIST  TIME   -------------------------   RUNOFF   ---------------------------------------
      ID        OPERATION     AREA        #    COND  INCREM  BEGIN     AMOUNT  DURATION  AMOUNT    ELEVATION   TIME       RATE        RATE
                             (SQ MI)                  (HR)   (HR)      (IN)     (HR)     (IN)        (FT)      (HR)       (CFS)       (CSM)


     ALTERNATE     1    STORM     1
  +  _____________________________________
   XSECTION    1  RUNOFF       .07        2      2     .05      .0      4.20    24.00     1.01         ---      12.41      39.07       558.1
   XSECTION    2  REACH        .07        2      2     .05      .0      4.20    24.00     1.01        2.11      12.47      38.88       555.4
   XSECTION    2  RUNOFF       .12        2      2     .05      .0      4.20    24.00     1.00         ---      12.52      57.61       488.2
   XSECTION    2  ADDHYD       .19        2      2     .05      .0      4.20    24.00     1.00        3.03      12.50      96.25       512.0
  1


   TR20 XEQ 12-15-93  05:21        RENO CREEK CATCHMENT ANAL FOR DIVERSION DITCH SIZING-TRIAL 2                    JOB  1   SUMMARY
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        REV PC 09/83(.2)


   SUMMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
                     (A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK
                      A QUESTION MARK(?) AFTER COEFF.(C) INDICATES PARAMETERS OUTSIDE ACCEPTABLE LIMITS, SEE PREVIOUS WARNINGS)

                          HYDROGRAPH INFORMATION                                     ROUTING PARAMETERS                         PEAK
  +               ______________________________________________  ____________________________________________________________
                                                  OUTFLOW+          VOLUME  MAIN  ITER-  Q AND A             PEAK    S/Q   ATT- TRAVEL TIME
  +                                                                                                                             ___________
   XSEC REACH     INFLOW        OUTFLOW      INTERV.AREA  BASE-    ABOVE  TIME  ATION  EQUATION    LENGTH  RATIO  @PEAK   KIN  STOR- KINE-
  +              ___________   ___________   ___________                               ___________
    ID  LENGTH  PEAK   TIME   PEAK   TIME   PEAK   TIME   FLOW     BASE   INCR    #    COEFF POWER  FACTOR  O/I     (K)  COEFF  AGE  MATIC
         (FT)  (CFS)  (HR)   (CFS)  (HR)   (CFS)  (HR)   (CFS)    (IN)   (HR)          (X)   (M)    (K*)   (Q*)   (SEC)  (C)   (HR)  (HR)

     ALTERNATE    1   STORM    1
  +  ____________________________
                                                                                   2.11
  +  2    800      39  12.4     39  12.4                   0     1.01*   .05    1          1.31   .017   .993    144  .77?  .05   .04
  +                                          96  12.5
  1


   TR20 XEQ 12-15-93  05:21       RENO CREEK CATCHMENT ANAL FOR DIVERSION DITCH SI
        REV PC 09/83(.2)


   SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AN

   XSECTION/           DRAINAGE
   STRUCTURE             AREA       STORM NUMBERS...........
     ID                (SQ MI)               1

  0 XSECTION    1          .07
  + ________________________
      ALTERNATE    1                       39.07
  0 XSECTION    2          .19
  + ________________________
      ALTERNATE    1                       96.25
  1END OF  1 JOBS IN THIS RUN
```

ATTACHMENT 1

RENO CREEK ISL PROJECT GEOTECHNICAL DESIGN REPORT FOR THE WATER TREATMENT PONDS AND IRRIGATION WATER STORAGE FACILITIES TO ACCOMPANY APPLICATION FOR PERMIT TO CONSTRUCT

Prepared for:

Energy Fuels Nuclear, Inc.
One Tabor Center, Suite 2500
1200 Seventeenth Street
Denver, Colorado 80202

Prepared by:

WESTEC™
WELSH ENGINEERING SCIENCE & TECHNOLOGY, INC

WESTEC Project No. 35701
Report No. 835

December 1993

ATTACHMENT 1

RENO CREEK ISL PROJECT

GEOTECHNICAL DESIGN REPORT
FOR THE WATER TREATMENT PONDS AND
IRRIGATION WATER STORAGE FACILITIES
TO ACCOMPANY APPLICATION FOR PERMIT TO CONSTRUCT

The following geotechnical design report for the Reno Creek water treatment ponds and the irrigation water storage facilities has been prepared by the staff of Welsh Engineering Science & Technology, Inc. (WESTEC) for Energy Fuels Nuclear, Inc. (EFNI).

This report has been prepared under the direction of, and reviewed by, Mr. Allan Breitenbach, P.E., for WESTEC. The design criteria and prepared drawings for the water treatment and storage facilities are presented within the limits described by the EFNI and prepared in accordance with generally accepted professional engineering principles and practice.

Prepared by:

Andrew J. Walsh

Andrew J. Walsh, E.I.T.

Reviewed by:

Allan J. Breitenbach
6051
Date 12/15/93

Allan J Breitenbach

Allan J. Breitenbach, P.E.
Project Manager
Wyoming P.E. No. 6051

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TABLES

APPENDICES

1.0 INTRODUCTION

Energy Fuels Nuclear, Inc. (EFNI) plans to permit and construct an in situ leach uranium project at its Reno Creek site located approximately 10 miles southwest of Wright, Wyoming. The project will consist of injecting a carbonate solution into the uranium ore body using injection wells and recovering the uranium enriched solution using recovery wells. The enriched solution will then be pumped to the processing plant for uranium extraction. A net surplus of extraction fluid will be maintained during operations to ensure a positive groundwater gradient towards the extraction wells to prevent contamination of the local groundwater.

A net excess of 40 to 60 gpm of extraction flow has been estimated by EFNI for routing to the primary and secondary treatment ponds. The treatment ponds provide retention time for sedimentation to occur prior to release of the water to the storage reservoir. Depending on the time of the year, the water stored in the water storage reservoir will be pumped to a large irrigation site for evaporating the excess fluid.

A groundwater sweep of the leached ore bodies will commence following the fourth year of mining operations. The net excess fluid to be treated and contained will increase to 260 gpm. This will necessitate increasing the storage capacity of the reservoir by phased embankment construction.

WESTEC was retained by EFNI to design the primary and secondary treatment ponds and the water storage reservoir. These facilities will comply with the current State of Wyoming Department of Environmental Quality (DEQ) and State Engineer's Office (SEO) regulations.

The scope of work to be performed by WESTEC will consist of two parts. Part 1 for this report includes performing all the engineering work necessary to permit the Reno Creek Project treatment ponds and irrigation water storage facilities through the DEQ and SEO.

2.0 PROJECT DESCRIPTION

The project site is located in Section 29 of Township 43N, Range 73W in Campbell County, Wyoming, as shown on Drawing Nos. 35701-01 and -02 in Appendix D. The project description as it relates to WESTEC's scope of work includes the treatment of over-production and restoration solutions using primary and secondary ponds and then discharging to a water storage reservoir.

The primary and secondary treatment ponds will be designed to maximize sedimentation of precipitates. The containment system for the treatment ponds will comply with the State of Wyoming regulations using a liner system and leak detection. The treatment pond layout and details are shown on Drawing Nos. 35701-03 and -04.

The initial stage (Phase 1) of the water storage reservoir will be sized to store a maximum over-production design flow rate of 60 gpm for an entire year. The total volume required for storage is 31.5 million gallons (96.8 acre-feet). The final stage (Phase 2) of the water storage reservoir will be constructed as needed after the fifth year of operations and is designed to store a maximum over-production and restoration flow rate of 260 gpm for a period of one half year. The total volume for Phase 2 storage is 68.3 million gallons (210 acre-feet) which includes excess water from flushing and restoring the spent in situ leach areas at 200 gpm. The water storage reservoir and embankment layout and details are shown on Drawing Nos. 35701-05 and -06.

Disposal of the stored excess water in the reservoir will be achieved by surface irrigation during the spring, summer and fall months when the climatic conditions are conducive to evaporation.

3.0 CLIMATE

Climatic conditions within the Reno Creek area can be classified as being semi-arid. Precipitation data from weather stations around the Reno Creek area varies from location to location due to the relatively long distances of 45 miles or more between weather stations and the site. Most of the annual precipitation occurs during the growing season of late spring and summer months. Thunderstorms are a common occurrence. Monthly snowfall amounts are relatively uniform from November through February and slightly heavier during the spring months of March and April. Snow has occurred as early as September and as late as early June. Temperatures vary from highs during the summer around 100° F to lows during the winter of -40° F.

3.1 PRECIPITATION

Precipitation within the Reno Creek area has been interpreted from the four nearest weather stations to the site: Gillette, Kaycee, Casper, and Midwest (Earth Info 1993). During 1982, Gillette received approximately 29.62 inches of rain while other stations around the area received 20.49 inches or less. During a dry year, 1988, Kaycee and Casper received 6.09 and 6.56 inches respectively while Gillette and Midwest received over 12.00 inches of rain. Over the last 11 years, average annual precipitation amounts for the monitoring stations are: Casper 13.26 inches; Gillette 16.00 inches; Kaycee 12.34 inches; and Midwest 11.51 inches.

The monthly precipitation data for the four stations around the Reno Creek Project are presented in Appendix A, Tables A.1 through A.4.

The maximum snowfall amounts for the Casper station are also presented in Table A.5, Appendix A. Maximum snowfall precipitation shown on the record is 62.8 inches for the month of December, 1982. The maximum snowfall recorded for a 24 hour period is 31.1 inches in December, 1982.

3.2 RELATIVE HUMIDITY

The relative humidity is dependent on both the moisture content and the temperature of the air. Average monthly relative humidity data from 1990 for Casper is presented in Appendix A. From these measurements, relative humidity in the morning is shown to average 70 percent, while the average is 41 percent in the afternoon. Yet, summer afternoons often exhibit relative humidity percentages in the 20's and 30's while winter afternoons exhibit humidity percentages in the 50' and 60's. The relative humidity data (percent) for the Year 1990 is presented in Table A.6, Appendix A.

3.3 TEMPERATURE

Average annual temperature for the four weather stations range from 42.5 to 49.9° F. The average for each of the stations for the past 11 years are: Casper 45.7° F; Gillette 45.4° F; Kaycee 46.1° F; and Midwest 47.4° F.

The average monthly temperatures for Casper, Gillette, Kaycee, and Midwest are included in Tables A.7 through A.10, Appendix A.

3.4 EVAPORATION

The closest site to the permit area where evaporation data are available is Gillette, Wyoming, approximately 45 miles north northeast of the project site. Data from Gillette records indicate an average annual total loss of 43 inches which occurs predominately during the months of May through September. July usually has the highest total evaporation loss, averaging 9 to 10 inches.

3.5 WIND

Wind roses for Casper, Wyoming are presented in Figure A.1, Appendix A. As indicated on the wind roses, the predominant wind direction in the Casper area is from the southwest for better than 25 percent of the time. Calm winds prevail about 5.1 percent of the time compared to Moorcroft which is calm 2.8 percent of the time. The predominant wind directions in the Moorcroft area are from the north and south southeast direction over 24 percent of the time.

4.0 SURFACE HYDROLOGY

The project site lies within an unnamed small tributary to the Belle Fourche River. The drainages at the site are intermittent and remain dry, except for short periods during storm events. An open ditch diversion drainage system will divert the natural storm runoff from uphill basin catchment areas around the irrigation reservoir facilities into the downstream natural drainages. An open channel spillway will be constructed on the left abutment of the reservoir embankment to divert reservoir overflows, if any, downhill of the facilities. Operational inflows and storm precipitation stored within the reservoir limits will be pumped to an irrigation site for evaporation in the spring through fall seasons.

The 100-year, 24-hour storm rainfall event for the Reno Creek Project site is 4.2 inches of precipitation (National Oceanic and Atmospheric Atlas II, 1973). This data will be used for the evaluation of the peak flow rates for the diversion runoff ditch design (see Section 8.0).

5.0 SURFICIAL SOILS

The predominant stratigraphic formations identified for the treatment ponds and the irrigation water storage reservoir were Hiland-Bowbac and the Theedle-Kishona units as described by the Soil Conservation Service (SCS) maps. The following is a brief description of the map units.

HILAND-BOWBAC ASSOCIATION (380AB)

This map unit is on hillslopes, fans, and low ridges. These soils have formed in colluvium and alluvium derived from sandstone. Areas are irregular in shape and consist of approximately 50 percent Hiland fine sandy loam on lower hillslopes and fans and 35 percent Bowbac sandy loam on upper hillslopes and ridges.

Included in this unit are small areas of Moskee fine sandy loam, Vonalee sandy loam, Maysdorf fine sandy loam, and Forkwood very fine sandy loam. Also included are soils similar to Hiland but with bedrock between 40 and 60 inches. Included areas make up about 15 percent of the total area.

The Hiland soil is very deep and well drained. Typically, the surface layer is brown, fine, sandy loam about 2 inches thick. The upper 22 inches of the subsoil is yellowish brown sandy clay loam. The lower 19 inches is grayish brown, sandy, clay loam. The substratum to a depth of 60 inches or more is yellowish brown, sandy loam. In some areas the surface layer is sandy, clay loam. Permeability of the Hiland unit is moderate.

The Bowbac soil unit is moderately deep and well drained. Typically, the surface layer is brown, sandy loam about 3 inches thick. The upper 9 inches of the subsoil is brown, sandy, clay loam. The lower 8 inches is pale brown, sandy, clay loam. The substratum is sandstone. In some areas, the surface texture is sandy, clay loam. Depth to bedrock varies from 20 to 40 inches. Permeability of the Bowbac soil is moderate.

THEEDLE-KISHONA ASSOCIATION (177)

This map unit is on hillslopes and fans. These soils formed in residuum and alluvium derived from interbedded sedimentary rock. Areas are irregular in shape and 150 to 500 acres in size.

The slope length of this unit ranges from 100 feet to 1,000 feet. The native vegetation is mainly grasses and shrubs.

This unit is 40 percent Theedle loam on upper hillslopes and 40 percent Kishona loam on lower hillslopes and fans. Included in this unit are small areas of Cambria loam, Forkwood loam, Bidman fine sandy loam, and Hiland sandy loam. The included areas make up about 20 percent of the total acreage.

The Theedle soil is moderately deep and well drained. Typically, the surface layer is light brownish gray loam about 4 inches thick. The substratum is light yellowish brown loam about 22 inches thick over siltstone. In some areas, the surface layer is clay loam. Depth to bedrock varies from 20 to 40 inches. Permeability of the Theedle soil is moderate.

The Kishona soil is very deep and well drained. Typically, the surface layer is light brownish gray loam about 4 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown loam. In some areas, the surface texture is clay loam. The permeability of the Kishona soil is moderate.

6.0 GEOTECHNICAL SITE INVESTIGATION

6.1 GENERAL

A geotechnical site investigation was performed by WESTEC for both the treatment pond site and the water storage reservoir area. This consisted of the excavation of eleven test pits, three test pits, WTP-1, -2, and -3, which were located in the vicinity of the treatment ponds, and eight test pits, WTP-4 through WTP-11, which were located in the water storage reservoir area. The test pits were profiled and logged by an experienced WESTEC geotechnical engineer during excavation. Soil samples were taken during excavation for visual classification, laboratory gradation testing, and correlation with laboratory test results by others in the vicinity of the site. Surface hand samples of soils in the water storage embankment limits were taken by EFNI for visual classification by WESTEC.

Exploration borehole logs by EFNI in the proposed treatment pond and reservoir area were reviewed by WESTEC to determine bedrock and groundwater conditions. The bedrock consists primarily of sedimentary claystones, siltstones, and sandstones of the Eocene Wasatch Formation. The groundwater level is more than 100 feet deep in the vicinity of the treatment ponds and reservoir impoundment based on EFNI boreholes.

The WESTEC test pit logs for both the treatment pond and water storage reservoir areas are included in Appendix B.1. The location of EFNI boreholes and WESTEC test pits are shown on Drawing Nos. 35701-03 and -05 in Appendix D.

6.2 TREATMENT PONDS

The treatment pond site is located near the process plant site in an area of low permeability, clayey foundation material, which acts as a secondary containment system in the event of a leak through the primary geomembrane lining system.

Three test pits were excavated near the treatment pond site. Results indicate that approximately 1-foot of clayey topsoil was present with roots and organics. Below the topsoil horizon, test pits WTP-1 and -2 indicated a weathered claystone and siltstone residual soil to weathered bedrock material of thickness varying from 2.5 to 5.5 feet, while in WTP-3 the material was identified as a weathered silty and clayey sandstone with a thickness of 2.3

feet. Underlying the above stratigraphy, is a hard to very hard less weathered claystone becoming more competent with depth. Summary logs of the test pits are shown on Drawing No. 35701-03.

6.3 WATER STORAGE RESERVOIR

Two sites were considered for the location of the solution storage dam and reservoir. The first site is located near test pits WTP-4, -5, and -6, and the second site is located approximately 400 feet downstream of the first site near EFNI hand samples HS-1 through 5. The second site, shown on Drawing No. 35701-05, has been selected for design.

The location of the irrigation water storage reservoir at the second location described above provides more flexibility for the treatment ponds and process plant site location. The second site is also located downhill from the treatment ponds, and in the unlikely event that the treatment ponds should overflow, the reservoir will provide a backup storage. Although the upstream watershed for the second site is larger than the watershed for the first impoundment site, the second site has been chosen as the best location from a practical design standpoint.

Eight test pits were excavated for the irrigation water storage reservoir. The test pits were all located within the impoundment area and are numbered WTP-4 through -11. The field test pit logs are included in Appendix B.1. Summary logs are shown on Drawing No. 35701-03. The test pit locations are shown on Drawing No. 35701-05.

Test pits WTP-4 and -5 were located on the south ridge in the impoundment and valley bottom respectively. Both of these test pit profiles indicated a clayey topsoil depth of 1-foot thickness while test pit WTP-6, located near the right hand abutment, indicated a sandy clayey topsoil thickness of 1-foot. Below the topsoil horizon of WTP-4 and -5 was a sandy clay material of medium stiff to stiff consistency from weathered in situ claystone bedrock. Below the topsoil horizon of WTP-6 was a weathered sandstone and siltstone material which gradually transitions from a firm to hard consistency.

WTP-7 located near the diversion retention berm in the second draw from the south, indicates a 0.5 to 1-foot thick topsoil layer overlying a 4-foot thick silty sand layer with clayey lenses. Below this horizon is a hard to very hard claystone material (bedrock) with sandstone and siltstone lenses. This soil profile varies from hole to hole. Test pits WTP-8, -9, -10, and -11, located in the second and third draws in the impoundment, show a topsoil layer of 0.5- to 1.0-foot thick clayey material overlying a medium stiff to stiff silty clay layer 7.0 to 8.0 feet thick and transitions into a hard to very hard claystone with siltstone lenses.

Soil samples were taken from the test pits in the impoundment area for laboratory analysis. All the soil samples taken during the site investigation were subjected to grain size analysis and Atterberg limit index testing. The results of the laboratory testing are included in Appendix B.2.1.

Hand samples HS-1 through HS-5 in the embankment area were sampled by EFNI personnel at approximately 1.5 feet below the ground surface. A visual examination of the samples indicate the embankment foundation consists of sandy and silty clays overlying bedrock similar to the reservoir impoundment.

7.0 ENGINEERING EVALUATION

7.1 GENERAL

Additional geotechnical investigations will be performed in Part 2 of the WESTEC workscope, including in situ borehole field permeability tests, to confirm foundation conditions at the treatment pond and water storage reservoir sites. Monitoring of the water storage embankment phreatic surface will include the installation of standpipe piezometers in lieu of an internal drain system. The Treatment Pond and Irrigation Water Storage Reservoir engineering evaluations for the Part 1 workscope are included herein.

7.2 TREATMENT PONDS

During the first four years of operation of the facility, the ponds are required to process an excess design solution flow rate of 60 gallons per minute (gpm). Following the first 4 years of operation, restoration of the previously leached areas will commence adding another 200 gpm to the excess solution flow rate bringing the total to 260 gpm.

The pond sizes have been determined and designed by EFNI using data from previous facilities which have operated successfully. The treatment pond bottoms are approximately 50 feet by 150 feet with 3H:1V side slopes. The pond depths are 10 feet below the perimeter berm crest levels with an additional 3 feet of depth in a sump area for cleanout of sediments, as needed. The ponds include 3 feet of dry freeboard allowance. The pond area of disturbance is approximately 1.2 acres.

A 4-inch diameter drain pipe on a 1 percent minimum grade will adequately drain the decanted pond flows to the reservoir (ADS 1983). The treatment pond inlet and outlet details are shown on Drawing Nos. 35701-03 and 04 and will be finalized in the WESTEC Part 2 workscope.

The excess solution will be processed through primary and secondary treatment ponds to settle and clarify the solution prior to discharging to the water storage reservoir. The ponds will be double lined with leak detection between the liners. The primary lining system for the ponds will be an 80-mil high density polyethylene (HDPE) and the secondary liner will be a clay liner. The HDPE liner permeability is generally less than 1 x 10^{-12} cm/sec (Federal Register 1987). The moderate plasticity clayey soils on site compacted to 95 percent of standard density (ASTM D-698) will generally be less than 1 x 10^{-7} cm/sec.

The leak detection system will be installed between the primary and secondary lining systems and consists of a sand drain layer and drain pipes in the pond bottom and wick drains on the side slopes. The side slope wick drains allow leaks, if any, to drain to the pond bottom sand drain layer for collection in a sump at the lowest corner of each treatment pond. A leak detection pipe, extending from the sump to the pond crest, allows visual observation for leaks and pumping access, if needed, until the pond liner leak is repaired. The treatment pond liner and leak detection details are shown on Drawing No. 35701-04.

7.3 WATER STORAGE RESERVOIR

The water storage reservoir has been designed in two phases. The Phase 1 embankment will store excess fluids during the first 4 years of operation, while Phase 2 will accommodate excess fluids for the following years which include the fluids from the restoration of the spent in situ leached areas. The high and low water lines, as well as the storage capacity are shown on the drawings.

The Phase 1 embankment includes a 15-foot crest width, 3H:1V upstream and 2H:1V downstream slopes, 5-foot nominal depth cutoff trench, drain blanket in the downhill valley bottom toe area, and a temporary side hill spillway. The Phase 2 embankment will be constructed in a downstream raise to the final level, similar to Phase 1, with the cut-off trench and drain blanket extended and a new spillway constructed to handle the 100-yr, 24-hr storm event. The embankment heights from the downstream toe to crest level are approximately 31 feet for Phase 1 and 39 feet for Phase 2. The embankment heights include a 3-foot freeboard allowance. The temporary Phase 1 and permanent Phase 2 spillway inlet levels will be constructed at 3 feet below the embankment crest level. Post-construction standpipe piezometers will be installed in the embankment to confirm phreatic surface levels discussed in Section 7.4 The storage and pool surface area versus elevation curves for the impoundment are shown on Drawing No. 35701-06.

The total embankment height is less than 50 feet and located in a remote area, thereby classifying the embankment and reservoir as a low hazard facility. The area of embankment and reservoir disturbance is 15.3 acres below the dry freeboard level for Phase 1 and an additional 9.1 acres for Phase 2. During operations, the excess reservoir fluids will be disposed of by land application using a sprinkler irrigation system.

Based on test pit data and site observations, the reservoir and embankment seepage losses are anticipated to be relatively low due to the natural liner characteristics of the clayey soil and claystone bedrock. Borehole explorations in Part 2 of the WESTEC workscope will include in situ field permeability tests to confirm foundation conditions beneath the embankment and reservoir.

7.4 EMBANKMENT STABILITY EVALUATION

7.4.1 General

This section summarizes the results of the stability analysis for the Phase 2 embankment and foundation. The dam is located in the valley just south of the plant site and treatment ponds. Analysis was conducted on the maximum dam section for circular failure modes for both the upstream and downstream slopes under steady-state hydrostatic conditions. Failure due to rapid draindown of impoundment water was also analyzed for the upstream slope. The less critical Phase 1 dam was not evaluated because higher factors of safety are related to a smaller dam section.

The Reno Creek Project is situated in a low seismic zone area. The Uniform Building Code (UBC) classifies this area as Zone I (ENR 1992). Zone I areas are usually associated with bedrock accelerations of less than 0.1g and corresponding pseudo-static accelerations of 0.05g which will be used in the stability calculations for this report. The STABL5 slope stability program developed by Purdue University (Boutrup 1977) in conjunction with a stability editor (STED), written by Harold Van Aller, was used to conduct the stability analysis. Safety factors were determined by the Modified Bishop Method (Bishop, 1955) for circular failures. A horizontal seismic acceleration of 0.05g was selected for the pseudo-static evaluation of the dam facility.

A dam height of 40 feet (Phase 2 embankment) was used for analysis of both the downstream and upstream slopes with 2H:1V and 3H:1V slopes, respectively. The foundation grade followed the natural ground contour with an 8 percent grade beneath the uphill toe and a 2 percent grade downgradient beneath the embankment. For analysis, a phreatic surface was assumed in the foundation at the natural ground surface, and a curved phreatic surface was assumed in the embankment starting three feet below the crest and terminating at the downhill toe. Piezometric monitoring wells will be installed for post-construction monitoring of phreatic surface levels in the embankment and foundation. For the steady-state analysis, the impoundment water level was assumed at the maximum water level (3 feet below the dam crest). For the rapid draindown analysis the impoundment water level was assumed to have zero height.

The clay embankment material was conservatively assumed to have a moderate strength friction angle of 24 degrees and a cohesion of 300 psf (Table 7.1). The foundation material was assumed to have a friction angle of 30 degrees and a cohesion of 500 psf. The material properties were based on available laboratory test information for the proposed Reno Ranch Pilot Plant (Chen 1978). Soil index tests, gradings and plasticity, for the Reno Ranch Pilot Plant project and for this report were compared for correlation prior to the use of soil strength parameters in the stability analysis. Moist and saturated unit weights were conservatively assumed to be 20 to 30 percent above dry density.

TABLE 7.1

MATERIAL PROPERTIES

SOIL	DESCRIPTION	MOIST DENSITY (pcf)	SAT. DENSITY (pcf)	FRICTION ANGLE (deg)	COHESION (psf)
1	EMBANKMENT MATERIAL	105	110	24	300
2	FOUNDATION MATERIAL	115	120	30	500

7.4.2 Results

A summary of the stability analysis safety factors are given in Table 7.2 with computer files presented in Appendix C. Results of the steady-state downstream stability analysis indicate a minimum safety factor of 1.6 static and 1.5 for the pseudo-static case. The upstream steady-state stability analysis resulted in a minimum value of 3.5 static and 2.6 for the pseudo-static case. For the rapid draindown analysis of the upstream slope, a minimum safety factor of 1.1 resulted for the static case. The likelihood of major seismic activity occurring during a rapid draindown condition is very small, therefore, a pseudo-static analysis was not performed.

The minimum steady-state static and pseudo-static factors of safety for high hazard water storage reservoirs are 1.5 and 1.2, respectively, as accepted good engineering practice. Acceptable rapid draindown factors of safety are above 1.0. The Reno Creek dam is not considered a high hazard structure, since it is in an undeveloped and remote area with the maximum planned dam height at less than 50 feet from the crest to downstream toe.

In conclusion, the minimum factors of safety obtained for the upstream and downstream steady-state analyses, the pseudo-static analysis, and the rapid draindown analysis all exceed the minimum acceptable factors of safety of 1.5, 1.2, and 1.0, respectively, thus indicating a suitable embankment design for the water storage reservoir.

TABLE 7.2

SUMMARY OF STABILITY ANALYSIS SAFETY FACTORS

FAILURE DESCRIPTION	ANALYSIS TYPE*	FACTOR OF SAFETY
DOWNSTREAM ANALYSIS:		
Circular Embankment (Steady-State)	Static	1.6
	Pseudo	1.5
Circular Foundation (Steady-State)	Static	1.9
	Pseudo	1.7
UPSTREAM ANALYSIS:		
Circular Embankment (Steady-State)	Static	3.5
	Pseudo	2.6
Circular Foundation (Steady-State)	Static	3.5
	Pseudo	2.6
Circular Embankment (Rapid Draindown)	Static	1.1
Circular Foundation (Rapid Draindown)	Static	1.1

* Pseudo-static horizontal acceleration assumed to be 0.05g.

8.0 RUNOFF DIVERSION

Section 4.0 contains a brief description of the hydrological data that will be used in the design of the runoff diversion system for the water storage reservoir. The runoff diversion system for the impoundment area will typically consist of three diversion retention berms and V-notch ditches to divert the 100-yr, 24-hr design storm runoff from entering the reservoir. The purpose of the retention berms is to reduce peak flows from the major drainages and divert flows to the diversion ditches. The retention berm maximum height will be 10 feet with a minimum height of 5 feet from the crest level to the downhill toe.

In general, the reservoir catchment basin is divided into three sub-basins: the southern, central, and northern sub-basins. Three diversion ditches were sized to accommodate peak flows from each of these sub-basins. Runoff flows from the central sub-basin are routed in Diversion Ditch No. 1 and intercept flows from the northern and southern sub-basins. Flow is then routed in Diversion Ditch Nos. 2 and 3 around the north and south sides of the reservoir impoundment, respectively. .The proposed locations of the diversion retention berms and diversion ditches and ditch sizes are shown on Drawing No. 35701-05.

Peak flow rates for the identified sub-basin areas have been estimated using the Soil Conservation Service computer model, TR-20, resulting from the 100-yr 24-hour storm event of 4.2 inches of precipitation (NOAA Atlas 2, Vol II). Channel flow parameters were determined using the computer model, FLOWMASTER, to aid in the design of the diversion ditches.

Diversion Ditch No. 1 was designed to accommodate a peak flow of 39.07 cfs at a depth of flow of 2.2 ft, and 0.5 ft of freeboard was added for a total diversion ditch design depth of 2.7 ft. Diversion Ditch No. 2 was designed for a peak flow of 86.41 cfs with flow depth and design depths of 3.0 ft and 3.5 ft respectively. Diversion Ditch No. 3 was designed for a peak flow of 96.25 cfs at a depth of flow of 3.1 ft for a total design depth of 3.6 ft. A summary of the hydrologic parameters used for diversion ditch sizing is presented in Appendix F.

9.0 TECHNICAL SPECIFICATIONS

The technical specifications for the materials to be used during construction are described and specified in Appendix E of this report. Technical specifications cover excavation, subgrade preparation, fill placement and compaction, 80-mil HDPE geomembrane liner material, and miscellaneous wick drains and pipes for the treatment ponds and water storage reservoir embankment.

10.0 USE OF THIS REPORT

This report was prepared for the exclusive use of the Energy Fuels Nuclear, Inc. and their staff and consultants for specific application in the preliminary design of the treatment ponds and water storage reservoir facilities at the Reno Creek Project near Gillette, Wyoming. The findings, recommendations, and conclusions for the preliminary design are based on results of site investigations, and information from the owner's files, combined with WESTEC experience on similar projects and our understanding of the project as stated in this report. If project details change, WESTEC should be notified so that the design can be verified or modified.

11.0 REFERENCES

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