

UNITED STATES DEPARTMENT OF ENERGY
Albuquerque, New Mexico

**Uranium Mill Tailings
Remedial Action Project
(UMTRAP-AML)
Spook, Wyoming**

SPK

Information for Bidders

Preliminary Design for Review

Volume I

April 1988



MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

8804260262 880422
PDR WASTE
WM-72 DCD

UMTRA PROJECT - SPOOK
INFORMATION TO BIDDERS
PRELIMINARY DESIGN FOR REVIEW
VOLUME I OF II

APRIL 1988

UMTRA PROJECT - SPOOK
INFORMATION TO BIDDERS

PRELIMINARY DESIGN FOR REVIEW

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UMTRA PROJECT - SPOOK
INFORMATION TO BODERS

1) INTRODUCTION

Disclaimer

Purpose

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INTRODUCTION

Disclaimer

This data is not part of the subcontract documents and is provided only for information and convenience for bidders. The Contractor disclaims any responsibility for the accuracy, true location, and extent of the information that has been prepared by others. The Contractor further disclaims responsibility for interpretation of this data by bidders, or for any opinions, conclusions or deductions that may be expressed or implied in the information contained herein.

Purpose

The purpose of this data is to provide bidders with information regarding geotechnical characteristics of the existing site soils, surface and ground water conditions, meteorological data, and soil contaminant measurements at the Spook processing site.

REFERENCES:

1. U.S. Department of Energy, "Remedial Action Plan and Site Conceptual Design for Inactive Uranium Mill Tailings Site at Spook, Wyoming"; Draft, Vol. I and II, July 1987.
2. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, "Climatography of the United States No. 20 (1951-80), Wyoming".
3. Morrison-Knudsen Engineers, Inc., "UMTRA - Spook, Construction Drawings", Preliminary Design, April 1988.
4. Jacobs Engineering Group, Inc., Acid Pond Drilling, Sampling and Testing Characterization Program, 1987-1988.
5. State of Wyoming, Department of Environmental Quality, Land Quality Division, "Report of Investigation, Abandoned Mined Lands Program 15-3", August 1987.

UMTRA PROJECT - SPOOK
INFORMATION TO BIDDERS

2) GEOTECHNICAL DATA

Location of Boreholds and Test Pits

MSRD Borehole Logs

TAC Borehole and Test Pit Logs

TAC Laboratory Test Results

TAC Acid Pond Characterization Data

Wyoming State AML Program Borehole Data

GEOTECHNICAL DATA

Location of Boreholes and Test Pits

References 1 and 3

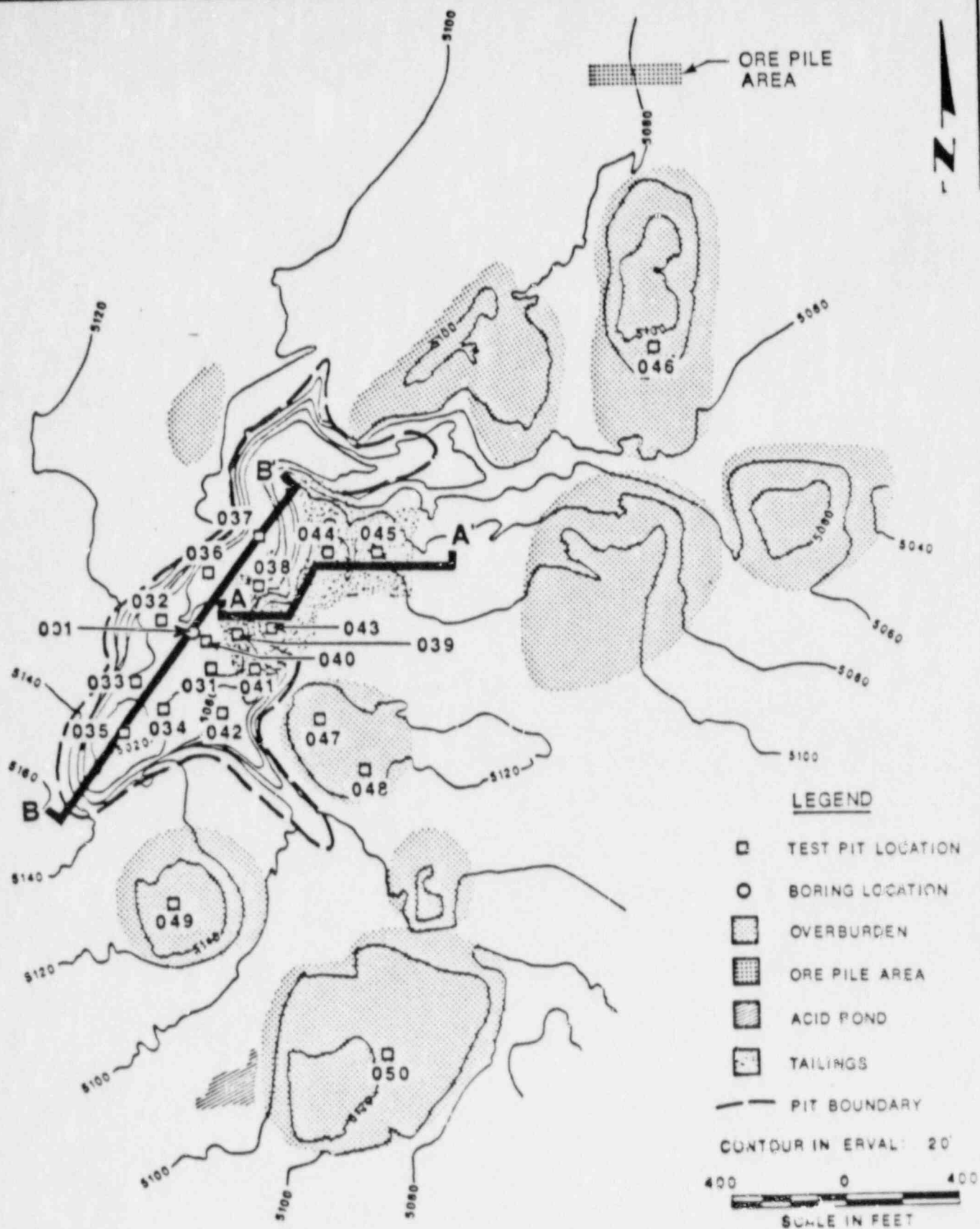
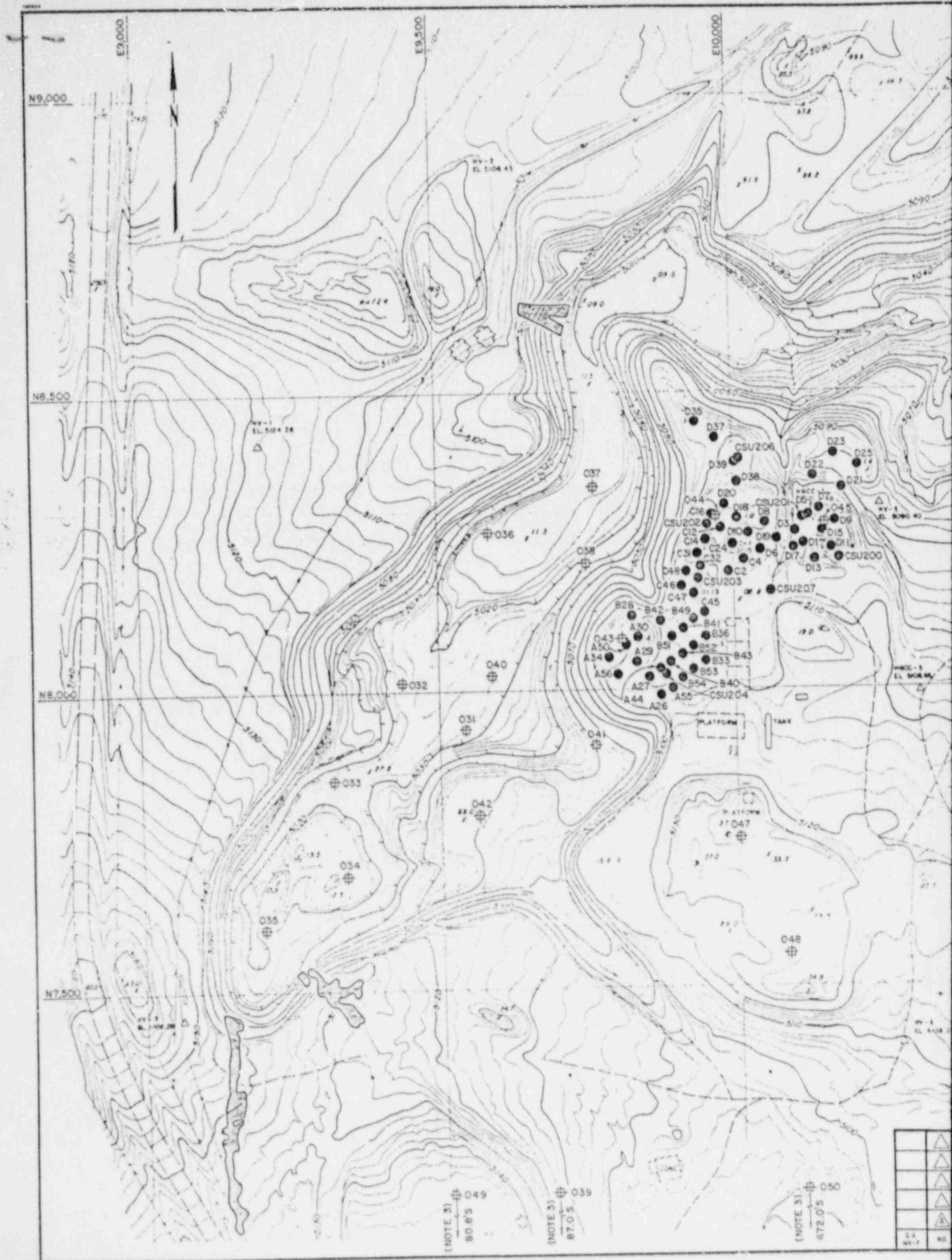
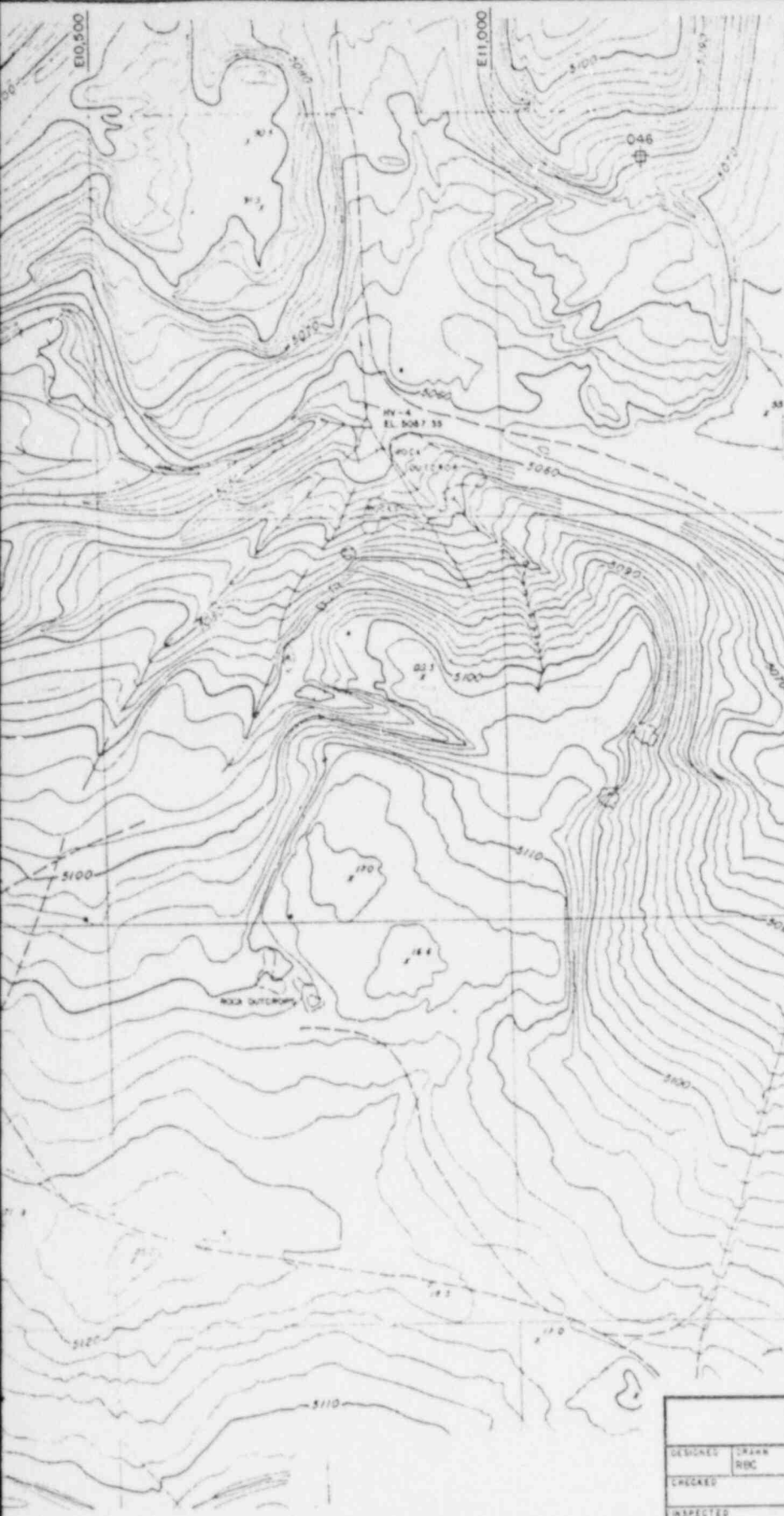


FIGURE 3.5
TEST PIT, BORING, AND CROSS SECTION LOCATIONS
SPOOK SITE
CONVERSE COUNTY, WYOMING





NOTES:

1. BOREHOLE LOCATIONS TAKEN FROM SERGENT, HAUSKINS & BECKWITH "SITE PLAN" DATED MAY 1982 IN DRAFT RAP FOR THE SPOOK SITE, VOLUME II, ADDENDUM D3 DATED JULY 1987. COORDINATES ARE NOT AVAILABLE AND THEREFORE LOCATIONS MAY NOT BE PRECISE.
2. TEST PIT LOCATIONS TAKEN FROM COORDINATES ON LOGS DATED FEBRUARY, 1987 IN DRAFT RAP FOR THE SPOOK SITE, VOLUME II, APPENDIX D, DATED JULY 1987.
3. TEST PITS O39 (N7,082.8; E9,685.1), O49 (N7,077.2; E9,508.9) AND O50 (N6,487.8; E10,103.9) ARE BEYOND THE LIMITS OF THIS PLAN.

TI APERTURE CARD

Also Available On
Aperture Card

REFERENCE DRAWINGS:

LEGEND:

- 5100 — EXISTING SITE FEATURES AND CONTOURS
- N 9,000
E 9,000 CONSTRUCTION GRID COORDINATE
- ⊕ O46 TEST PIT
- D25 BOREHOLE
- ABANDONED MINE DRIFT

8804260262 -01

100 0 100 200
SCALE FEET

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

SPOOK SITE
SPOOK, WYOMING

TEST PIT AND BOREHOLE LOCATION PLAN

DESIGNED: []
CHECKED: []
INSPECTED: []
RECOMMENDED: []

APPROVED

DATE

DOE PROJECT ENGINEER

DATE



MORRISON-KNUDSEN ENGINEERS, INC.
A HARBOR HERRICK COMPANY
ULTRA PROJECT

360 HOWARD ST. SAN FRANCISCO, CA 94102

PROJECT NO.

DE- ACO4-83AL18796

DRAWING NO.

SPK PS-10-0109

REV
A

ISSUED FOR PRELIMINARY REVIEW

REVISIONS

BY

CK

E&D

MDR

CHIEF

ENG.

TAC

REV

DOE

APP

DATE

GEOTECHNICAL DATA

MSRD Borehole Logs

Reference 1

LOG OF TEST BORING NO. D001

REMARKS	VISUAL CLASSIFICATION
moist medium	SAND very coarse some gravels dk brown to black highly cemented
dry fine	
	TAI 1065 subbase
v. fine	clayey sand medium grained trace of gravel dk brown highly cemented organics present
	sample stopped @ 32' 6"

CONSULTING GEOTECHNICAL ENGINEERS
P.O. BOX 108, LONDON E.C. 2A 4BT U.K.

LOG OF TEST BORING NO. CZ

PROJECT _____
JOB NO. E91-137 DATE 11/15/81

RIG TYPE CINE 75(20G) CC

BORING TYPE 6" H.S.

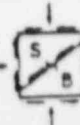
SURFACE ELEV.

DATUM

GROUND WATER		
DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A - Auger cuttings. B - Block sample.
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.



SERGEANT, HAUSKINS & BECKWITH

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PROJECT SF038
JOB NO. 191-17

DATE 11/5/81

LOG OF TEST BORING NO. D003

RIG TYPE CME-55 # 203
BORING TYPE 4 1/2" H.C.
SURFACE ELEV. 10' E of SP-41
DATUM 10' E of SP-41

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0								
1		21"	X	U	4-8-4-8-9			SP
5		20"	X	U	11-13-10-12-12			
		23"	X	U	30-12-14-14-13			
		21"	X	U	22-24-11-13-14			
10		24"	X	U	10-12-7-10-12			
		23"	X	U	8-7-7-6-5			
15		22"	X	U	15-14-8-6-8			
		21"	X	U	7-6-7-7-8			
20		23"	X	U	7-8-7-9-14			
25		23"	X	U	11-10-12-12-14			SC
		19"	X	U	18-14-12-23-30			
		21"	X	U	20-23-24-27-32			
30								

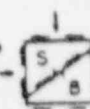
REMARKS	VISUAL CLASSIFICATION
moist	SAND very coarse w/ly rounded to P.F. dk brown
mod firm	
firm	clayey, sand coarse grained low P.I. w/ly rounded dk brown to lt brown trace of organics
	auger stopped @ 27 1/2' Sample @ 30.0'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.



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RIG TYPE C112 75(20G)CC
BORING TYPE 6 1/2" HSA
SURFACE ELEV. _____
DATUM _____

Auger stopped @ 15'
Sampler stopped @ 20'

A - Auger cuttings; B - Block sample
S - 2" O.D. 1.38" I.D. tube sample.
L - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.



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PROJECT SPOOK
 JOB NO. 627 DATE 11/15/81

LOG OF TEST BORING NO. 205

RIG TYPE AP-55 #203
 BORING TYPE 6-1/2" 4/5"
 SURFACE ELEV. 4
 DATUM

Depth In Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist	firm
1		23"	X	U	4-5-4-10-10-9			SP		SAND
2		23"	X	U	4-3-7-4-5-5				mod	very coarse
3		24"	X	U	8-6-4-6-7				firm	no P.I.
4		23"	X	U	4-5-4-4-5					very rounded
5		21"	X	U	5-4-6-4-7					dk brown
6		22"	X	U	5-6-6-5-8					
7		23"	X	U	5-5-5-5-7					
8		21"	X	U	6-6-7-7-9					
9		19"	X	U	7-8-7-8-7					
10		21"	X	U	8-7-10-9-14					
11		22"	X	U	9-12-14-14-20					
12		23"	X	U	17-19-23-26-39					
13		21"	X	U	21-21-23-27-21			SC	U. moist	playey SAND
14		18"	X	U	17-21-21-23-24					very rounded
15		18"	X	U	31-28-24-27-32					low P.I.
16										dk brown
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										

TAILINGS
 SUBMERGE

Aug. stopped @ 5'
 sampler @ 37'6"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. 2.42" I.D. tube sample.



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LOG OF TEST BORING NO. De

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM.

GROUND WATER

SAMPLE TYPE

A - Auger cuttings, B - Block sample

S = 2" O.D., 1.38" I.D., tube sample.

U = 3" O.D., 2.42" I.D. tube sample.

T = 3" O.D. thin-walled Shelby tube.



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3000 C. ALBUQUERQUE • SANTA FE

PROJECT Spook
 JOB NO. SP-43 DATE 10/15/91

LOG OF TEST BORING NO. 0007

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0		23"	X	U	6-7-12-14-22			SP
		24"	X	U	12-11-10-10-14			
5		22"	X	U	5-16-10-7-8			
		18"	X	U	5-5-5-5-9			
10		21"	X	U	6-6-5-2-1			
		20"	X	U	6-6-1-6-10			
15		20"	X	U	7-7-7-7-3			
		21"	X	U	7-7-2-10-11			
20		23"	X	U	10-13-8-8-10			
		22"	X	U	8-8-8-9-12			
25		18"	X	U	9-9-7-12-14			
30		22"	X	U	11-14-2-36-35			SC
		24"	X	U	24-26-30-29-29			
		20"	X	U	25-37-25-24-31			

RIG TYPE CHE-55 #203
 BORING TYPE 6 1/2" HSA
 SURFACE ELEV. _____
 DATUM 12' SE of SP-43

REMARKS	VISUAL CLASSIFICATION
moist firm	SAND likely cemented have to low p.r. dk brown to brown coarse grained
u. moist hard	CLAYEY SAND likely cemented Low p.r. coarse grained dk brown to brown
	Auger stopped @ 35.0' sample @ 35.0'

GROUND WATER

DEPTH	MOOR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.



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LOG OF TEST BORING NO. 28

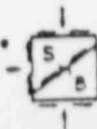
BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

GROUND WATER		
DEPTH	HOUR	DATE
None		

A = Auger cuttings. B = Block sample
S = 2" O.D. 1.38" I.D. tube sample.
U = 3" O.D. 2.42" I.D. tube sample.
T = 3" O.D. thin-walled Shelby tube.



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PROJECT 5100
JOB NO. 100-127 DATE 11-24-91

RIG TYPE CRP-551203
BORING TYPE CRP-112A
SURFACE ELEV. 41.2 SP-27
DATUM SP-27

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
									RIG TYPE <u>1 1/4" 50' 200</u> BORING TYPE <u>2 1/2" H/A</u> SURFACE ELEV. <u>4' 11" SP 2' 9"</u> DATUM <u>4' 11" SP 2' 9"</u>	
1		24"	X	12-9-12-13-15				SP	moist	SAND very coarse NO PI w/ly cemented 4' ben h ben
5		26"	X	12-10-11-12-13						
		19"	X	12-6-5-4-6						
		21"	X	14-4-3-4-6						
10		21"	X	11-4-4-4-6						
		23"	X	15-5-5-5-5						
15		21"	X	15-7-5-5-4						
		22"	X	15-6-6-5-7						
20		22"	X	15-6-6-6-7						
		23"	X	17-6-7-7-3						
25		22"	X	16-6-6-3-9						tanings SURFACE
30		23"	X	12-9-10-10-29-26				SC	hard	clayey SAND w/ly cemented low sp di ben h ben
		21"	X	12-17-17-14-20						
		16"	X	14-1-12-21-17						
35										Aug 25/65 @ 50' Sample @ 350'

SAMPLE TYPE

A - Auger cuttings. B - Block sample
S - 2" O.D., 1.38" I.D. tube sample. -
U - 3" O.D., 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.



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VISUAL CLASSIFICATION

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PROJECT Spunk
 JOB NO. SP-1-637 DATE 11/16/61

LOG OF TEST BORING NO. 2011

RIG TYPE CME-55 #203
 BORING TYPE 1 1/2" HSA
 SURFACE ELEV. 2' NE of SP-15
 DATUM 2' NE of SP-15

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		23'	X	U	7-13-16-16-21			SP	mod. firm	SAND
		24"	X	U	14-11-15-21-27				u firm	No P.I. loosely cemented coarse grained dk brown sand
5		20'	X	U	30-28-16-14-20					
		22"	X	U	5-7-5-5-6				mod. firm	
10		18"	X	U	5-5-4-4-6					
		20"	X	U	4-4-4-5-7					
15		22"	X	U	6-6-5-8-8					TAILINGS SUBBASE
20		24"	X	U	11-17-20-29-30 SC				dry	HARD
		22"	X	U	21-21-21-20-17					clayey sand wkly cemented low P.I. dk brown to lt brown layers of gravel also found
25		19"	X	U	13-18-17-24-22					
30										Avg. 12 blows @ 5.0' complete @ 25.0'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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PROJECT Spork tailings
JOB NO. EYI-631 DATE 11/16/81

LOG OF TEST BORING NO. 2

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0								SC
20'			X	U	4-8-7-9-17			
20'			X	U	16-13-12-12-10			
23'			X	U	7-5-9-7-16			
20'			X	U	5-4-4-8-11			
20'			X	U	4-13-14-17-20			
21'			X	U	14-18-29-38-36			
20'			X	U	16-21-22-23-22			
20'			X	U	15-14-19-25-30			
20'			X	U	10-12-16-14-27			CL
21"			X	U	22-24-28-27-20			
			X	U	10-10-3-21-11			

RIG TYPE CME 75 (206) CC
BORING TYPE 6 1/2" HSA
SURFACE ELEV. _____
DATUM _____

REMARKS	VISUAL CLASSIFICATION
moist	Clayey Sand Lo PI brown
moist	tailings subbase sandy clay Lo PI brown-tan
	Auger stopped @ 25' Sampler stopped @ 27 1/2'

GROUND WATER		
DEPTH	HOUR	DATE
NCE		

SAMPLE TYPE
A - Auger cuttings. B - Block sample
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.



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PROJECT Sink
 JOB NO. FAI-437 DATE 11/16/81

LOG OF TEST BORING NO. D013

RIG TYPE CME-55 #233
 BORING TYPE 6 1/2" HST
 SURFACE ELEV. North of hole
 DATUM North of hole

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Melchior Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		24"	X		2-5-7-12-20			SP	moist	red firm SAND
		26"	X		u 16-17-23-26-28/5"				hard	COARSE GRAINED with cemented dk brown to brown
5		23"	X		u 31-46-32-31-37					
		16'	X		u 13-17-17-16-17					
10		22"	X		u 11-9-11-14-21					
		21"	X		u 13-11-11-13-22			SP	dry V. firm	SAND
15		22"	X		u 6-12-12-11-13					NO P.F.
		19"	X		u 9-10-11-11-10					COARSE GRAINED med cementation lt brown to white (quartz)
20										Aug. 1.0 gph @ 15.0' sample @ 20.0'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE
 A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin walled Shelby tube.

1
 SERGENT, HAUSKINS & BECKWITH
 CONSULTING GEOTECHNICAL ENGINEERS
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PROJECT Spunk Tailings
 JOB NO. _____ DATE _____

LOG OF TEST BORING NO. C14

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb., 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	RIG TYPE _____	
									BORING TYPE _____	SURFACE ELEV. _____
									DATUM _____	
									REMARKS	VISUAL CLASSIFICATION
0								SC		
5									moist	Clayey Sand Lo Pz brown
10										
15								CL		tailings shale
20										Sandy Clay Lo Pz tan
25										Auger stopped @ 15' Sampler stopped @ 22 1/2'
30										

GROUND WATER		
DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE
 A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.


 SERGENT, MAUSKINS & BECKWITH
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PROJECT Spook

LOG OF TEST BORING NO. DW5

JOB NO. 2-1-22 DATE 11/16/51

RIG TYPE CME-E5 #203

BORING TYPE 6 1/2" HSH

SURFACE ELEV. _____

DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		21'	X	U	10-10-16-10			SP	moist mod firm	SAND w/ky cemented
5			X	T	2 1/2'					NO P.I.
			X	T	2 1/2'					COARSE GRAINED
			X	T	2 1/2'					dk. brn to brn
10			X	T	2 1/2'					
			X	T	2 1/2'					
15			X	T	2 1/2'					
			X	T	2 1/2'					
			X	T	2 1/2'					
20			X	T	2 1/2'			SC	V. firm	clayey sand
			X	T	2 1/2'					LOW P.I.
			X	T	2 1/2'					w/ky cemented
25			X	T	2 1/2'					dk. brn to brn
			X	T	2 1/2'					
30										sample stopped @ 27 1/2'

GROUND WATER		
DEPTH	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings. B - Block sample
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.



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PROJECT Spunk Tailings
JOB NO. EP-62E DATE 11/16/81

LOG OF TEST BORING NO. CL

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0								SL
		24"	X	U	6-2-2-3-5			
		20"	X	U	24-4-4-5			
5		23"	X	U	2-4-3-4-3			
		20"	X	U	3-4-3-7-9			
10		23"	X	U	8-7-7-10-15			
		16"	X	U	12-8-7-7-7			
15		20"	X	U	5-7-15-12-12			
		20"	X	U	13-17-22-32-41			
20		20"	X	U	15-21-21-16-21			CL
		21"	X	U	21-21-20-14-19			
25		20"	X	U	11-14-14-16-8			
30								

RIG TYPE CME 75 (200) CC
BORING TYPE 6 1/2" HSA
SURFACE ELEV. _____
DATUM _____

REMARKS	VISUAL CLASSIFICATION
moist	Clayey Sand pred med grained Lo PE brown
moist	tailings subbase Sandy Clay Lo PE brown-tan
	Auger stopped @ 25' sampler stopped @ 27 1/2'

GROUND WATER		
DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE
A - Auger cuttings. B - Block sample
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.



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									RIG TYPE <u>CME-55 P203</u>	
									BORING TYPE <u>6 1/2" HSP</u>	
									SURFACE ELEV. <u>15' W of CP 14</u>	
									DATUM <u>6</u>	
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			10"	X u	1-2-50/3			SP	moist	SAND w/ky cemented. SUBBASE
			21"	X u	6-8-9-9-12					No P.F. coarse gradat DK base below
5			22"	X u	9-9-9-10-37					Note: F. layer of structure present 6" thick was passed through @ 1 1/2'
10										Auger stopped @ 2 1/2' sample @ 7 1/2'

PROJECT Spook Tailings
 JOB NO. EP-631 DATE 10/16/81

LOG OF TEST BORING NO. DR

RIG TYPE CME 75(200)CC
 BORING TYPE 6 1/2" HSA
 SURFACE ELEV. _____
 DATUM _____

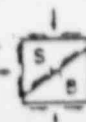
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			23'	U	5-7-6-8			SC	moist	Clayey Sand
			20'	U	5-5-4-5-8					prod. med. grain
5			22'	U	8-7-6-12-17					Lo PI
			20"	U	12-11-13-17-18					brown
10			20'	U	11-14-10-18-20					
			24'	U	10-11-14-26-34					
15			23'	U	14-15-17-18-14					
			20"	U	12-12-13-13-19					
20			22'	U	9-12-11-14-15			CL	moist	tailings subbase
			20"	U	11-12-19-22-28					Sandy Clay
25			20'	U	24-24-23-17-16					Lo PI
										tan
30										Auger stopped @ 25'
										Sampler stopped @ 27 1/2'

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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PROJECT SpookJOB NO. FRI-431DATE 11/16/21LOG OF TEST BORING NO. DOFRIG TYPE CME-55 #203BORING TYPE 6 1/2" HSASURFACE ELEV. DATUM 17 ft of SP 40

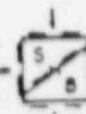
RIG TYPE <u>C.M.C. 55-203</u>										
BORING TYPE <u>6 1/2" HSA</u>										
SURFACE ELEV. <u>17 E of SP 40</u>										
DATUM <u>17 E of SP 40</u>										
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	U	1-5-8-10-15			SP	moist	firm
2		22"	X	U	9-10-15-13-14					
5		18"	X	U	16-18-13-14-15					
		21"	X	U						
10										sampler stopped @ 7 1/2'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. open-ended Shelby tube



SERGENT, HAUSKINS & BECKWITH

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PROJECT Gravel To / ngs
 JOB NO. 1-12 DATE 11/16/91 - 11/17/91

LOG OF TEST BORING NO. 120

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0								SC
22"			X	U	2-5-4-0-6			
20"			X	U	5-5-5-4-4			
20"			X	U	4-4-3-4-6			
21"			X	U	4-6-11-10-11			
20"			X	U	4-6-11-12-14			
21"			X	U	9-11-10-17-23			
17"			X	U	17-15-20-19-20			
20"			X	U	13-15-26-27-31			
21"			X	U	16-17-32-36-32			CL
19"			X	U	19-15-21-26-31			
13-15-16-17-20			X	U				
16-19-20-20-19			X	U				

RIG TYPE CMG 75 (200) CC
 BORING TYPE 6 1/2" HSA
 SURFACE ELEV. _____
 DATUM _____

REMARKS	VISUAL CLASSIFICATION
moist	Clayey Sand pred. med. grained Lo PI brown
moist	tailings subbase Sandy Clay Lo PI tan
	Auger stopped @ 25' sampler stopped @ 30'

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE
 A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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PROJECT Spook
 JOS NO. ES-1-25 DATE 11/16/91

LOG OF TEST BORING NO. 2021

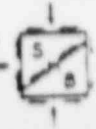
RIG TYPE CME-55 #203
 BORING TYPE 6 1/2" HSA
 SURFACE ELEV. _____
 DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb., 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		21"	X	4	1-3-27-33-23			SC	mist	hard clay, sand subbase
		20"	X	u	17-14-16-17-14					wkly cemented low P.I. dk brown to tan
5		23"	X	u	7-10-9-7-10				firm	
10										sample stopped @ 7 1/2'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE
 A - Auger cuttings. B - Block sample
 S - 2" O.D., 1.38" I.D. tube sample.
 U - 3" O.D., 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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LOG OF TEST BORING NO. 1-2

REMARKS	VISUAL CLASSIFICATION

sample depth @ 70.0'

SAMPLE TYPE

A = Auger cuttings. B = Block sample
S = 2" O.D. 1.38" I.D. tube sample.
U = 3" O.D. 2.42" I.D. tube sample.
T = 3" O.D. thin-walled Shelby tube.



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PROJECT Spook
 JOB NO. 64637 DATE 11/17/61

LOG OF TEST BORING NO. 1023

RIG TYPE CPIE-55 #203
 BORING TYPE 6 1/2" HSA
 SURFACE ELEV. _____
 DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0										
		13'	X	U	3-6-9-9-15			SD	moist fine	SAND w/ly cemented no PI. dk brown & brn
		22'	X	U	11-14-16-14-16					tailings subbase
5		23'	X	U	9-7-9-8-11					clayey sand low P.T. w/ly cemented brn
		14'	X	U	9-8-9-8-10			SG		
10		22'	X	U	7-7-7-9-11					
15										sample stopped 12 1/2'
20										

GROUND WATER		
DEPTH	HOUR	DATE

SAMPLE TYPE
 A - Auger cuttings. B - Block sample.
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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PROJECT Spook Tailings
 JCS NO. EP-1-431 DATE 11/17/81

LOG OF TEST BORING NO. 221

RIG TYPE LME 75 (206) CC
 BORING TYPE 6 1/2" HSA
 SURFACE ELEV. _____
 DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SC	moist	Clayey Sand
		25"	X	U	5-10-13-21-24					med. fine grained
5		23"	X	U	15-14-15-14-15					Lo FI
		22"	X	U	14-12-11-16-17					brown
10		23"	X	U	9-9-11-13-16					
		22"	X	U	13-12-13-34-37					
15		20"	X	U	17-21-23-21-24			LL		tailings subbase
		20"	X	U	5-6-7-8-13					Sandy Clay
20		20"	X	U	10-13-13-12-14					Lo FI
		20"	X	U	9-10-10-10-13					tan-brown
25										Auger stopped @ 32 1/2'
30									piezometer	Sampler stopped @ 22 1/2'
35										
40										4" ABS pipe set to 30' 11"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



SERGEANT, HAUSKINS & BECKWITH
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PROJECT Smok
 JOB NO. EC-1637 DATE 11/17/61

LOG OF TEST BORING NO. 203

RIG TYPE Cole-55 #203
 BORING TYPE 6 1/2" 1637
 SURFACE ELEV. _____
 DATUM _____

Depth in Feet	Continuous Penetration Resistance	Geophysical Log	Sample	Sample Type	Blows per foot 1/2 in lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist	firm
		23'	X	U	4-8-13-16-10			SP		
		23"	X	U	7-8-12-17-15					
5		22"	X	U	9-7-8-8-9			SC	U. mod	
		23'	X	U	7-7-9-10-11				mod	
10		21"	X	U	6-7-8-8-10				firm	
										clayey sand low PI wkly cemented tk brns to brown
										sample stopped @ 12 1/2'
15										
20										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.



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PROJECT Synok
JOB NO. EX-137 DATE 11/17/41

LOG OF TEST BORING NO. 1021

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
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22								
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29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								
46								
47								
48								
49								
50								

RIG TYPE CME-55 #203
BORING TYPE 6" HSP
SURFACE ELEV. _____
DATUM _____

REMARKS	VISUAL CLASSIFICATION
moist	SAND
hard	mod. cementation
	subbase
	no PT
	coarse - gra. sized
	lt. brown to tan
	Auger stopped 5.0'
	Sampler refusal @ 5' 9"

GROUND WATER		
DEPTH	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings. B - Block sample.
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.



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PROJECT 250016
JOB NO. EN-437 DATE 11/17/81

LOG OF TEST BORING NO. AD21

RIG TYPE PM-SS #203
BORING TYPE 6 1/2" H.S.H.
SURFACE ELEV. _____
DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0										
		20"	X	U	1-8-16-21-20			SP	moist	V. firm SAND w/ky cementation
		22"	X	U	15-17-17-16-18					NO P.T. dk brn to brn
5		21"	X	U	12-9-8-6-8				mod	cc AR = g. cased
		20"	X	U	7-5-5-7-6				firm	
10		20"	X	U	5-6-5-5-8					
		22"	X	U	5-4-5-5-5					
15		23"	X	U	4-5-4-5-5					
		20"	X	U	4-6-9-26-29			SP	dry	hard SAND mod. cementation
20		6"	X	U	50-50 1/2"					subbase
		NR	X	U	43-53 1/2" (NR)					NO P.T. tan to lt brn
25										finger stopped @ 22 1/2"
										sample refusal @ 23 2"
30										

GROUND WATER		
DEPTH	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings. B - Block sample
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.



SERGEANT, HAUSKINS & BECKWITH
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PROJECT Crook Tailings
 JOB NO. EP11631 DATE 11/19/21

LOG OF TEST BORING NO. 22
8' south

RIG TYPE CM2 75(200) CC
 BORING TYPE 6 1/2" HSA
 SURFACE ELEV. _____
 DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SC	moist	Clayey Sand
			26"	X	4 3-7-10-10-11					red. medium-grained
5			25"	X	4 6-6-6-5-6					to 10 ft
			23"	X	4 4-3-4-4-6					brown
10			20"	X	4 7-6-5-6-7					
			21"	X	4 6-4-7-6-8					
15			21"	X	4 6-6-9-7-9					
			20"	X	4 5-4-5-6-10					
20			20"	X	4 4-5-5-5-6					
			20"	X	4 5-4-5-8-9					
25			20"	X	4 6-5-6-10-7					
			20"	X	4 17-17-13-10-17					
30			20"	X	4 9-10-11-12-10					
			20"	X	4 7-6-5-10-12					
35			20"	X	4 12-11-10-13-17					
			20"	X	4 14-13-9-20-20					
40			21"	X	4 13-16-20-14-23					
			20"	X	4 16-13-12-12-18					
45			20"	X	4 8-14-12-14-16					
			20"	X	4 15-14-13-14-17					
50			20"	X	4 13-21-23-16-18					

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE
 A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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 PHOENIX • ALBUQUERQUE • SANTA FE

SN 5-

PROJECT Spook Tailings
 JOB NO. E81-631 DATE 11/19/91

LOG OF TEST BORING NO. B-7
2 of 2

RIG TYPE CME 75 (200) CC
 BORING TYPE 6 1/2" HSA
 SURFACE ELEV. _____
 DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50		21"	X	U	4-16-14-22-30					
		20"	X	U	4-18-20-24-39					
55		20"	X	U	8-12-16-22-26					
		21"	X	U	18-20-24-28-34					
60		20"	X	U	20-22-26-29-33					
		21"	X	U	22-26-31-21-37					
65		20"	X	U	13-15-18-24-37					
		20"	X	U	20-26-28-32-42					
70		21"	X	U	12-14-18-24-37					
		20"	X	U	17-25-31-27-19					
75		21"	X	U	21-23-37-24					
75 1/2		20"	X	U	32-34-38-44-47					
80		12"	X	U	35-49-55-62					
			X	S	35-50/4"				dry	tailings subsoil Sandstone
85			X	S	49-50/8"					
90										Auger stopped @ 85' Sampler retracted @ 85'6"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

*SAMPLE TYPE
 A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.

SERGENT, HAUSKINS & BECKWITH
 CONSULTING GEOTECHNICAL ENGINEERS

PROJECT Spring
 JOB NO. 121 DATE 11/17/91

LOG OF TEST BORING NO. 121

RIG TYPE CME-55 #203
 BORING TYPE 6 3/8" HPA
 SURFACE ELEV. _____
 DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		23"	X	u	2-10-22-23-31			SP	moist mod firm	SAND No PF. w/ky cemented DIC 5KN to 6KN
5		23"	X	u	17-16-14-10-11					
		20"	X	u	15-9-11-10-14					
		22"	X	u	10-7-9-10-12					
10		22"	X	u	9-8-10-9-11					
		21"	X	u	7-6-5-7-9					
15		20"	X	u	12-21-11-10-12					
		21"	X	u	6-7-8-8-10					
20		23"	X	u	7-7-5-7-10					
		22"	X	u	8-9-10-11-13					
25		20"	X	u	9-9-9-9-11					
		24"	X	u	11-11-12-12-15					
30		20"	X	u	11-13-11-14-15					
		18"	X	u	24-17-15-15-16					
35		18"	X	u	9-10-13-12-13					
		22"	X	u	16-17-20-22-25				V. firm	
40		21"	X	u	12-15-15-18-22					
		16"	X	u	8-16-17-21-22					
45		21"	X	u	16-12-14-19-23				V. moist	
			X	u	12-16-17-16-19					

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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PROJECT Spork
JOB NO. Ext-237 DATE 11/17/81

LOG OF TEST BORING NO. 7027

RIG TYPE CRIE-65 #203
BORING TYPE 6 1/2" H-SP
SURFACE ELEV. _____
DATUM _____

Borehole No.		DATE		RIG TYPE		BORING TYPE		SURFACE ELEV.		DATUM	
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION	
5		21"	X	4	11-17-15-16-17						
		23"	X	4	18-18-16-23-50				HARD	TAILINGS SUBBASE	
55			X	5	42-50/4"				dry	SAND med. cementation NO PT. TAN to Lt brown	
			X	5	50/3"						
60											
65											
70											

Aug 11 stoped @ 57 1/2' sample @ 57' 0" 44 6 10 2 2'

GROUND WATER		
DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
S - 2" O.D. 1.38" I.D. tube sample. =
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.



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PROJECT Spook Tailings
 JOB NO. EQ1-621 DATE 11/20/81

LOG OF TEST BORING NO. A30

Depth in Feet	Continuous Penetration Reference	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0								SC
		25"	X	u	14-11-14-18			
		22"	X	u	12-13-13-12-13			
5		24"	X	u	8-8-11-11-12			
		20"	X	u	5-4-4-5-8			
10		20"	X	u	9-9-12-12-13			
		20"	X	u	9-9-8-8-9			
15		20"	X	u	10-7-9-9-13			
		20"	X	u	7-5-6-7-8			
20		20"	X	u	9-6-7-10-10			
		20"	X	u	9-7-8-11-12			
25		20"	X	u	5-20-12-10-14			
		21"	X	u	15-14-17-17-23			
30		20"	X	u	17-13-16-17-32			
		20"	X	u	21-19-25-18-24			
35		20"	X	u	21-15-17-23-31			
		20"	X	u	27-24-26-23-20			
40		20"	X	u	12-16-22-24-31			
		20"	X	u	28-2-34-29-26			
45		21"	X	u	15-16-21-24-31			
		20"	X	u	18-23-28-31-39			
50								

RIG TYPE CME TS (200) CC
 BORING TYPE 6 1/2" HSA
 SURFACE ELEV. _____
 DATUM _____

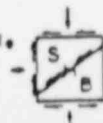
REMARKS	VISUAL CLASSIFICATION
moist	Clayey Sand pred. medium grained medium PI brown

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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PROJECT Sprock Tailings
 JOB NO. EP-14-31 DATE 11/20/81

LOG OF TEST BORING NO. A30
 SN 20
 ZF 2

RIG TYPE CMS 75(206) CC
 BORING TYPE 6 1/2" HSA
 SURFACE ELEV. _____
 DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Melature Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50			20'	U	14-20-31-31					
			16'	U	27-21-31-38-40					
55			20'	U	14-22-24-31-42					
			NR	U	[50/0]				dry	to large subgrade Sandstone
60			NR	S	[50/0]					Auger stopped @ 60' Sample refused @ 60'
65										
70										
75										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.

SERGEANT, HAUSKINS & BECKWITH
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RIG TYPE API 55 H 203 (SPS)
BORING TYPE GL HCH
SURFACE ELEV. _____
DATUM _____

TAILINGS
SUBBASIN

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DURAN & ALBUQUERQUE, S.A. S.C.

RIG TYPE CIM-55 #203
BORING TYPE 6 1/2" HST
SURFACE ELEV. _____ 4'
DATUM _____

DEPTH	HOUR	DATE

A - Auger cuttings. B - Block sample
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled 5/8" x tube.



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PROJECT Spook Tailings
 JOB NO. E91-621 DATE 11/20/81

LOG OF TEST BORING NO. 833

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0			25"	X	41-8-15-20-34			SC
5			X		49-37-46-50/5"			
			X		49-50/4"			CL
10								
15								
20								
25								

RIG TYPE CME 75(200) CP
 BORING TYPE 6 1/2" HSA
 SURFACE ELEV. _____
 DATUM _____

REMARKS	VISUAL CLASSIFICATION
	Clayey Sand pred. medium grained medium PL tailings s. base
	Sandy Clay Lo PL tan
	Auger stopped @ 7 1/2' Sampler refused @ 8'

GROUND WATER

DEPTH	HOUR	DATE
<u>None</u>		

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 2" O.D. thin-walled Shelby tube.



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PROJECT Spork Tailings
 JOB NO. ECI-63 I DATE 12/11/81-12/17/81

LOG OF TEST BORING NO. 434
 18-2

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0			24"	u	22-19-11-12-14			SC
5			20"	u	9-7-11-14-13			
			20"	u	6-4-5-4-5			
10			24"	u	3-3-3-2-3			
			20"	u	3-4-5-4-5			
15			20"	u	3-3-3-3-4			
			20"	u	6-7-6-12-12			
20			21"	u	6-7-6-5-6			
			20"	u	7-6-8-9-8			
25			20"	u	7-5-6-7-9			
			20"	u	7-6-7-7-14			
30			20"	u	7-12-17-9-8			
			20"	u	8-9-9-12-13			
35			21"	u	17-15-16-17-17			
			20"	u	7-6-9-10			
40			20"	u	9-11-11-16-14			
			20"	u	9-9-10-12-16			
45			20"	u	12-9-12-11-12			
			20"	u	12-10-10-11-22			
50			20"	u	9-9-12-14-21			

RIG TYPE CME 75 (206) CC
 BORING TYPE 6 1/2" AISA
 SURFACE ELEV. _____
 DATUM _____

REMARKS	VISUAL CLASSIFICATION
moist	Clayey Sand pred. medium grained medium to ck, brown

GROUND WATER		
DEPTH	HOUR	DATE

SAMPLE TYPE
 A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.

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DATUM

CONSULTING GEOTECHNICAL ENGINEERS
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Aggr stopped @ 90'
Sample returned
@ 94'5"

PROJECT Spook
 OB NO. 41-622 DATE 12/1/91

LOG OF TEST BORING NO. 035

RIG TYPE CME-55 #203
 BORING TYPE 1 1/2" D.C.
 SURFACE ELEV. _____
 DATUM _____

Depth In Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		24"	X		3-3-2-2-2			SP	moist soil	SAND loosely cemented 100% F.I. 1/2" brn - 1/2" brn concrete grained
5		27"	X		6-7-11-14-14-18					
		NR	X		49-50 1/2" (NR)					
10		22"	X		6-14-15-15-17					
		22'	X		8-7-6-6-8					
15		21"	X		4-12-11-10-9-11			SC		loose, SAND loosely cemented 100% F.I. 1/2" - 1/2" brn
		22"	X		6-1-5-17-11-15				11. moist	
		21"	X		4-19-27-50-50 1/2"				11. ref.	
20										Auger stopped @ 15.0 sampler refusal @ 19'5"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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DATE 17/3/21

LOG OF TEST BORING NO B736

RIG TYPE CME 55 # 203

BORING TYPE 6' 1/2" LSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		8"	X	U	28-50/5"			SP	indist	SAND slightly cemented No F ₂₀ congr. grained (K _h low to brn)
5		20	X	U	20-11-14-11/1			(SI)		
		18	X	U	13-10-10-10-B					TAILINGS
		11	X	U	13-2-24-50/4"					trace of organics Note: SAND changing to trivulgar and more uniform grain size
10										Auger stopped @ 7 1/2' Sample refused @ 9' 10"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A = Auger cuttings. B = Block sample.
S = 2" O.D. 1.38" I.D. tube sample.
U = 3" O.D. 2.42" I.D. tube sample.
T = 3" O.D. thin-walled Shelby tube.



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LOG OF TEST BORING NO. 0037

RIG TYPE CAT 330
BORING TYPE 6 1/2" HSA
SURFACE ELEV. _____
DATUM _____

GROUND WATER		
DEPTH	HOUR	DATE

A - Auger cuttings. B - Block sample.
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.



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LOG OF TEST BORING NO. 0538

RIG TYPE CR11-55 #203
BORING TYPE 1.5" DIA
SURFACE ELEV. _____
DATUM _____

REMARKS	VISUAL CLASSIFICATION
moist mud fine	SANDS w/ly cemented NO P.I. coarse grained dk brn to brn
fin hard	TAICID 65 SUBBASE - heavy sand Low P.I. w/ly cemented L brn to tan
	Auger stopped @ 15.0' sample @ 25.0'

SAMPLE TYPE
 A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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LOG OF TEST BORING NO. D039[illegible]

VISUAL CLASSIFICATION

SAD
w/ly comatd
no P.F.
coast guard
dk ben to ben

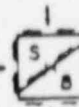
tailings
subbits

clayey, sand
with cemented
low p2.
be to tan

Auger depth @ 5.0
samples @ 25.0'

DEPTH	HOUR	DATE

A = Auger cuttings. B = Block sample
S = 2" O.D. 1.38" I.D. tube sample.
U = 3" O.D. 2.42" I.D. tube sample.
T = 3" O.D. thin-walled Shelby tube.



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B NO.		DATE		RIG TYPE		BORING TYPE		SURFACE ELEV.		DATUM	
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION	
0		24"			44-50/4"			SP	inst	hms	SAND Wtly cemented NO P.I. coarse grained All brn to brn
5		7"			23-50/3"			SP	diag		+TAILINGS subbase
10											SAND and cementations NO P.I. brn to brn
15											Auger stopped @ 5.5' sample refusal @ 5'8"
20											

PROJECT SP-200
 JOB NO. ES-1-6-2-1 DATE 12/3/41

LOG OF TEST BORING NO. B041

RIG TYPE Q-100 55" 200
 BORING TYPE 6 1/2" HSA
 SURFACE ELEV. _____
 DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		26"	X	7	5 1/2			SP	12' 1/2" 10' 1/2" 10' 1/2"	SAND w/ky cemented NO P.T. COARSE GRAINED dk brown to black
5		24"	X	5	5-6-5-7-4			SB2	5' 1/2" 5' 1/2" 5' 1/2"	SAND w/ky cemented NO P.T. well graded (fine)
10		15"	X	5	2-10-12-13-50 1/2				10' 1/2" 10' 1/2" 10' 1/2"	
15										auger stopped @ 50' sample started @ 100'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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PROJECT Spunk
 JOB NO. 131-771 DATE 6/3/21

LOG OF TEST BORING NO. 8042

RIG TYPE CIM 55 #203
 BORING TYPE 6" DIA
 SURFACE ELEV. _____
 DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0										
		22'	X		14-20	14-15	32	SP	moist clay	clay, cemented
		18'	X		19-16	15-16	TL			no FT - coarse grained in blocks etc
5		21'			16-15	16-15	TL			
		18"			6-5	4-3	4			
10										
		18'			2-3	5-5	8	SU		SPND well graded - ALL 100% sand
		16"	X		1-7	2-2	3 1/2		fine sand	no FT - 100% sand
15										Auger stopped @ 5.0' sampler refused @ 14' 3"
20										
25										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE
 A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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PROJECT Sanon
 JOB NO. 2457 DATE 12/3/31

LOG OF TEST BORING NO. 8043

RIG TYPE CR-55-203
 BORING TYPE 1 1/2" A
 SURFACE ELEV. _____
 DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		24" X		U	9-15-17-37-46			SP	moist	SPH
		14" X		U	43-46-50/53 1/4"					wildy cemented
5		15" X		U	7-12-14-50/64"			30	here	110 P.T.
										- coarse grained
										st & nodules
10										741 No 5
										subgrade
										SPH
										well graded
										no. 5
										to 4 ft
15										Auger stopped at 3.0'
										may be refect @ 6' 1 1/2"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 W - 3" O.D. 1.5" I.D. tube sample.

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PROJECT San Juan
 JOB NO. 7-4 DATE 7-4

LOG OF TEST BORING NO. A044

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0		27"			30-50-26-27-40			SW
		8"			46-50/2			
5								
10								
15								
20								

RIG TYPE Open pit
 BORING TYPE Hand
 SURFACE ELEV. 1000
 DATUM 1000

REMARKS	VISUAL CLASSIFICATION
Hand no well graded fine to med	no well graded fine to med
	sample removed at 3'2"
	[concrete at that depth]

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 1" O.D. thin-walled Shelby tube.



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PROJECT Spook
 JOB NO. E-1-25 DATE 12-1-18

LOG OF TEST BORING NO. C-15

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0								SP
		21"	X	4	12-13-17-21-27			
		22"	X	6	28-16-19-15-3			SD
5		21"	X	4	10-5-6-7-5			
		19"	X	6	6-7-8-13-12			
10								
15								
20								

RIG TYPE OP-1 55' 203
 BORING TYPE 1.5" I.D.
 SURFACE ELEV. _____
 DATUM _____

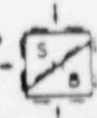
REMARKS	VISUAL CLASSIFICATION
min. 1 in.	fine dry cemented no p.z. hard, granular siliceous
1 in.	SAND silty cemented no p.z. hard to 4 lb
	sample stopped @ 10.0'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



SERGEANT, HAUSKINS & BECKWITH
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PROJECT 22001
 JOB NO. 19 DATE 12/14/21

LOG OF TEST BORING NO. 0047

RIG TYPE CR-55 H-203
 BORING TYPE SP
 SURFACE ELEV. 5' N of SP-25
 DATUM 5' N of SP-25

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free fall drop hammer	Dry Density Lbs. per cu. ft.	Molature Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
26"					42-210-77-14-20			SP	moist	fine silty sand
23"					11-11-15-16-35					fine silty sand
22"					9-16-17-16-22					fine silty sand
17"					14-14-16-16-32					fine silty sand
22"					20-15-18-18-19			SLC		fine silty sand
18"					22-14-11-11-15					fine silty sand
19"					5-16-7-7-11					fine silty sand

FAILURES
 subbase

sample at 15.0'
 sample at 17.6'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE
 A - Auger cuttings. B - Block sample.
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.

PROJECT 5751
 JOB NO. _____ DATE _____

LOG OF TEST BORING NO. 2048

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Melchior Content Per Cent of Dry Wt.	Unified Soil Classification
0		24"	✓		4-3	3-2-4		SW
5		23"	✓		5-7	7-6-8		
		23"	✓		4-3	1-1-6		
10		19"	✓		5-6	8-9-11		
		21"	X		12-10	8-9-12		
15		23"	X		4-16	17-18-17-17		SW
		23"	X		4-4	5-6-7		
20		21"	X		4-7	5-10-7		

RIG TYPE _____
 BORING TYPE _____
 SURFACE ELEV. 4' 5" 0" 27.77
 DATUM _____

REMARKS	VISUAL CLASSIFICATION
	1.11D not cemented fine grained to brown blue
	typical silts
dry	1.11D not cemented fine grained to brown blue
	Auger dropped @ 15.5' sample @ 20.5'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. 1.38" I.D. Shelby tube.

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LOG OF TEST BORING NO. B049

RIG TYPE Oil 25 203
BORING TYPE 2 1/2 in
SURFACE ELEV. _____
DATUM 65' 54" of 317.22

GROUND WATER		
DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample.
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.47" I.D. tube sample.



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PROJECT San Antonio
 JOB NO. FB-1-122 DATE 12/4/91 - 12/5/91

LOG OF TEST BORING NO. A 50
142

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0		24"	U	23-30-23-20-27	SC		
5		20"	U	23-22-20-17-19			
10		20"	U	8-5-4-3-4			
		21"	U	4-3-4-5-6			
		21"	U	6-5-6-9-11			
15		23"	U	7-4-5-4-6			
		22"	U	7-5-5-8-8			
		22"	U	5-4-5-5-7			
20		22"	U	7-4-7-9-9			
		21"	U	5-6-6-9-10			
25		22"	U	12-17-13-9-15			
		22"	U	13-20-14-12-19			
30		21"	U	12-20-18-15-19			
		22"	U	20-17-17-17-19			
35		21"	U	13-7-9-10-20			
		20"	U	14-17-20-21-19			
40		20"	U	10-13-18-24-34			
		20"	U	17-27-20-19-31			
45		21"	U	20-20-31-24-30			
50		20"	U	20-20-20-29-24			

RIG TYPE CME 75 (200) CC
 BORING TYPE 6 1/2" HSA
 SURFACE ELEV. _____
 DATUM _____

REMARKS	VISUAL CLASSIFICATION
moist	Clayey Sand pred. med. grained med PL clay brown

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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PROJECT Sprink Tailing
JOB NO. EP1021 DATE 12/4/81-12/5/81

LOG OF TEST BORING NO. ASD
242

RIG TYPE CHIEF TS (206) CC
BORING TYPE 6" 2" LISA
SURFACE ELEV. _____
DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50		20"	U	12	27-10	21-24	32			
		20"	U		20-20	24-22	39			
55		21"	U		24-28	21-23	27			
		20"	U		4-21	21-21	27			
60		22"	U		25-26	38-20	37			
		21"	U		15-20	23-28	50			
65		22"	U		12-15	20-33	33			
		20"	U		15-30	30-34	36			
70		20"	U		10-11	24-27	26			
		20"	U		16-18	22-25	20			
75		20"	U		9-19	23-21	23			
		20"	U		8-15	16-40	40			
80		17"	U		17-21	28-25	41			
		3"	U		[50/1 1/2]					
85										
90										

tailing
subbase
sandstone

Auger stopped @ 80'
Sampler retracted
@ 82' 11 1/2"

GROUND WATER		
DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE
A - Auger cuttings. B - Block sample
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin walled Shelby tube.



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PROJECT Synak
 JOB NO. 181-637 DATE 12/4/91

LOG OF TEST BORING NO. B051

RIG TYPE CME 55 #203
 BORING TYPE 6.5" HSA
 SURFACE ELEV. _____
 DATUM 5' E of SP-20

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0		24'	X		15-40-30-27-30			ST
5		23'	X		39-24-23-24-25			SW
		21'	X		14-11-8-8-6			
		23'	X		14-10-30-30-30			

REMARKS	VISUAL CLASSIFICATION
moist medium	CLAY not cemented not graded to 1/2" bls
	TAILINGS SUBBASE
light	CLAY not cemented not graded to 1/2" bls
	Auger stopped @ 2' 1/2" sample refusal @ 9' 5 1/2"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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PROJECT Drank
 JOB NO. 7-1-63

DATE 12/11/61

LOG OF TEST BORING NO. 8032

RIG TYPE CME-EE-H202
 BORING TYPE 1-1/2" HCA
 SURFACE ELEV. _____
 DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		28"	X	11	24-30-24-20-50/5P				moist h ACO	SAND lightly cemented 10% F.T. coarse grained little bit
5		21"	X	1	36-40-43-19-20					
		21"	X	1	10-7-11-11-21			SUS		
		12"	X	1	40-50/5"				dry	SAND 10% F.T. lightly cemented well graded low to 10 blow
10										prop. sheet @ 2 1/2' sample alluvial @ 8' 5"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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PROJECT Spink
 JOB NO. 91-237 DATE 12/11/81

LOG OF TEST BORING NO. 253

RIG TYPE CMT-55 #203
 BORING TYPE 6" HSA
 SURFACE ELEV. _____
 DATUM _____

NO.									RIG TYPE		BORING TYPE		SURFACE ELEV.		DATUM	
Depth in Feet.	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION						
0		9	X	42-54/5				SP	11.5 ft	hard	SAND lightly cemented NO P.T. coarse grained fine to medium					
5		23		16-18-27-15-5/5				SW	4.8		SAND lightly cemented NO P.T. well graded fine to medium					
		18		16-12-34-50/5							Auger stopped @ 2' h' sample refused @ 7' 5" (refused on sandstone)					

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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PROJECT Squad
 JOB NO. 101 DATE 11/10/51

LOG OF TEST BORING NO. 3054

RIG TYPE Cantilever
 BORING TYPE Hand
 SURFACE ELEV. 100.00
 DATUM 100.00

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0							ST
1							50/5
2							50/5
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
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21							
22							
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37							
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39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

REMARKS	VISUAL CLASSIFICATION
Hand 11-12 118	SAND w/ly cemented NO FT. course grained dk brown to black tailings substance
	SAND w/ly cemented fine light brown dark : red soil mat - 11/10/51
	pipe stopped @ 2 1/2' casing removed @ 3 5'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE
 A - Auger cuttings. B - Block sample.
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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LOG OF TEST BORING NO. A-55

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb., 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
1		26"			13-14	133	27.36	SP

VISUAL CLASSIFICATION

100 ft. H.A. 2 SAND
 mostly cemented
 no pit.
 - some gravel
 in pits to 100 ft.

100 ft. TALLINGS
 subbase

100 ft. SAND
 mostly cemented
 to 100 ft.

100 ft. FLATS
 mostly cemented in the
 center - and some in the
 center

sample of 26

DEPTH	HOUR	DATE

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PROJECT Spont
 JOB NO. 7516 DATE 12-22

LOG OF TEST BORING NO. 1056

RIG TYPE 1165 55 1000 3 4 (n/2 75(200) cc
 BORING TYPE 100 100
 SURFACE ELEV. _____
 DATUM _____

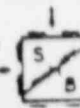
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0										
		24"	X	4	17-20	13-15	21	SI		SNND
		26"	X	4	14-20	12-16	75			11797
5		24"		4	17-5-4-5-8					only cemented
		22"		4	5-4-6-5-5					very hard
10		21"		4	5-5-5-5-7					1 found in
		20"		4	4-4-4-3-6					
15		21"		4	3-3-3-3-4					
		23"		4	5-4-7-5-2					
20		24"		4	5-6-5-5-9					
		25"		4	6-5-5-6-8					
25		22"		4	7-6-7-7-10					
		23"	X	4	10-8-7-10-14					
30		24"		4	12-11-12-8-12					
		22"		4	13-12-14-21-14					
35		23"	X	4	13-14-13-18-20					
		22"	X	4	13-14-13-15-15					
40		22"	X	4	16-7-16-11-13					
		21"	X	4	14-13-14-12-25					
45		23"	X	4	17-17-17-20-21					
		24"	X	4	15-14-17-22-28					

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A - Auger cuttings. B - Block sample
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.



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$$\frac{2}{27}$$

CONSULTING GEOTECHNICAL ENGINEERS
DUBOIS & ALBUQUERQUE, SANTA FE

talang
subbase
Sandstone

Aggs stopped @ 78'
Samples returned @
77 1/2'

GEOTECHNICAL DATA

TAC Borehole and Test Pit Logs

Reference 1

LOG OF TEST PIT NO. 031

Backhoe Type INT'L. 260-A

Location N 57,941.6 E 59,544.0

Elevation 5029.7

Datum MSL[illegible]

D-71

LOG OF TEST PIT NO. 033

18 NO. _____ DATE 02/17/87Backhoe Type INT'L. 260-A

Location N 57,852.3 E 59,322.1

Elevation 5026.8

Datum MSL

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	GROUND WATER			Backhoe Type	INT'L. 260-A	
						DEPTH	HOUR	DATE	Location	N 57,852.3	E 59,322.1
0					SM	DR		2/17/87	Elevation	5026.8	
									Datum	MSL	
						REMARKS			VISUAL CLASSIFICATION		
						Moist			Silty, fine to medium sand, occasional cobbles brown, PIT FILL		
5									Sandstone Bedrock		

TE 02/17/87

LOG OF TEST PIT NO. 034

Backhoe Type INT'L. 260-A

Location N 57,694.4 E 59,340.4

Elevation 5015.9

Datum MSL

[illegible]

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

FIGURE D.4.1.B
TEST PIT LOGS

D-72

OBJECT SPK-01
 B NO. DATE 02/17/87

LOG OF TEST PIT NO. 035

Backhoe Type INT'L. 260-A
 Location N 57,607.8 E 59,205.0
 Elevation 5021.6
 Datum MSL

DEPTH (ft)	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	GROUND WATER	
						DEPTH	MOOR DATE
						DRY	2/17/87
REMARKS						VISUAL CLASSIFICATION	
0					SM	Moist	Silty, fine to medium sand, occasional cobble size rock fragments, brown PIT FILL.
5		X D	12.0			Dry unit weight (104.1 pcf)	
					SP-SM	Moist	Fine to medium sand, some silt, occasional rock fragments and boulders, light brown, PIT FILL.
		X D	8.8				
10							Sandstone Bedrock.

E 02/17/87

LOG OF TEST PIT NO. 036

Backhoe Type INT'L. 260-A
 Location N 58,262.4 E 59,588.4
 Elevation 5012.3
 Datum MSL

DEPTH (ft)	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	GROUND WATER	
						DEPTH	MOOR DATE
						DRY	2/17/87
REMARKS						VISUAL CLASSIFICATION	
0					SM	Moist	Silty, fine to medium sand, occasional rock fragments and boulders, grayish brown, PIT FILL.
5		X D					
		X D					
		X D	10.0			Dry unit weight (101.1 pcf)	
		X D					
10							Sandstone bedrock

SAMPLE TYPE
 B — Undisturbed Block Sample
 D — Disturbed Bulk Sample

FIGURE D.4.1.C
 TEST PIT LOGS

PROJECT SPK-01
 OB NO. _____ DATE 02/17/87

LOG OF TEST PIT NO. 037

Backhoe Type INT'L. 260-A
 Location N 58,341.6 E 59,766.2
 Elevation 5011.8
 Datum MSL

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	GROUND WATER	
						DEPTH	DATE
						13.0	2/17/87
REMARKS						VISUAL CLASSIFICATION	
0					SP-SM	Moist	Fine to medium sand, some silt, occasional cobbles, brown, PIT FILL.
		D					
		D					
5		D		6.5			
		D					
10							
		D		17.1			
15						WET	
							Sandstone Bedrock

DATE 02/17/87

LOG OF TEST PIT NO. 038

Backhoe Type INT'L. 260-A
 Location N 58,213.6 E 59,750.3
 Elevation 5025.2
 Datum MSL

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	GROUND WATER	
						DEPTH	DATE
						DRY	2/17/87
REMARKS						VISUAL CLASSIFICATION	
0					SM	Moist	TAILINGS, silty, fine to medium sand, brown.
		D		9.5			
5							
							Stopped at 4.0"

SAMPLE TYPE
 B - Undisturbed Block Sample
 D - Disturbed Bulk Sample

FIGURE D.4.1.D
 TEST PIT LOGS D-74

LOG OF TEST PIT NO. 039

Backhoe Type INT'L. 260-A

Location N 57,082.8 E 59,685.1

Elevation 5039.2

Datum MSL [illegible]

TE 02/18/87

LOG OF TEST PIT NO. 040

Backhoe Type INT'L. 260-A

Location N 58,025.7 E 59,590.8

Elevation 5028.8

Datum MSL[illegible]

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

FIGURE D.4.1.E
TEST PIT LOGS

D-75

PROJECT SPK-01
 JOB NO. DATE 02/18/87

LOG OF TEST PIT NO. 041

Backhoe Type INT'L. 260-A
 Location N 57,909.7 E 59,762.0
 Elevation 5048.7
 Datum MSL

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	GROUND WATER			REMARKS	VISUAL CLASSIFICATION
						DEPTH	HOUR	DATE		
0					SM				Moist	TAILINGS, silty, fine to medium sand, trace coarse sand and gravel, brown. Dry unit weight (100.8 pcf) Stopped at 3.0'
5										

DATE 02/18/87

LOG OF TEST PIT NO. 042

Backhoe Type INT'L. 260-A
 Location N 57,797.8 E 59,563.1
 Elevation 5059.2
 Datum MSL

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	GROUND WATER			REMARKS	VISUAL CLASSIFICATION
						DEPTH	HOUR	DATE		
0					SM				Moist	Silty, fine to medium sand, trace to some gravel to boulders, gray and brown, PIT FILL. Dry unit weight (108.5 pcf) Stopped at 15.0'
5										
10										
15										

SAMPLE TYPE
 B - Undisturbed Block Sample
 D - Disturbed Bulk Sample

FIGURE D.4.1.F
 TEST PIT LOGS

PROJECT SPR-01
 DATE 02/18/87

LOG OF TEST PIT NO. 043

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0					SM
5		X	D	12.9	
10			D		
15					

GROUND WATER		
DEPTH	HOUR	DATE
DRY		2/18/87

REMARKS	VISUAL CLASSIFICATION
Moist	TAILINGS, silty, fine to medium sand, trace gravel, brown.
Dry unit weight (123.9 pcf)	
	Stopped at 13.5'

DATE 02/18/87

LOG OF TEST PIT NO. 044

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0					SM
5		X	D	10.9	
10			D		
15					

GROUND WATER		
DEPTH	HOUR	DATE
DRY		2/18/87

REMARKS	VISUAL CLASSIFICATION
Moist	TAILINGS, silty, fine to medium sand, trace gravel, brown.
Dry unit weight (114.3 pcf)	
	Rubber and cardboard fragments.
	Stopped at 14.5'

SAMPLE TYPE

- B — Undisturbed Block Sample
- D — Disturbed Bulk Sample

FIGURE D.4.1.G
 TEST PIT LOGS

PROJECT SPK-01
 B NO. DATE 02/18/87

LOG OF TEST PIT NO. 045

Backhoe Type INT'L. 260-A

Location N 58,279.9 E 60,150.1

Elevation 5110.3

Datum MSL

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	GROUND WATER			Backhoe Type	INT'L. 260-A		
						DEPTH	HOUR	DATE	Location		N 58,279.9 E 60,150.1	
						DRY		2/18/87	Elevation		5110.3	
									Datum		MSL	
						REMARKS	VISUAL CLASSIFICATION					
0					St.	Moist	TAILINGS, silty, fine to medium sand, trace gravel, brown.					
5				12.9		Dry unit weight (129.9 pcf)						
10												
</												

DATE 02/18/87

LOG OF TEST PIT NO. 046

Backhoe Type INT'L. 260-A

Location N 58,941.8 E 61,182.6

Elevation 5080.9

Datum MSL

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	GROUND WATER			Backhoe Type		INT'L. 260-A	
						DEPTH	HOUR	DATE	Location		N 58,941.8 E 61,182.6	
						DRY		2/18/87	Elevation		5080.9	
									Datum		MSL	
						REMARKS			VISUAL CLASSIFICATION			
					SM-MI	Moist			Fine to medium sand and clayey silt, low plasticity, brown.			
			D	13.4								
					SM	Moist			Silty, fine to medium sand, trace coarse sand and gravel, gray and brown.			
			D	10.1								
			D	11.4								

LOG OF TEST PIT NO. 047

Backhoe Type INT'L. 260-A

Location N 57,754.3 E 60,002.4

Elevation 5133.8

Datum _____ MSL _____

GROUND WATER		
DEPTH	MOUR	DATE
DRY		2/19/67

Depth in Feet	Gravel/Shell Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	GROUND WATER			Backhoe Type	INT'L. 260-A
						DEPTH	HOUR	DATE	Location	N 57,754.3 E 60,002.4
						DRY		2/19/87	Elevation	5133.8
									Datum	MSL
						REMARKS	VISUAL CLASSIFICATION			
0					SM	Moist	Silty, fine to medium sand, some clay, non-plastic, brown.			
5						Dry unit weight (109.3 pcf)				
10							Clay grades out.			
							Trace coarse sand and gravel			
15							Stopped at 14.5'			

TE 02/19/87

LOG OF TEST PIT NO. 046

Backhoe Type INT'L 260-A

Location N 57,557.5 E 60,082.9

Elevation 5129.7

Datum MSL

GROUND WATER		
DEPTH	HOUR	DATE
DRY		2/19/87

Depth in Feet		Geophysical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	GROUND WATER		Backhoe Type	INT'L. 260-A	
							DEPTH	HOUR	DATE	Location N 57,557.5 E 60,082.9	
							DRY		2/19/67	Elevation 5129.7	
										Datum MSL	
							REMARKS		VISUAL CLASSIFICATION		
0						SP-SM	Moist		Fine to medium sand, some silt, trace coarse sand and gravel, occasional cobbles and boulders, yellowish brown and gray.		
5					8.8		Dry unit weight (98.8 pcf)				
10									Stopped at 14.0'		

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

FIGURE D.4.1.1

D-79

PROJECT SPK-01
 DB NO. _____ DATE 02/19/87

LOG OF TEST PIT NO. 049

Backhoe Type INT'L. 260-A
 Location N 57,077.2 E 59,508.9
 Elevation 5149.2
 Datum MSL

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	GROUND WATER	
						DEPTH	MOURE DATE
						DRY	2/19/87
REMARKS						VISUAL CLASSIFICATION	
5				6.7	SP-SM	Moist	Fine to medium sand, some silt, trace gravel, occasional cobbles and boulders, yellowish brown.
						Dry unit weight (111.8 pcf)	
10							
				7.6			
15							Stopped at 14.0'

DATE 02-19-87

LOG OF TEST PIT NO. 050

Backhoe Type INT'L. 260-A
 Location N 56,487.8 E 60,103.9
 Elevation 5123.4
 Datum MSL

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	GROUND WATER	
						DEPTH	MOURE DATE
						DRY	2/19/87
REMARKS						VISUAL CLASSIFICATION	
0					SP-SM	Moist	Fine to medium sand, some silt, trace gravel, occasional cobbles and boulders, yellowish brown.
5				6.9		Dry unit weight (112.2 pcf)	
10							Large Boulder (>6') Stopped at 8.5'

SAMPLE TYPE
 B - Undisturbed Block Sample

FIGURE D.4.1.J

GEOTECHNICAL DATA

TAC Laboratory Test Results

Reference 1

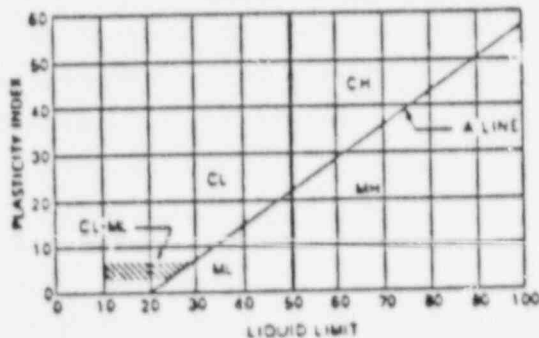
UNIFIED SOIL CLASSIFICATION SYSTEM

Soils are visually classified by the Unified Soil Classification system on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System" Corp of Engineers, US Army Technical Memorandum No. 3-357 (Revised April 1960) or ASTM Designation D2487-66T.

MAJOR DIVISIONS				GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GP	Poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		CM	Silty gravels, gravel-sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)			SW	Well graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SP	Poorly graded sands, gravelly sands.
			Limits plot above "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS (Liquid Limit Less Than 50 and Plasticity Less Than 7)	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50)			MH	Inorganic silts, micaceous or diatomaceous silty silts, elastic silts.
	CLAYS (Liquid Limit More Than 50 and Plasticity Greater Than 7)	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sand-clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50)			CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity.

NOTE: Coarse grained soils with between 5% & 12% passing the No. 200 sieve and fine grained soils with limits plotting in the hatched zone on the plasticity chart to have double symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Cobbles	Above 3 in.
Gravel	3 in. to No. 4 sieve
Coarse gravel	3 in. to 1/2 in.
Fine gravel	1/2 in. to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

FIGURE D.4.1.K
UNIFIED SOIL CLASSIFICATION SYSTEM

LOCATION ID: 031

SAMPLE ID: 01

DEPTH INTERVAL (FT): 2.5 - 3.0

UNIFIED SOIL CLASSIFICATION: GP-GM

GRAVEL (%): .0

SAND (%): 91.0

#200 SIEVE (% FINER): 9.0

DATE: 5/21/87

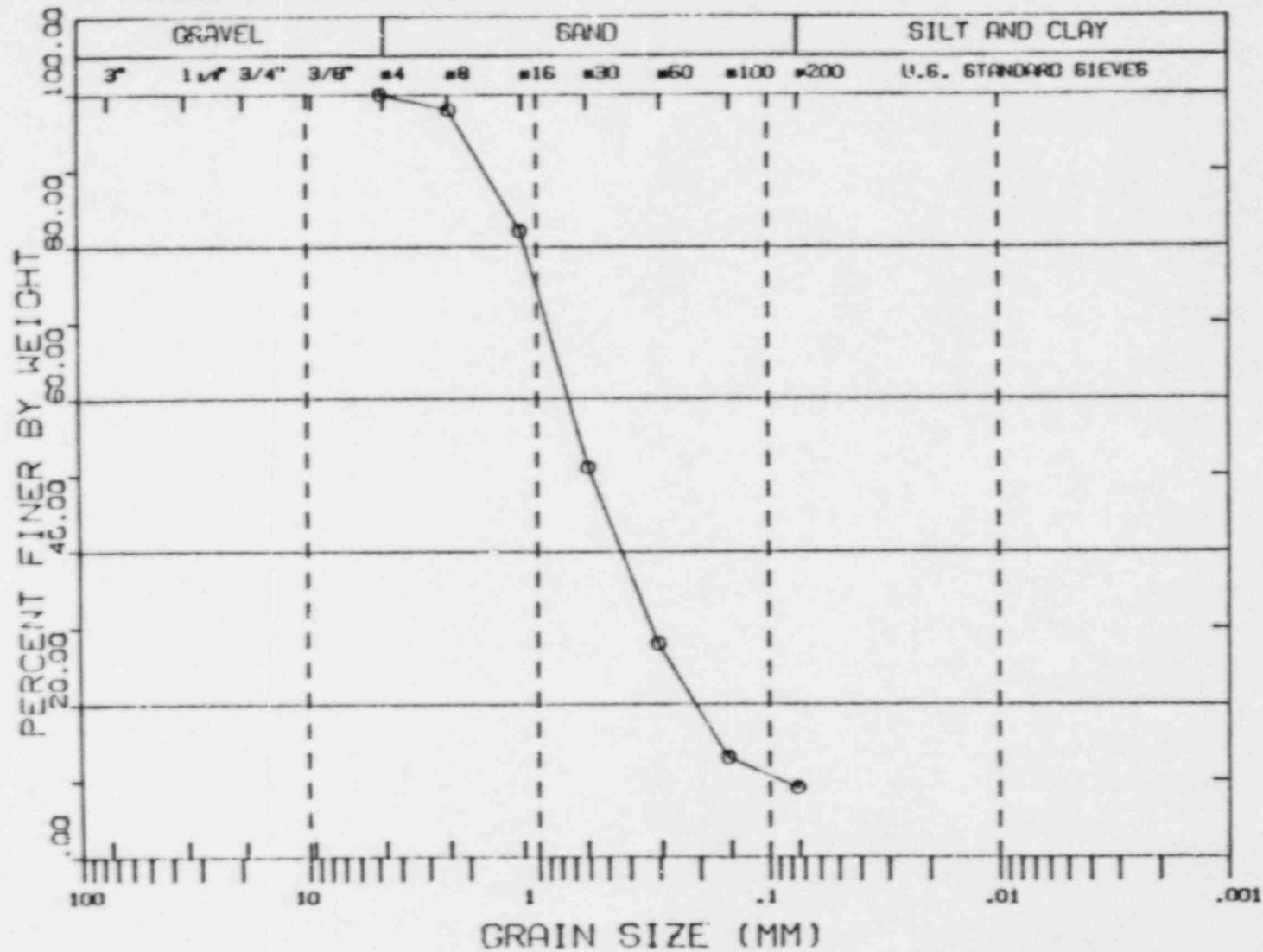


FIGURE D.4.2.A
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 031

SAMPLE ID: 02

DEPTH INTERVAL(FT): 4.5 - 5.0

UNIFIED SOIL CLASSIFICATION: GM

GRAVEL(%): .0

SAND(%): 78.0

#200 SIEVE(% FINER): 22.0

DATE: 5/21/87

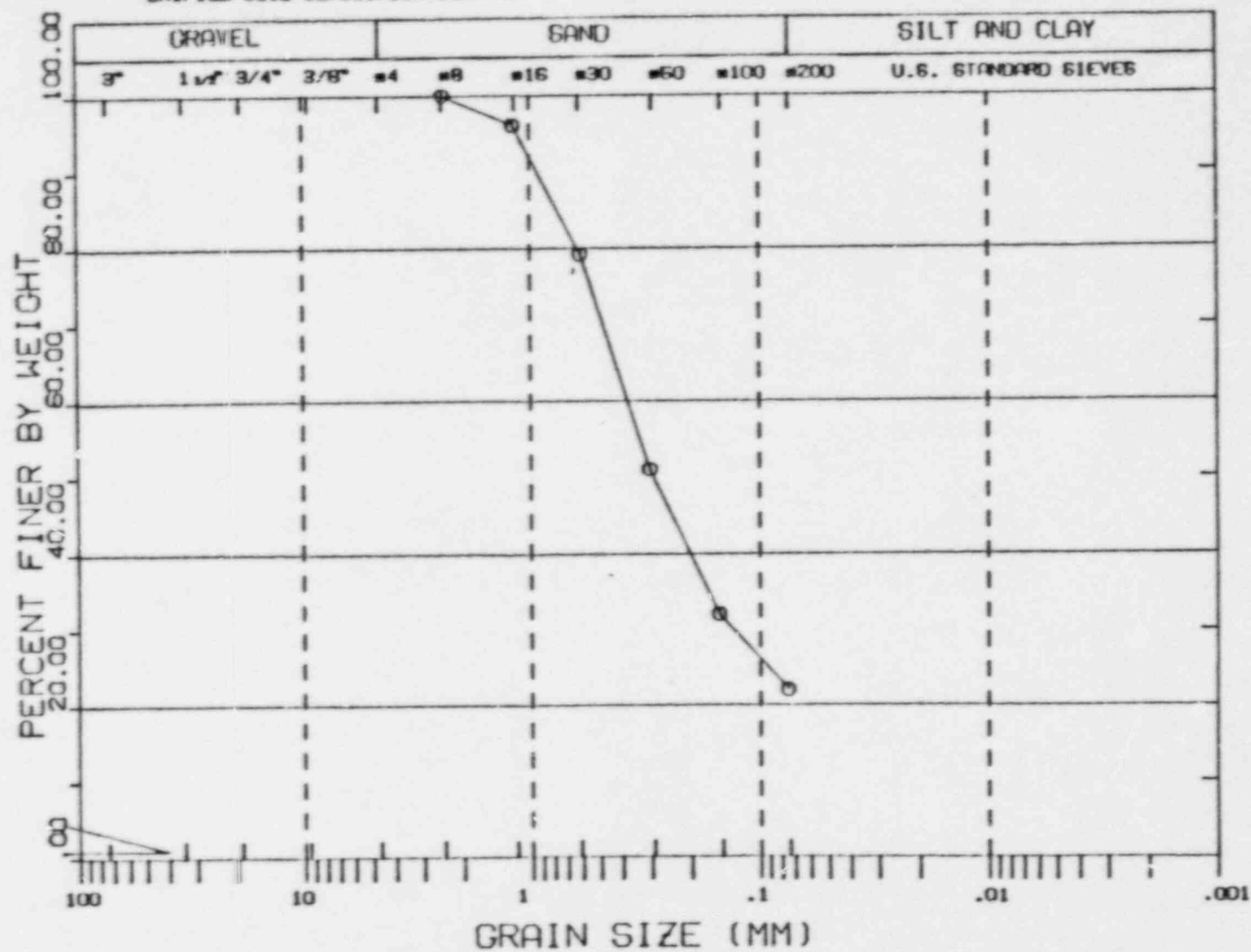


FIGURE D.4.2.B
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 032
 SAMPLE ID: 01
 DEPTH INTERVAL (FT): 2.5 - 9.0
 UNIFIED SOIL CLASSIFICATION: GM

GRAVEL (%): .0
 SAND (%): 86.0
 #200 SIEVE (% FINER): 14.0
 DATE: 5/21/87

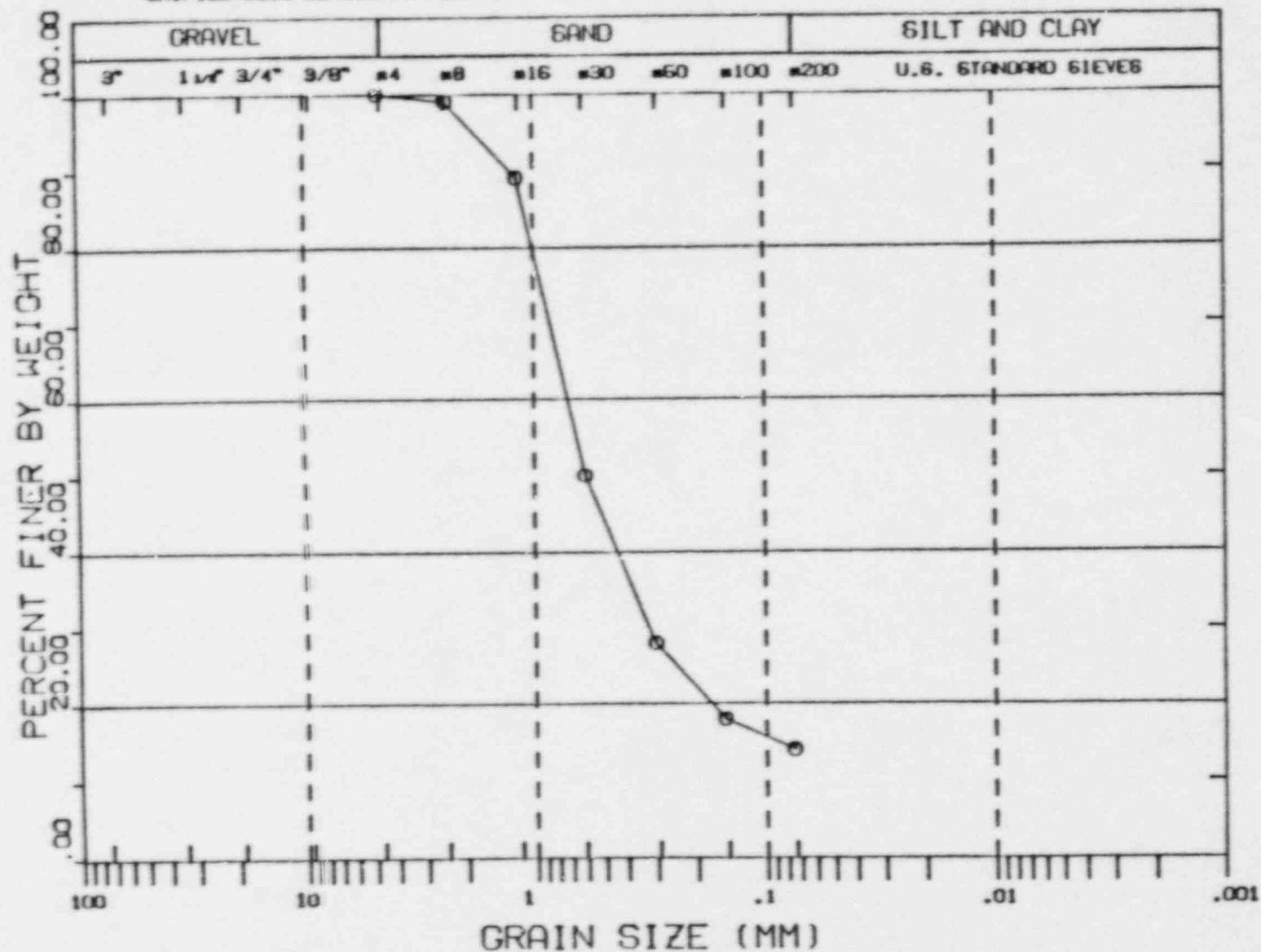


FIGURE D.4.2.C
 GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 033
SAMPLE ID: 01
DEPTH INTERVAL (FT): 2.5 - 9.0
UNIFIED SOIL CLASSIFICATION: GM

GRAVEL (%) : 1.0
SAND (%) : 79.0
#200 SIEVE (% FINER) : 20.0
DATE: 5/21/87

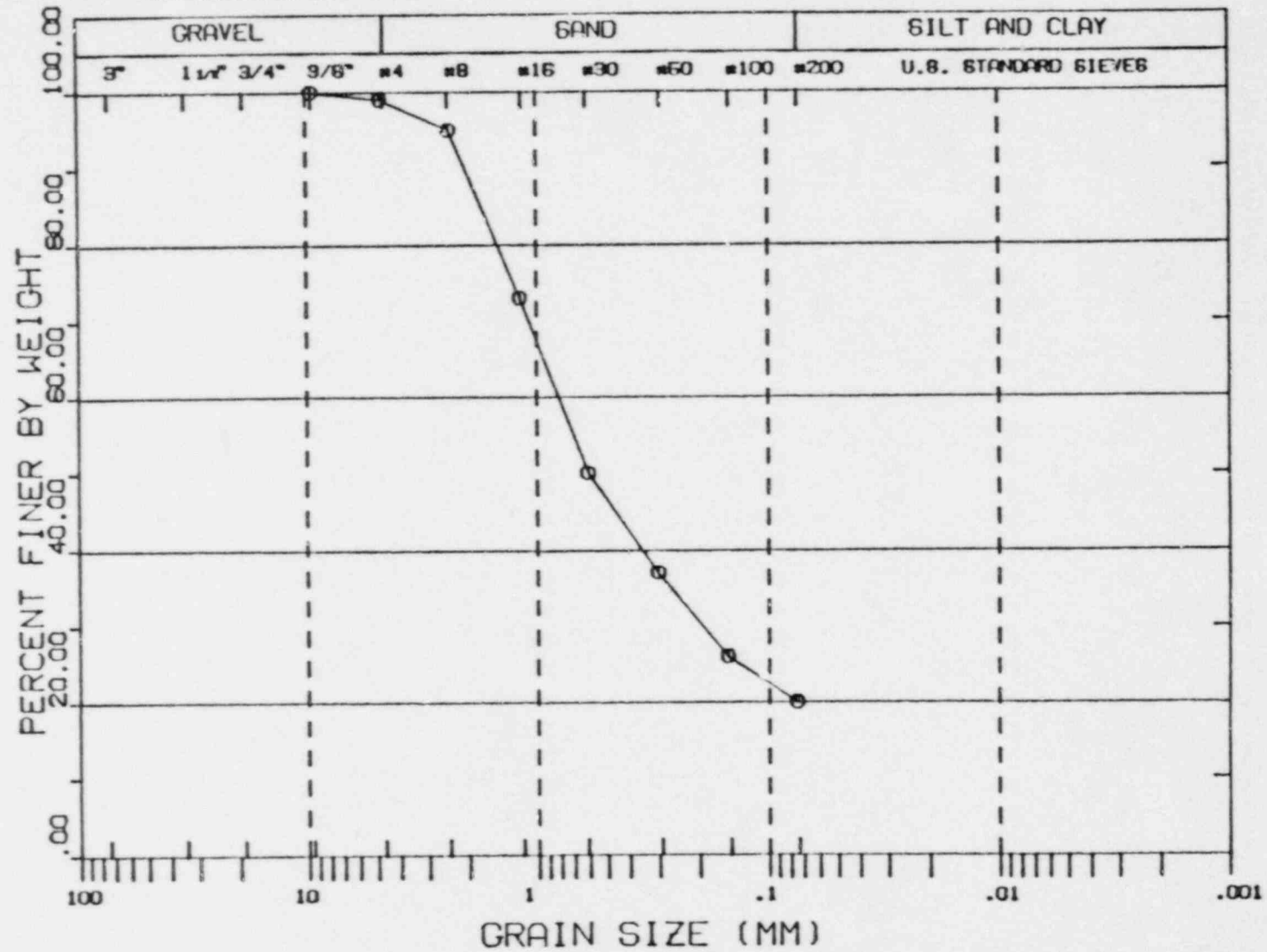


FIGURE D.4.2.D
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 094

SAMPLE ID: 01

DEPTH INTERVAL(FT): 2.5 - 3.0

UNIFIED SOIL CLASSIFICATION: GP-GM

GRAVEL(%) = .0

SAND(%) = 87.0

#200 SIEVE(% FINER) = 19.0

DATE: 6/21/87

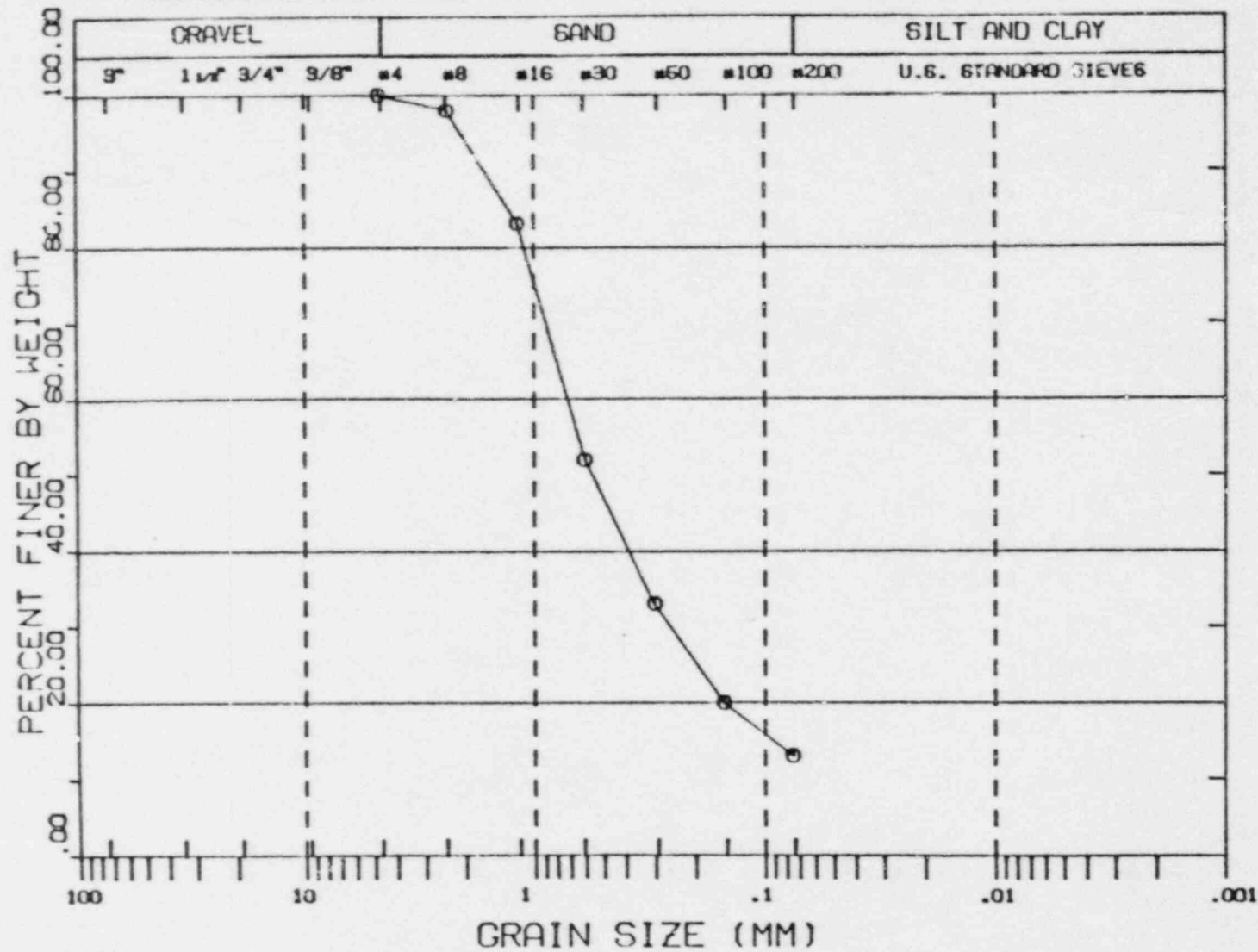


FIGURE D.4.2.E
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 035
 SAMPLE ID: 01
 DEPTH INTERVAL(FT): 4.5 - 5.0
 UNIFIED SOIL CLASSIFICATION: SM

GRAVEL(%) : .0
 SAND(%) : 80.0
 #200 SIEVE(% FINER) : 20.0
 DATE: 5/21/87

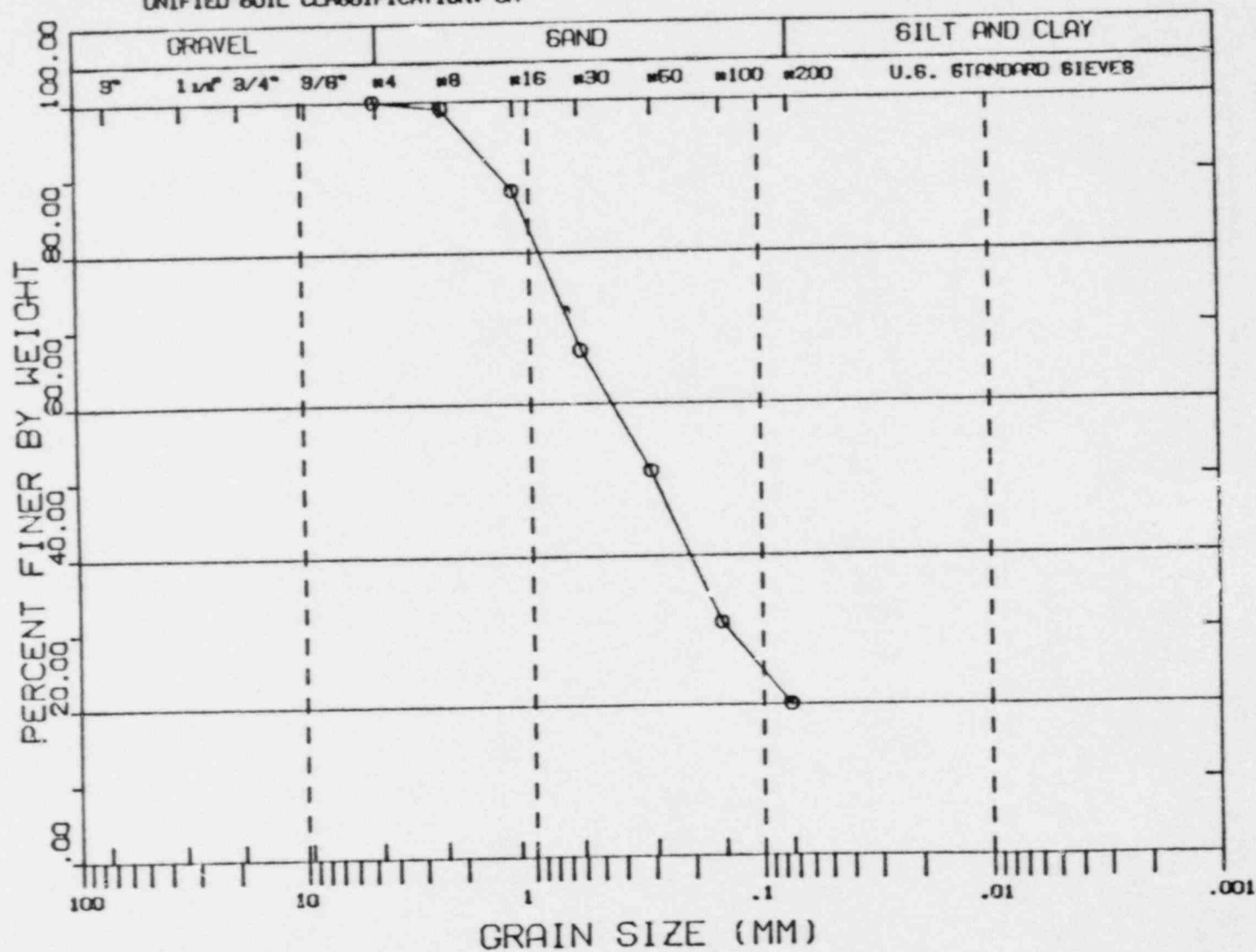


FIGURE D.4.2.F
 GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 036

SAMPLE ID: 02

DEPTH INTERVAL(FT): 8.0 - 8.5

UNIFIED SOIL CLASSIFICATION: GP-6M

GRAVEL(%): .0

SAND(%) = 88.0

#200 SIEVE(% FINER) = 12.0

DATE: 5/21/87

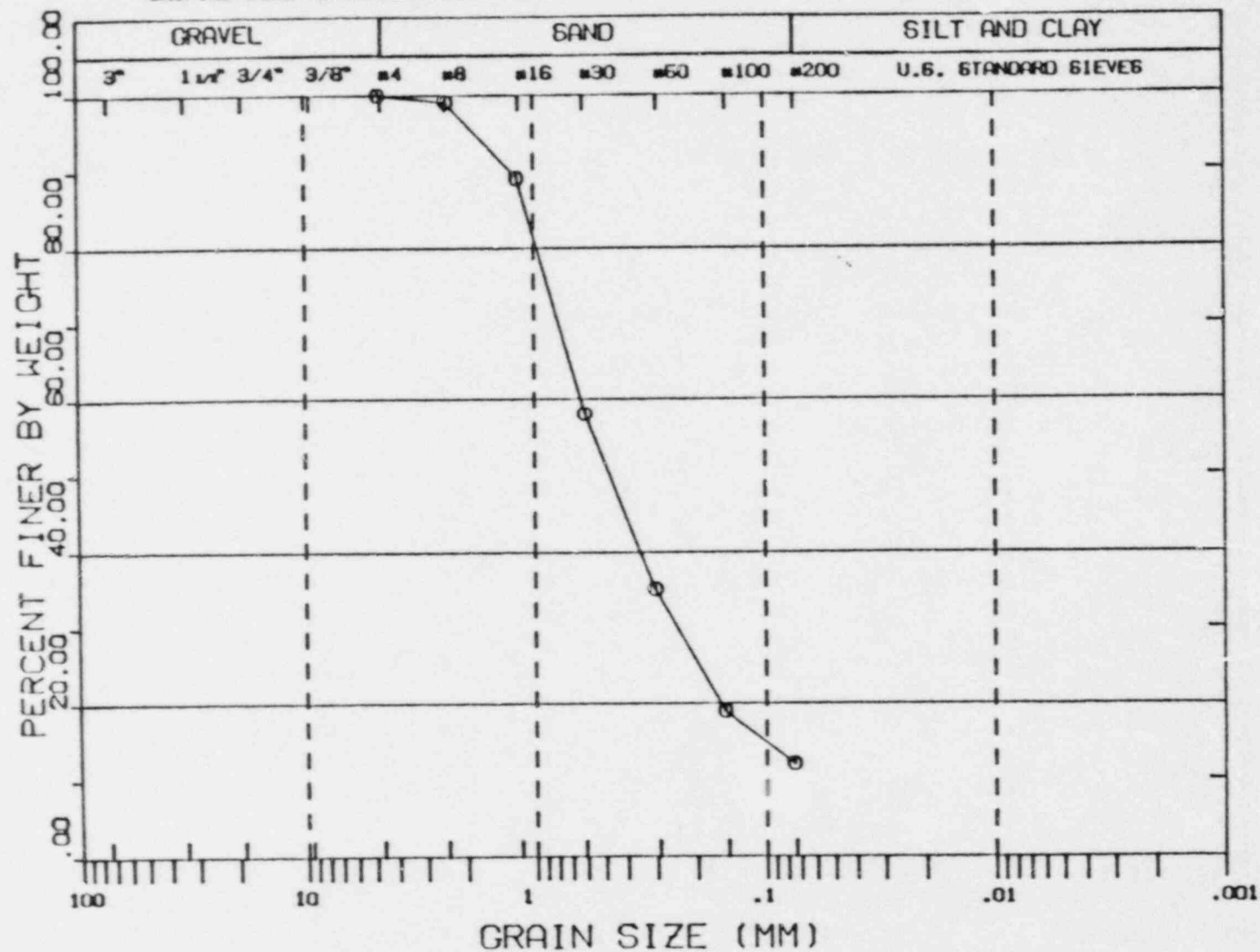


FIGURE D.4.2.G
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 036

SAMPLE ID: 09

DEPTH INTERVAL(FT): 4.0 - 4.5

UNIFIED SOIL CLASSIFICATION: GM

GRAVEL(%): .0

SAND(%): 82.0

#200 SIEVE(% FINER): 18.0

DATE: 5/21/67

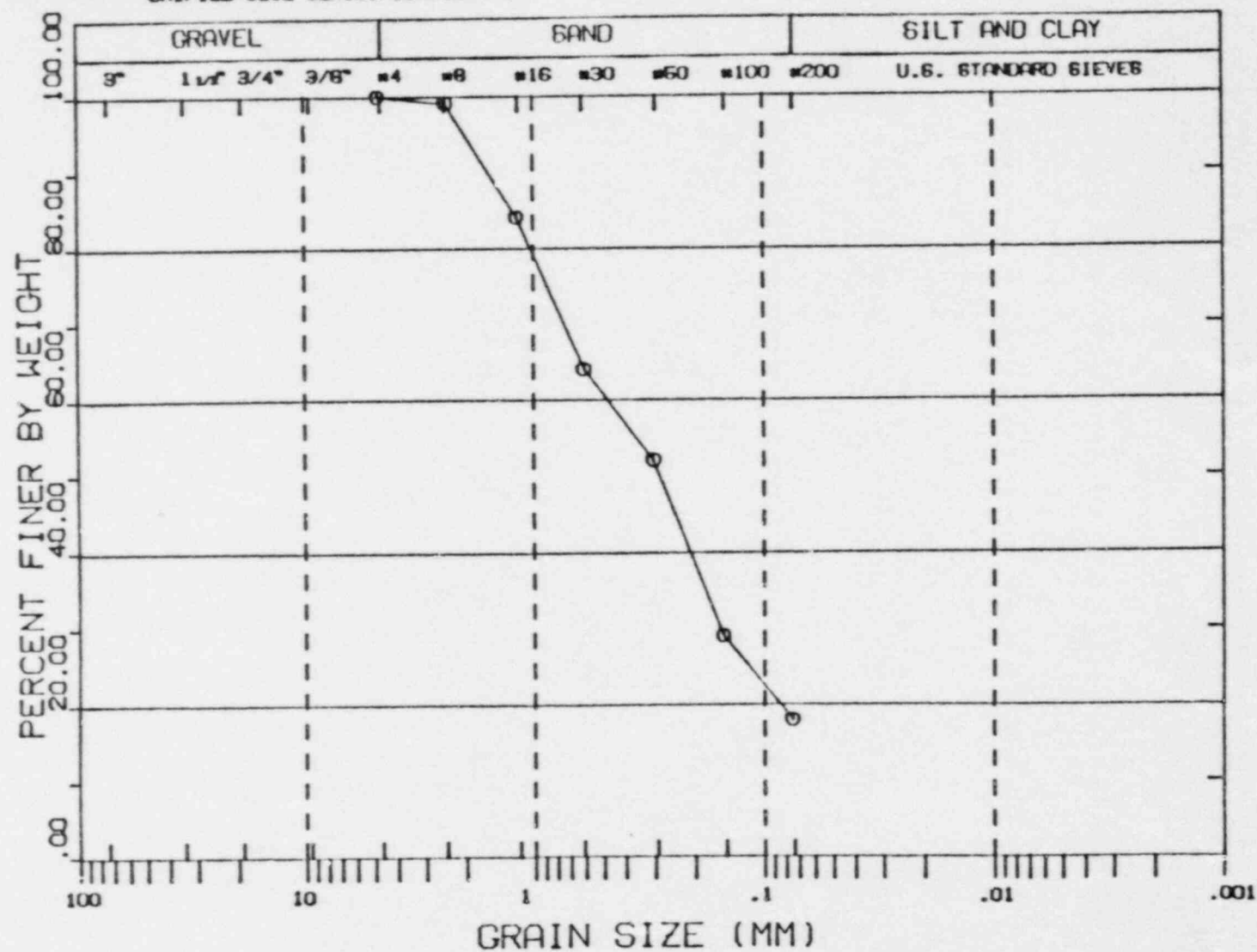


FIGURE D.4.2.H
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 037

SAMPLE ID: 02

DEPTH INTERVAL(FT): 4.0 - 4.5

UNIFIED SOIL CLASSIFICATION: GP-GM

GRAVEL(%): 1.7

SAND(%): 80.0

#200 SIEVE(% FINER): 9.0

DATE: 5/21/87

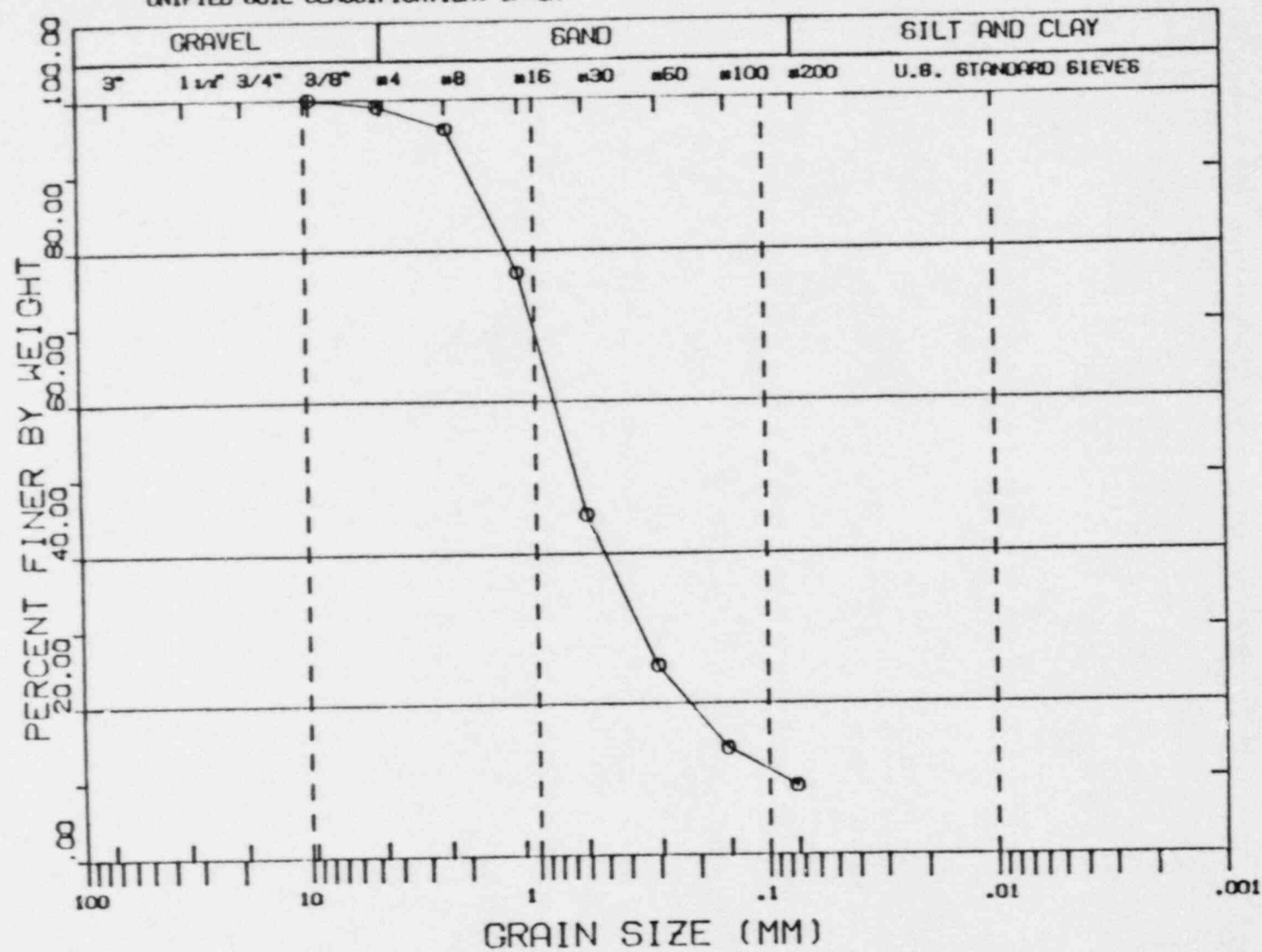


FIGURE D.4.2.1
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 097
SAMPLE ID: 06
DEPTH INTERVAL (FT): 12.5 - 19.0
UNIFIED SOIL CLASSIFICATION: SP-SM

GRAVEL (%) : .0
SAND (%) : 87.0
#200 SIEVE (% FINER) : 13.0
DATE: 6/21/87

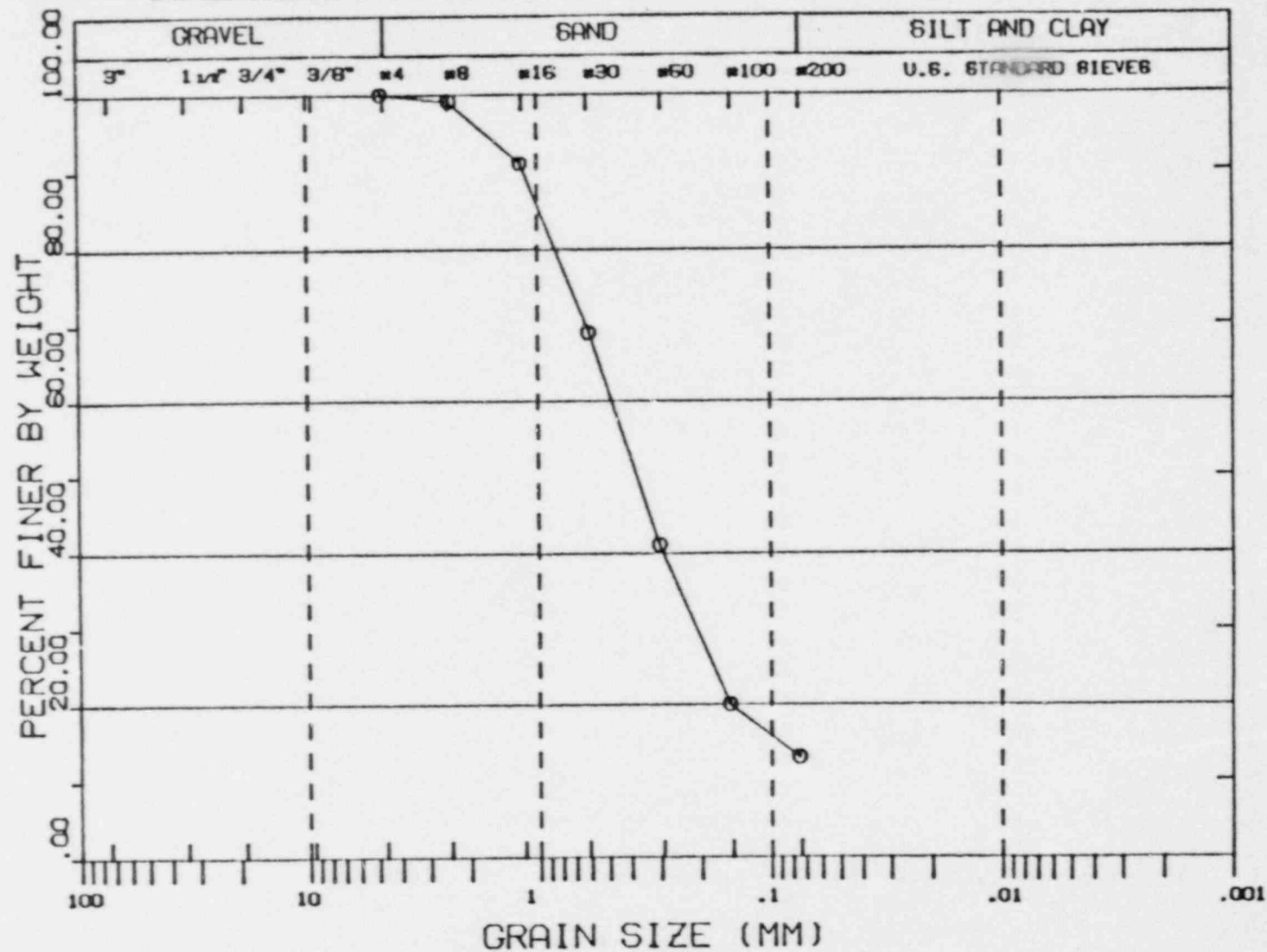


FIGURE D.4.2.J
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 038
 SAMPLE ID: 01
 DEPTH INTERVAL (FT): 9.0 - 9.5
 UNIFIED SOIL CLASSIFICATION: SM

GRAVEL (%) = .0
 SAND (%) = 81.0
 #200 SIEVE (% FINER) = 19.0
 DATE: 6/21/87

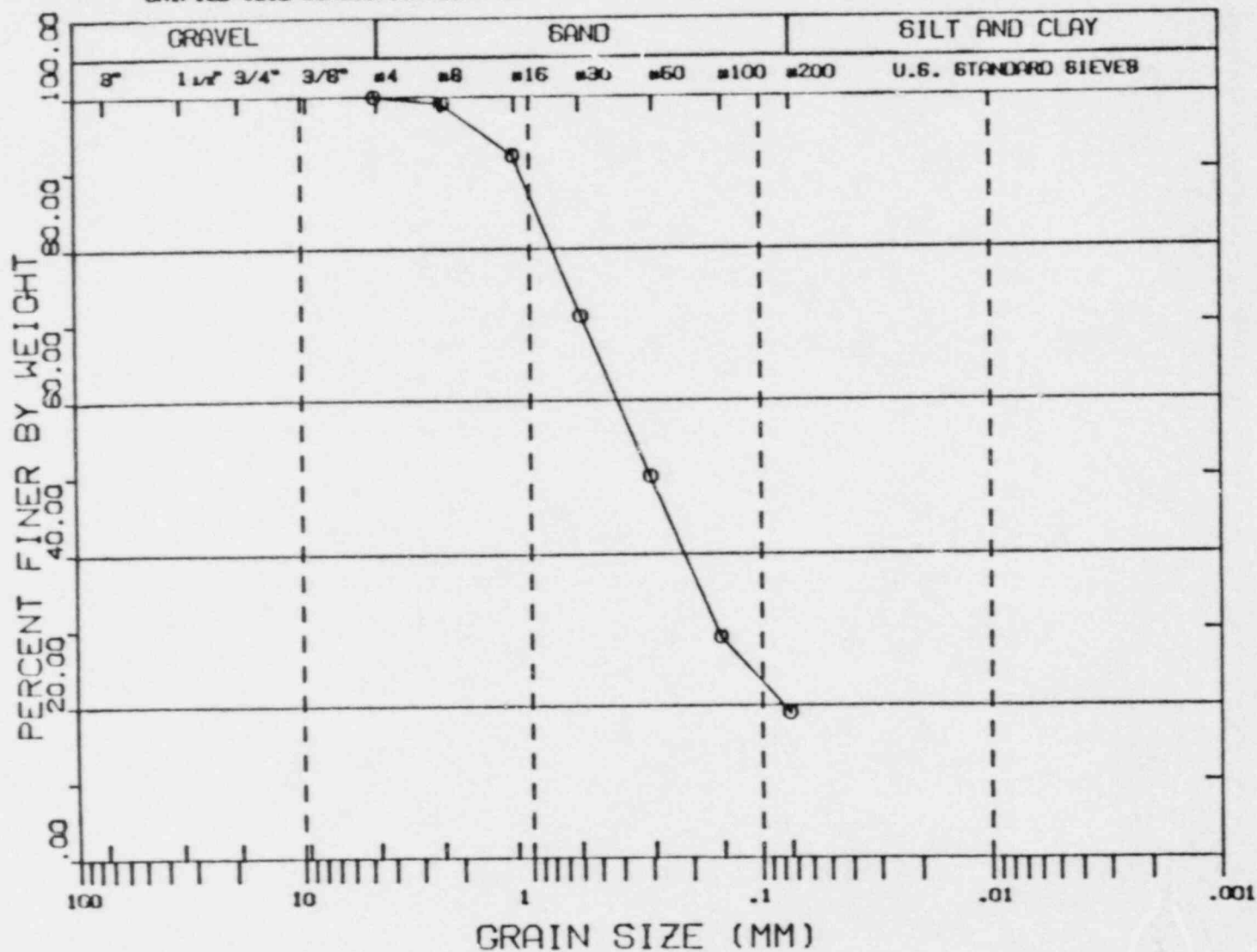


FIGURE D.4.2.K
 GRAIN SIZE DISTRIBUTION CURVE

UNIFIED SOIL CLASSIFICATION: SM

DATE: 5/21/87

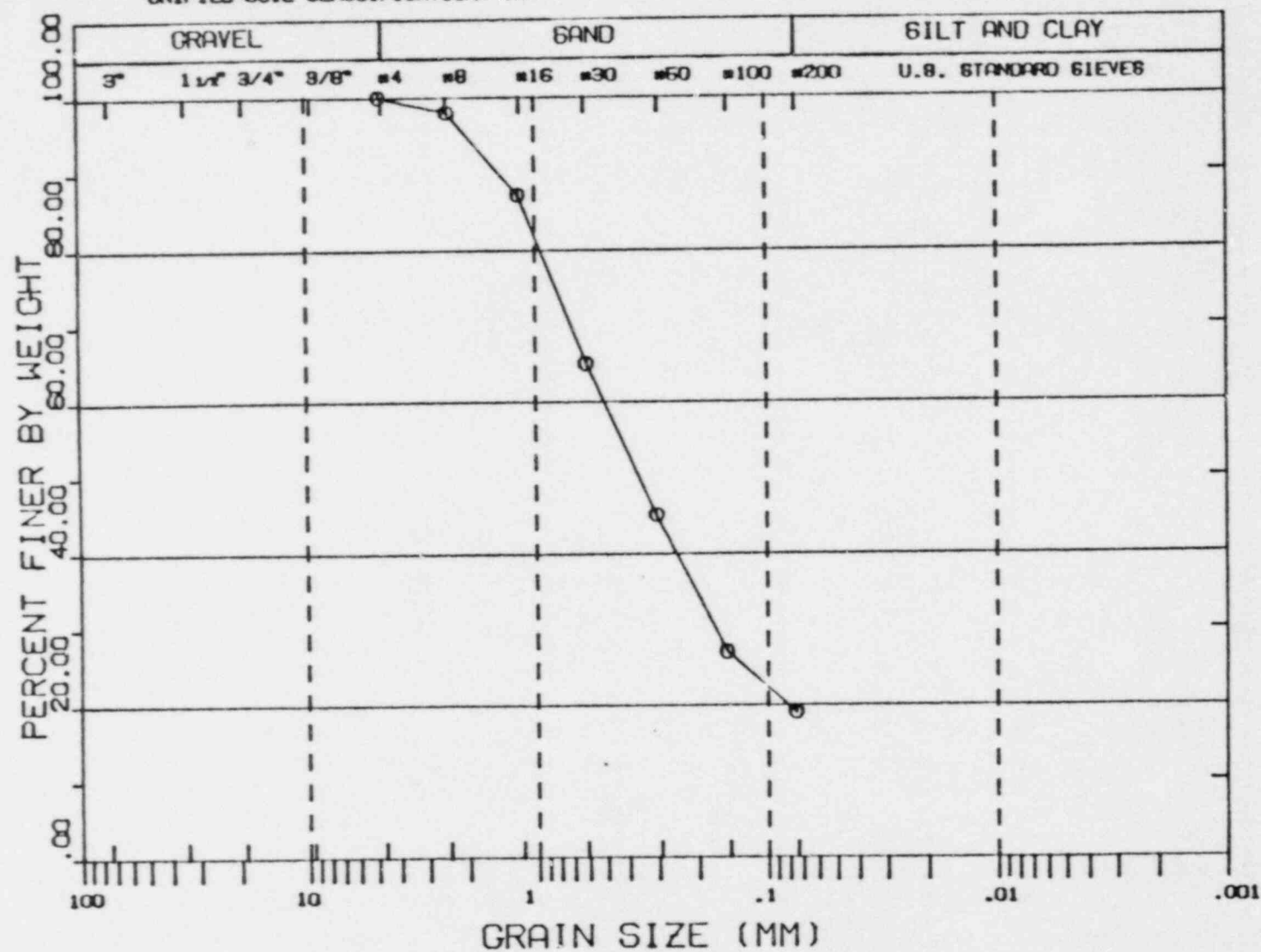


FIGURE D.4.2.L
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 040
SAMPLE ID: 01
DEPTH INTERVAL (FT): 3.5 - 4.0
UNIFIED SOIL CLASSIFICATION: GM

GRAVEL (%): .0
SAND (%) = 86.0
#200 SIEVE (% FINER) = 14.0
DATE: 5/21/87

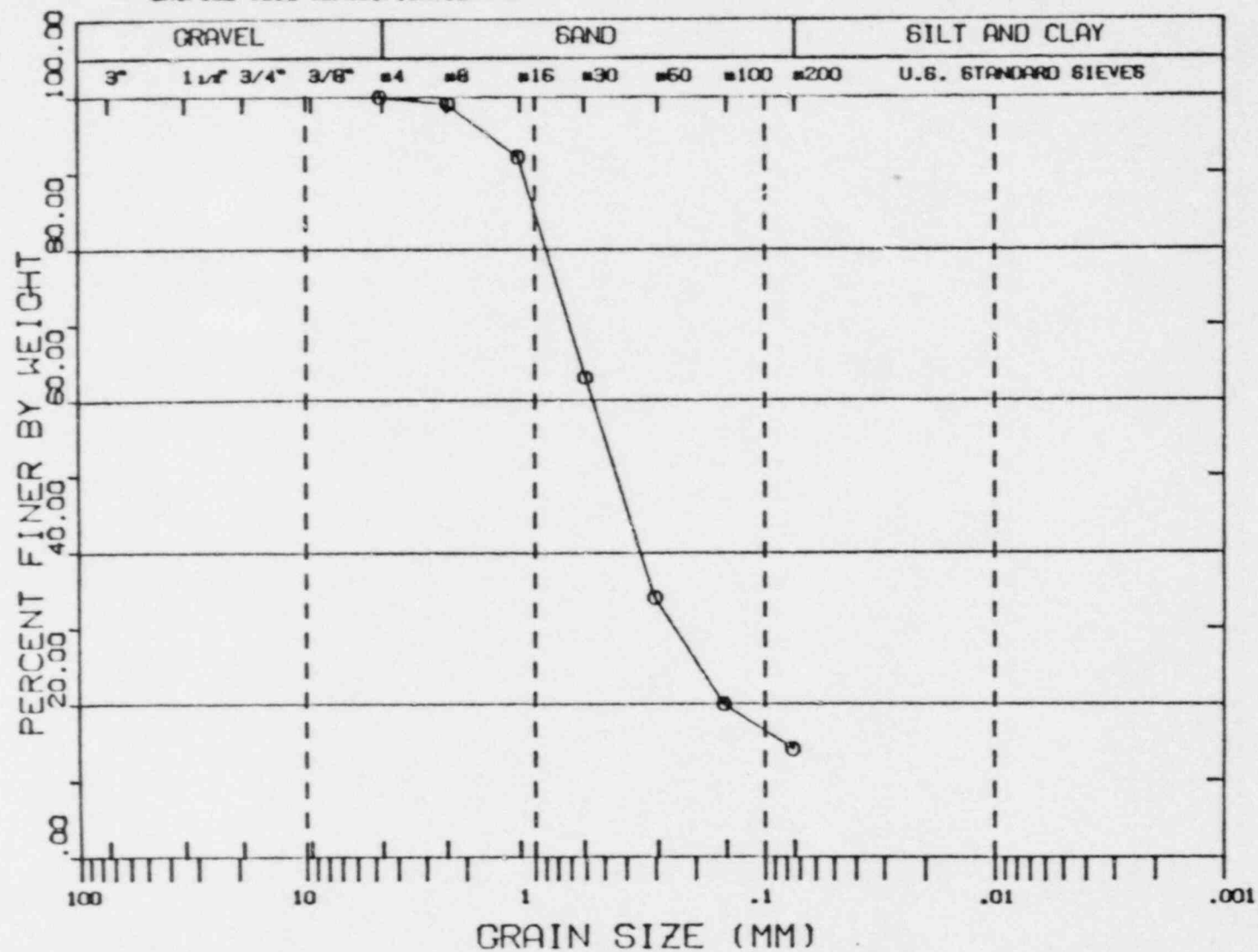


FIGURE D.4.2.M
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 040
 SAMPLE ID: 04
 DEPTH INTERVAL(FT): 11.0 - 11.5
 UNIFIED SOIL CLASSIFICATION: GP-6M

GRAVEL(%): .0
 SAND(%): 91.0
 #200 SIEVE(% FINER): 9.0
 DATE: 5/21/87

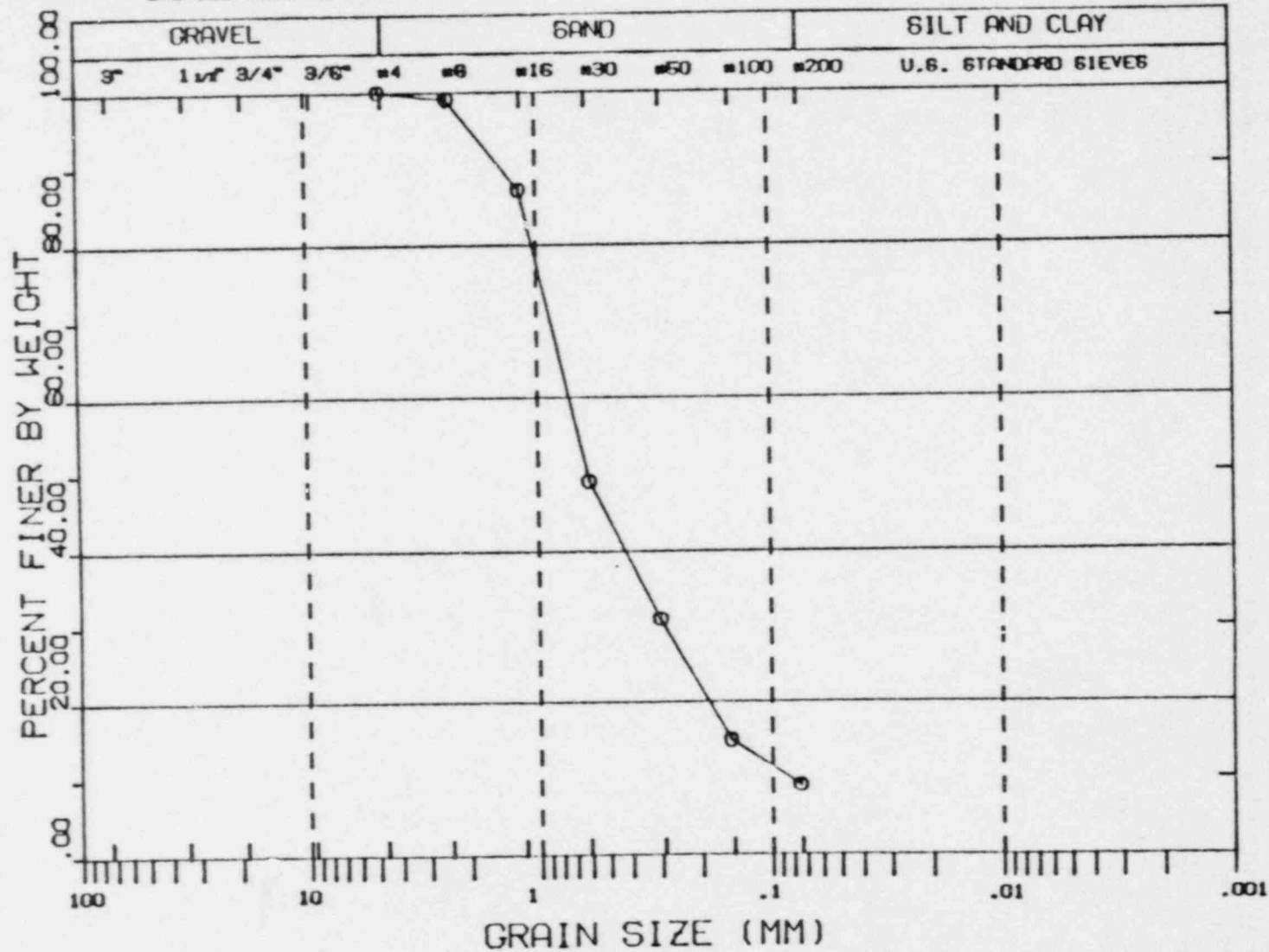


FIGURE D.4.2.N
 GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 041

SAMPLE ID: 01

DEPTH INTERVAL(FT): 2.5 - 9.0

UNIFIED SOIL CLASSIFICATION: GM

GRAVEL(%): .0

SAND(%): 84.0

#200 SIEVE(% FINER): 18.0

DATE: 5/21/87

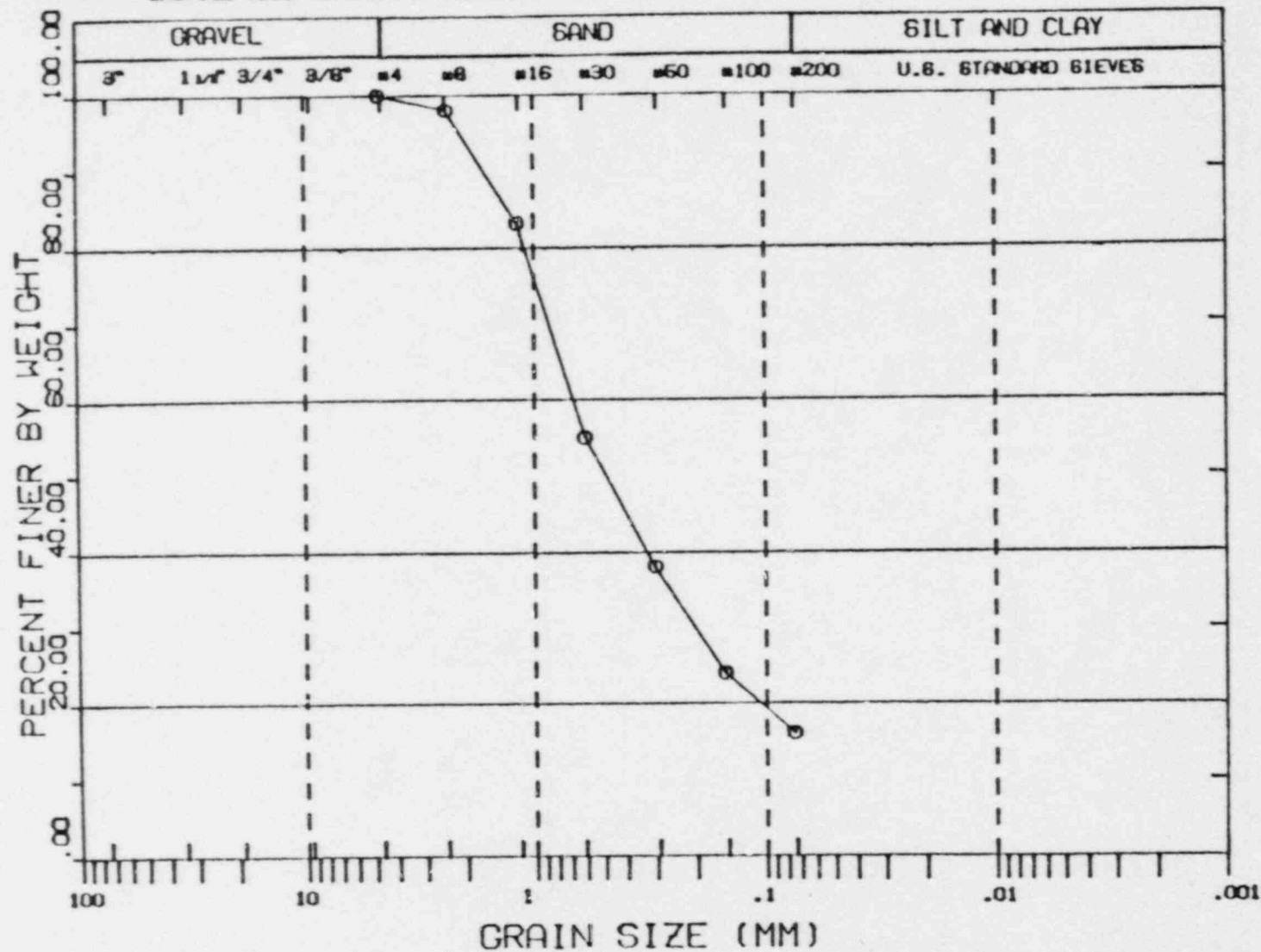


FIGURE D.4.2.0
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 042
SAMPLE ID: 01
DEPTH INTERVAL(FT): 3.5 - 4.0
UNIFIED SOIL CLASSIFICATION: SM

GRAVEL(%): .0
SAND(%) = 86.0
#200 SIEVE(% FINER) = 14.0
DATE: 5/21/87

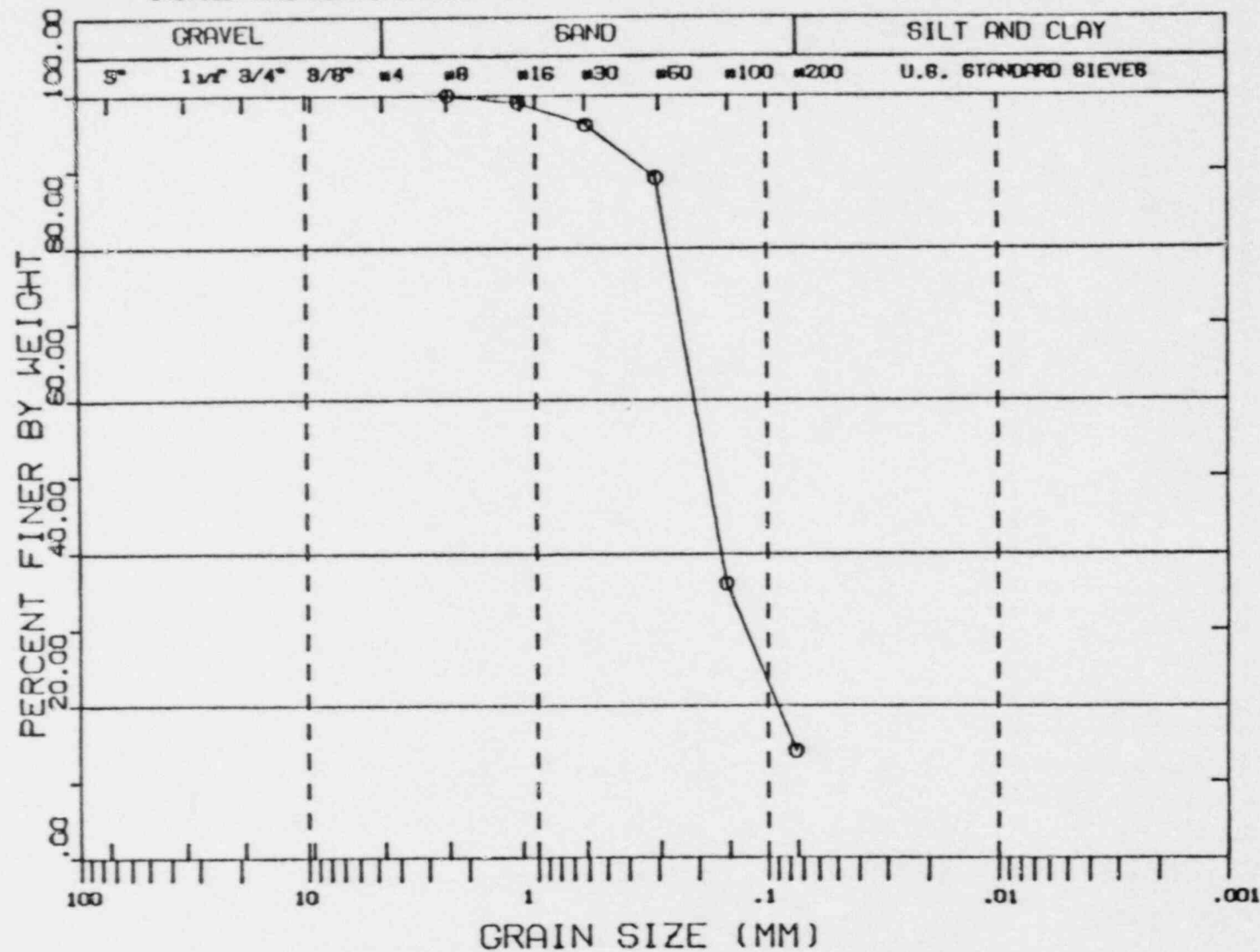


FIGURE D.4.2.P
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 042
 SAMPLE ID: 04
 DEPTH INTERVAL (FT): 14.5 - 15.0
 UNIFIED SOIL CLASSIFICATION: SM

GRAVEL (%): 1.0
 SAND (%): 72.0
 #200 SIEVE (% FINER): 27.0
 DATE: 5/21/87

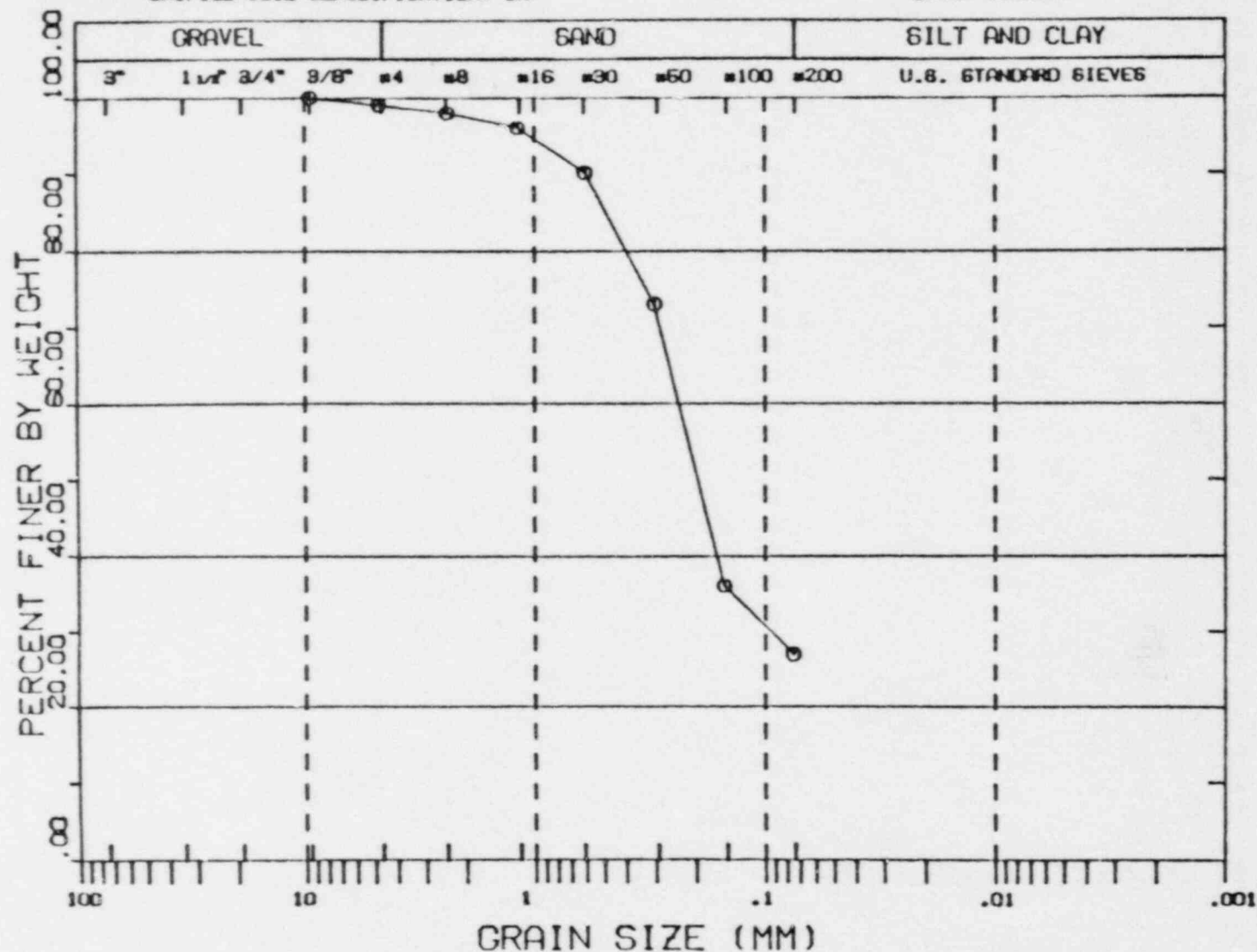


FIGURE D.4.2.Q
 GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 049
 SAMPLE ID: 01
 DEPTH INTERVAL (FT): 4.5 - 5.0
 UNIFIED SOIL CLASSIFICATION: SM

GRAVEL (%): .0
 SAND (%): 82.0
 #200 SIEVE (% FINER): 18.0
 DATE: 5/21/87

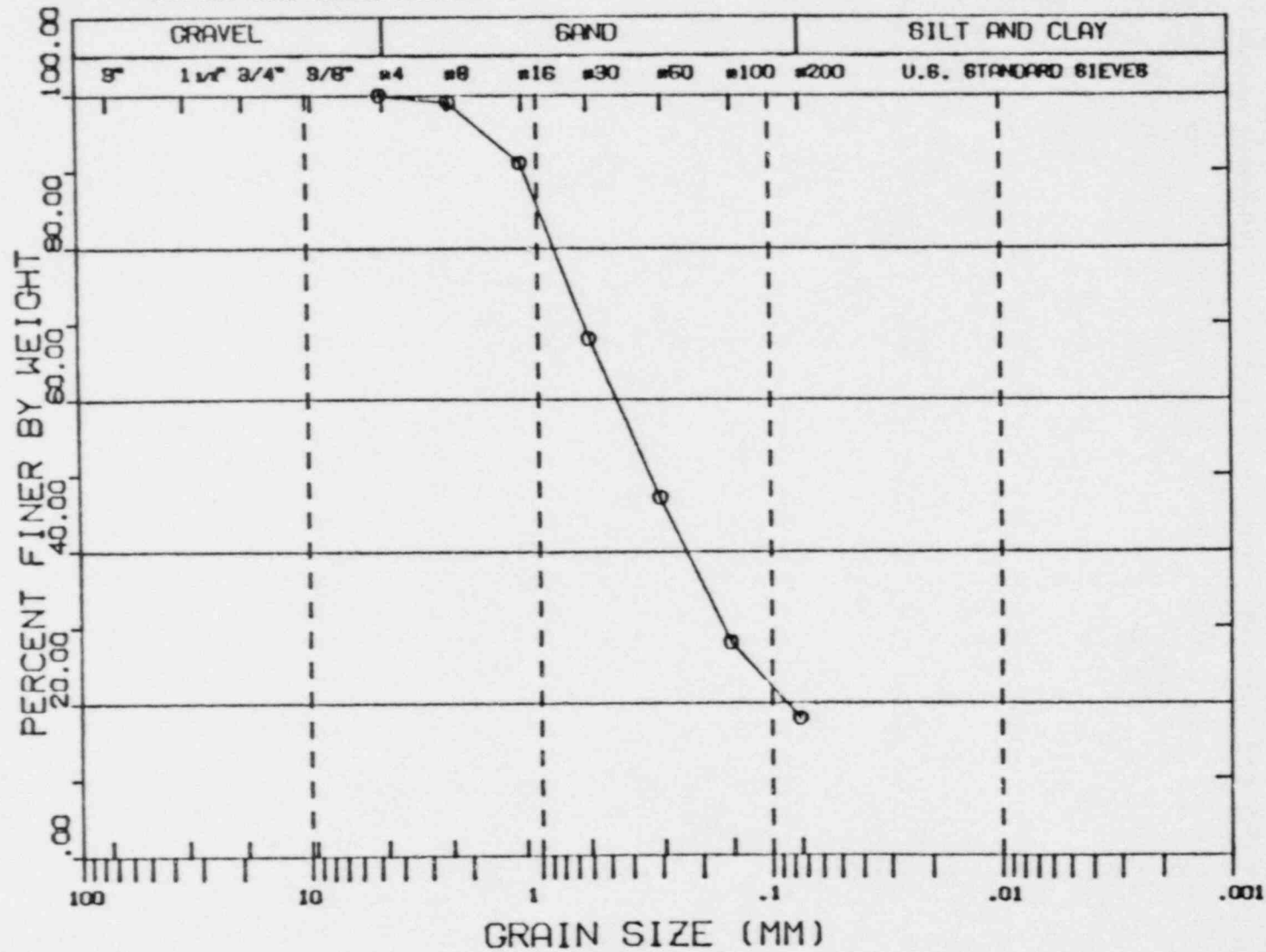


FIGURE D.4.2.R
 GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 049
 SAMPLE ID: 04
 DEPTH INTERVAL(FT): 19.0 - 19.5
 UNIFIED SOIL CLASSIFICATION: GM

GRAVEL(%): .0
 SAND(%) : 81.0
 #200 SIEVE(% FINER): 19.0
 DATE: 5/21/87

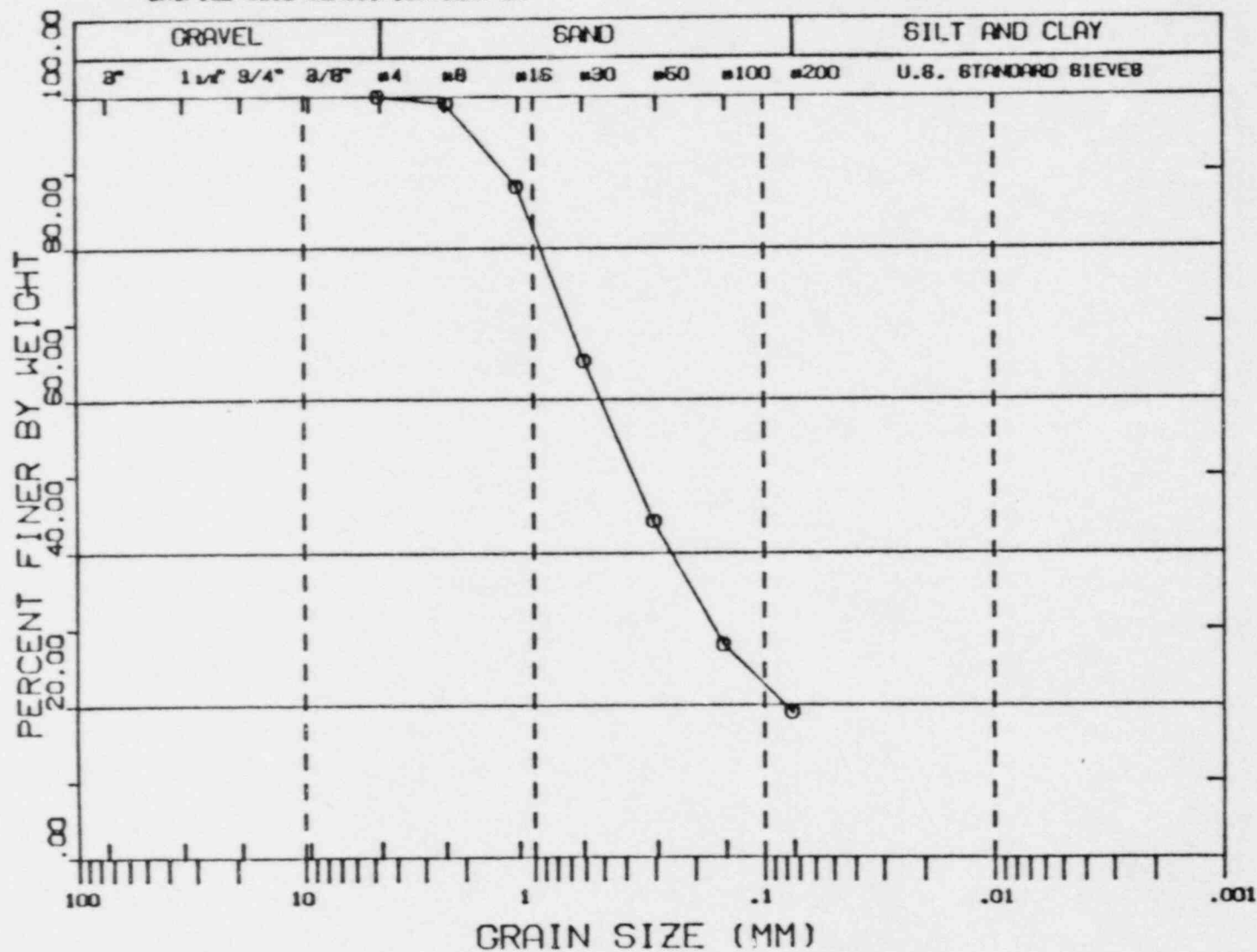


FIGURE D.4.2.S
 GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 044
 SAMPLE ID: 01
 DEPTH INTERVAL(FT): 9.5 - 4.0
 UNIFIED SOIL CLASSIFICATION: GM

GRAVEL(%): .0
 SAND(%) = 84.0
 #200 SIEVE(% FINER) = 18.0
 DATE: 6/21/87

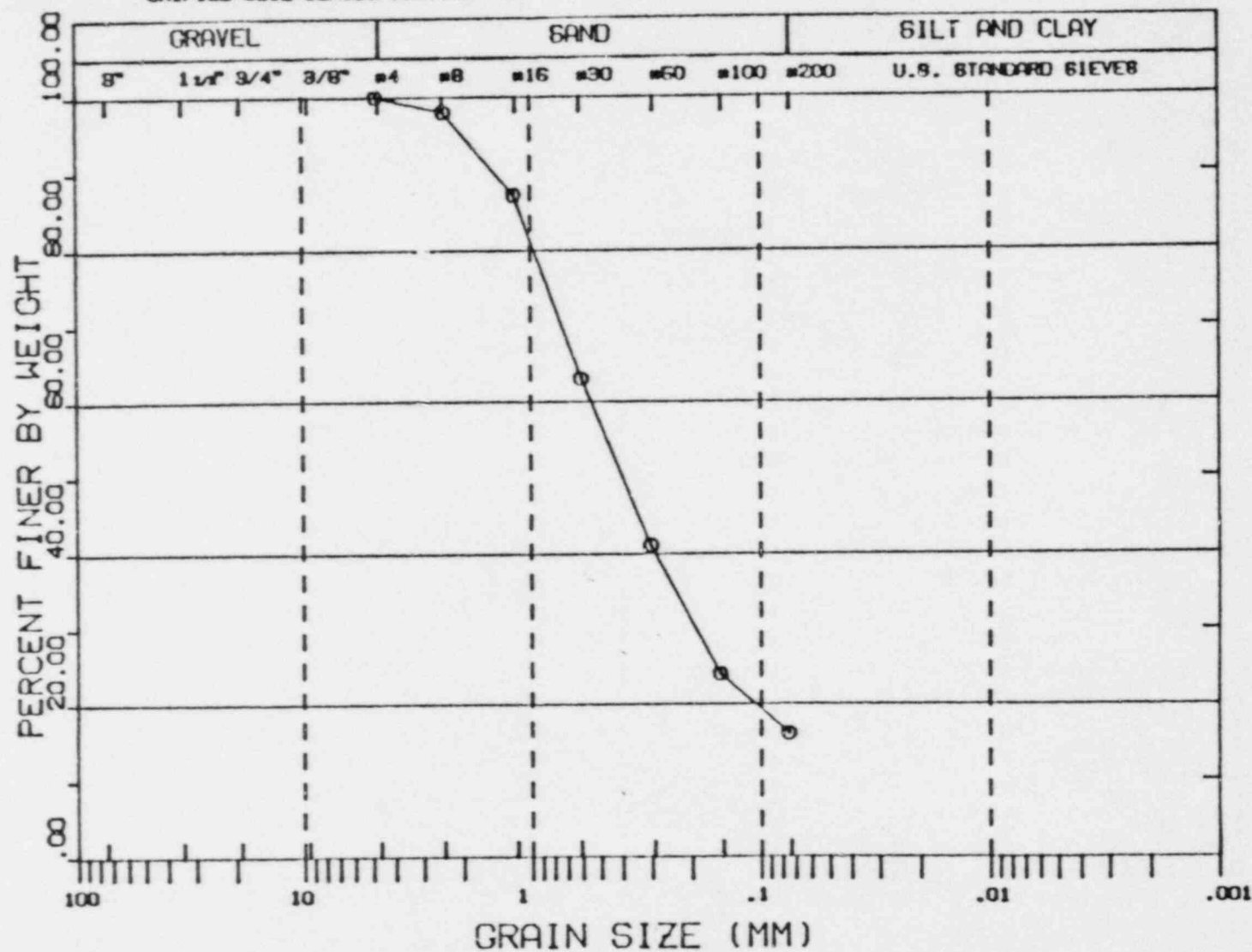


FIGURE D.4.2.T
 GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 044

SAMPLE ID: 04

DEPTH INTERVAL(FT): 14.0 - 14.5

UNIFIED SOIL CLASSIFICATION: SM

GRAVEL(%): .0

SAND(%): 84.0

#200 SIEVE(% FINER): 16.0

DATE: 6/22/87

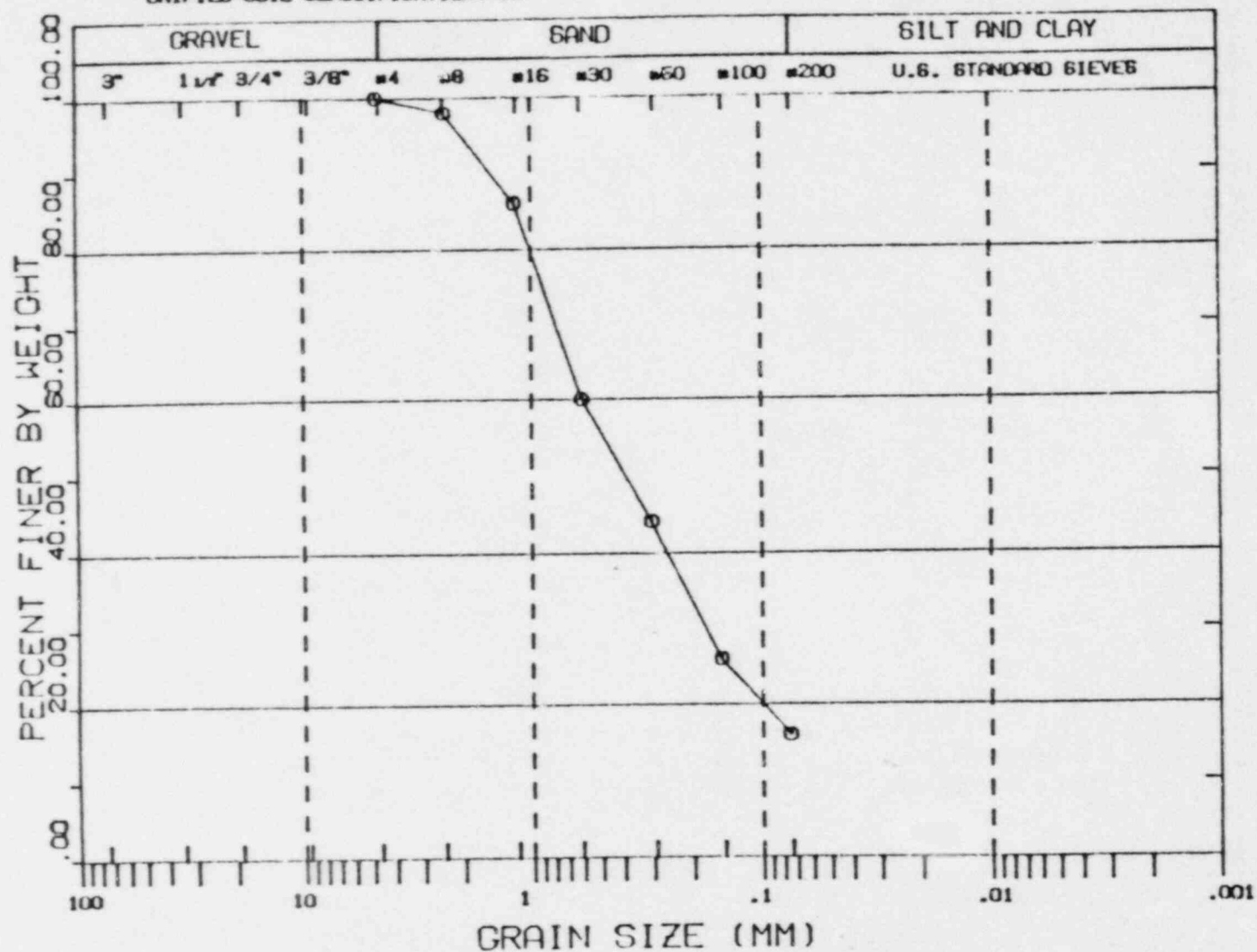


FIGURE D.4.2.U
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: D45
 SAMPLE ID: 01
 DEPTH INTERVAL (FT): 4.5 - 5.0
 UNIFIED SOIL CLASSIFICATION: GM

GRAVEL (%) : .0
 SAND (%) : 78.0
 #200 SIEVE (% FINER) : 22.0
 DATE : 5/22/87

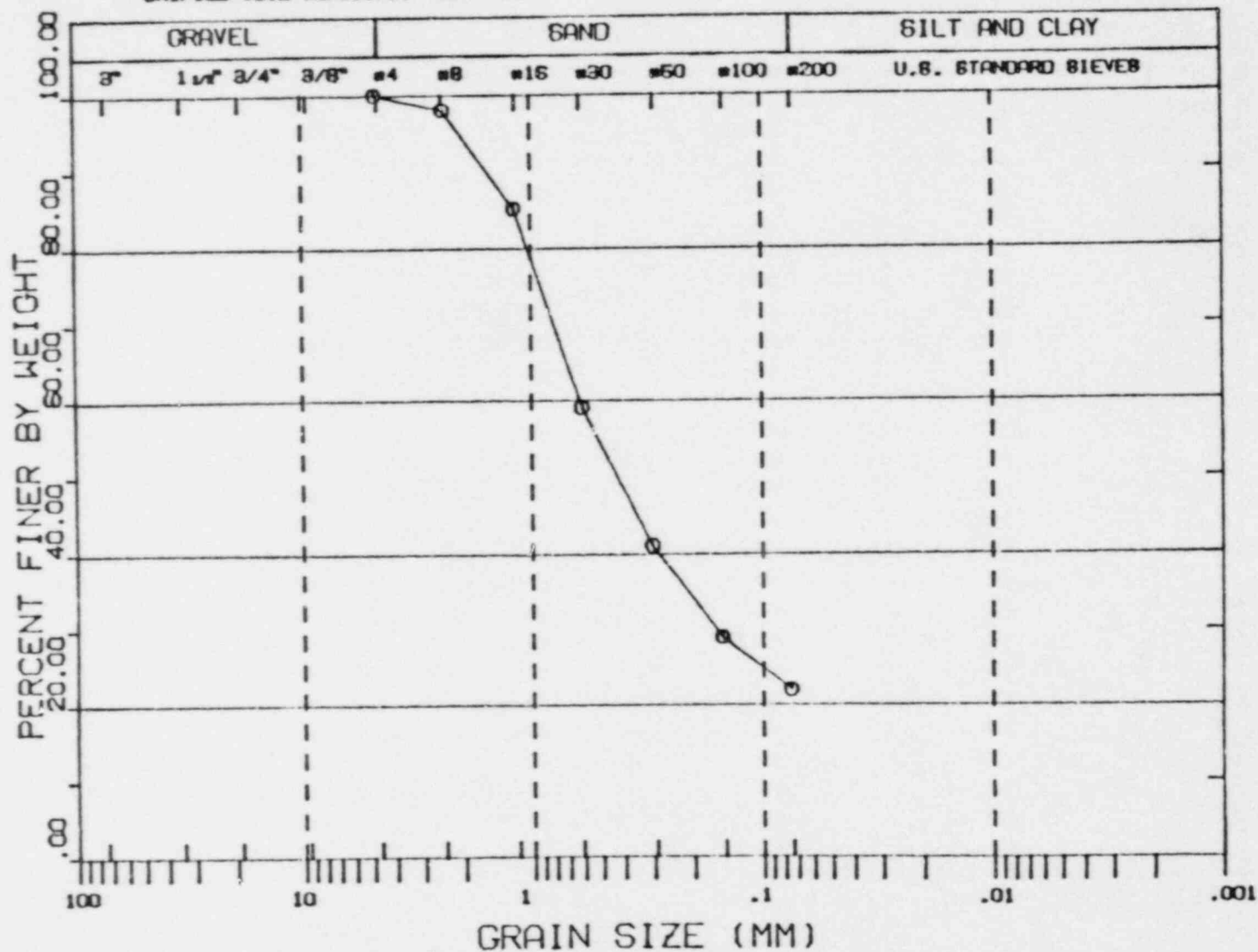


FIGURE D.4.2.V
 GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 045
 SAMPLE ID: 04
 DEPTH INTERVAL(FT): 19.5 - 14.0
 UNIFIED SOIL CLASSIFICATION: SM

GRAVEL(%) = .0
 SAND(%) = 85.0
 #200 SIEVE(% FINER) = 15.0
 DATE: 6/22/87

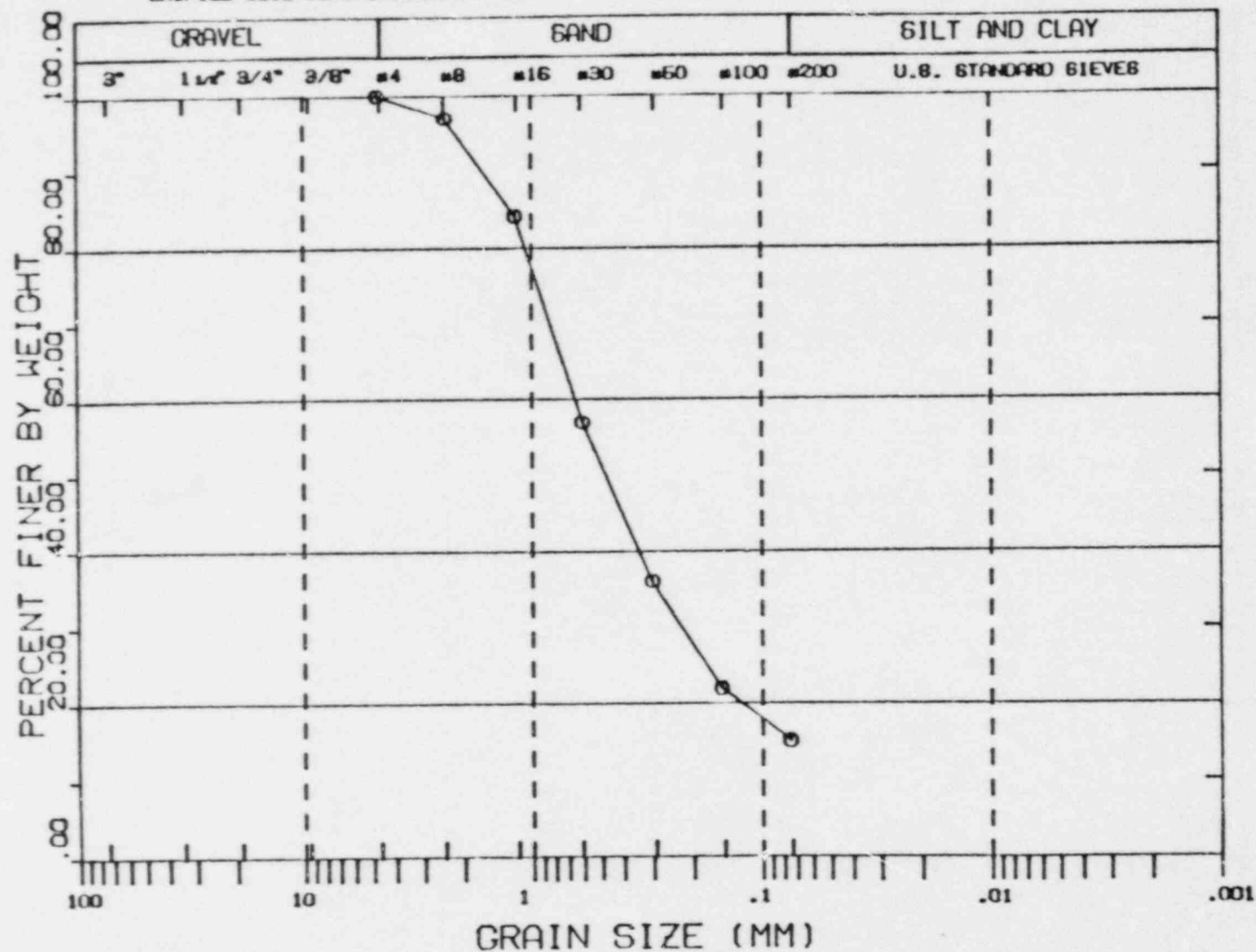


FIGURE D.4.2.W
 GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 046
 SAMPLE ID: 01
 DEPTH INTERVAL(FT): 2.0 - 2.5
 UNIFIED SOIL CLASSIFICATION: GM/ML

GRAVEL(%): .0
 SAND(%) : 46.0
 #200 SIEVE(% FINER) : 54.0
 DATE: 5/22/87

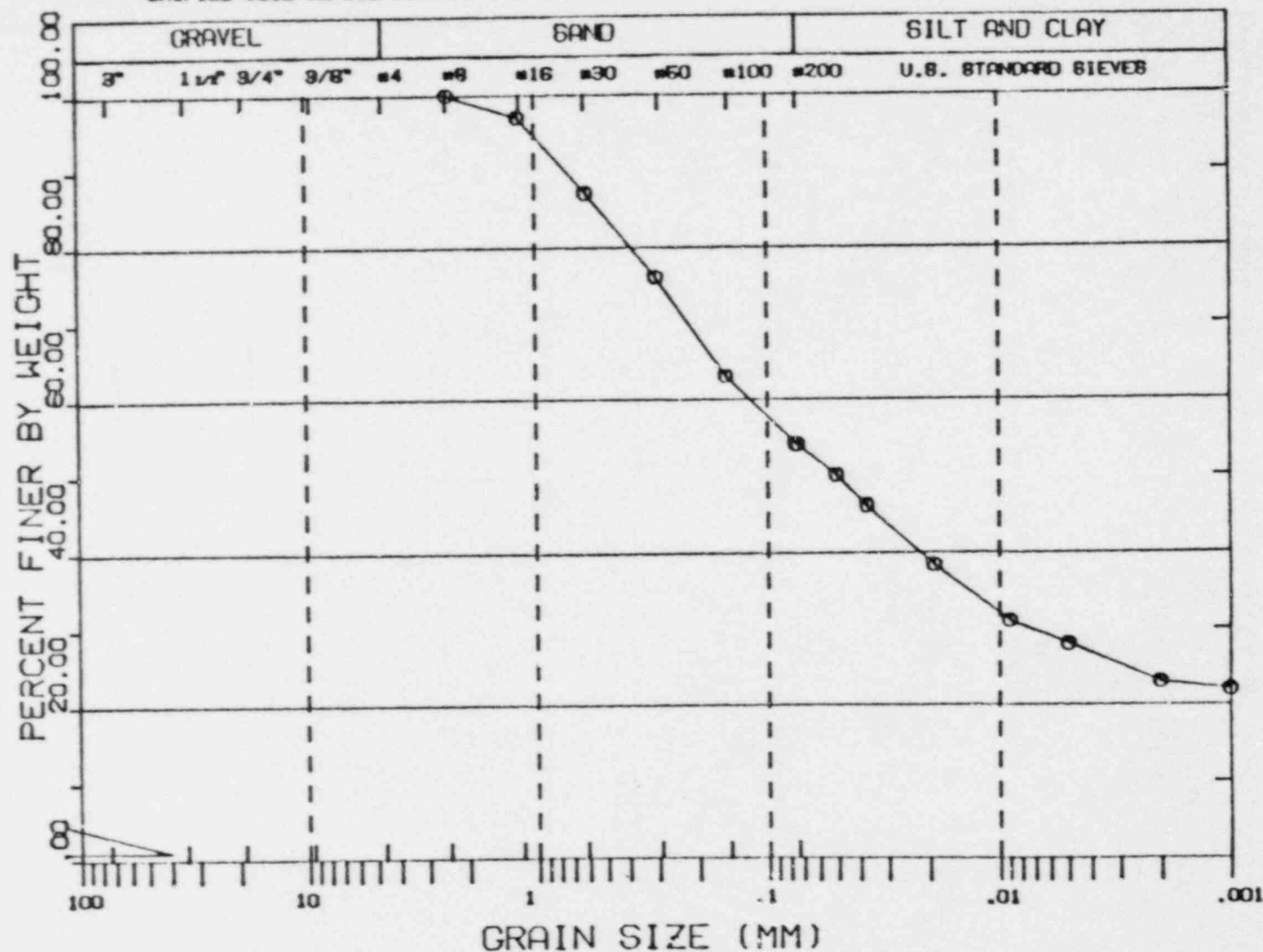


FIGURE D.4.2.X
 GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 046
 SAMPLE ID: 02
 DEPTH INTERVAL(FT): 4.5 - 5.0
 UNIFIED SOIL CLASSIFICATION: BM

GRAVEL(%): .0
 SAND(%) = 89.0
 #200 SIEVE(% FINER) = 17.0
 DATE: 5/22/87

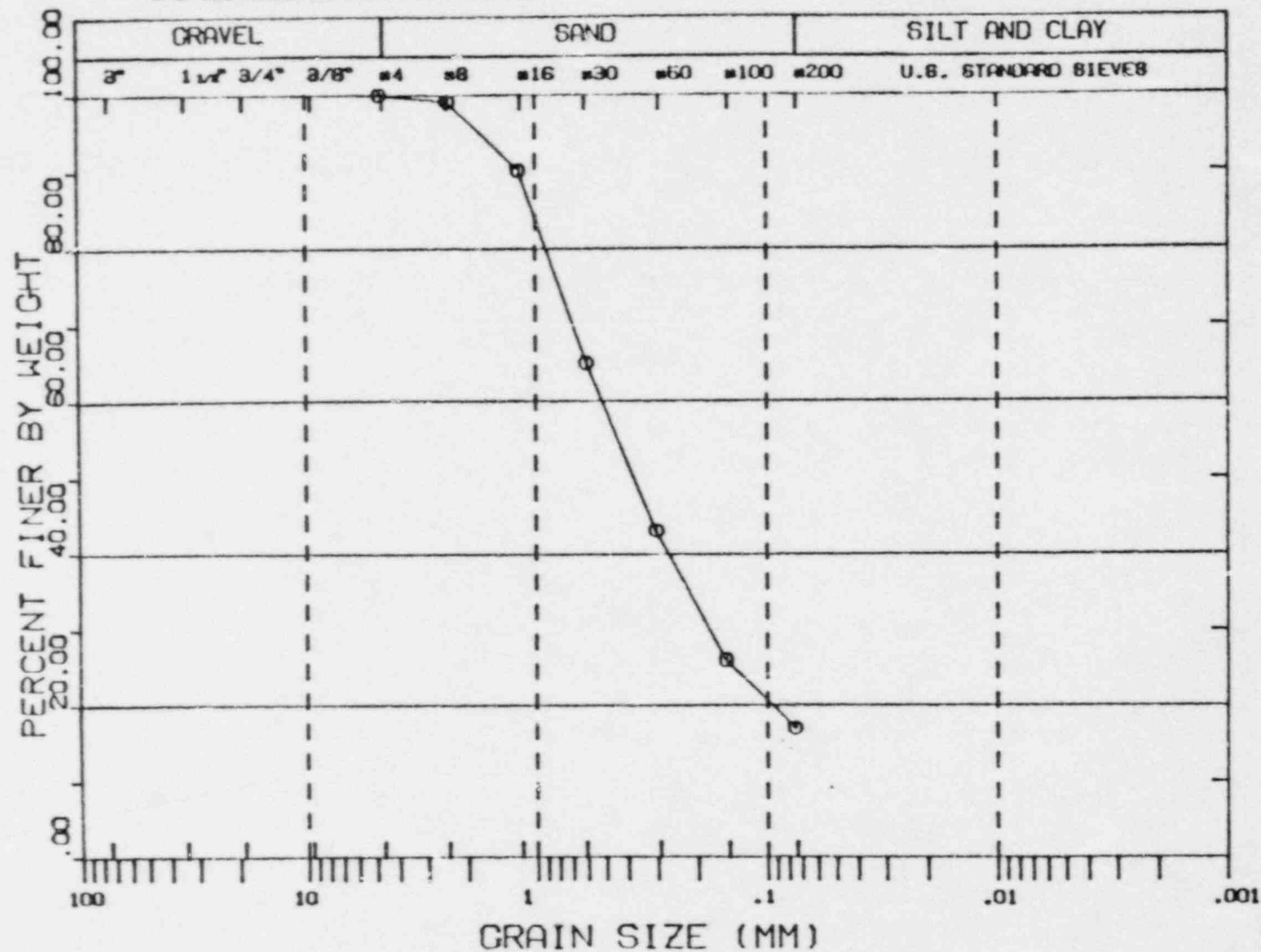


FIGURE D.4.2.Y
 GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 046

SAMPLE ID: 03

DEPTH INTERVAL(FT): 9.5 - 10.0

UNIFIED SOIL CLASSIFICATION: SM

GRAVEL(%) = .0

SAND(%) = 75.0

#200 SIEVE (% FINER) = 25.0

DATE: 6/22/87

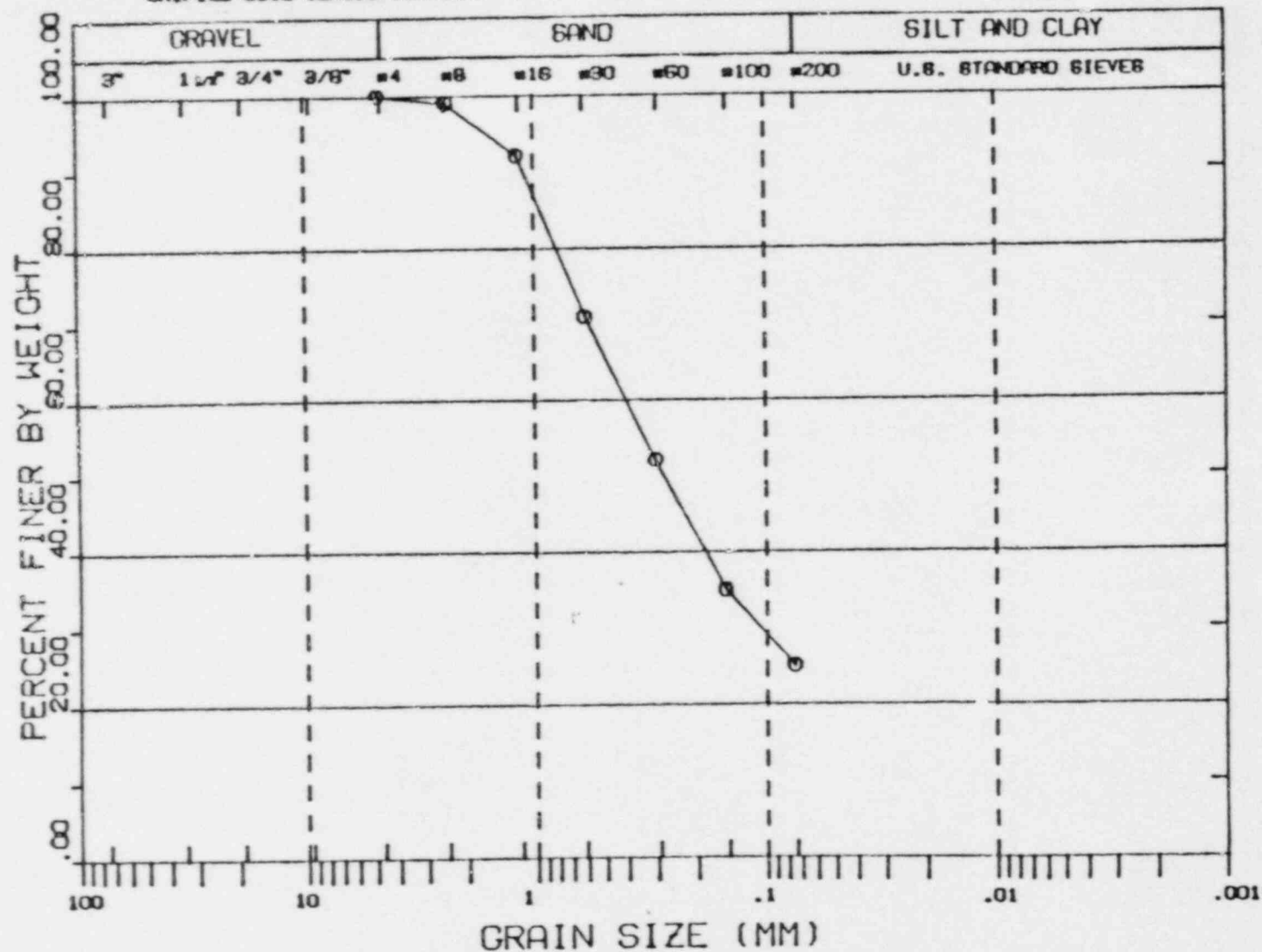


FIGURE D.4.2.Z
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 047

SAMPLE ID: 01

DEPTH INTERVAL(FT): 4.0 - 4.5

UNIFIED SOIL CLASSIFICATION: SM

GRAVEL(%): .0

SAND(%): 95.0

#200 SIEVE(% FINER): 36.0

DATE: 5/22/87

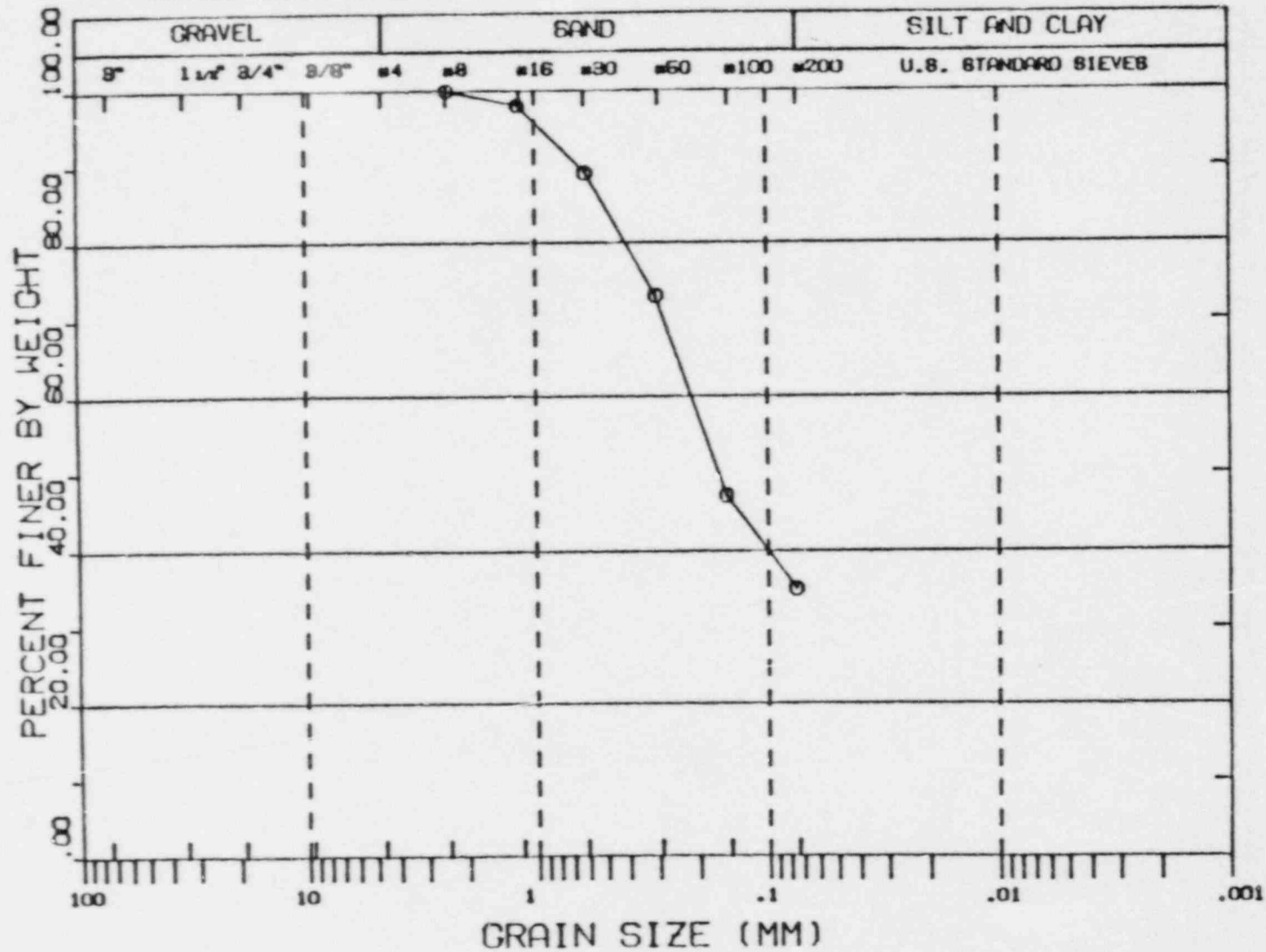


FIGURE D.4.2.AA
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 047
SAMPLE ID: 04
DEPTH INTERVAL(FT): 14.0 - 14.6
UNIFIED SOIL CLASSIFICATION: SM

GRAVEL(%): .0
SAND(%) = 78.0
#200 SIEVE(% FINER) = 22.0
DATE: 5/22/87

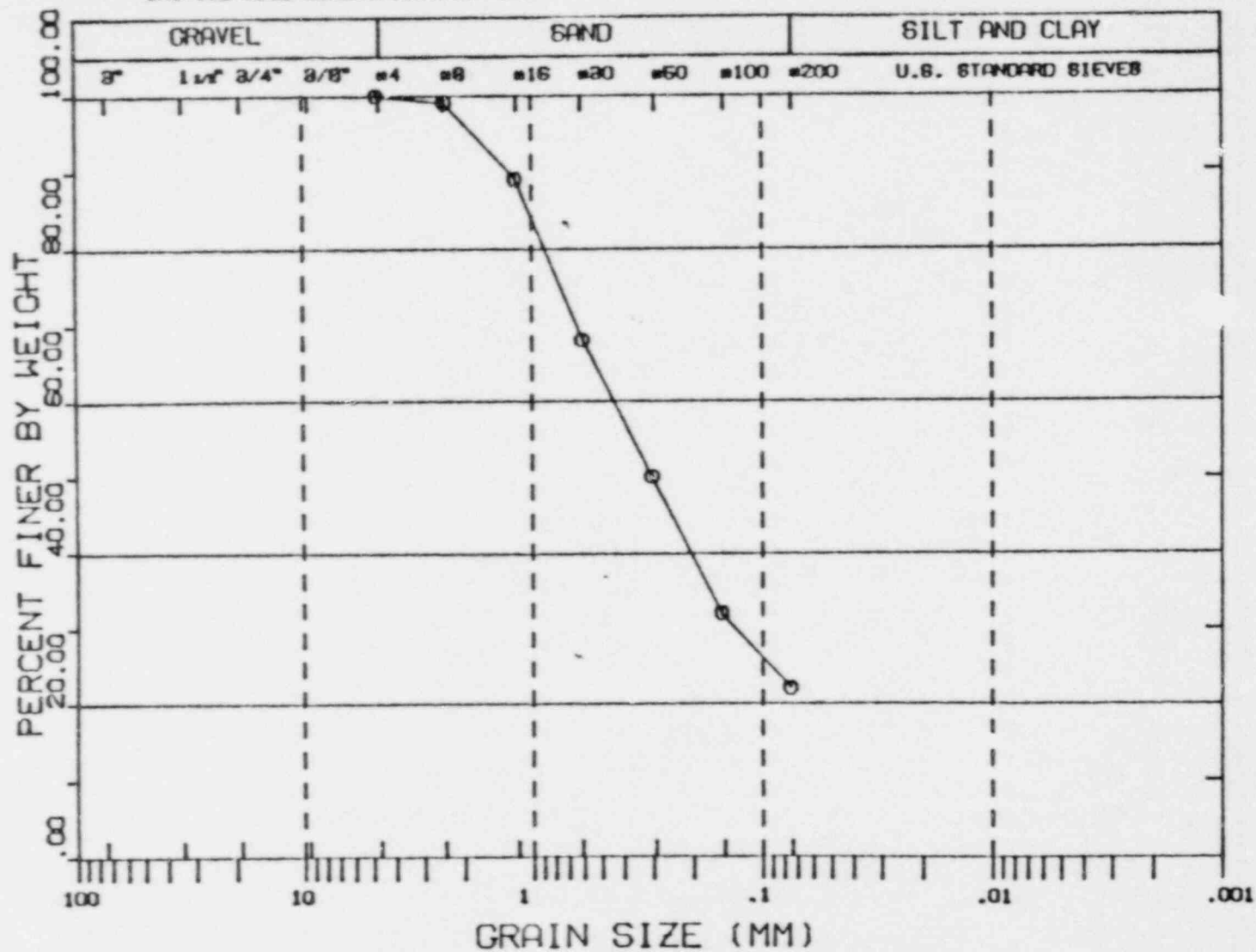


FIGURE D.4.2.AB
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 048

SAMPLE ID: 01

DEPTH INTERVAL (FT): 4.5 - 5.0

UNIFIED SOIL CLASSIFICATION: SP-SM

GRAVEL (%) : .0

SAND (%) : 87.0

#200 SIEVE (% FINER) : 19.0

DATE: 5/22/87

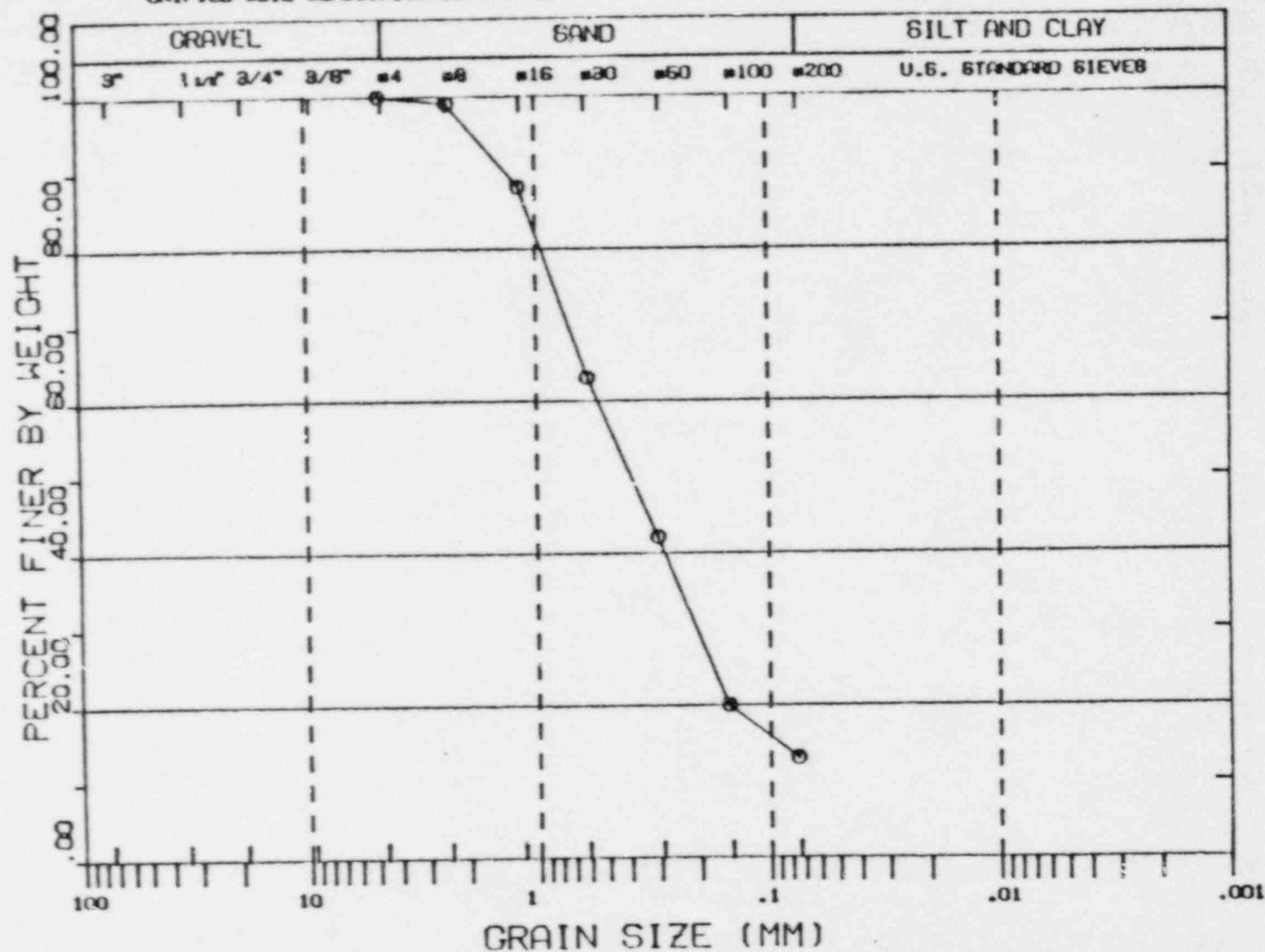


FIGURE D.4.2.AC
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 048

SAMPLE ID: 09

DEPTH INTERVAL(FT): 13.5 - 14.0

UNIFIED SOIL CLASSIFICATION: SP-SM

GRAVEL(%): .0

SAND(%) : 89.0

#200 SIEVE(% FINER) : 11.0

DATE: 6/22/87

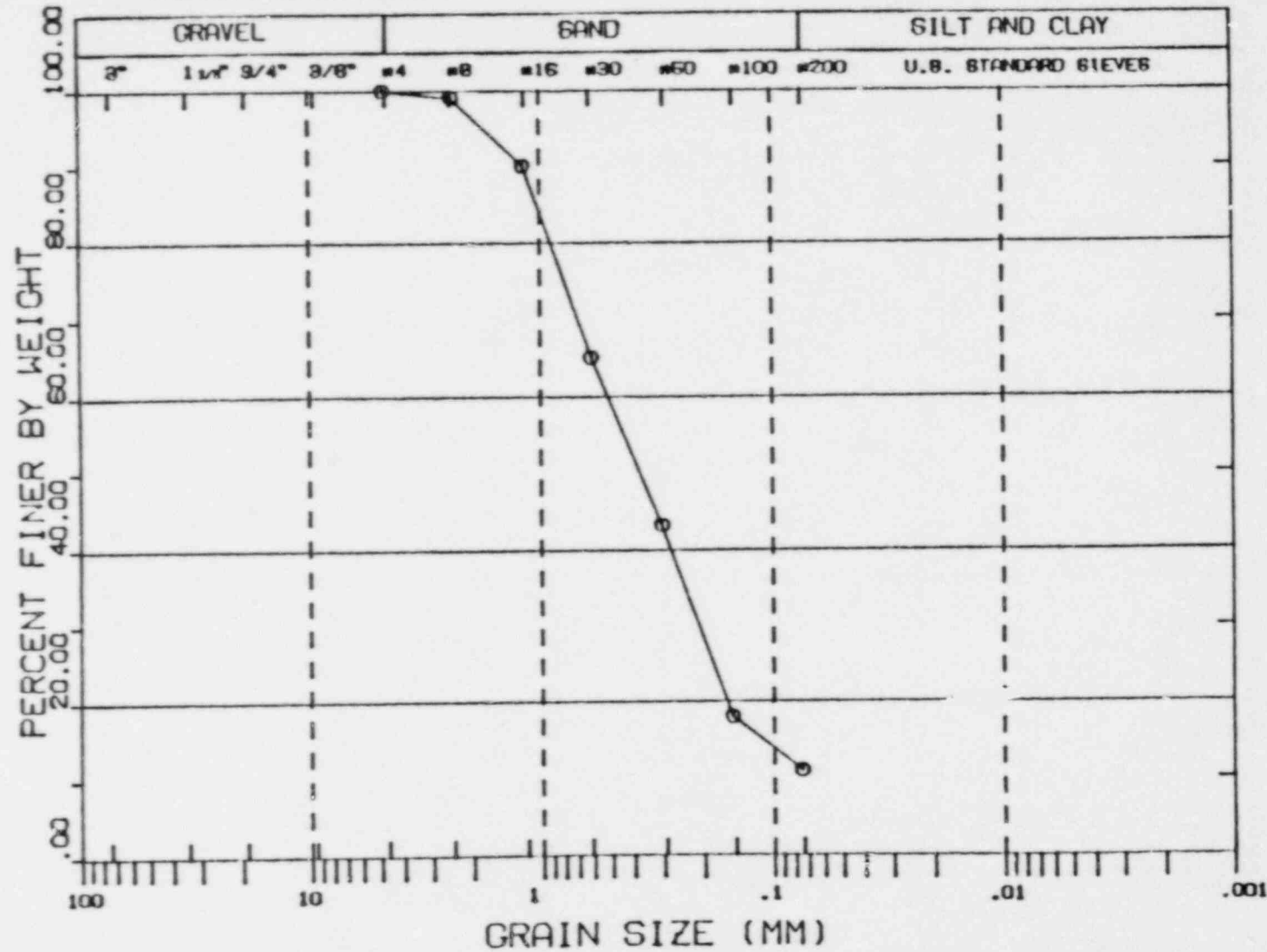


FIGURE D.4.2.AD
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 048

SAMPLE ID: 01

DEPTH INTERVAL (FT): 4.0 - 4.5

UNIFIED SOIL CLASSIFICATION: GP-SM

GRAVEL (%) = .0

SAND (%) = 88.0

#200 SIEVE (% FINER) = 14.0

DATE: 5/22/87

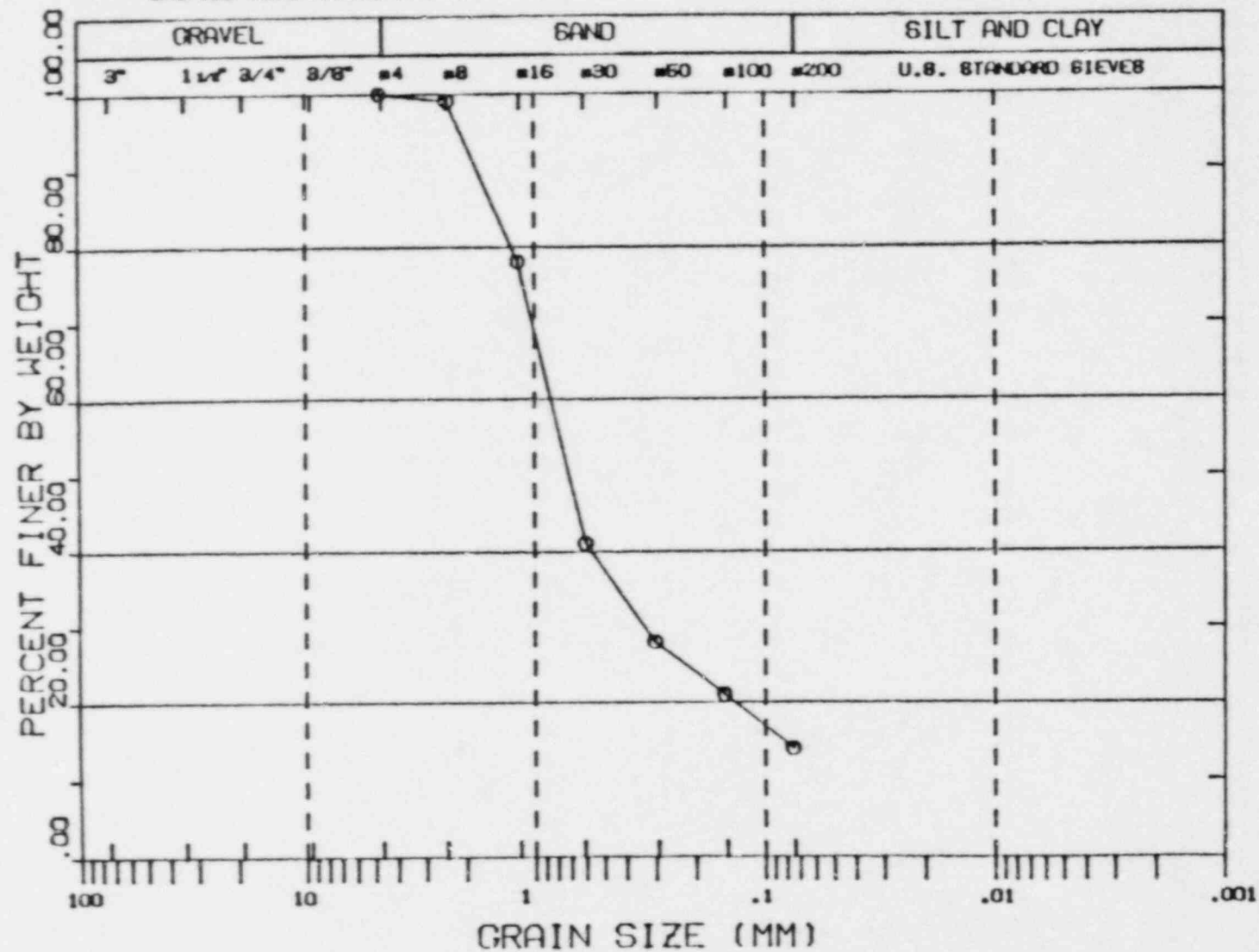


FIGURE D.4.2.AE
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 048
 SAMPLE ID: 09
 DEPTH INTERVAL (FT): 19.5 - 14.0
 UNIFIED SOIL CLASSIFICATION: GP-6M

GRAVEL (%): .0
 SAND (%): 87.0
 #200 SIEVE (% FINER): 13.0
 DATE: 6/22/87

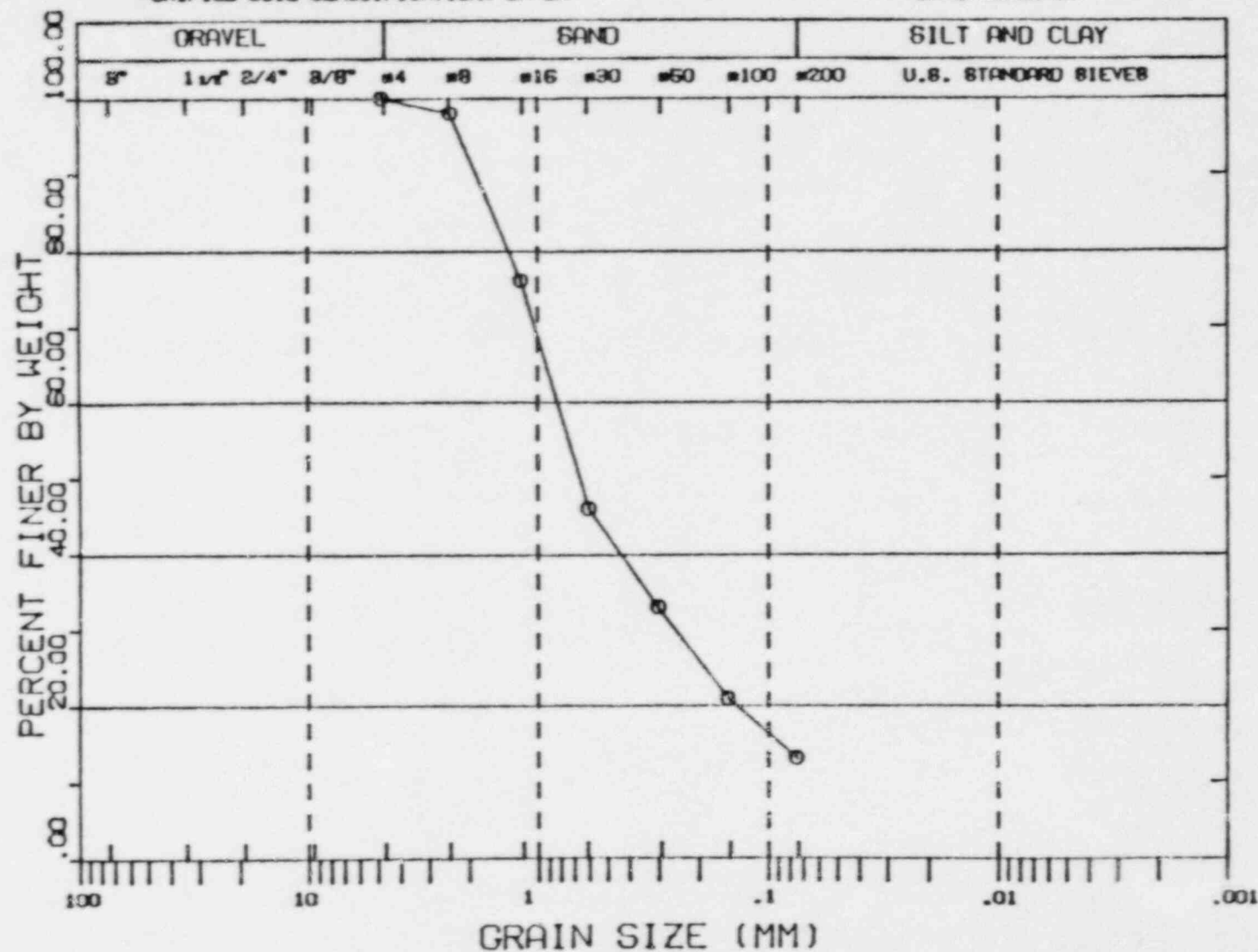


FIGURE D.4.2.AF
 GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 049

SAMPLE ID: 04

DEPTH INTERVAL(FT): 2.0 - 2.5

UNIFIED SOIL CLASSIFICATION: GM

GRAVEL(%) : .0

SAND(%) : 77.0

#200 SIEVE(% FINER) : 22.0

DATE: 6/22/87

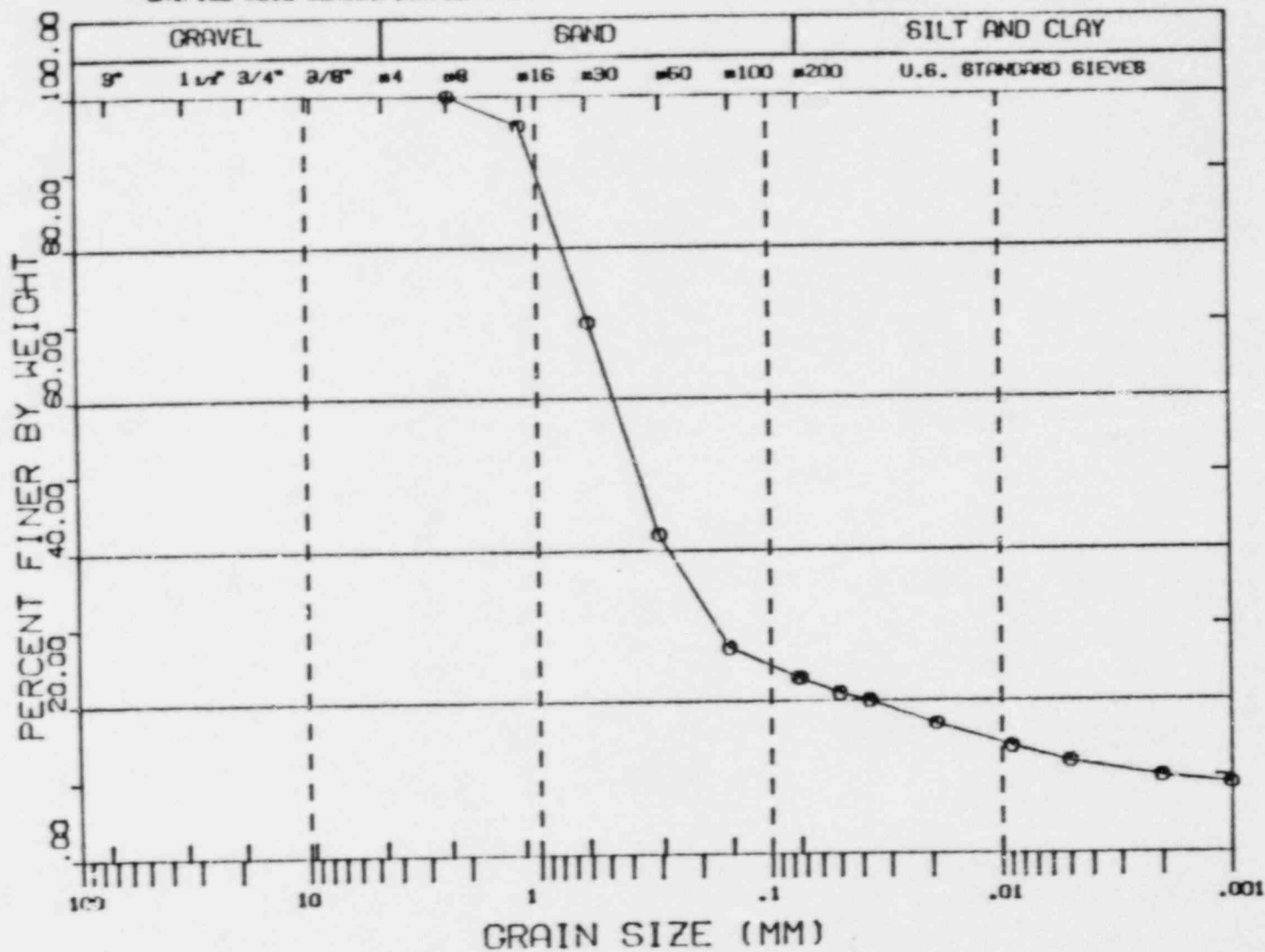


FIGURE D.4.2.AG
GRAIN SIZE DISTRIBUTION CURVE

LOCATION ID: 060
 SAMPLE ID: 01
 DEPTH INTERVAL(FT): 4.0 - 4.5
 UNIFIED SOIL CLASSIFICATION: SP-SM

GRAVEL(%): .0
 SAND(%): 88.0
 #200 SIEVE(% FINER): 12.0
 DATE: 6/22/87

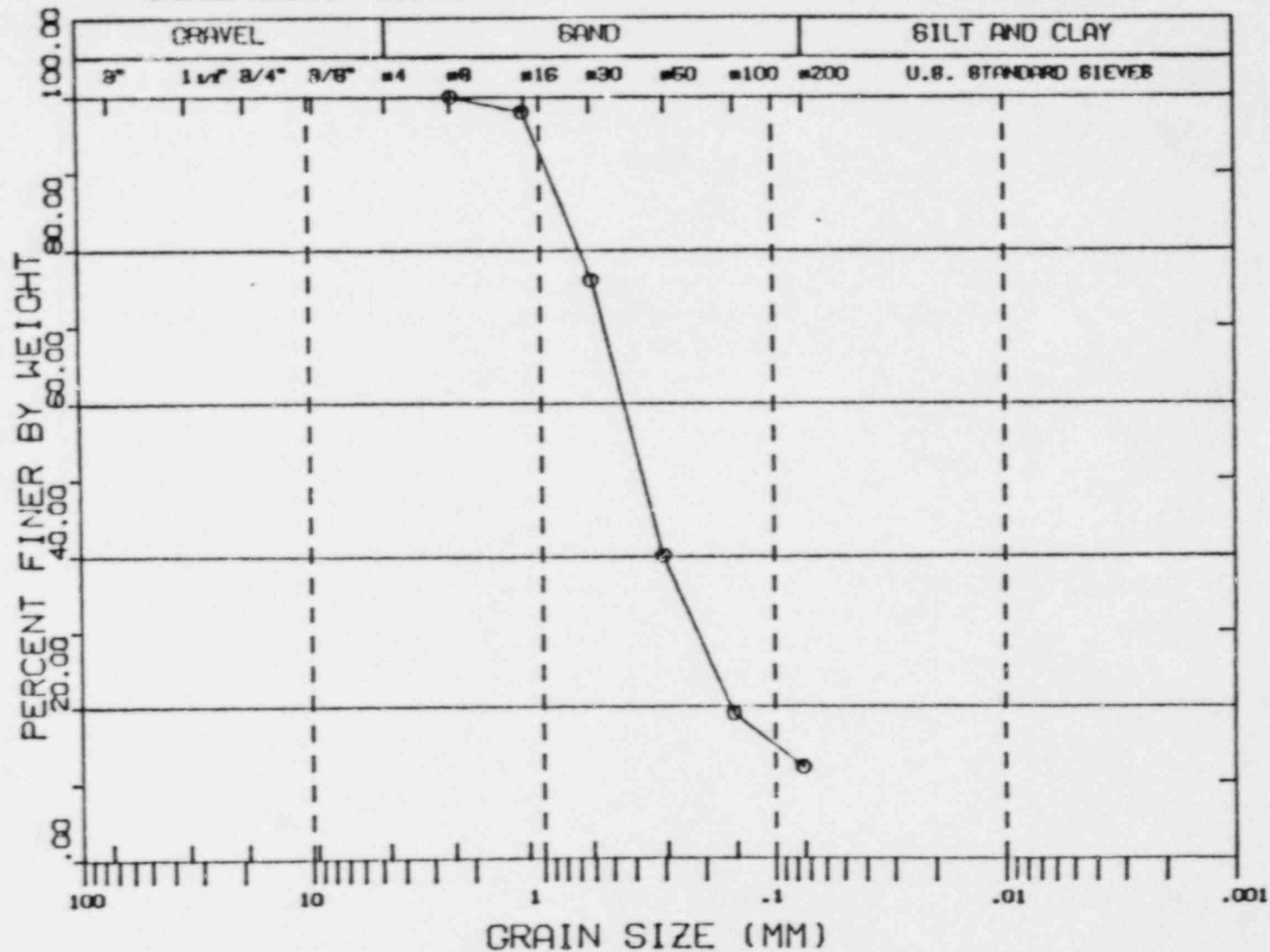


FIGURE D.4.2.AH
 GRAIN SIZE DISTRIBUTION CURVE

COMPACTION TEST

SPOOK

LOCATION ID: 098
SAMPLE ID: 02
DEPTH INTERVAL (FT): 3.5- 4.0
UNIFIED SOIL CLASSIFICATION: SM

DATE: 5/14/87
OPT MOISTURE CONTENT (%): 13.5
MAX DRY DENSITY (PCF): 115.2

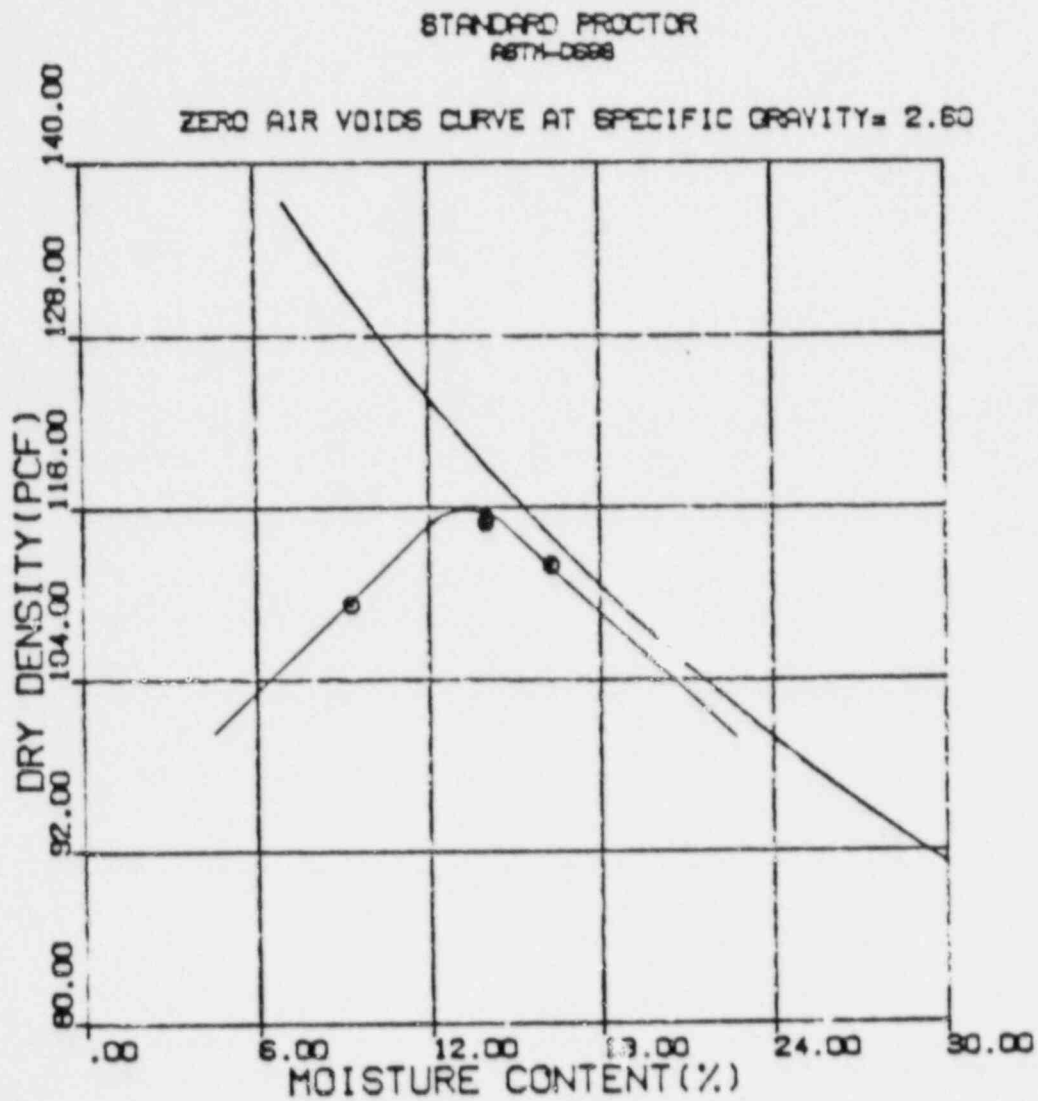


FIGURE D.4.3.A
COMPACTION TEST

COMPACTION TEST

SP00K

LOCATION ID: 041
SAMPLE ID: 02
DEPTH INTERVAL(FT): 9.0- 9.5
UNIFIED SOIL CLASSIFICATION: SM

DATE: 5/14/87
OPT MOISTURE CONTENT(%): 13.0
MAX DRY DENSITY(PCF): 116.9

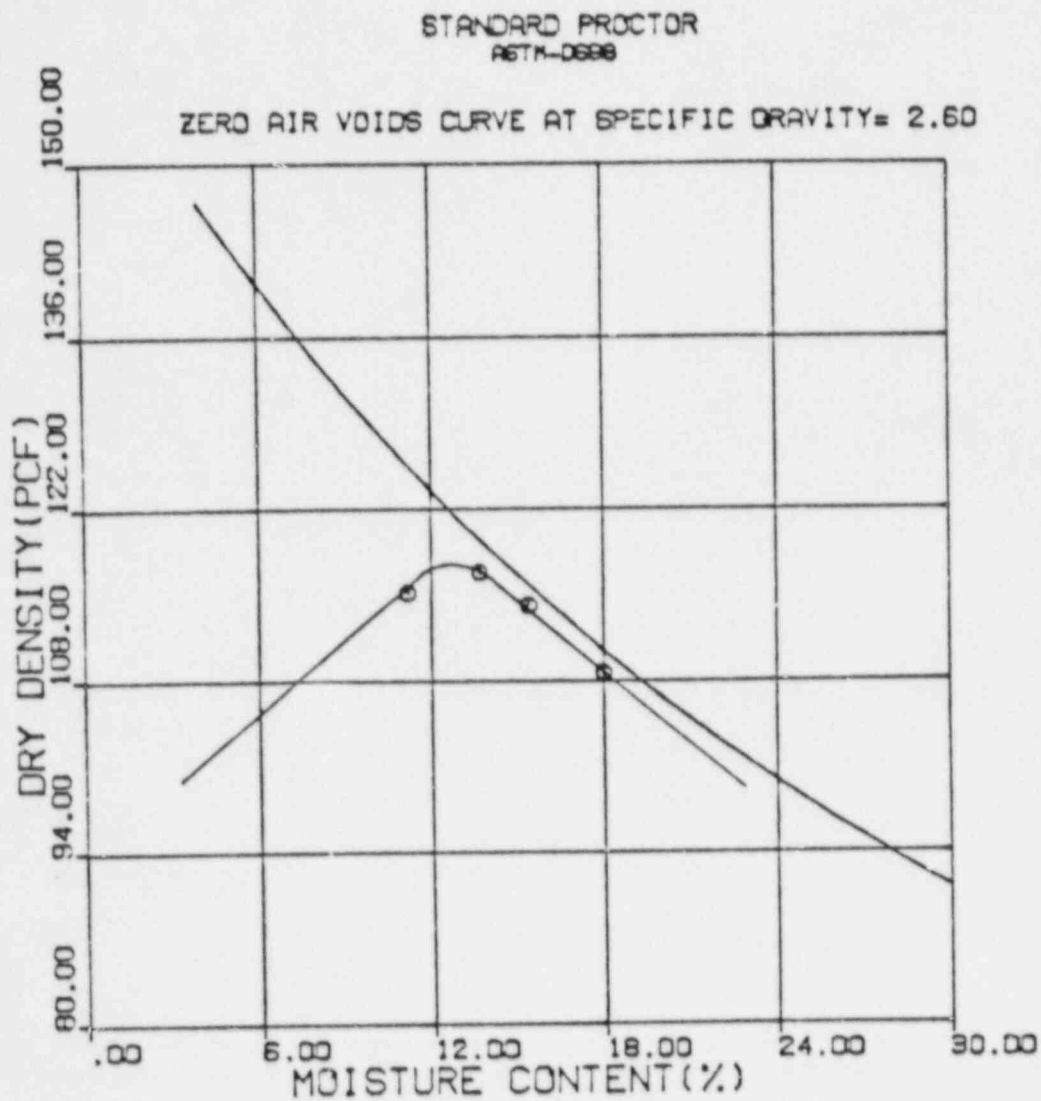


FIGURE D.4.3.B
COMPACTION TEST

COMPACTION TEST

SPOCK

LOCATION ID: 046
SAMPLE ID: 01
DEPTH INTERVAL (FT): 2.0- 2.5
UNIFIED SOIL CLASSIFICATION: SM/ML

DATE: 5/14/87
OPT MOISTURE CONTENT (%): 13.0
MAX DRY DENSITY (PCF): 115.4

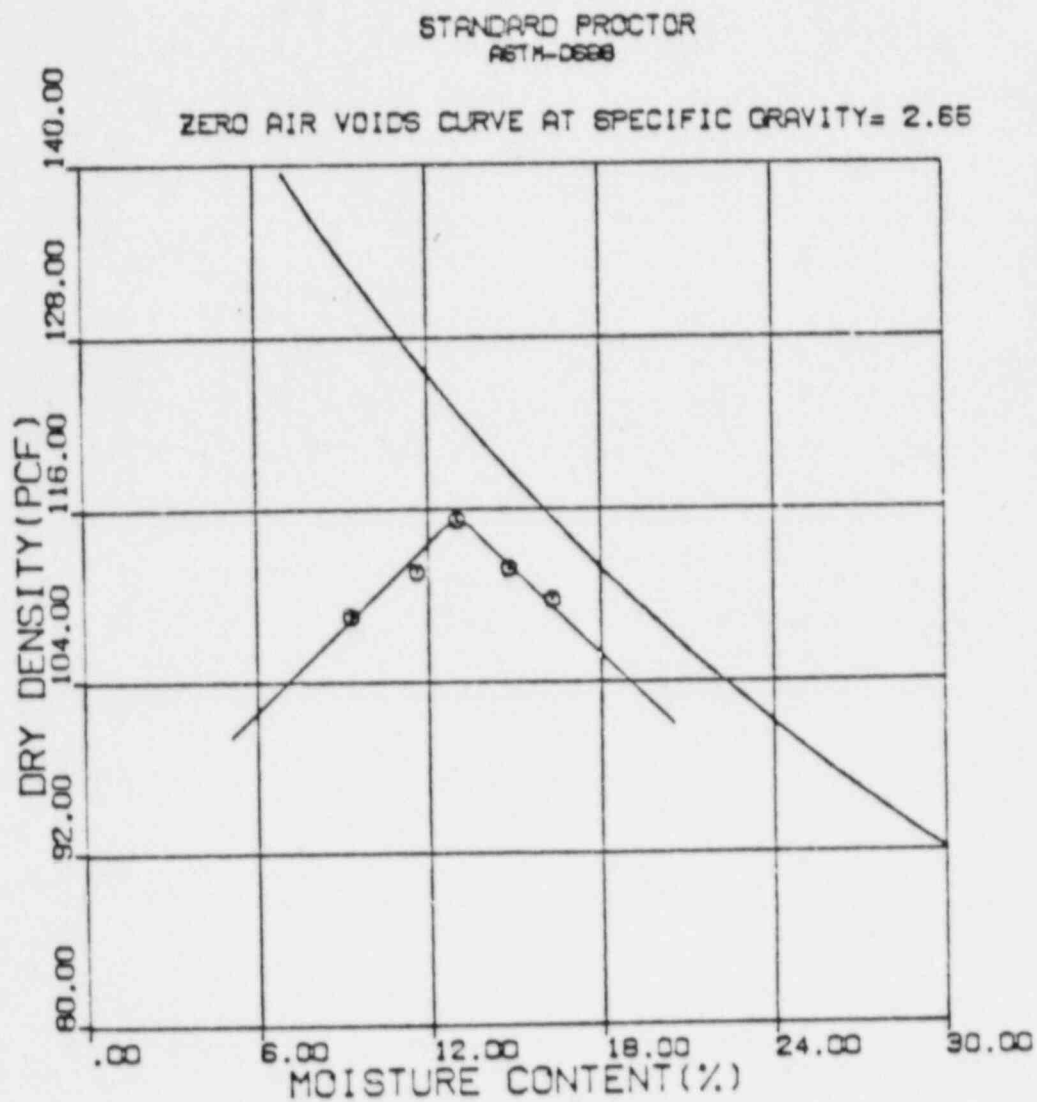


FIGURE D.4.3.C
COMPACTION TEST

COMPACTION TEST

SP00K

LOCATION ID: 047

SAMPLE ID: 02

DEPTH INTERVAL(FT): 4.5- 5.0

UNIFIED SOIL CLASSIFICATION: SM

DATE: 5/14/87

OPT MOISTURE CONTENT(%): 11.9

MAX DRY DENSITY(PCF): 118.9

STANDARD PROCTOR
ASTM-D698

ZERO AIR VOIDS CURVE AT SPECIFIC GRAVITY= 2.70

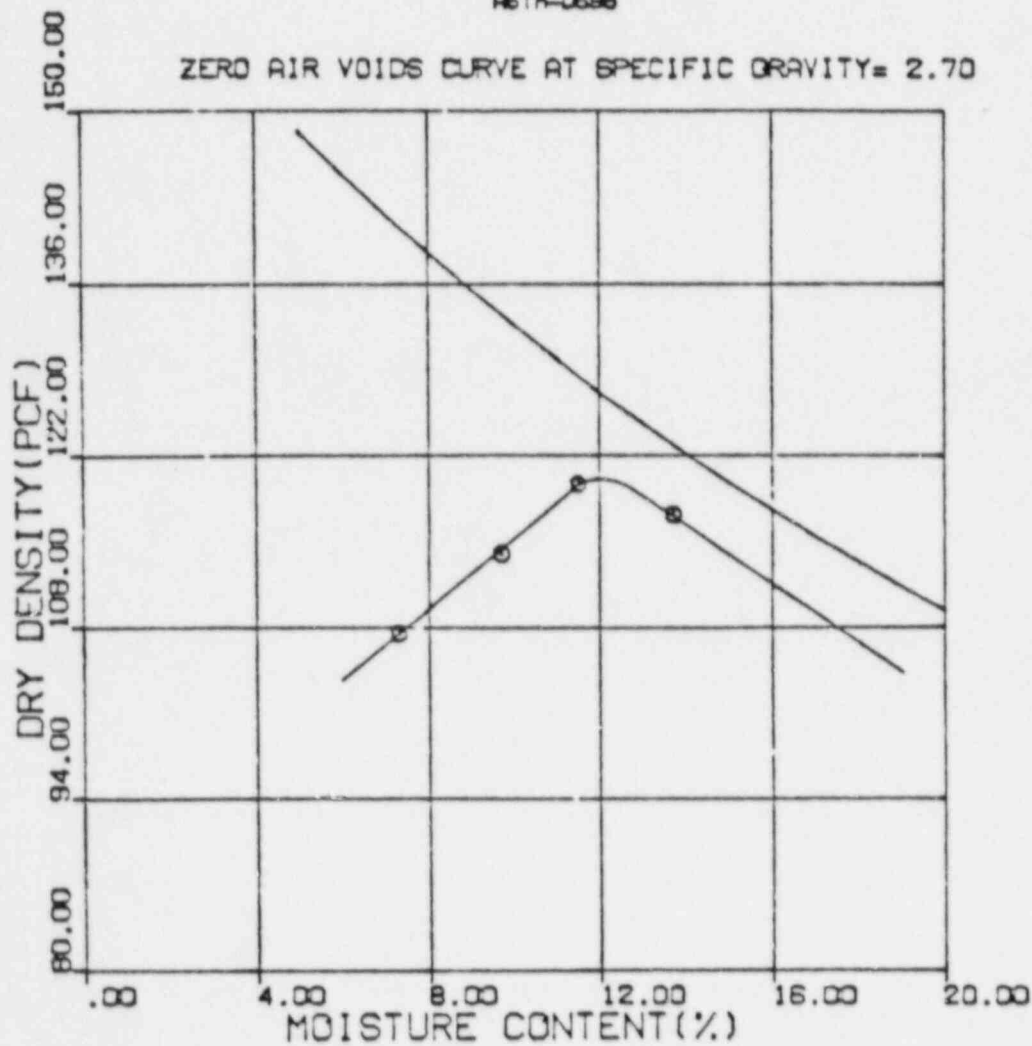


FIGURE D.4.5.D
COMPACTION TEST

COMPACTION TEST

SPOCK

LOCATION ID: 049
SAMPLE ID: 04
DEPTH INTERVAL (FT): 2.0- 2.5
UNIFIED SOIL CLASSIFICATION: SP-SM

DATE: 5/14/87
OPT MOISTURE CONTENT (%): 13.2
MAX DRY DENSITY (PCF): 114.9

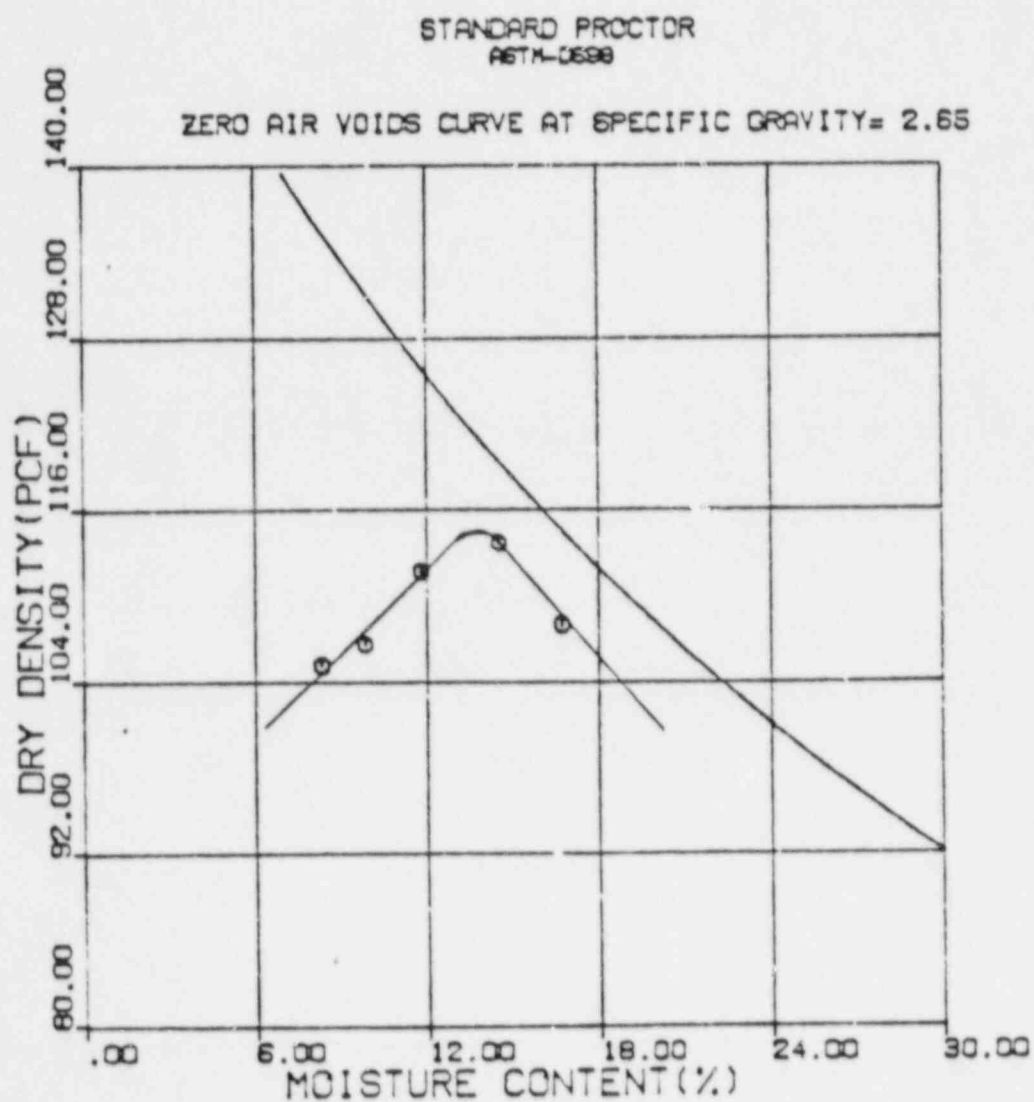


FIGURE D.4.3.E
COMPACTION TEST

COMPACTION TEST

SPOCK

LOCATION ID: 060
SAMPLE ID: 02
DEPTH INTERVAL(FT): 4.5- 6.0
UNIFIED SOIL CLASSIFICATION: SP-8M

DATE: 6/14/87
OPT MOISTURE CONTENT(%): 11.6
MAX DRY DENSITY(PCF): 111.9

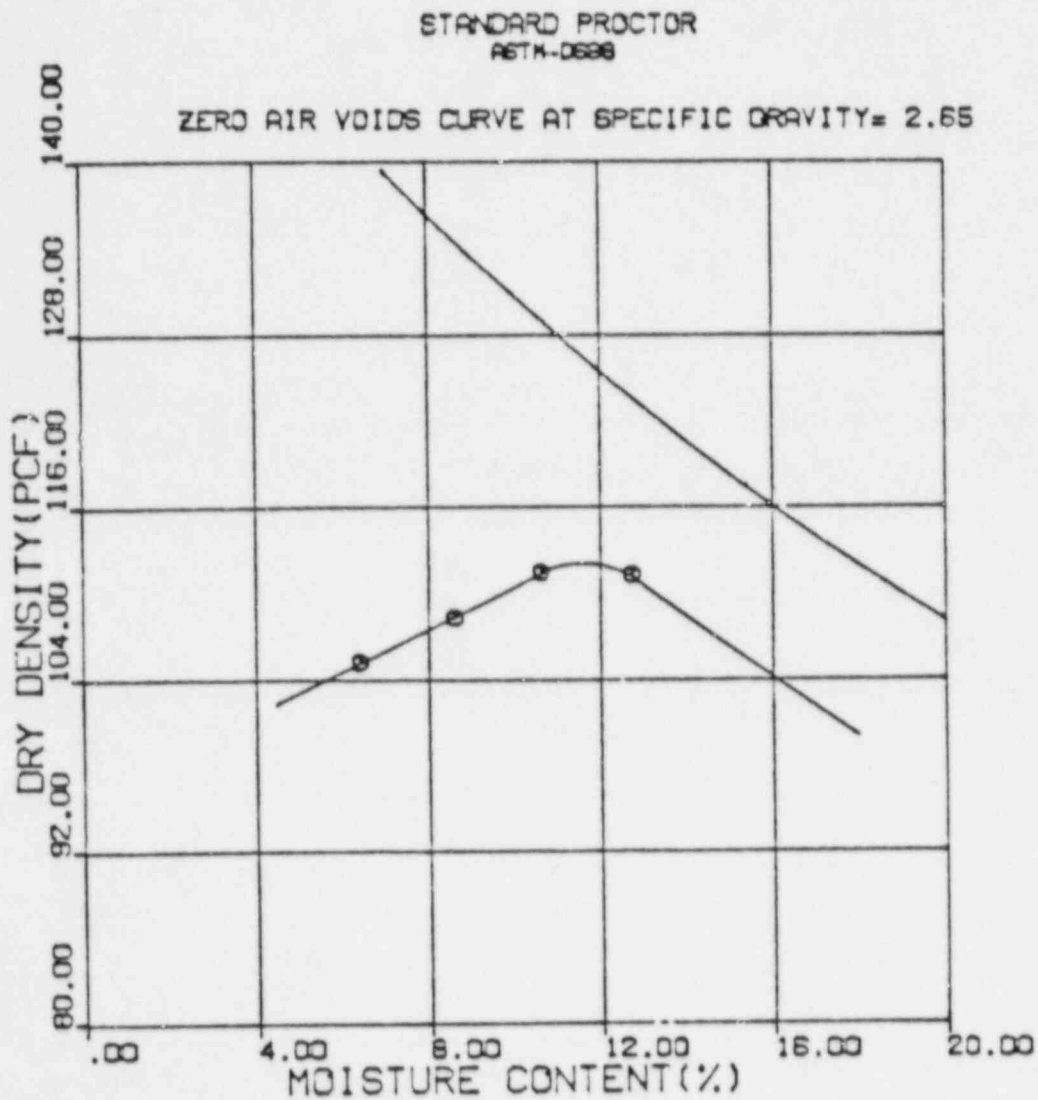
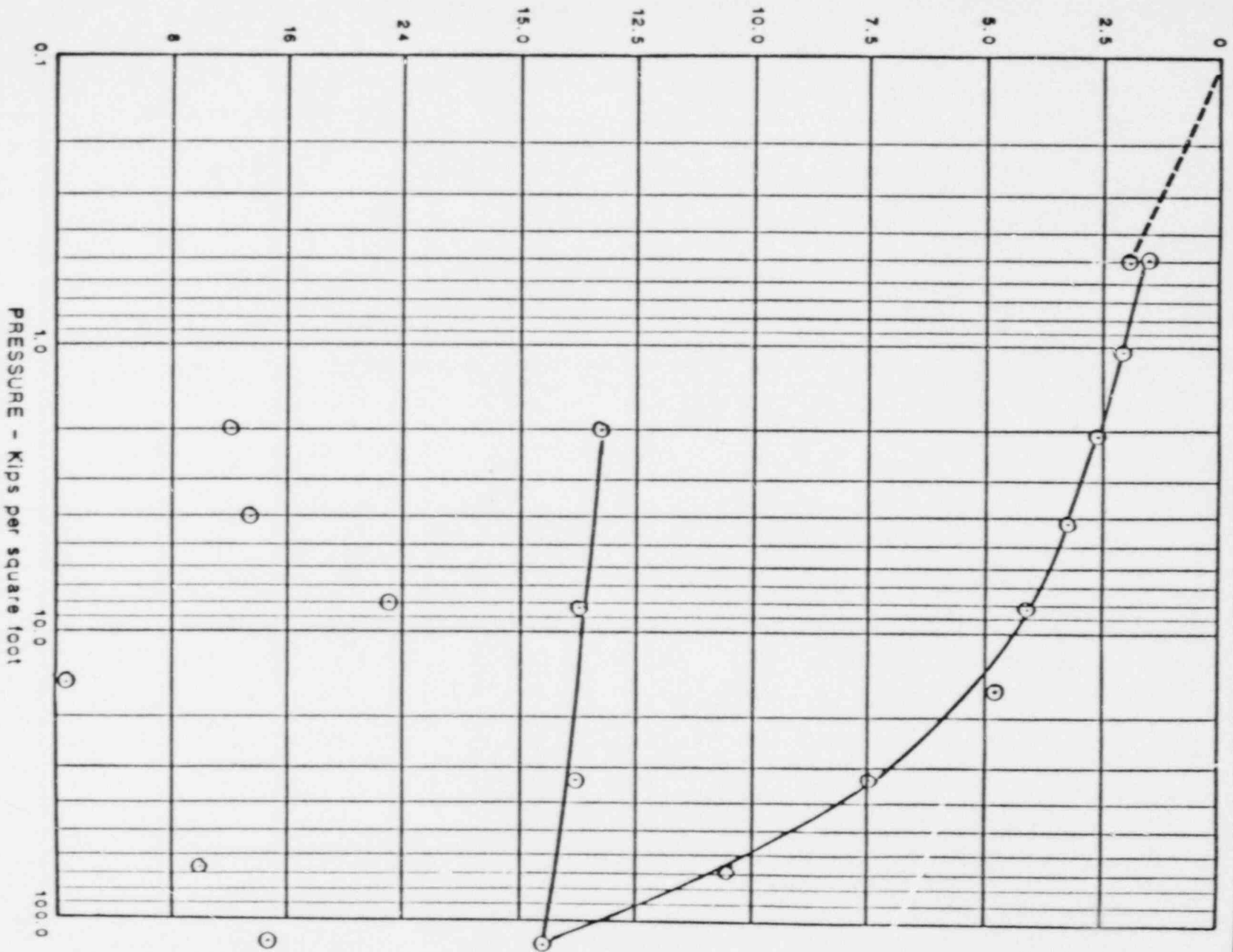


FIGURE D.4.3.F
COMPACTION TEST

COEFFICIENT of CONSOLIDATION $\times 10^{-3}$
(cm^2/sec)

CONSOLIDATION - % of Initial height



PRESSURE - Kips per square foot

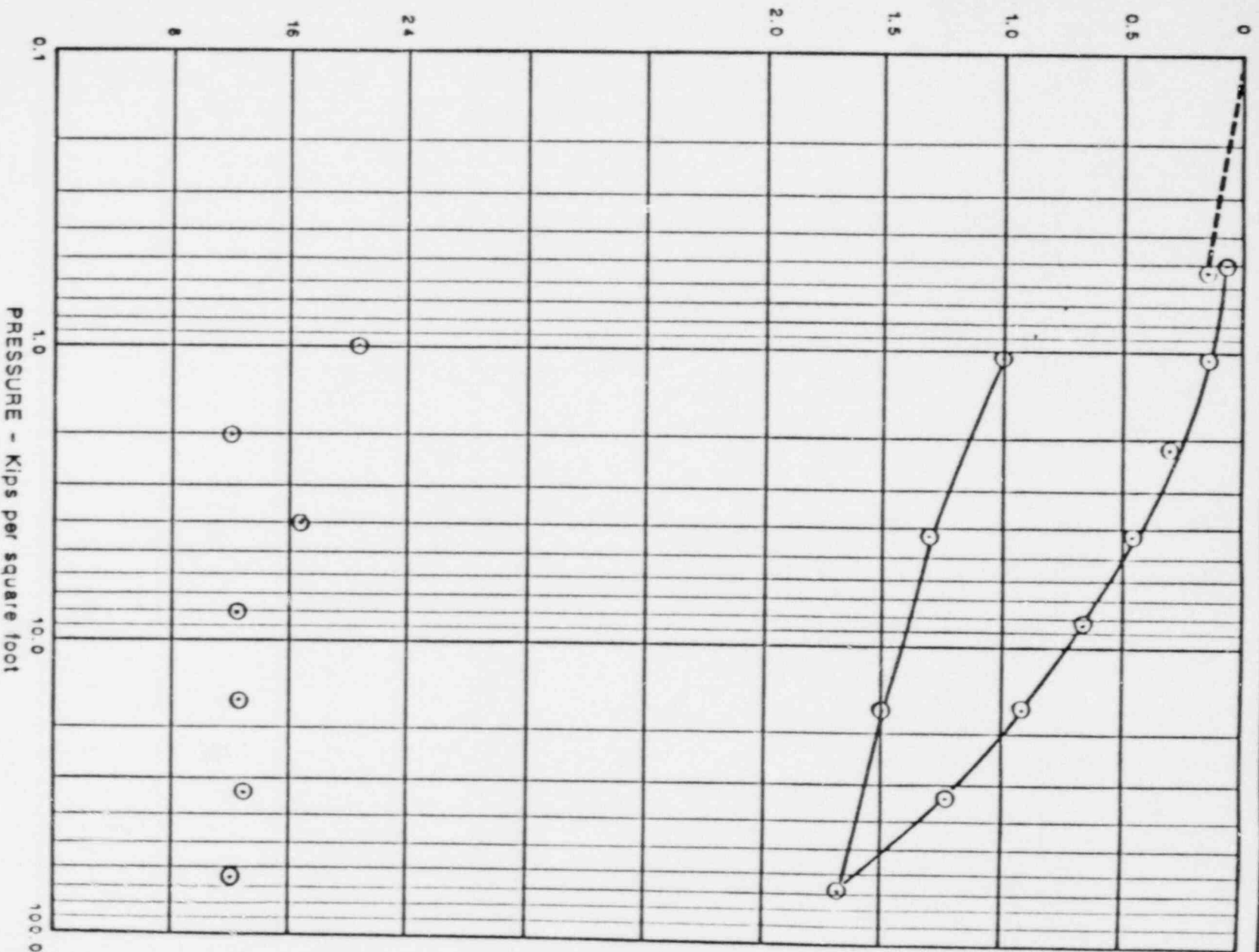
SAMPLE ID	DEPTH INTERVAL (ft.)	INITIAL CONDITIONS		FINAL CONDITIONS		UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	
SPK 01-037-03	3.5-4.0	108.8	125.1	6.5	13.5	SP-SM

FIGURE D.4.4.A

SUMMARY OF CONSOLIDATION TESTS

COEFFICIENT of CONSOLIDATION $\times 10^{-3}$
(cm^2/sec)

CONSOLIDATION - % of initial height



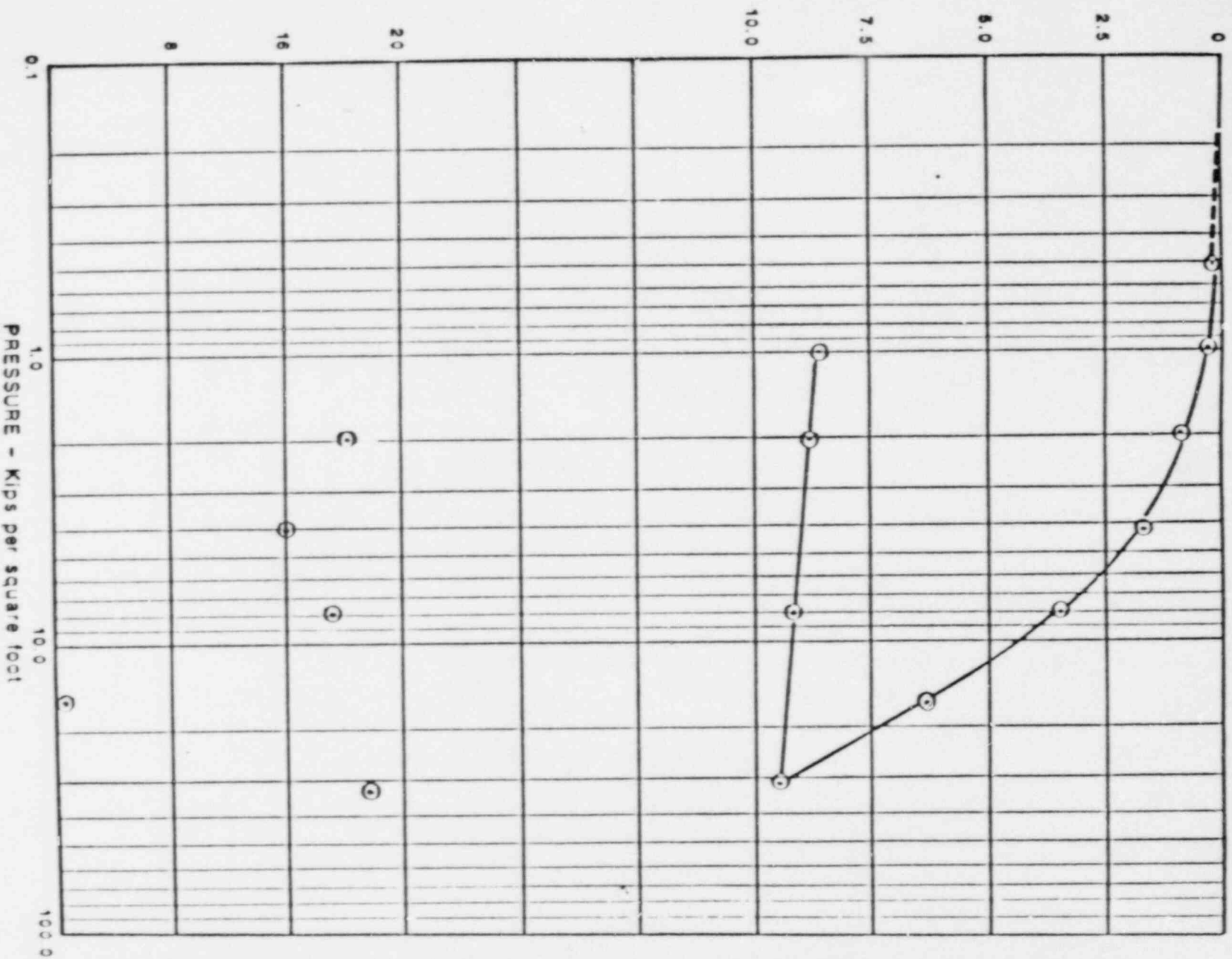
PRESSURE - Kips per square foot

SAMPLE ID	DEPTH INTERVAL (ft.)	INITIAL CONDITIONS		FINAL CONDITIONS		UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	
SPK 01-040-02	4.0'-4.5'	117.8	119.1	7.9	13.4	SM

FIGURE D.4.4.B
SUMMARY OF CONSOLIDATION TESTS

COEFFICIENT of CONSOLIDATION $\times 10^{-3}$
(cm²/sec)

CONSOLIDATION - % of initial height



PRESSURE - Kips per square foot

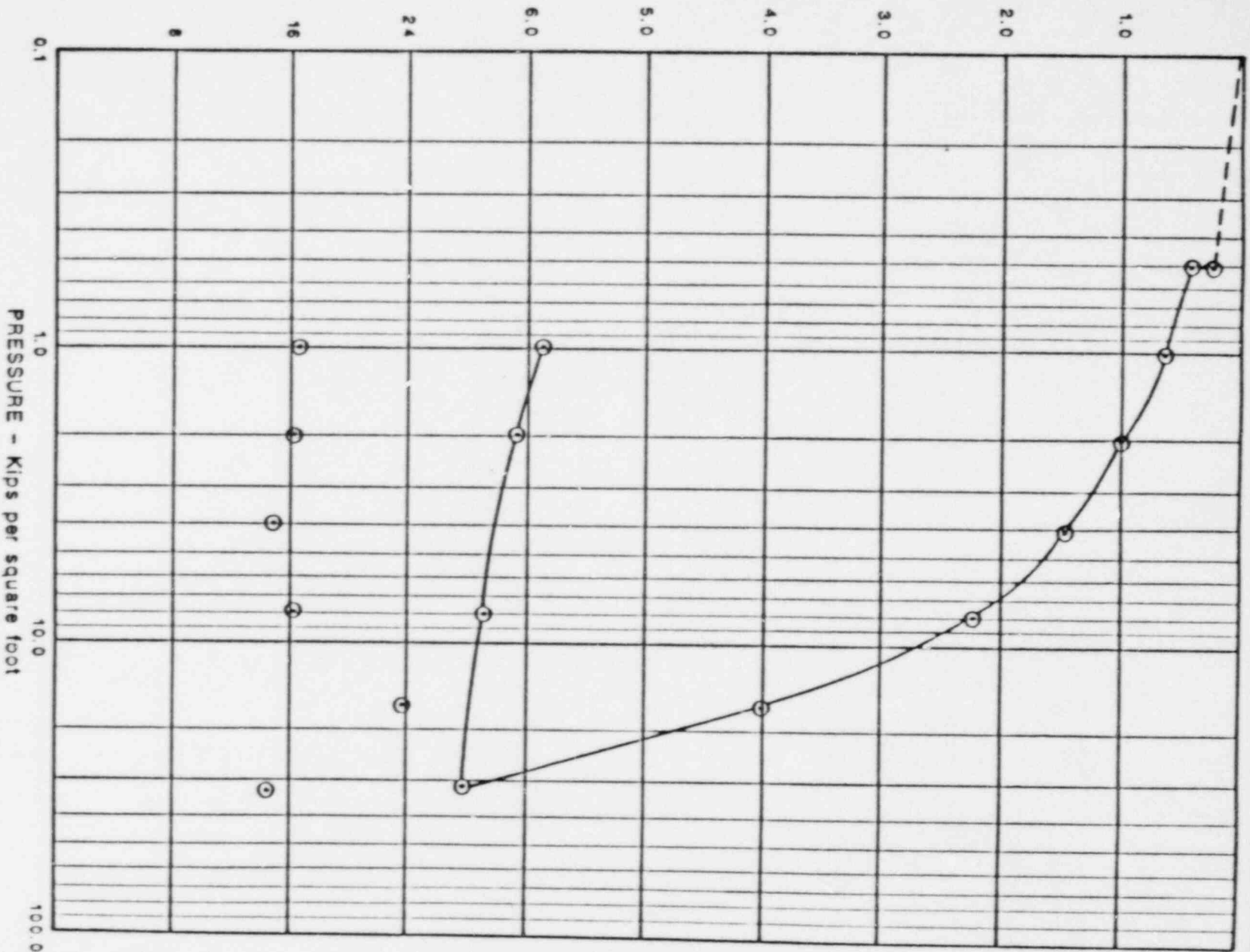
SAMPLE ID	DEPTH INTERVAL (ft)	INITIAL CONDITIONS		FINAL CONDITIONS		UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	
SPK01-041-02A	3.0'-3.5'	105.4	115.4	10.3	16.2	SM

FIGURE D.4.4.C

SUMMARY OF CONSOLIDATION TESTS

COEFFICIENT of CONSOLIDATION $\times 10^{-3}$
(cm²/sec)

CONSOLIDATION - % of Initial height



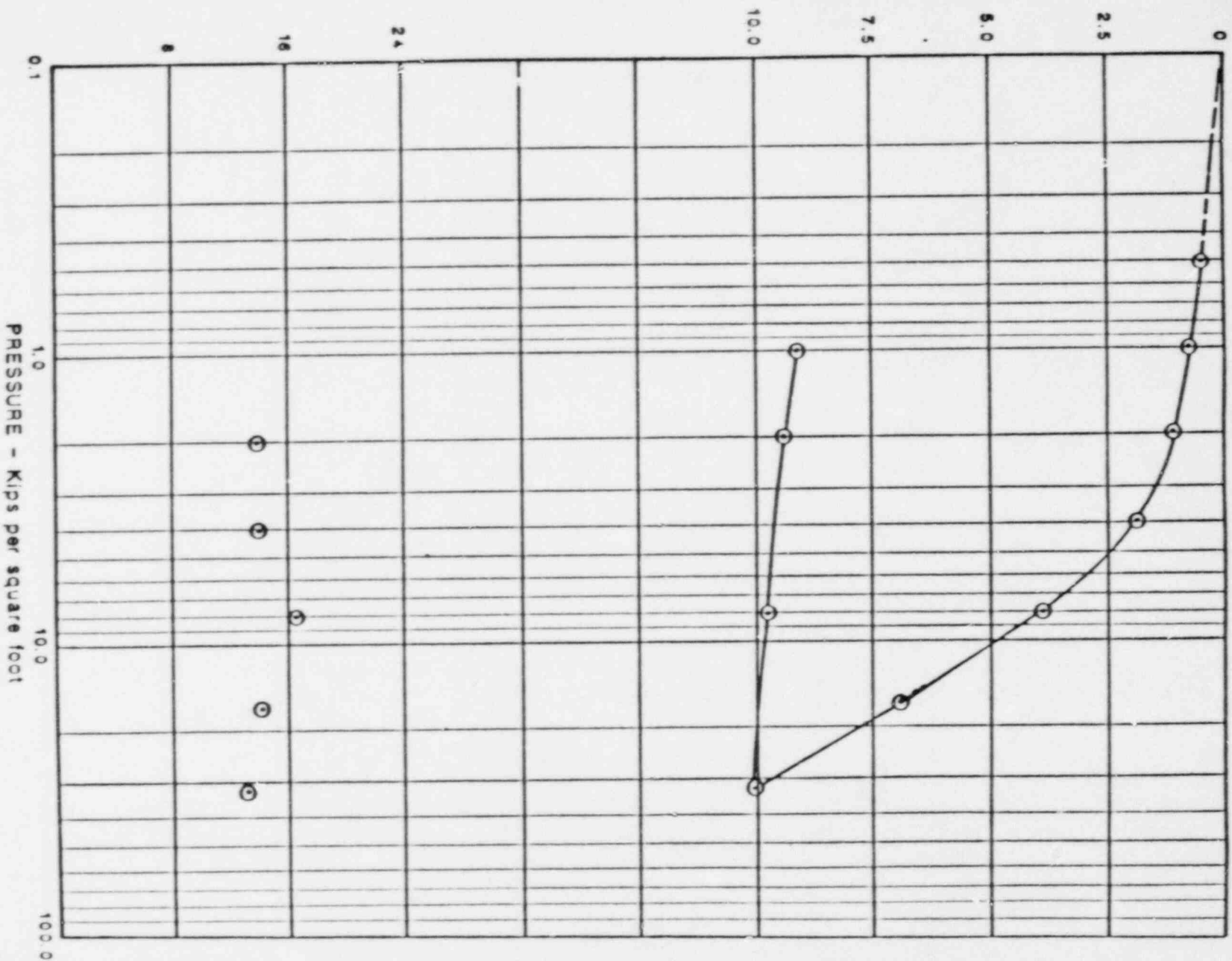
PRESSURE - Kips per square foot

SAMPLE ID	DEPTH INTERVAL (ft.)	INITIAL CONDITIONS		FINAL CONDITIONS		UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	
SPK01 - 041-028	3.0-3.5	108.4	115.1	12.5	14.9	SM

FIGURE D.4.4.D
SUMMARY OF CONSOLIDATION TESTS

COEFFICIENT of CONSOLIDATION $\times 10^{-3}$
(cm²/sec)

CONSOLIDATION - % of Initial height



PRESSURE - Kips per square foot

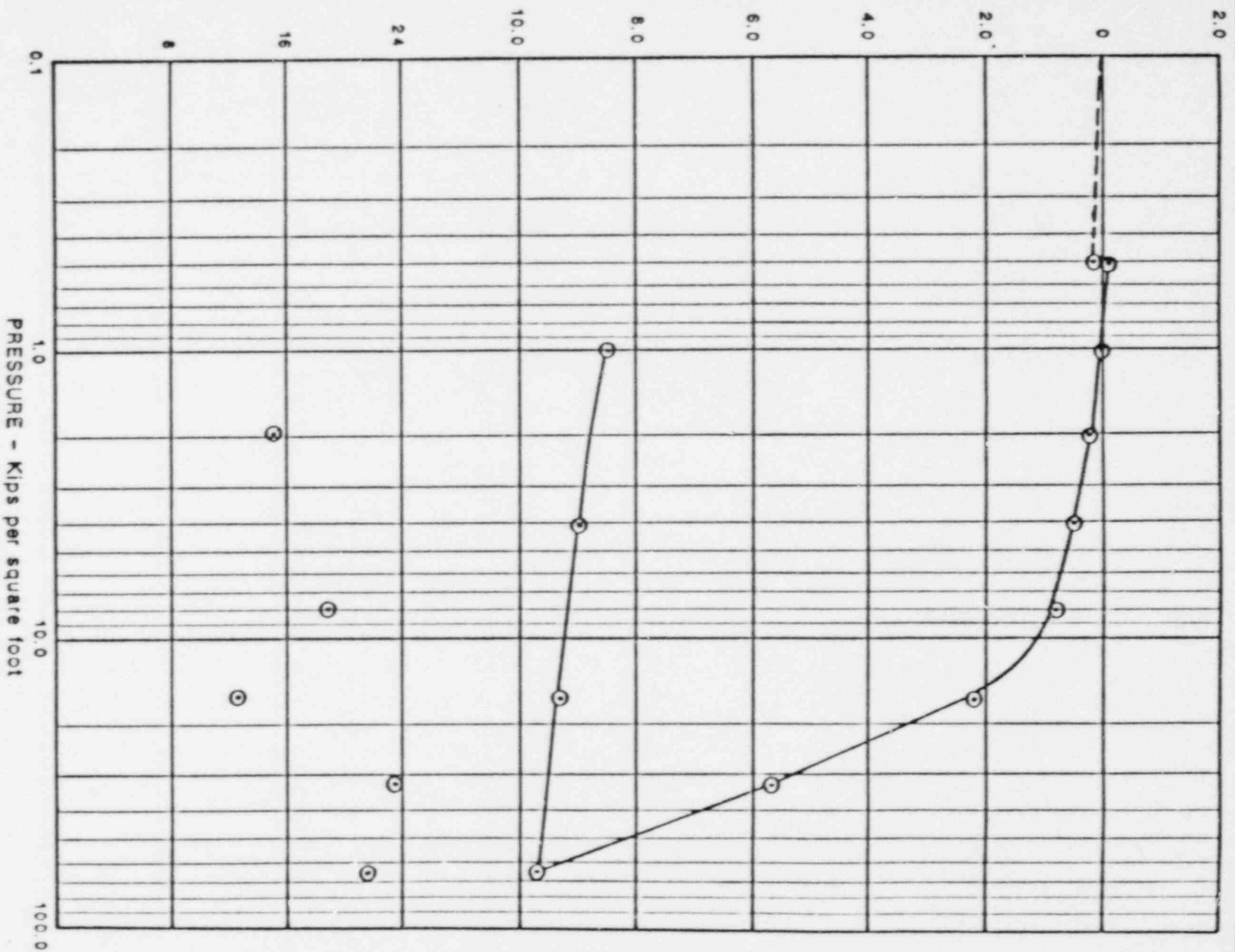
SAMPLE ID	DEPTH INTERVAL (ft.)	INITIAL CONDITIONS		FINAL CONDITIONS		UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	
SPK 01-044-02A	4.0-4.5	102.3	112.7	13.2	16.4	SH

FIGURE D.4.4.E

SUMMARY OF CONSOLIDATION TESTS

COEFFICIENT of CONSOLIDATION $\times 10^{-3}$
(cm^2/sec)

CONSOLIDATION - % of Initial height

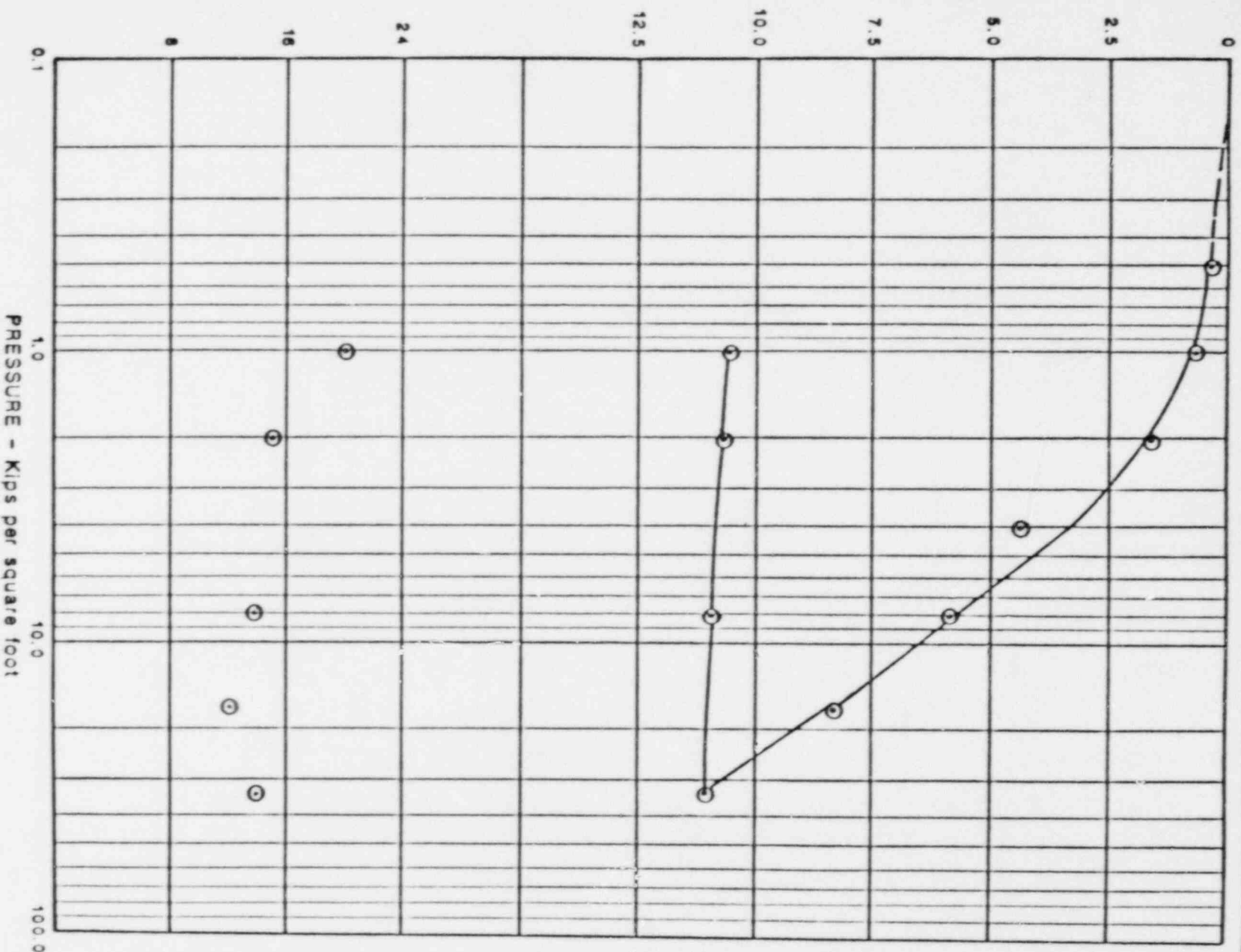


SAMPLE ID	DEPTH INTERVAL (ft.)	INITIAL CONDITIONS		FINAL CONDITIONS		SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	
SPK 01-044-02B	4.0-4.5	105.0	115.4	8.6	15.4	SM

FIGURE D.4.4.F
SUMMARY OF CONSOLIDATION TESTS

COEFFICIENT of CONSOLIDATION $\times 10^{-3}$
(cm²/sec)

CONSOLIDATION - % of Initial height



SAMPLE ID	DEPTH INTERVAL (ft.)	INITIAL CONDITIONS		FINAL CONDITIONS		UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	
SPK01-044-02C	4.0-4.5	102.3	114.5	14.8	15.8	SM

FIGURE D.4.4.G
SUMMARY OF CONSOLIDATION TESTS

COEFFICIENT of CONSOLIDATION $\times 10^{-3}$
(cm²/sec)

CONSOLIDATION - % of Initial height

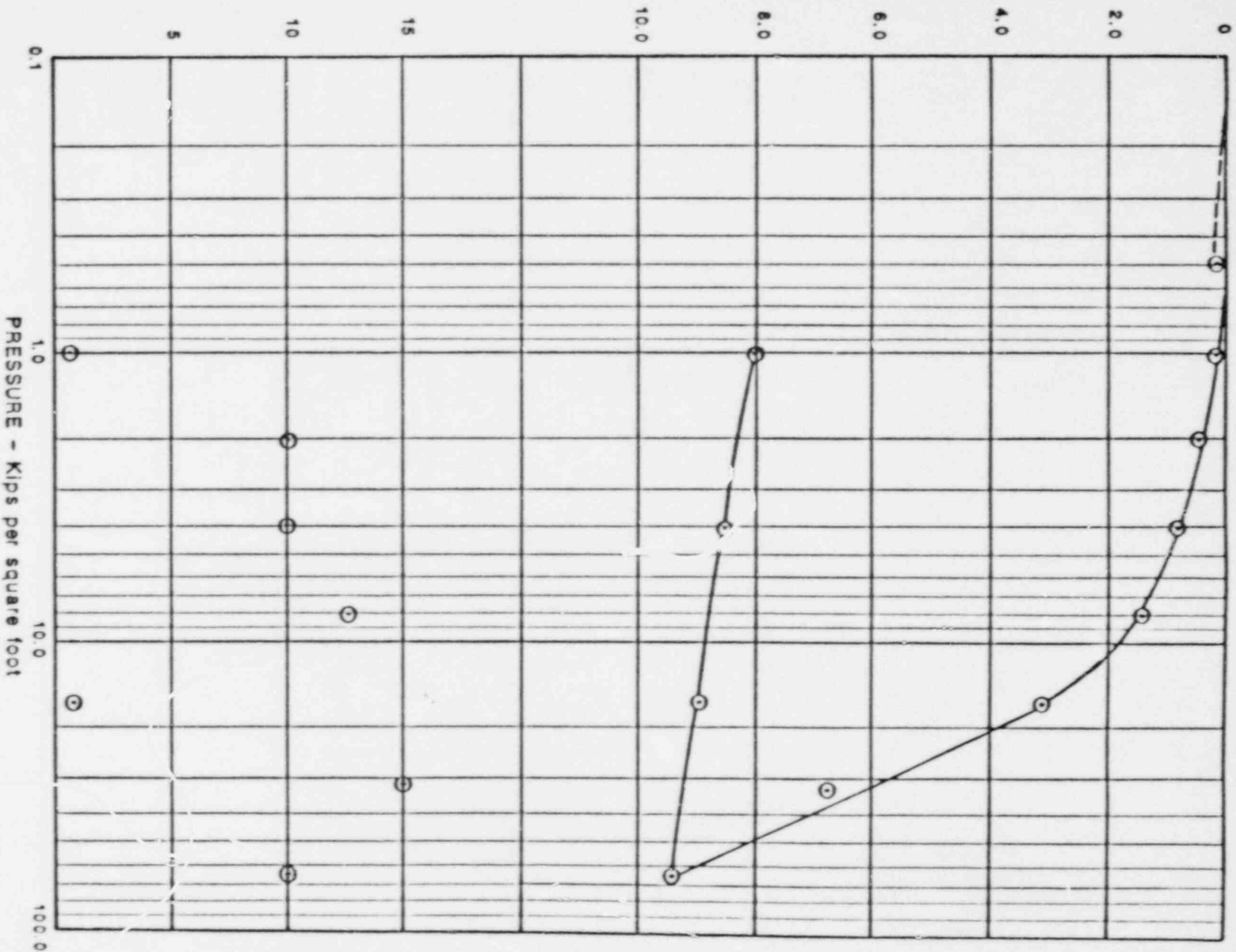
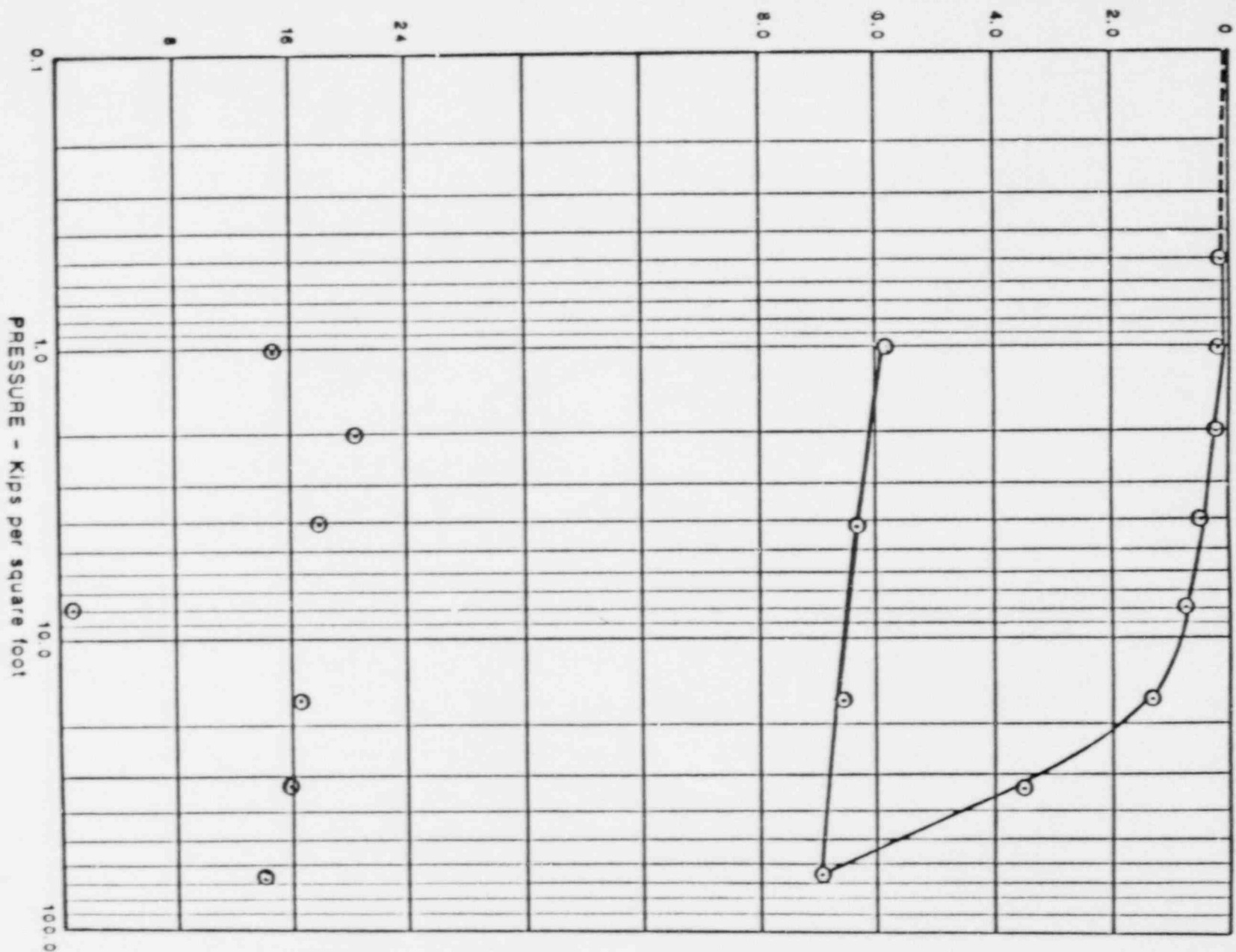


FIGURE D.4.4.H
SUMMARY OF CONSOLIDATION TESTS

SAMPLE ID	DEPTH INTERVAL (ft.)	INITIAL CONDITIONS		FINAL CONDITIONS		UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	
SPK01-047-02	4.5'-5.0'	11.5	121.2	11.5	13.1	SM

COEFFICIENT of CONSOLIDATION $\times 10^{-3}$
(cm²/sec)

CONSOLIDATION - % of Initial height

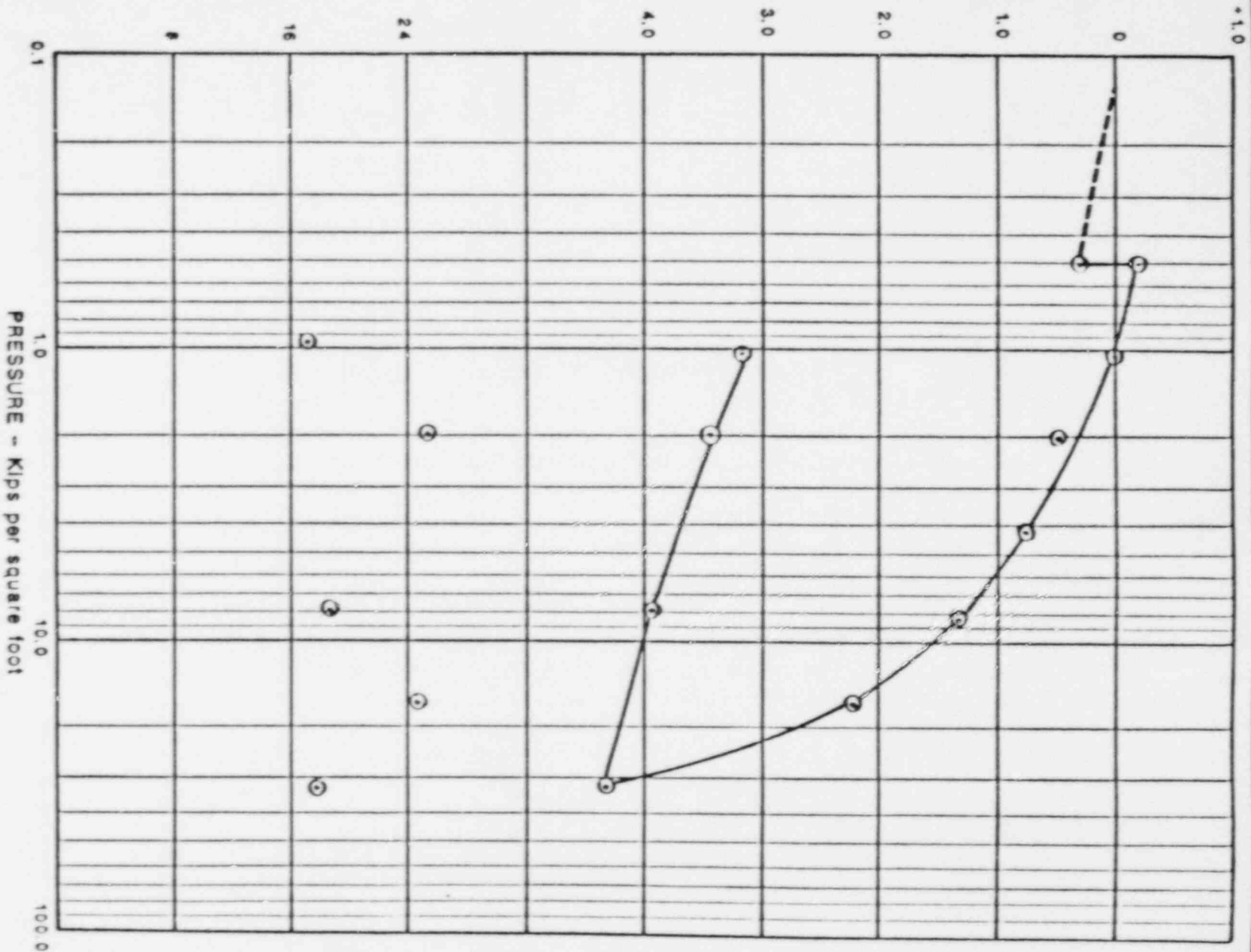


SAMPLE ID	DEPTH INTERVAL (ft.)	INITIAL CONDITIONS		FINAL CONDITIONS		UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	
SPK01-050-02A	4.5'-5.0'	104.0	110.5	111.1	16.9	SP-SM

FIGURE D.4.4.1
SUMMARY OF CONSOLIDATION TESTS

COEFFICIENT of CONSOLIDATION $\times 10^{-3}$
(cm^2/sec)

CONSOLIDATION - % of Initial height

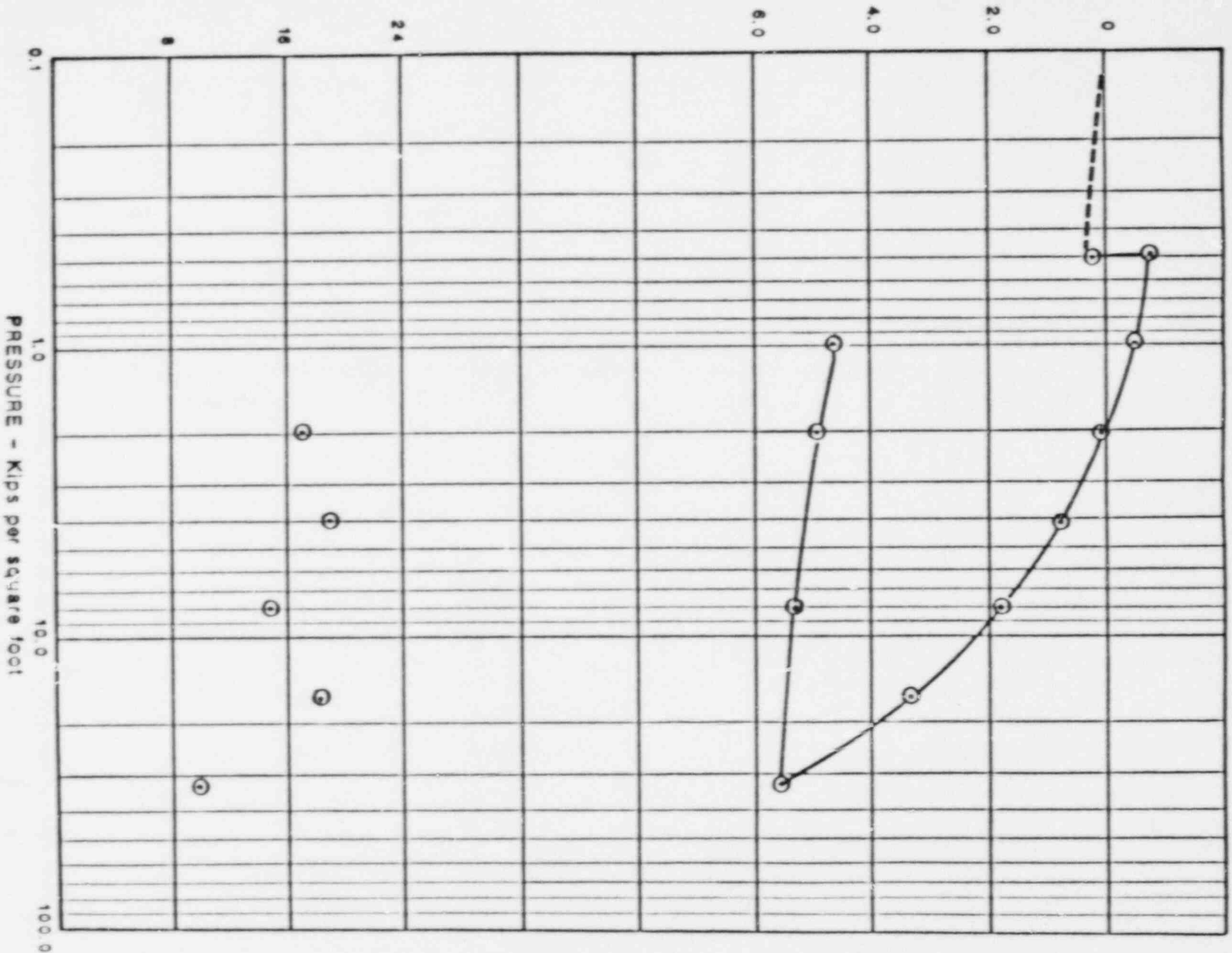


SAMPLE ID	DEPTH INTERVAL (ft.)	INITIAL CONDITIONS		FINAL CONDITIONS		UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	
PK01-050-02B	4.5-5.0	103.8	107.2	6.9	19.5	SP-SM

FIGURE D.4.4.J
SUMMARY OF CONSOLIDATION TESTS

COEFFICIENT of CONSOLIDATION $\times 10^{-3}$
(cm²/sec)

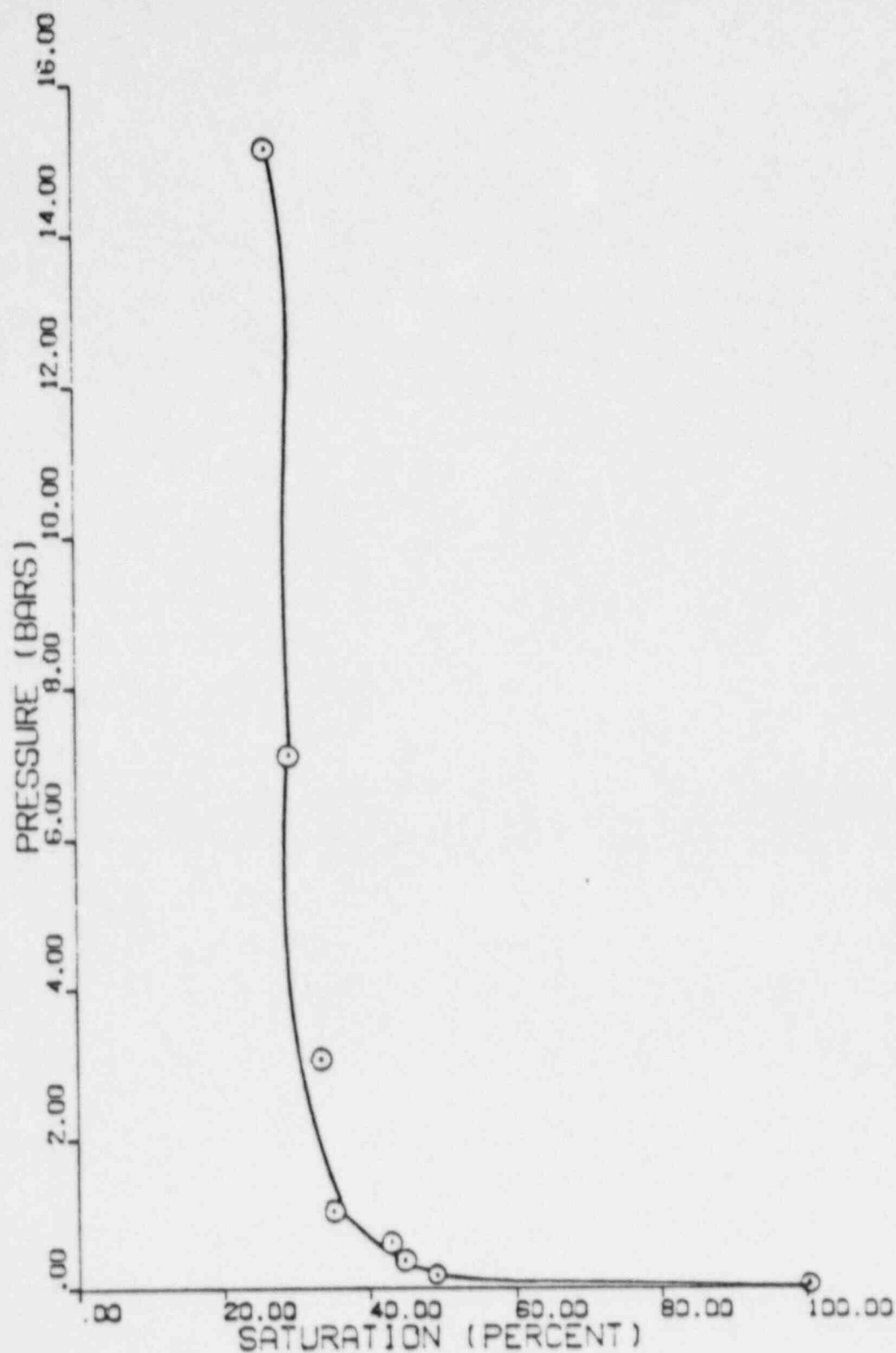
CONSOLIDATION - % of Initial height



PRESSURE - Kips per square foot

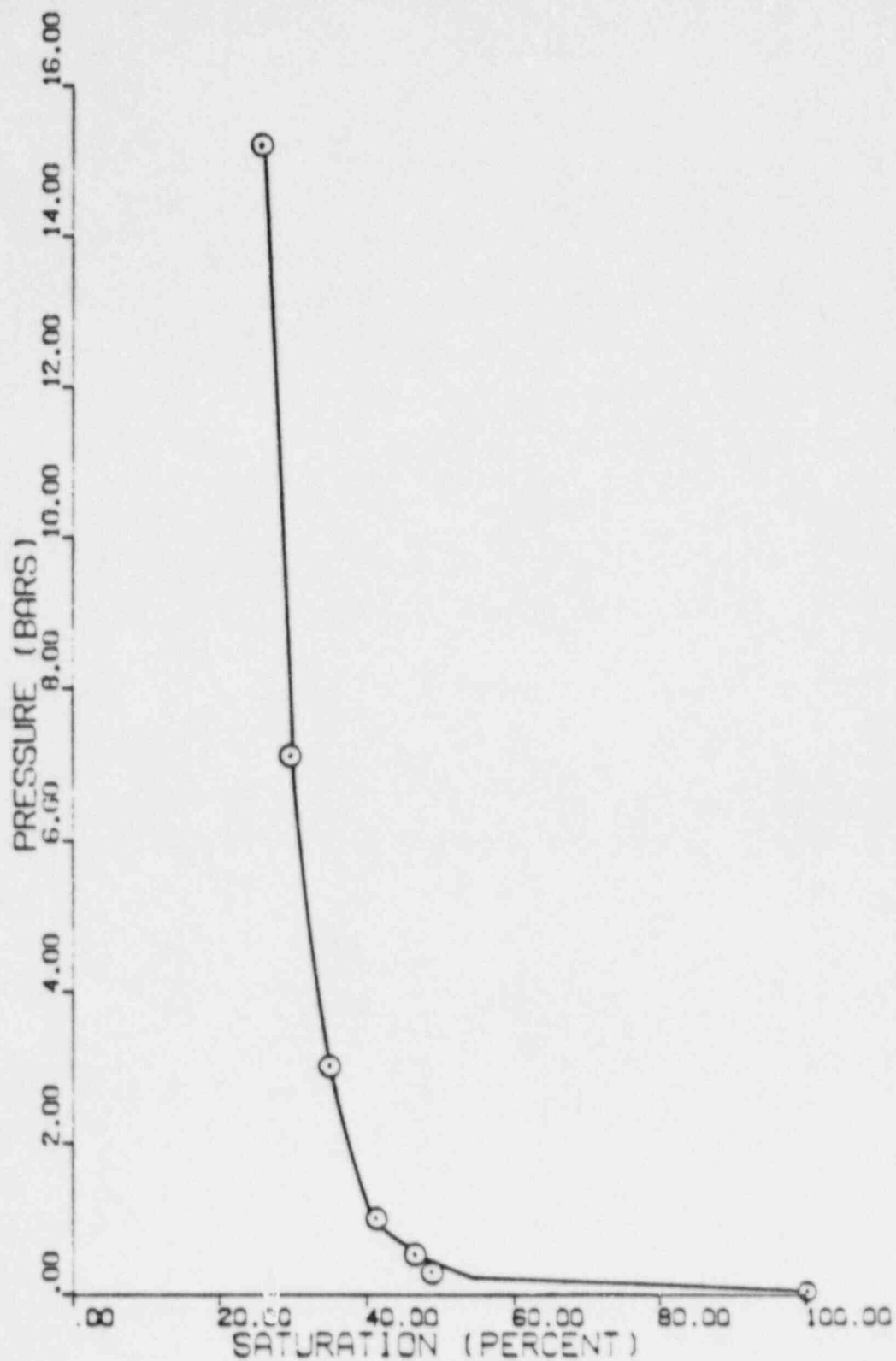
SAMPLE ID	DEPTH INTERVAL (ft.)	INITIAL CONDITIONS		FINAL CONDITIONS		UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	
SPK 01-050-020	4.5-5.0	104.1	109.1	93.8	18.1	SP-SM

FIGURE D.4.4.K
SUMMARY OF CONSOLIDATION TESTS



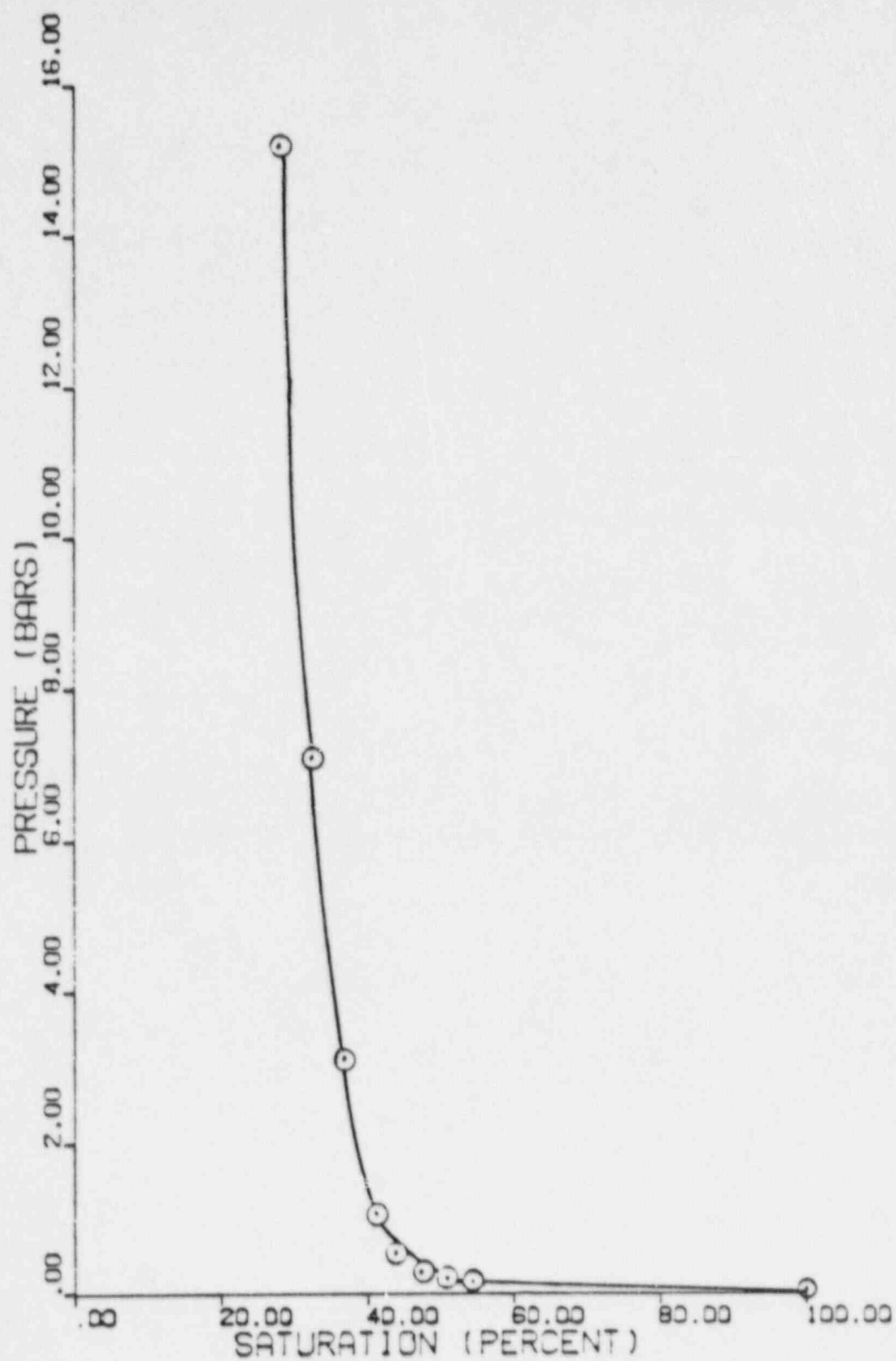
SAMPLE ID	DEPTH (ft.)	INITIAL CONDITIONS		COMPACTION (%)	UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)		
SPK01-036	4.5-50	101.6	8.8	100%	BR SILTY SAND (SM)

FIGURE D.4.5.A
CAPILLARY MOISTURE CURVE



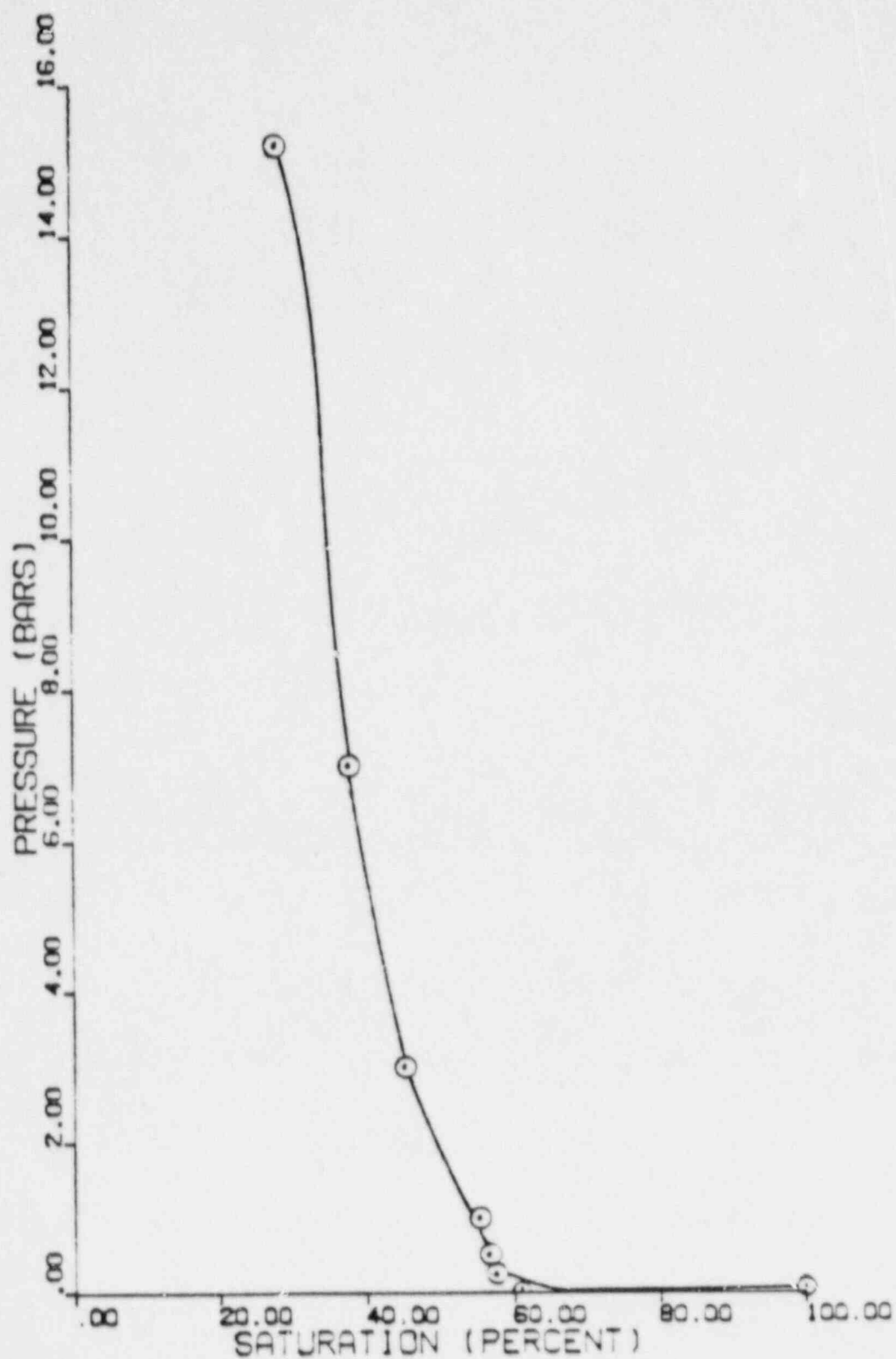
SAMPLE ID	DEPTH (ft.)	INITIAL CONDITIONS		COMPACTION (%)	UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)		
SPK01-032	3.5-4.0	102.5	8.8	100%	BR SILTY SAND (SM)

FIGURE D.4.5.B
CAPILLARY MOISTURE CURVE



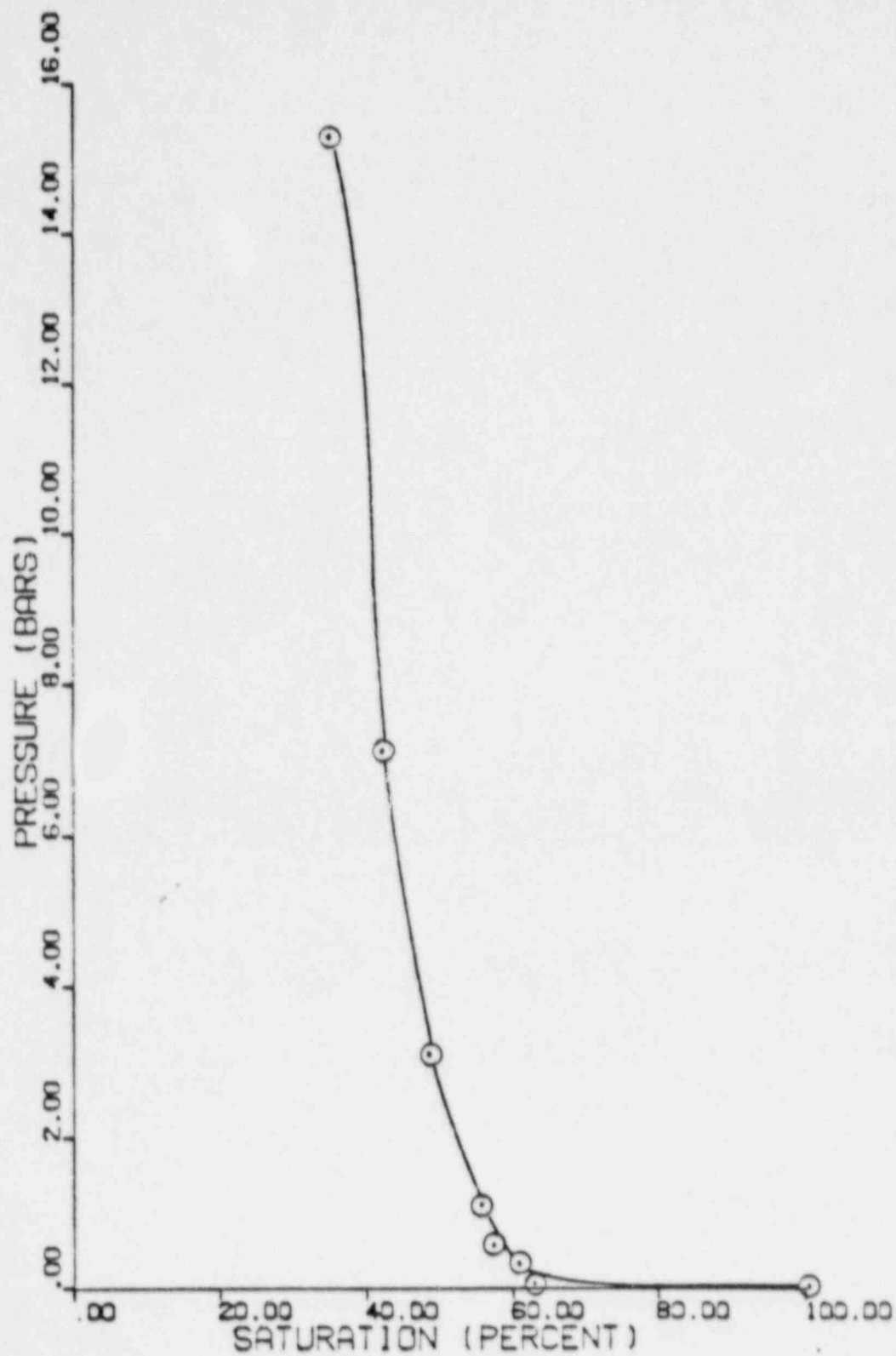
SAMPLE ID	DEPTH (ft.)	INITIAL CONDITIONS		COMPACTION (%)	UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)		
SPK01-040	4.0-4.5	114.2	7.3	100%	BR SILTY SAND (SM)

FIGURE D.4.5.C
CAPILLARY MOISTURE CURVE



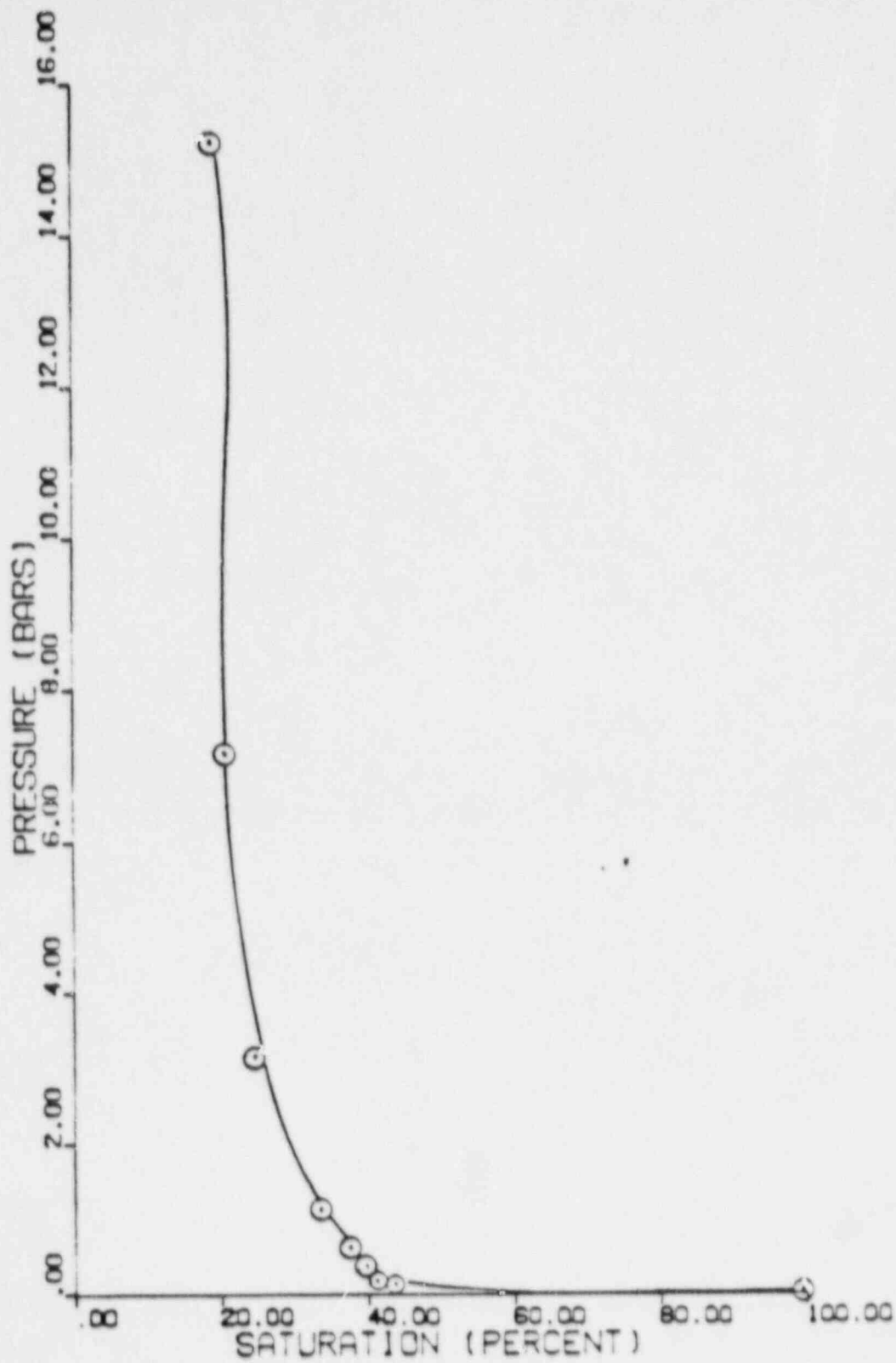
SAMPLE ID	DEPTH (ft.)	INITIAL CONDITIONS		COMPACTION (%)	UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)		
SPK01-045	5.0-5.5	104.8	12.6	90%	BR SILTY SAND (SM)

FIGURE D.4.5.D
CAPILLARY MOISTURE CURVE



SAMPLE ID	DEPTH (ft.)	INITIAL CONDITIONS		COMPACTION (%)	UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)		
SPK01-047	4.5-5.0	108.3	11.4	90%	BR SILTY SAND (SM)

FIGURE D.4.5.E
CAPILLARY MOISTURE CURVE



SAMPLE ID	DEPTH (ft.)	INITIAL CONDITIONS		COMPACTION (%)	UNIFIED SOIL CLASSIFICATION
		DRY DENSITY (pcf)	MOISTURE CONTENT (%)		
SPK01-049	13.5-14.0	100.7	11.1	90%	BR SILTY SAND (SM)

FIGURE D.4.5.F
CAPILLARY MOISTURE CURVE

Table D.4.1 Mechanical properties of Spook site material, Spook, Wyoming

Site and location ID	Sample ID	Depth interval (ft)	Particle size distribution			USCS	Soil description ^a	Specific gravity
			% gravel	% sand	% fines			
SPK01-031	01	2.5 - 3.0	-	91	9	SP-SM	D, poorly graded silty sand	-
SPK01-031	02	4.5 - 5.0	-	78	22	SM	D, silty sand	-
SPK01-032	01	2.5 - 3.0	-	86	14	SM	D, silty sand	-
SPK01-033	01	2.5 - 3.0	1	79	20	SM	D, silty sand	-
SPK01-034	01	2.5 - 3.0	-	87	13	SP-SM	D, poorly graded silty sand	-
SPK01-035	01	4.5 - 5.0	-	80	20	SM	D, silty sand	-
SPK01-035	02	8.0 - 8.5	-	88	12	SP-SM	D, poorly graded silty sand	-
SPK01-036	01	4.0 - 4.5	-	82	18	SM	D, silty sand	-
SPK01-037	02	4.0 - 4.5	1	90	9	SP-SM	D, poorly graded silty sand	-
SPK01-037	05	12.5 - 13.0	-	87	13	SP-SM	D, poorly graded silty sand	-
SPK01-038	01	3.0 - 3.5	-	81	19	SM	T, silty sand	-
SPK01-039	01	2.5 - 3.0	-	91	19	SM	T, silty sand	-

Table D.4.1 Mechanical properties of Spook site material, Spook, Wyoming (Continued)

Site and location ID	Sample ID	Depth interval (ft)	Particle size distribution			USCS	Soil description ^a	Specific gravity
			% gravel	% sand	% fines			
SPK01-040	01	3.5 - 4.0	-	86	14	SM	D, silty sand	-
SPK01-040	04	11.0 - 11.5	-	91	9	SP-SM	D, poorly graded silty sand	-
SPK01-041	01	2.5 - 3.0	-	84	16	SM	T, silty sand	-
SPK01-042	01	3.5 - 4.0	-	86	14	SM	D, silty sand	-
SPK01-042	04	14.5 - 15.0	1	72	27	SM	D, silty sand	-
SPK01-043	01	4.5 - 5.0	-	82	18	SM	T, silty sand	-
SPK01-043	04	13.0 - 13.5	-	81	19	SM	T, silty sand	-
SPK01-044	01	3.5 - 4.0	-	84	16	SM	T, silty sand	-
SPK01-044	04	14.0 - 14.5	-	84	16	SM	T, silty sand	-
SPK01-045	01	4.5 - 5.0	-	78	22	SM	T, silty sand	-
SPK01-045	04	13.5 - 14.0	-	85	15	SM	T, silty sand	-
SPK01-046	01	2.0 - 2.5	-	46	54	ML	B, low plasticity silt	2.65
SPK01-046	02	4.5 - 5.0	-	83	17	SM	B, silty sand	-
SPK01-046	03	9.5 - 10.0	-	75	25	SM	B, silty sand	-
SPK01-047	01	4.0 - 4.5	-	65	35	SM	B, silty sand	-

Table D.4.1 Mechanical properties of Spook site material, Spook, Wyoming (Concluded)

Site and location ID	Sample ID	Depth interval (ft)	Particle size distribution			USCS	Soil description ^a	Specific gravity
			% gravel	% sand	% fines			
SPK01-047	04	14.0 - 14.5	-	78	22	SM	B, silty sand	-
SPK01-048	01	4.5 - 5.0	-	87	13	SP-SM	B, poorly graded silty sand	-
SPK01-048	03	13.5 - 14.0	-	89	11	SP-SM	B, poorly graded silty sand	-
SPK01-049	01	4.0 - 4.5	-	86	14	SM	B, silty sand	-
SPK01-049	03	13.5 - 14.0	-	87	13	SP-SM	B, poorly graded silty sand	-
SPK01-049	04	2.0 - 2.5	-	77	23	SM	B, silty sand	2.65
SPK01-050	01	4.0 - 4.5	-	88	12	SP-SM	B, poorly graded silty sand	-

^a0 = disposal area soils; T = tailings; B = overburden pile soils.

Table D.4.2 Saturated hydraulic conductivities of Spook site material, Spook, Wyoming

Site and location ID	Sample ID	Depth interval (ft)	Soil type	% 200 sieve	Test method ^a	Compaction (% ASTM D698)	Initial dry density (pcf)	Hydraulic conductivity (cm/sec)
SPK01-036	04	4.5-5.0	Pit fill (SP-SM)	18	CH	100.7	101.6	1.2×10^{-4}
SPK01-038	02	3.5-4.0	Tailings (SM)	16	CH	88.7	102.4	2.3×10^{-4}
SPK01-040	02	4.0-4.5	Pit fill (SM)	14	CH	100.8	114.9	1.6×10^{-4}
SPK01-045	02	5.0-5.5	Tailings (SM)	16	CH	88.8	103.0	2.7×10^{-4}
SPK01-047	02	4.5-5.0	Overburden (SM)	35	CH	90.6	108.6	2.9×10^{-5}
SPK01-049	03	13.5-14.0	Overburden (SP-SM)	13	CH	90.2	100.9	1.0×10^{-3}
702U ^b	-	0-40.0	Low-permeability cover (SC)	47	FH	100.0	116.4	3.0×10^{-8}

^aCH indicates constant head permeability.

FH indicates falling head permeability.

^bRef. Hydro-Engineering (1987a).

GEOTECHNICAL DATA

TAC Acid Pond Characterization Data

Reference 4



JACOBS ENGINEERING

DATE 03/10/88

BY dux CHKD

SUBJECT SUMMARY OF
SPOOK ACID POND
BOREHOLE LOCATIONS

SHEET NO 1 of 1

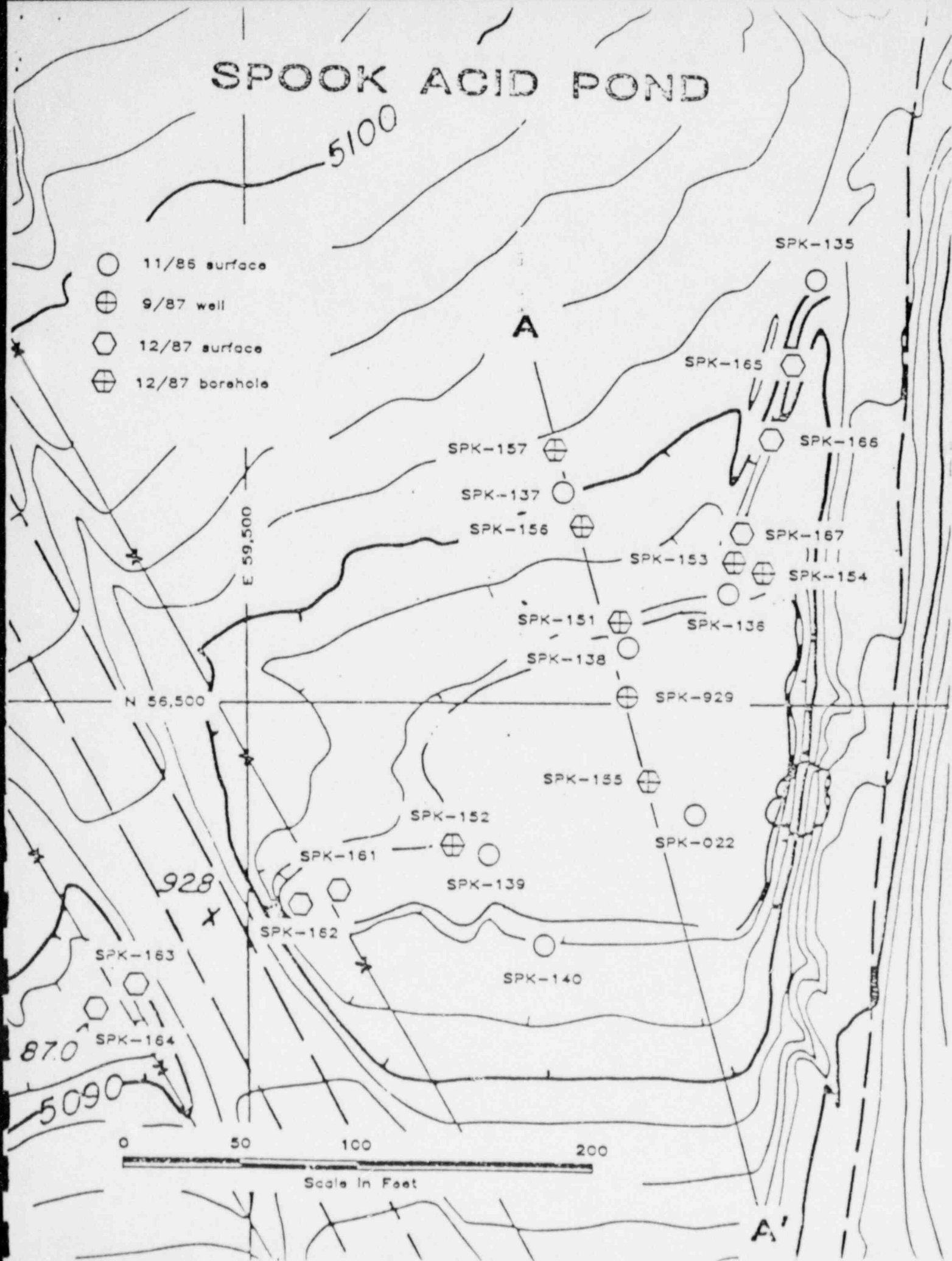
JOB NO 05011520100

Borehole	North Coordinate (ft)	East Coordinate (ft)	Elevation (ft)
151	56,534.5	59,650.6	~ 5086
152	56,440.4	59,538.8	
153	56,562.7	59,709.9	
154	56,558.0	59,722.3	
155	56,466.1	59,670.9	~ 5082.5
156	56,576.2	59,643.4	~ 5089
157	56,608.5	59,632.8	~ 5091
929	56,502.8	59,663.1	5083.0

well 929 was surveyed and its coordinates should be accurate to standard survey accuracy. Boreholes 151 through 157 were surveyed by pacing distances and measuring angles from well 929, and should be accurate to less than five feet or so.

SPOOK ACID POND

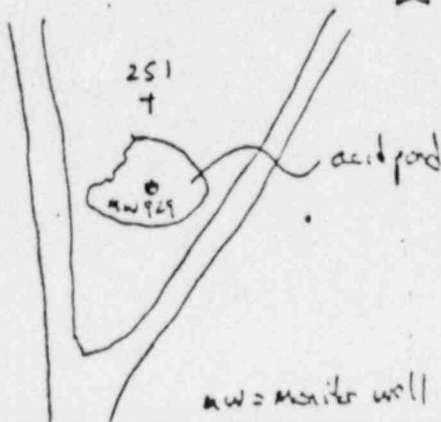
- 11/86 surface
- ⊕ 9/87 well
- ⬡ 12/87 surface
- ⬢ 12/87 borehole



BOREHOLE LOG (SOIL)

Page 1 of 2

LOCATION MAP:



SITE ID: S.k.01 LOCATION ID: 251
SITE COORDINATES (ft.):
N N/K E N/K
GROUND ELEVATION (ft. MSL): N/K
DRILLING METHOD: 7" HSA
DRILLING CONTR.: Baylor Bros / SMO20
DATE STARTED: 12/5/97
DATE COMPLETED: 12/16/97
FIELD REP.: JTAIN

GROUNDWATER LEVELS

DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION ±1/2' N of edge of dry acid pond
SITE CONDITION sandy sloping grasses

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 8 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	18	18	S	301				fine sand, some clay + silt, rootlets, yellow-brown
	X	12	12	S	302				clayey sand, some silt, yellow-brown, sl. moist
5.0	X	15	15	S	303				
	X	15	15	S	304				
	X	15	15	S	305				moist
10.0	X	17	17	S	306				
	X	4	14	S	307				sand, fine, some clay, yellow-brown, sl. moist
15.0	X	12	12	S	308				clayey sand, fine, yellow-brown, moist.
	X	15	15	S	309				trace coal
	X	16	16	S	310				
20.0									
25.0	X	16	16	S	311				
30.0									

COMMENTS: Scaph ID's all preceded by M.D.D.
ex: M.D.D.-301

NOTE: Can not "roll" soils so no USCS classification
due to contamination

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube



BOREHOLE LOG (SOIL)

Page 2 of 3

LOCATION MAP:



SITE ID: Sok 01 LOCATION ID: 251
SITE COORDINATES (ft.):
N N/K E N/K
GROUND ELEVATION (ft. MSL): N/K
DRILLING METHOD: 7 1/2" HSA
DRILLING CONTR.: Boyle Bros / S Moore
DATE STARTED: 12/5/82
DATE COMPLETED: 12/16/82
FIELD REP.: J Frith

GROUNDWATER LEVELS

DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION

SITE CONDITION

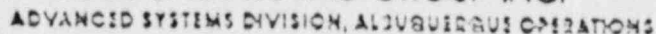
DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOW 3 PER 6 in.	N VALUE	U3C3	VISUAL CLASSIFICATION
35.0	X	19	19	S	312				sand, some clay. Fine to med sand, lt. brn. sl. moist.
37.0	X	16	16	S	313				trace coal
40.0	X	19	19	S	314				sand, trace clay. Fine to med. sand lt brn sl. moist
45.0	X	19	19	S	315				
50.0	X	19	19	S	316				trace coal
55.0	X	18	18	S	317				
60.0									

COMMENTS:

Note: AD U3C3 class because I can not tell soil

SAMPLE TYPE

A - Auger cuttings
S - 3" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. ther-waxed Shelby tube



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SITE ID: Soc #1 LOCATION ID: 251
SITE COORDINATES (ft.):
N N/A E N/A
GROUND ELEVATION (ft. MSL): N/A
DRILLING METHOD: 3" HSA
DRILLING CONTR.: Baylor, R., S MOORE
DATE STARTED: 12/5/82
DATE COMPLETED: 12/6/82
FIELD REP.: JTH/HZ

DATE	TIME	DEPTH (ft.)
------	------	-------------

SITE CONDITION

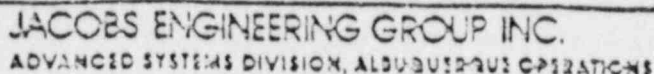
[illegible]

COMMENTS:

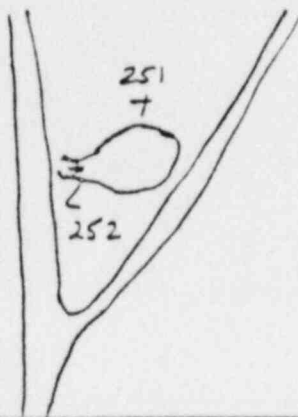
5' bentonite seal at bottom - grow
to surface

SAMPLE TYPE

A - Auger cuttings
S - 2" O.D. 1.38' I.D. drive sample
U - 3" O.D. 2.42' I.D. tube sample
T - 3" O.D. ther-waxed Shelby tube

Page 1 of 1

A
B
C



SITE ID: 5601 LOCATION ID: 252
SITE COORDINATES (ft.):
N N/A E N/A
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: HA
DRILLING CONTR.: Baylor / S. Moore
DATE STARTED: 12/10/82
DATE COMPLETED: 12/10/82
FIELD REP.: J. F. Smith

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION W side of acid pond, is a drainage into pond
SITE CONDITION gaily sloping, 2 miles

[illegible]

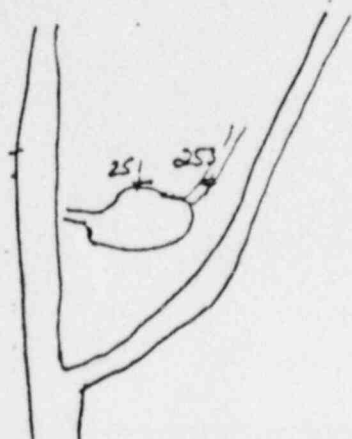
COMMENTS: Used Moss system - no blow
M 2 Moss system
1' bentonite in bottom - 9' gravel

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

BOREHOLE LOG (SOIL)

Page 1 of 1

LOCATION MAP:



SITE ID: Spk 1 LOCATION ID: 253
SITE COORDINATES (N.):
N n/a E n/a
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: HSR
DRILLING CONTR.: Baylor Bros / S Moore
DATE STARTED: 12/12/82
DATE COMPLETED: 12/16/82
FIELD REP.: T Faltz

GROUNDWATER LEVELS

DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION In drainage which enters acid pond, 225' N of pond edge (up)
SITE CONDITION gently sloping, grasses willow

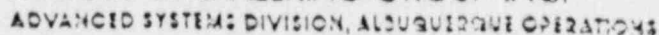
[illegible]

COMMENTS: $M =$ Mass system

1' barometer in bottom - 9' grow

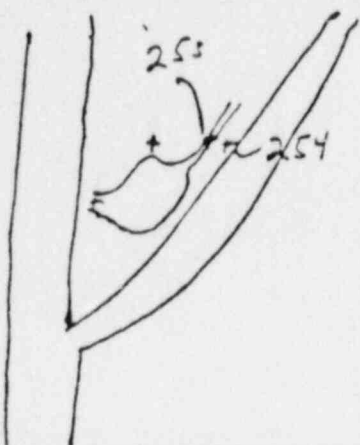
SAMPLE TYPE

A = Auger cuttings
S = 2" O.D. 1.38' I.D. drive sample
U = 3" O.D. 2.42' I.D. tube sample
T = 3" O.D. thermated Shelby tube



Page 1 of 1

A
B
C



SITE ID: Sak 01 LOCATION ID: 254
SITE COORDINATES (ft.):
N N/C E N/C
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: HSA
DRILLING CONTR.: Raker / Moore
DATE STARTED: 12/15/92
DATE COMPLETED: 12/16/92
FIELD REP.: J. Friths

DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION 2/6' E of drainage into acid pond
SITE CONDITION mostly sloping, grasses

[illegible]

COMMENTS:

M = Mass system

~~grows in bottom - 'g' grows~~

SAMPLE TYPE

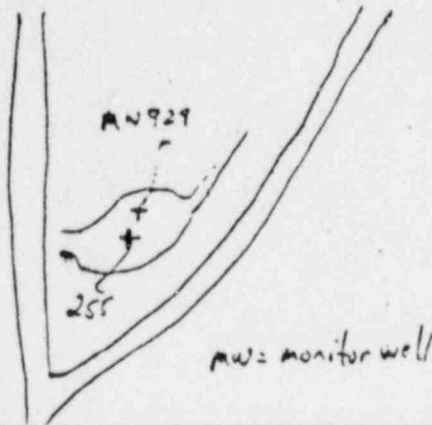
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sampler
U - 3" O.D. 2.42" I.D. tube sampler
T - 3" O.D. thin-walled Shelby tube



BOREHOLE LOG (SOIL)

Page 1 of 2

LOCATION MAP:



SITE ID: Sob-01 LOCATION ID: 255
SITE COORDINATES (ft.):
N N/K E N/K
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: HSA
DRILLING CONTR.: Baker/5 core
DATE STARTED: 12/14/92
DATE COMPLETED: 12/14/92
FIELD REP.: J.F.H.

GROUNDWATER LEVELS

DATE	TIME	DEPTH (ft.)

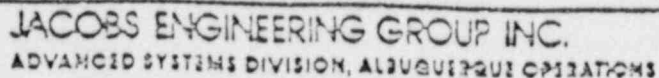
LOCATION DESCRIPTION ± 90' S of monitor well 929, in acid pond
SITE CONDITION low, little or no vegetation

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 8 in.	N VALUE	U303	VISUAL CLASSIFICATION
0									
		17	17	X	201				clay, fine sand, gray, moist
		18	18	M	202				1" of fine sand at 1'
									Fine sandy clay, gray moist
5.0		12	12	M	203				
		26	26	M	204				
				M	205				
		26	26	M	206				
10.0									
		25	20	M	207				clay, some sand, gray-ben moist
		24	28	M	208				
15.0				M	209				fine sandy clay, ben, moist, 6" from surface of soil sand at 13 & 15'
		30	15						
20.0		30	22	M	210				Fine sand, some clay, lt. ben, moist
		30	0	M	—				
25.0									
		30	0	M	—				
		30	19	M	211				

COMMENTS: M2 MESS system

SAMPLE TYPE

A - Auger cuttings
S - 3" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thermostated Shelby tube



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SITE ID: S-261 LOCATION ID: 255
SITE COORDINATES (ft.):
N N/K E N/K
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: HSA
DRILLING CONTR.: Baylor, S. Moore
DATE STARTED: 12/11/92
DATE COMPLETED: 12/11/92
FIELD REP.: J.F.H.

DATE	TIME	DEPTH (ft.)
------	------	-------------

LOCATION DESCRIPTION
SITE CONDITION _____

[illegible]

COMMENTS:

4' heatshrink insulation - grafted to surface

SAMPLE TYPE

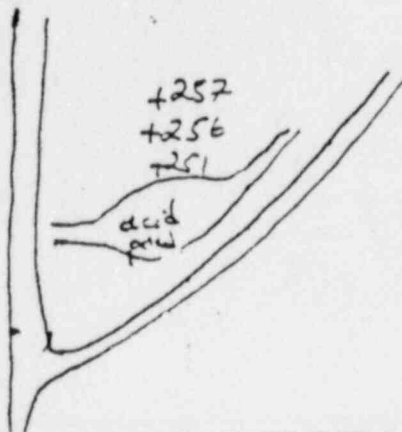
A - Auger cuttings
S - 2" O.D. 138" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. therm-welded Shelby tube



BOREHOLE LOG (SOIL)

Page L of 3

LOCATION MAP:



SITE ID: Spk 61 LOCATION ID: 256
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: 6.5" HSA
DRILLING CONTR.: Baylor Bros. / SMOORE
DATE STARTED: 12/15/82
DATE COMPLETED: 12/16/82
FIELD REP.: J. F. Hill

GROUNDWATER LEVELS

DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION 250' N of acid pond edge
SITE CONDITION gentle slope, Jr, grasses

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	18	12	M	231				Fine sand, some silt & clay 1 ft. br, particles, dry
	X	20	13	M	232				Silty fine sand, 1 ft. br, dry
5.0	X	20	17	M	232				
	X	30	13	M	232				
	X	23	13	M	235				
10.0	X	24	13	M	236				Fine sand, some silt 1 ft. br dry
	X	20	13	M	237				
15.0	X	19	13	M	238				
	X	13	23	M	239				
	X	23	13	M	240				
20.0									
25.0	X	23	13	M	241				Fine med sand, some silt 1 ft. br dry
30.0									

COMMENTS: M: 232 Spk 61

SAMPLE TYPE

A - Auger cuttings
S - 3" O.D. 1.33" I.D. drive sampler
U - 3" O.D. 2.42" I.D. tube sampler
T - 3" O.D. thermostated Shelby tube



BOREHOLE LOG (SOIL)

Page 2 of 3

LOCATION MAP:



SITE ID: 59k 61 LOCATION ID: 256
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: 6 5/8" HSA
DRILLING CONTR.: Baylor Bros./Mesa
DATE STARTED: 12/15/82
DATE COMPLETED: 12/16/82
FIELD REP.: J. Friths

GROUNDWATER LEVELS

DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____

SITE CONDITION _____

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
32.0	X	24	13	M	242				
35.0	X	24	13	M	243				
40.0	X	15	10	M	244				
45.0	X	24	13	M	245				
50.0	X	15	11	A	246				Fine to med sand, trace clay, silt, yellow-brn.
55.0	X	24	14	M	247				
60.0									

COMMENTS: _____

SAMPLE TYPE

A = Auger cuttings
S = 2" O.D. 1.36" I.D. drive sample
U = 3" O.D. 2.42" I.D. tube sample
T = 3" O.D. thin-walled Shelby tube

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: Spk 1 LOCATION ID: 256
SITE COORDINATES (ft.):
N W/K E W/K
GROUND ELEVATION (ft. MSL): W/K
DRILLING METHOD: 65/8" HSA
DRILLING CONTR.: Baylor Bros / S. Moore
DATE STARTED: 12/15/82
DATE COMPLETED: 12/16/82
FIELD REP.: J. F. H.

GROUNDWATER LEVELS

DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION

SITE CONDITION

[illegible]

COMMENTS:

SAMPLE TYPE

A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. Ther-waxed Shelby tube



JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

Page 1 of 2

LOCATION MAP:



SITE ID: Sokgl LOCATION ID: 257
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: 15 ft. / 1.5 in. System
DRILLING CONTR.: Boyle Bros. / 1 in. 2 ft.
DATE STARTED: 12/14/87
DATE COMPLETED: _____
FIELD REP.: T. Frith

GROUNDWATER LEVELS

DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: 25' N of acid pond
SITE CONDITION: gently sloping S. grass

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	19	17A	M	216				Fine sand, some silt & clay, H. brn, wet, dry
	X	20	18	M	217				silty sand, Fine sand, H. brn. dry
5.6	X	25	16	M	218				
	X	12	19	M	219				
	X	10	22	M	220				
10.0	X	27	12	M	221				fine sand, some silt. H. brn dry
	X	24	12	M	222				
15.0	X	24	12	M	223				
	X	24	12	M	224				
	X	24	12	M	225				
20.0									
25.0	X	24	12	M	226				
	X								
30.0									

COMMENTS: m 2 m. c. system

SAMPLE TYPE

A - Auger cuttings
S - 3" O.D. 1.38" I.D. drive sampler
U - 3" O.D. 2.42" I.D. tube sampler
T - 3" O.D. thermostated Shelby tube



BOREHOLE LOG (SOIL)

Page 2 of 2

LOCATION MAP:



SITE ID: Sok 61 LOCATION ID: 252
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: HSA w/ mast system
DRILLING CONTR.: Bayless Bros. / S. Place
DATE STARTED: 10/14/92
DATE COMPLETED: _____
FIELD REP.: J.E. H.

GROUNDWATER LEVELS

DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE REMOVED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
30	X	19	12	M	227				Fine to med sand, some silt. H. ben, dry
35	X	19	12	M	228				
40	X	16	12	M	229				
45.6	X	22	12	M	230				
50.0									slg auger at 47'
55.0									
60.2									

COMMENTS:

SAMPLE TYPE

A - Auger cuttings
S - 2" O.D. 1.38' LD. drive sample
U - 3" O.D. 2.42' LD. tube sample
T - 3" O.D. thermalized Shelby tube

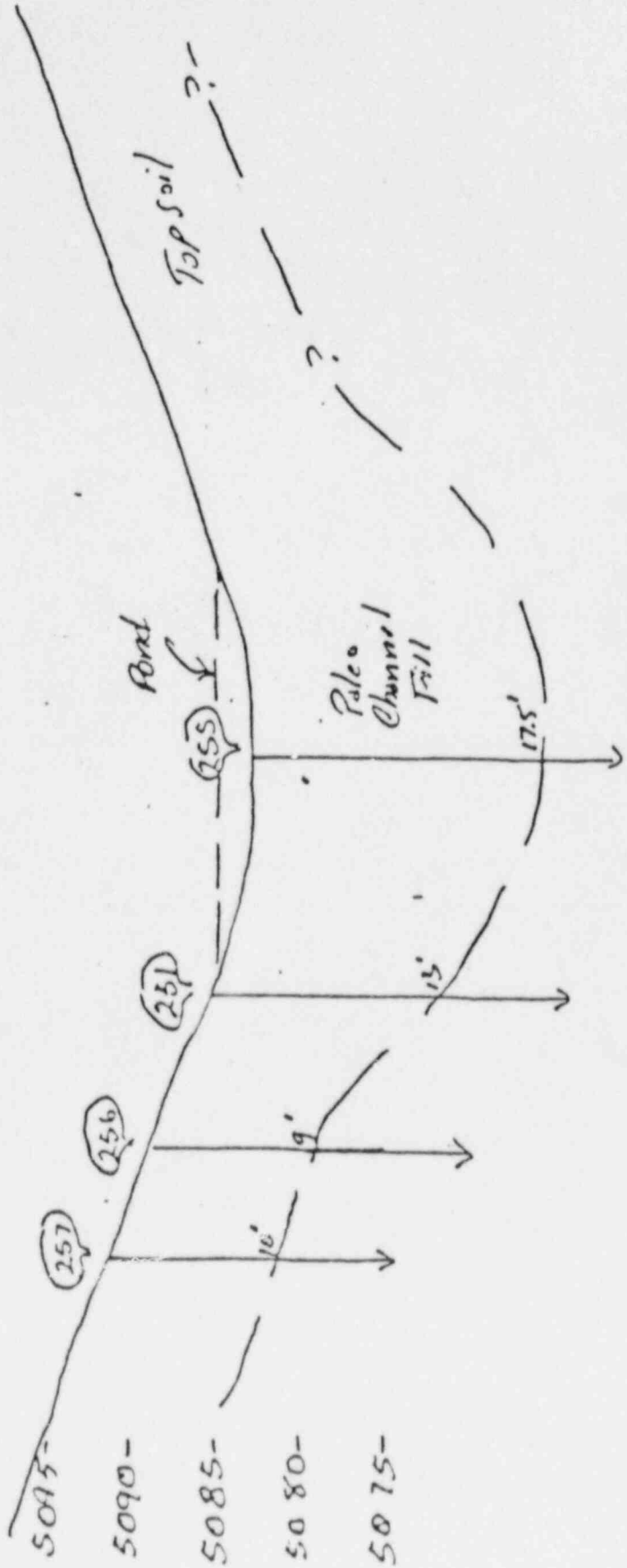
SHEET NO. _____
JOB NO. _____

SUBJECT

DATE 3/14/88
DRAWN BY [Signature]
CHECKED BY [Signature]

Restoration of Acid Pond:
Remove Contaminated Soil and
bedrock to a depth of ~ 2
below top of bedrock.
Determine lowest point of bedrock
in paleo channel by test pit or borehole
just downstream of pond.

Horizontal scale 1" = 50'
Vertical scale 1" = 10'



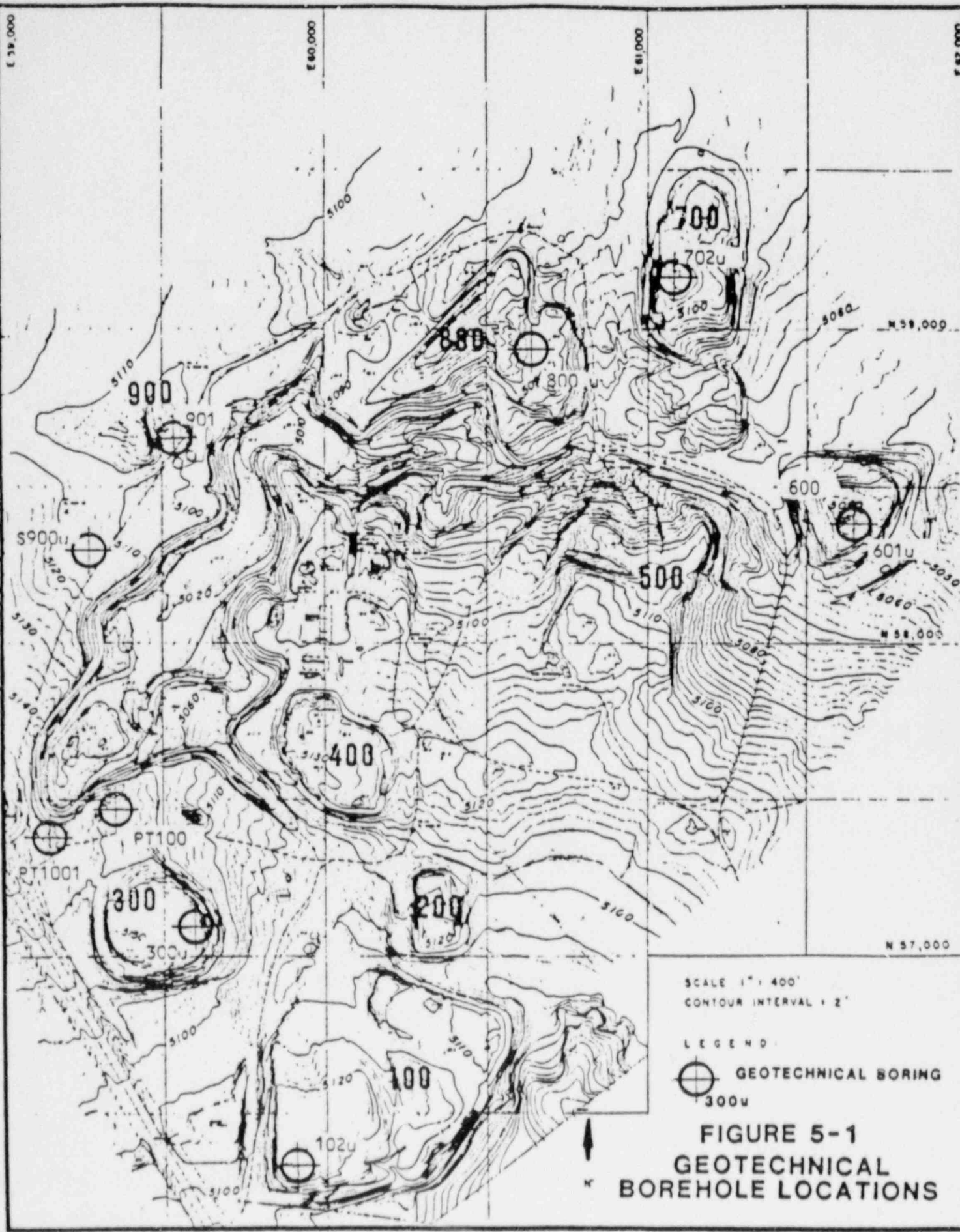
ESTIMATED DEPTH TO BEDROCK
IN ACID POND, SPOON SITE

GEOTECHNICAL DATA

Wyoming State AML Program Borehole Data

Reference 5

DRAWING 1000-A1
 CHECKED BY JJC
 APPROVED BY 6-15-87
 L AN BY



SCALE 1" = 400'
 CONTOUR INTERVAL = 2'

LEGEND:
 (Circle with crosshair) GEOTECHNICAL BORING
 300U

FIGURE 5-1
 GEOTECHNICAL
 BOREHOLE LOCATIONS

GORMLEY
 CONSULTANTS INC.

DRAWN BY	J.J.G.	CHECKED BY	J.J.G.	DRAWING NUMBER	1086-A3

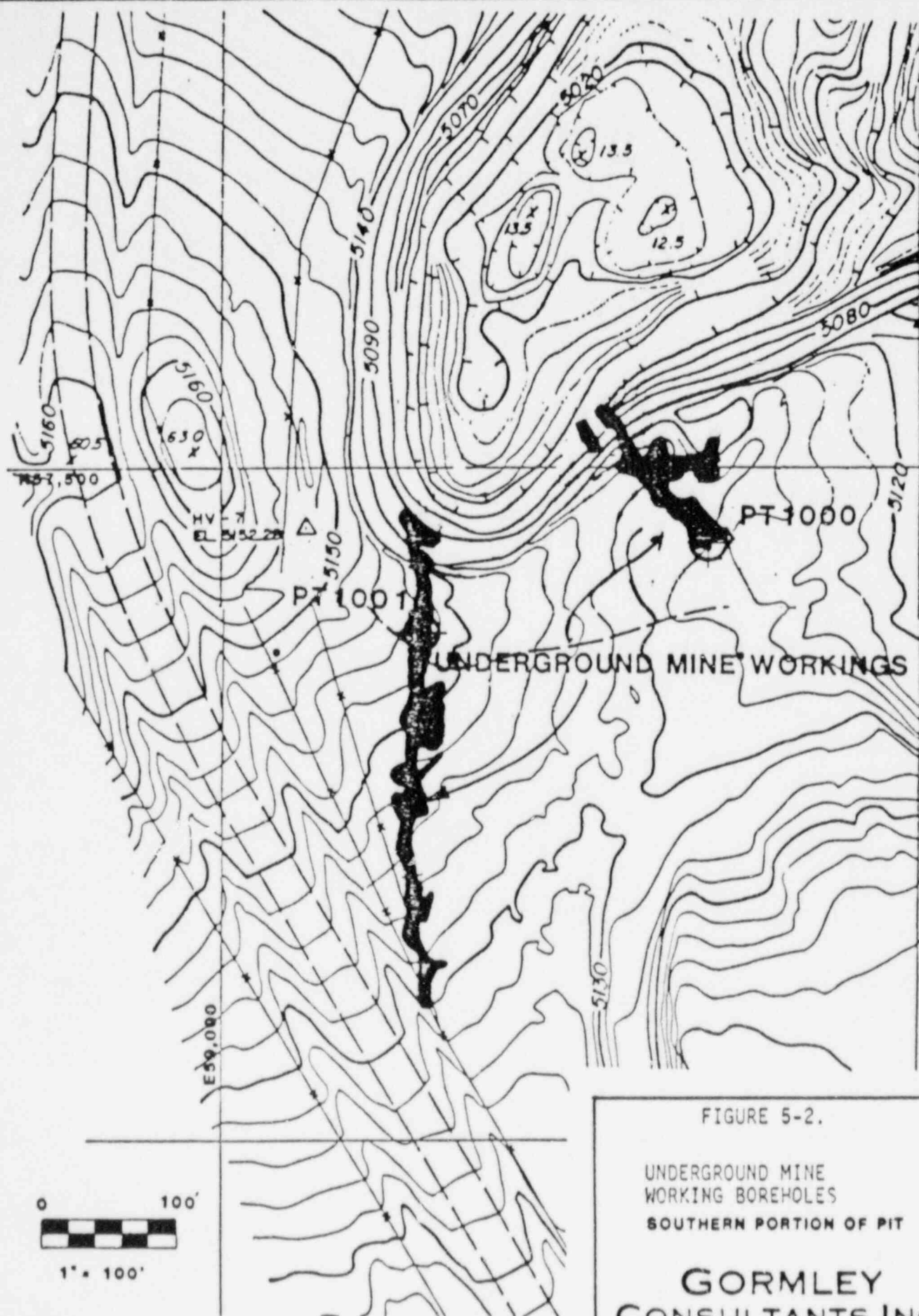


FIGURE 5-2.

UNDERGROUND MINE
WORKING BOREHOLES
SOUTHERN PORTION OF PIT

**GORMLEY
CONSULTANTS INC.**

TABLE 5-1

SUMMARY OF MATERIAL PROPERTIES
SPOOK PIT

BORING NO.	SAMPLE TYPE/NO.	SPT IMPLIED DENSITY	ASTM D2487/8 SYMBOL	MATERIAL TYPE/ SAMPLE INTERVAL	WC%	γ_d (PCF)	γ_w (PCF)	LL (%)	PL (%)	PI (%)	% -#200	COMP STRGTH (PSI)	PROCTR MAX D (PCF)	PROCTR OPT M (%)
102u	SS-4	VD	SP-SM	Sand w/clay (15'-16.7')	8.1	---	---	NP	NP	NP	9.2	---	---	---
102u	ST-2	---	---	Tan sand (25'-26')	9.7	114.0	125.1	---	---	---	---	---	---	---
102u	SS-7	VD	SC	Clayey sand (35'-36.5')	7.7	---	---	---	---	---	---	---	---	---
300u	SS-4	D	SC-CL	Clayey sand (15'-16.3')	10.6	---	---	29	20	9	43.5	---	---	---
300u	SS-6	D	SP-SC	Sand w/clay (25'-26.8')	9.6	---	---	---	---	---	---	---	---	---
601u	SS-3	M	SP-SC	Sand w/clay (15'-16.8')	10.0	---	---	---	---	---	---	---	---	---
601u	SS-5	M	SM-SC	Clayey sand (25'-26.9')	14.8	---	---	23	18	5	32.7	---	---	---
702u	SS-2	M	SC	Clayey sand (5'-6.6')	11.1	---	---	---	---	---	---	---	---	---
702u	ST-1	---	SC	Clayey sand (10'-11.1')	20.8	113.9	137.6	---	---	---	---	---	---	---
702u	SS-4	M	SC	Clayey sand (20'-21.7')	6.5	---	---	---	---	---	47.0	---	---	---
702u	SS-6	VD	SC	Clayey sand (35'-36.3')	14.1	---	---	25	17	8	---	---	---	---
800u	SS-1	D	SP-SC	Sand w/clay (0'-1.5')	7.7	---	---	---	---	---	---	---	---	---
600u	SS-3	D	SP-SM	Med sand w/clay (15'-16.2')	8.7	---	---	NP	NP	NP	7.5	---	---	---
5900u	SS-3	D	SC	Tan silty sand (10'-11.3')	8.1	---	---	36	20	16	38	---	---	---
5900u	ST-1	---	---	Tan silty sand (6.3'-7.7')	7.0	102.9	110.1	---	---	---	---	---	---	---

Note: See Table 5-1A for an explanation of the abbreviations and the significance of each test.

TABLE 5-1 (CONTINUED)
SUMMARY OF MATERIAL PROPERTIES
SPOOK PIT

BORING NO.	SAMPLE TYPE/NO.	SPT IMPLIED DENSITY	ASTM D2487/B SYMBOL	MATERIAL TYPE/ SAMPLE INTERVAL	WC%	γ_o (PCF)	γ_u (PCF)	LL (%)	PL (%)	PI (%)	λ -0.200	COMP STRGTH (PSI)	PROCTR MAX D (PCF)	PROCTR OPT M (%)
702u	BULK	---	---	Overburden (0'-40')	---	---	---	---	---	---	---	---	116.4	14.1
RS47	BULK	---	---	Overburden (0'-30')	---	---	---	---	---	---	---	---	108.8	17.9
302- 303	BULK COMP	---	---	Overburden (0'-25')	---	---	---	---	---	---	---	---	117.0	13.5
1000-PT	CORE A	---	---	Tan sandstone (80'-84.5')	7.52	111.0	120.0	---	---	---	---	101	---	---
1000-PT	CORE B	---	---	Tan sandstone (80'-84.5')	7.66	114.3	123.8	---	---	---	---	140	---	---
1000-PT	CORE C	---	---	Tan sandstone (84.5'-89')	7.73	115.5	125.2	---	---	---	---	90	---	---
1001-PT	CORE A	---	---	Tan sandstone (79'-88')	8.40	116.1	126.8	---	---	---	---	146	---	---
1001-PT	CORE B	---	---	Tan sandstone (88'-98')	8.58	111.9	122.4	---	---	---	---	69	---	---
1001-PT	CORE C	---	---	Silty claystone (98'-103.5')	11.4	118.3	133.5	---	---	---	---	356	---	---

PERMEABILITY TEST DATA

BULK SAMPLE IDENTIFIER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	% PROCTR MAX D (%)	PERMEABILITY (CM/SEC)	COMMENTS
702u	11.1	109.4	94	2.31×10^{-3}	Mixed Overburden Spoil,
702u	14.1	116.4	100	3.03×10^{-3}	Pile 700
702u	18.2	110.8	95	3.95×10^{-3}	
RS47	14.5	104.3	96	1.85×10^{-3}	
RS47	17.9	107.2	99	5.11×10^{-3}	
302-303	9.8	109.2	93	5.24×10^{-3}	Composite Sample,
302-303	13.5	115.5	99	1.20×10^{-3}	Spoil pile 300
302-303	15.8	112.9	96	1.92×10^{-3}	
S900u-ST1	7.0	102.9	-	1.11×10^{-3}	Undisturbed Alluvium

Note: See Table 5-1A for an explanation of the abbreviations and the significance of each test.

DATE BEGAN: 4-24-87

DATE FINISHED:

GROUND SURFACE EL:

BORING NO. 102U
10' east of 102

FIELD ENGINEER: JJC/AFS

CHECKED BY: JJS

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT)			WATER CONT. (PERCENT)	
						10	30	50	20	40
	0			0'-4' tan fine sand 4'-9' light brown slightly clayey sand 9'-12' sandy-tan limonite stain 12'-15' tan clean fine sand			27			
	5.0									
				0-2' pebble-sandstone-broken 2'-11' tan iron stained sand-med to fine 11'-16' tan clean medium sand			41			
	10.0									
	11.0			driller missed mark						
				0-19' medium to coarse clean to tan sand 19'-20' medium to coarse sand with coaly parting 20'-21' slightly clayey sand with coal					79	
	15.0									
				0-3' coarse sand with 1/2" pebble 3'-12' orange brown silty sand 12'-14' white coarse clean sand 14'-20.5' orange brown silty sand				52		
	20.0									
				0-4' coarse sand-clean 4'-7' slightly clayey sand with carb matl 7'-17' clean brown coarse sand 17'-20' clayey sand 20'-21' clean white med sand					60	
	25.0									
				tan sand						
	30.0									
				0-6' clean coarse sand 6'-14' silty coarse sand 14'-17.5' dark brown clayey sand					80	
	35.0									
				0-3' brown coarse sand 3'-5' clayey sand 5'-17' silty brown coarse sand, nothing in tip					80	
	40.0									
				0-3' tan medium to coarse sand 3'-5' clayey sand w/clay lens 5'-10' silty brown coarse sand 10'-13' clayey sand 13'-15' 1" lump of coal, black 15'-18.5' clayey coarse sand					91	
	45.0									
				td alluvium-no sample						
	50.0									

DATE BEGAN: 4-24-87

300U

FIELD ENGINEER: AFS/JJC

DATE FINISHED: _____

BORING NO. _____
Pile 300 N23E 36.5' from bMark.CHECKED BY: *JSF*

GROUND SURFACE EL: _____

N _____

E _____

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT)			WATER CONTE (PERCENT)	
						10	30	50	20	40
	0									
	5.0			8-12' med to coarse sand 12' 1' piece of gravel and carb matl 12'-14' medium to coarse sand				31		
	10.0			hit a rock 8-16' med to coarse tan sand, trace coal in tip sandy? clay lens-driller report				49		
	15.0			8-1' tan coarse sand 1'-11' dark clayey sand very compacted				36		
	20.0			top of sample 8-3' dark clayey sand 3'-5' tan coarse sand 5'-12' damp dark clay 12'-14' tan coarse sand				39		
	25.0			17' no recovery-picked up a calcite cemented sandstone - gravel size 8-2' tan coarse sand 2'-6' dark clayey sand 6'-9' medium clayey sand 9'-14.5' tan coarse sand					55	
	30.0			8-3' damp coarse sand w/minor clay 3'-8' clayey coarse sand 8'-19' coarse sand					SE	
	35.0									
	40.0									
	45.0									
	50.0									

DATE BEGAN: 4-24-87

DATE FINISHED: _____

GROUND SURFACE EL: _____

BORING NO. 601U
 88' due west of _____
 N _____ E _____

FIELD ENGINEER: JJC/AFS

CHECKED BY: JJC

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT)			WATER CONTENT (PERCENT)	
						10	30	50	20	40
	0			2'-9" clean coarse tan sand			15			
				9'-11" orange brown medium to coarse silty sand						
				11'-13" dark brown sandy clay						
				13'-16" tan med to coarse silty sand						
	5.0			16'-18" clean white med to fine sand						
				0-1" clean white med sand					57	
				1'-9" tan med silty sand						
				9'-11.5" clean orange brown coarse sand						
	10.0			11.5'-17" tan med to coarse silty sand						
				17'-19" white to red med to coarse sand						
	15.0									
				0-4" tan med to fine silty sand			27			
				4'-6" coarse carbonaceous sand						
				6'-11" tan med to coarse silty sand						
				11'-13" white clean med to coarse sand						
	20.0			13'-16" dark brown clayey sand						
				16'-19" white clean slightly cemented sand					58	
				0-2" tan med to fine sand						
				2'-7" tan med to coarse sand						
				7'-10" brown clayey fine sand						
	25.0			10'-13" brown clay shale						
				13'-15.5" tan clayey med sand			31			
				0-4" tan med sand						
				4'-7" clay shale dark brown						
				7'-10" orange brown coarse sand						
	30.0			10'-14" med silty sand						
				14'-16" clayey med sand					42	
				16'-19" silty med to coarse sand						
				19'-21.5" clayey med sand						
	35.0			0-4" tan med sand						
				4'-5" blue grey shaley sand						
				5'-12.5" clayey (stringers) med to fine sand						
				soil						
				alluvium						
	40.0			TD 40'						
	45.0									
	50.0									

DATE BEGAN: 4-24-87

702U

FIELD ENGINEER: JJG/AFS

DATE FINISHED: _____

BORING NO. 702U
This hole is 39" S58W of Hole 702. CHECKED BY: JJG

GROUND SURFACE EL: _____

N _____ E _____

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT)			WATER CONTENT (PERCENT)	
						10	30	50	20	40
	0			0-8' tan med to coarse sand 8'-8.5' grey clay stringer 8.5'-14.5' tan med to coarse silty sand 14.5'-17' clay stringer in med sand			25			
	5.0						31			
	10.0			0-7' tan med to fine silty sand 7'-11' dark brown sandy clay coarse 11'-19.5' brown clayey coarse to med sand						
	15.0			ST1-more clayey sand and clay				43		
	20.0			0-3' coarse silty sand 3'-6.5' sandy clay poor recovery? - no rock...						
	25.0			0-20' tan silty med to coarse sand with clay stringers & minor carbonaceous matl			24			
	30.0			0-2' clayey med to coarse s. d 2'-12' brown sandy clay 12'-13' sandstone pebble 1"-wedged in 13'-15.5' sandy clay						
	35.0			stockpiled alluvium balling up sand and clay						
	40.0			0-15' brown sandy clay easily rolled into 2" dia					71	
	45.0			soil penetrometer reading on foot-compacted soil, 2-3.25 TSF 0-9' slough in hole 9'-21' brown clayey fine to med sand					58	
	50.0			TD						

DATE BEGAN: 4-25-87

BORING NO. 800U

FIELD ENGINEER: JJG/AFS

DATE FINISHED: This hole is S48E from hole 805 108 feet.

CHECKED BY: *JS*

GROUND SURFACE EL: N E

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT)			WATER CONTENT (PERCENT)	
						10	30	50	20	40
	0			0-6' clean white coarse to med sand 6'-13' tan med to coarse carb silty sand 13'-20' brown clayey coarse sand				37		
	5.0									
	10.0			0-1' 1" dia sandstone pebble-angular-broken 1'-6' tan to buff silty coarse sand						
	15.0			coarse tan silty sand						
	20.0			0-2' sandstone frag-1" w/silty coarse sand 2'-6' silty coarse sand 6'-7' shale/clay lens 8'-14' white clean coarse to med sand				37		
	25.0			0-6' clayey coarse sand 6'-14' brown stiff clay w/coarse sand lenses 14'-16' brown grey claystone				46		
	30.0									
	35.0									
	40.0									
	45.0									
	50.0									

DATE BEGAN: 4-24-87

BORING NO. 5900U

FIELD ENGINEER: AFS/JJC

DATE FINISHED: _____

CHECKED BY: JJS

GROUND SURFACE EL: _____

N _____ E _____

ELEV (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT)			WATER CONTE (PERCENT)	
						10	30	50	20	40
	0			0-3' soil					73	
	5.0			3'-6' damp dense brown clayey sand, takes high polish when cut						
	10.0			8-16' dry tan silty sand - 1' separations laminated, minor plastic clay						
	15.0			8-16' dry tan silty sand - 1' separations to 5' laminated						
	20.0			very firm 8-4' dry tan silty sand - 1' laminated 4'-8' brown clayey sand						
	23.0			8-8' dense brown clay						
	25.0			sandstone						
	30.0									
	35.0									
	40.0									
	45.0									
	50.0									

DATE BEGAN: 4-24-87

BORING NO. 901

FIELD ENGINEER: AFS/JJG

DATE FINISHED: _____

CHECKED BY: *jjg*

GROUND SURFACE EL: _____

N _____ E _____

ELEV (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT)			WATER CONTENT (PERCENT)	
						10	30	50	20	40
	5.0			first 25' was gathered as bulk sample - all alluvial sand with minor clay at bottom						
	10.0									
	15.0									
	20.0									
	25.0									
	30.0			PUSH a splitspoon for a sample of bottom matl 8-9' alluvium 9'-15' damp clayey sand						
	32.0			damp clayey sand						
	35.0			damp clayey sand						
	37.0			clay						
	39.0			less clay more sand						
	40.0			sandstone contact						
	41.0			TD						
	45.0									
	50.0									

DATE BEGAN 4-25-87BORING NO. PT1000FIELD ENGINEER: AFS

DATE FINISHED: _____

CHECKED BY: WJG

GROUND SURFACE EL: _____

N _____ E _____

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT)			WATER CONTENT (PERCENT)	
						10	30	50	20	40
	0			0-88' tan coarse lightly cemented sandstone & minor shale, drilled with drag bit						
	5.0									
	10.0									
	15.0									
	20.0									
	25.0									
	30.0									
	35.0									
	40.0									
	45.0									
	50.0									

DATE BEGAN: 4-25-87

BORING NO. PT1000

FIELD ENGINEER: AFS

DATE FINISHED: _____

CHECKED BY: JJS

GROUND SURFACE EL: _____

N _____ E _____

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT)			WATER CONTE (PERCENT)	
						10	30	50	20	40
	55.0			2-88' tan coarse lightly cemented sandstone & minor shale, drilled with drag bit						
	60.0									
	65.0									
	70.0									
	75.0									
	80.0									
	84.5 85.0			lt grey coarse sandstone one piece 35' long cored flushing w/air only one pink clay concretions last one inch						
	89.0 90.0			same as above trouble getting core out of barrel						
	95.0			8:35 p.m. end of coring, secured operation at 9:00 p.m.						
	100.0									
	105.0									

DATE BEGAN: 4-25-87

BORING NO. PT1001

FIELD ENGINEER: JJG/AFS

DATE FINISHED: _____

CHECKED BY: *JJG*

GROUND SURFACE EL: _____

N _____ E _____

ELEV (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT)			WATER CONTENT (PERCENT)	
						10	30	50	20	40
	0			8-78' tan coarse lightly cemented sandstone & minor shale, drilled with drag bit						
	5.0									
	10.0									
	15.0									
	20.0									
	25.0									
	30.0									
	35.0									
	40.0									
	45.0									
	50.0									

DATE BEGAN: 4-25-87

BORING NO. PT1001

FIELD ENGINEER: JJG/AFS

DATE FINISHED: _____

CHECKED BY: JJG

GROUND SURFACE EL: _____

N _____ E _____

ELEV (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT)			WATER CONTENT (PERCENT)	
						10	30	50	20	40
	55.0			8-70' tan coarse lightly cemented sandstone & minor shale, drilled with drag bit						
	60.0									
	65.0									
	70.0									
	75.0			CORE tan, very coarse arkosic sand sub rounded more of same						
	78.0									
	80.0			same as above (A/A)						
	83.0									
	85.0			A/A with oily looking substance near bottom						
	88.0									
	90.0			A/A with few clay concretions at top						
	93.0									
	95.0			A/A no clay						
	98.0									
	100.0			coarse sandstone contact w/dark grey clay at top - then 8" and clay - fine tan sandstone						
				fine tan sandstone intbd w/grey clay						
	103.5									
	105.0			void at 103.5'						

Project: DEQ AML 15-3
 Job No.: 3947-CM
 Client: Hydro-Engineering

TABLE 1. SUMMARY OF FALLING HEAD PERMEABILITY TESTS

SAMPLE NO.

702u

Maximum Standard Dry Density = 116.4 pcf
 Optimum Moisture Content = 14.1%

TEST CONDITION	MOISTURE CONTENT %	DRY UNIT Wt., pcf	PERMEABILITY cm/sec
Dry of Optimum	11.1	109.4	2.31×10^{-5}
@ Optimum	14.1	116.4	3.02×10^{-8}
Wet of Optimum	18.2	110.8	3.95×10^{-8}

RS47

Maximum Standard Dry Density = 108.8 pcf
 Optimum Moisture Content = 17.9%

TEST CONDITION	MOISTURE CONTENT %	DRY UNIT Wt., pcf	PERMEABILITY cm/sec
Dry of Optimum	14.5	104.3	1.85×10^{-6}
@ Optimum	17.9	107.2	5.11×10^{-8}

302-303
 Composite

Maximum Standard Dry Density = 117.0 pcf
 Optimum Moisture Content = 13.5%

TEST CONDITION	MOISTURE CONTENT %	DRY UNIT Wt., pcf	PERMEABILITY cm/sec
Dry of Optimum	9.0	109.2	5.24×10^{-5}
@ Optimum	13.5	115.5	1.20×10^{-5}
Wet of Optimum	15.8	112.9	1.92×10^{-5}

S900u-ST1

Undisturbed Sample

TEST CONDITION	MOISTURE CONTENT %	DRY UNIT Wt., pcf	PERMEABILITY cm/sec
Undisturbed	7.0	98.8	1.11×10^{-6}

Project: DEQ AML 15-3
 Job No.: 3947-CM
 Client : Hydro-Engineering

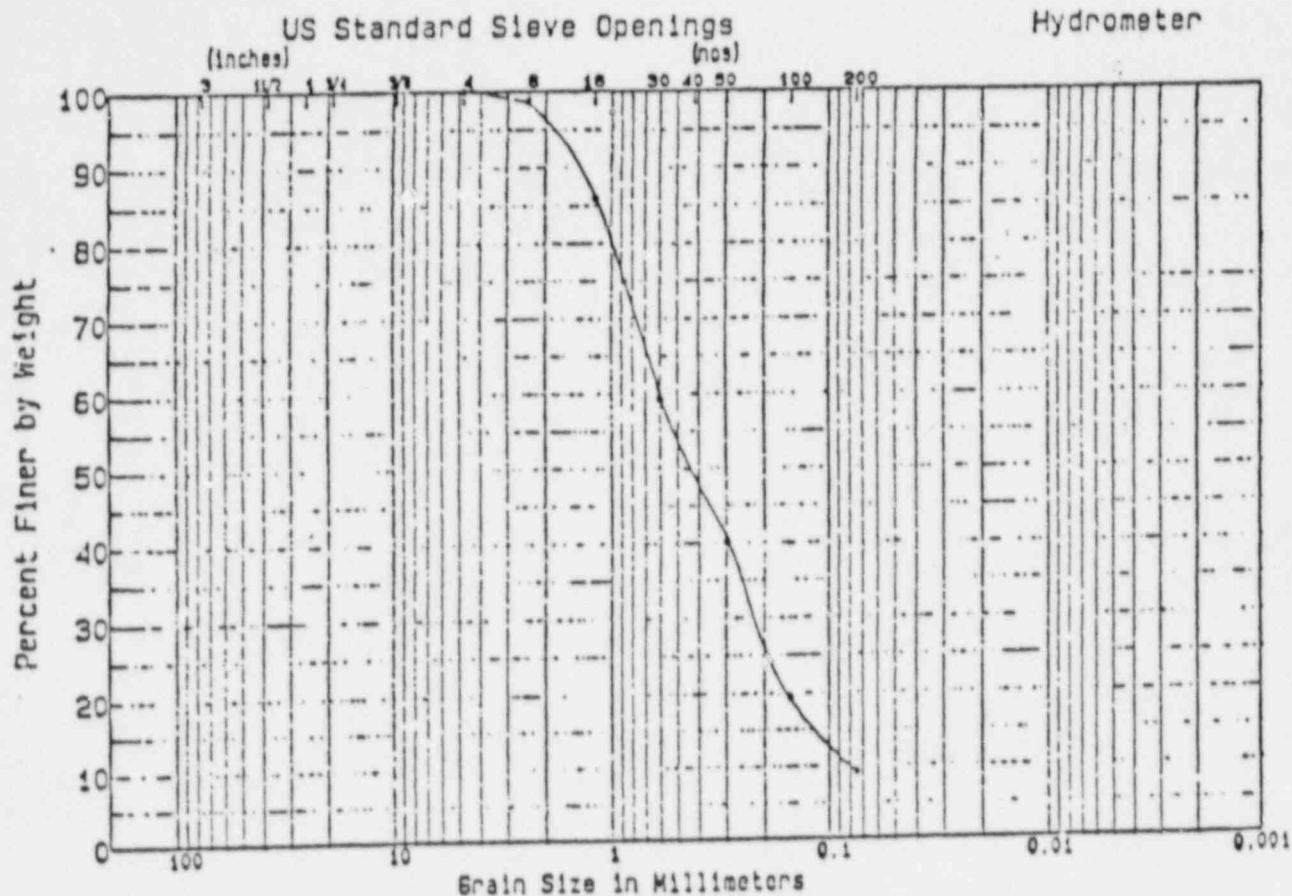
TABLE 2. SUMMARY OF LABORATORY TEST RESULTS

Sample No.	Natural Moisture Content, %	Atterberg Limits, %			Dry Unit Wt., pcf
		LL	PL	PI	
102u-SS4	8.1	Non-Plastic			
102u-SS7	7.7				
300u-SS4	10.6	29	20	9	
300u-SS6	9.6				
601u-SS3	10.0				
601u-SS5	14.8	23	13	5	
702u-SS4	6.5				
702u-SS6	14.1	25	17	8	
702u-SS2	11.1				
800u-SS1	7.7				
800u-SS3	8.7	Non-Plastic			
S900u-SS3	8.1	36	20	16	
102u-ST2	9.7				114.0
702u-ST1	20.8				103.9
S900u-ST1	7.0				102.9

PARTICLE SIZE ANALYSIS

Project: DEQ AML 15-3
 Job No.: 3947-CM
 Client: Hydro-Engineering

Test Date: 4-27-87
 Tested By: GDS



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay
---------	---------------	-------------	-------------	-------------	-----------	------	------

Unified Soil Classification System (ASTM D2487)

Sample No.: 102u:SS-4
 Sampled By: -
 Source: -

Soil Description: Fine to
medium SAND, little silt,

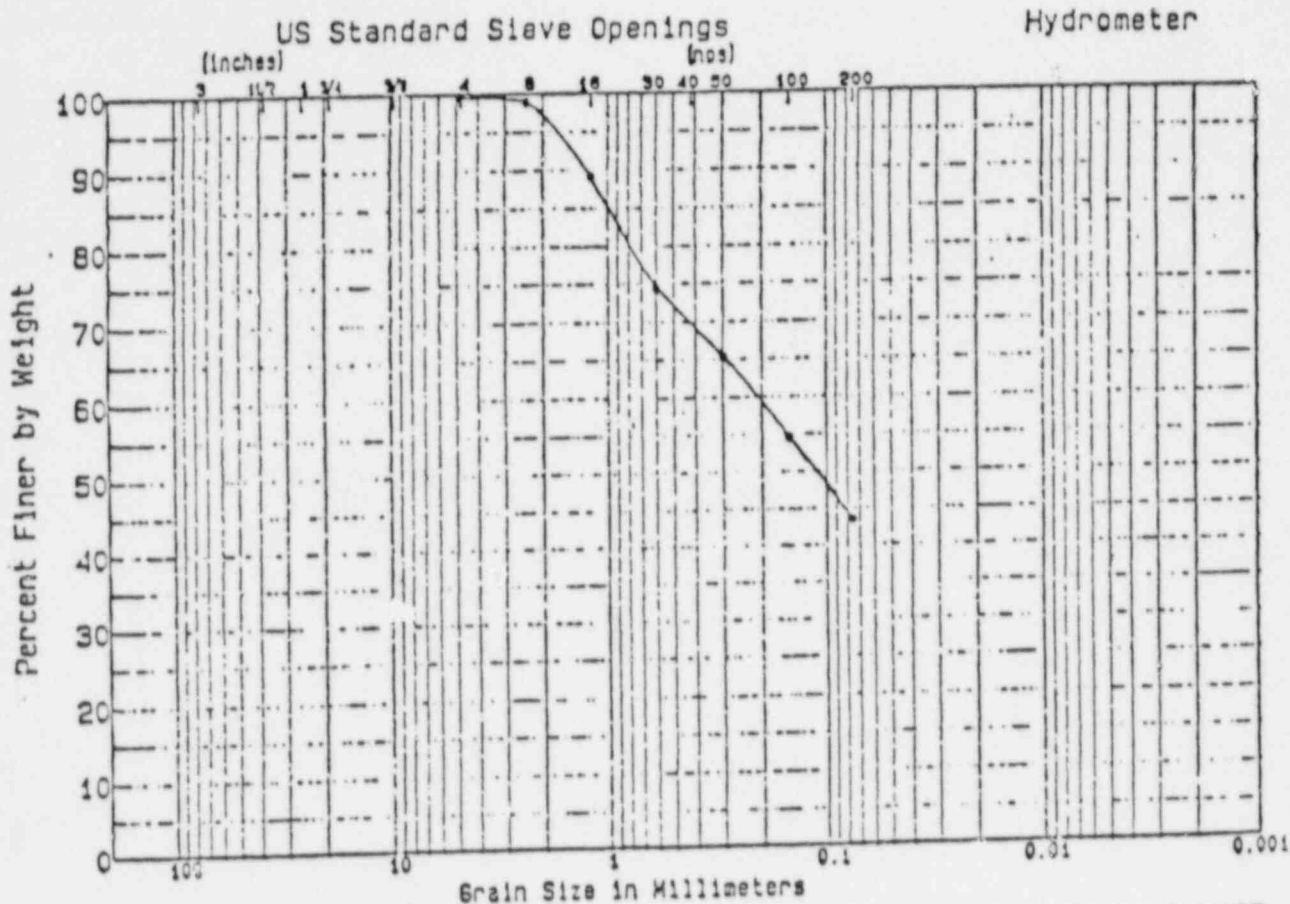
Percent Gravel: 0
 Percent Sand: 90.8
 Percent Silt & Clay: 9.2

Reviewed By: JZ/11
 Date: 5-1-87

PARTICLE SIZE ANALYSIS

Project: DEQ AML 15-3
 Job No.: 3947-CM
 Client: Hydro-Engineering

Test Date: 4-27-87
 Tested By: GDS



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay
---------	---------------	-------------	-------------	-------------	-----------	------	------

Unified Soil Classification System (ASTM D2487)

Sample No.: 300u; SS-4
 Sampled By: -
 Source: -

Soil Description: Clayey SAND

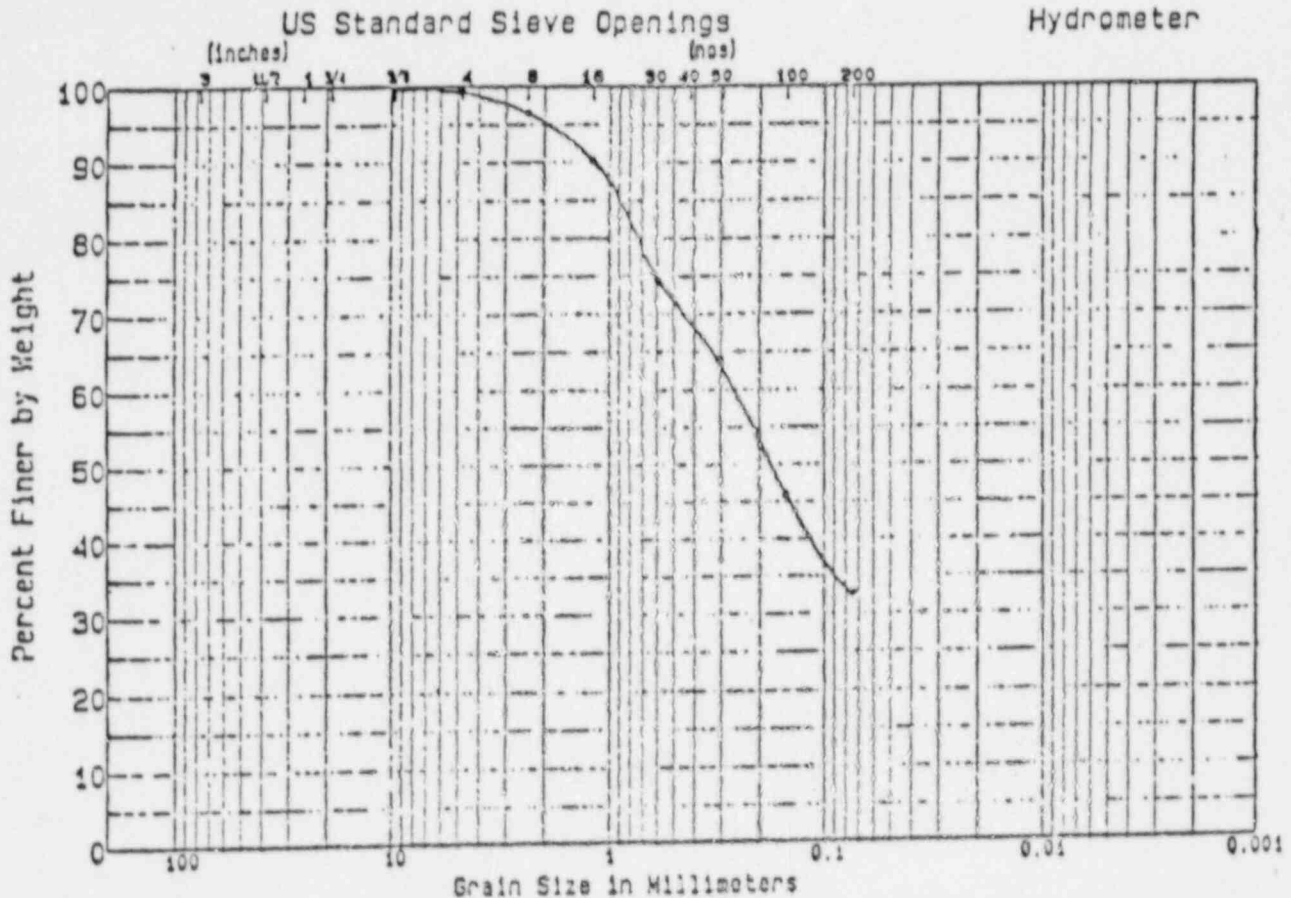
Percent Gravel: 0
 Percent Sand: 56.5
 Percent Silt & Clay: 43.5

Reviewed By: SDM
 Date: 5-1-87

PARTICLE SIZE ANALYSIS

Project: DEQ AML 15-3
 Job No.: 3947-CM
 Client: Hydro-Engineering

Test Date: 4-27-07
 Tested By: CDS



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay
---------	---------------	-------------	-------------	-------------	-----------	------	------

Unified Soil Classification System (ASTM D2487)

Sample No.: 60lu;SS-5
 Sampled By: -
 Source: -

Soil Description: Clayey SAND

Percent Gravel: 1.0
 Percent Sand: 66.3
 Percent Silt & Clay: 32.7

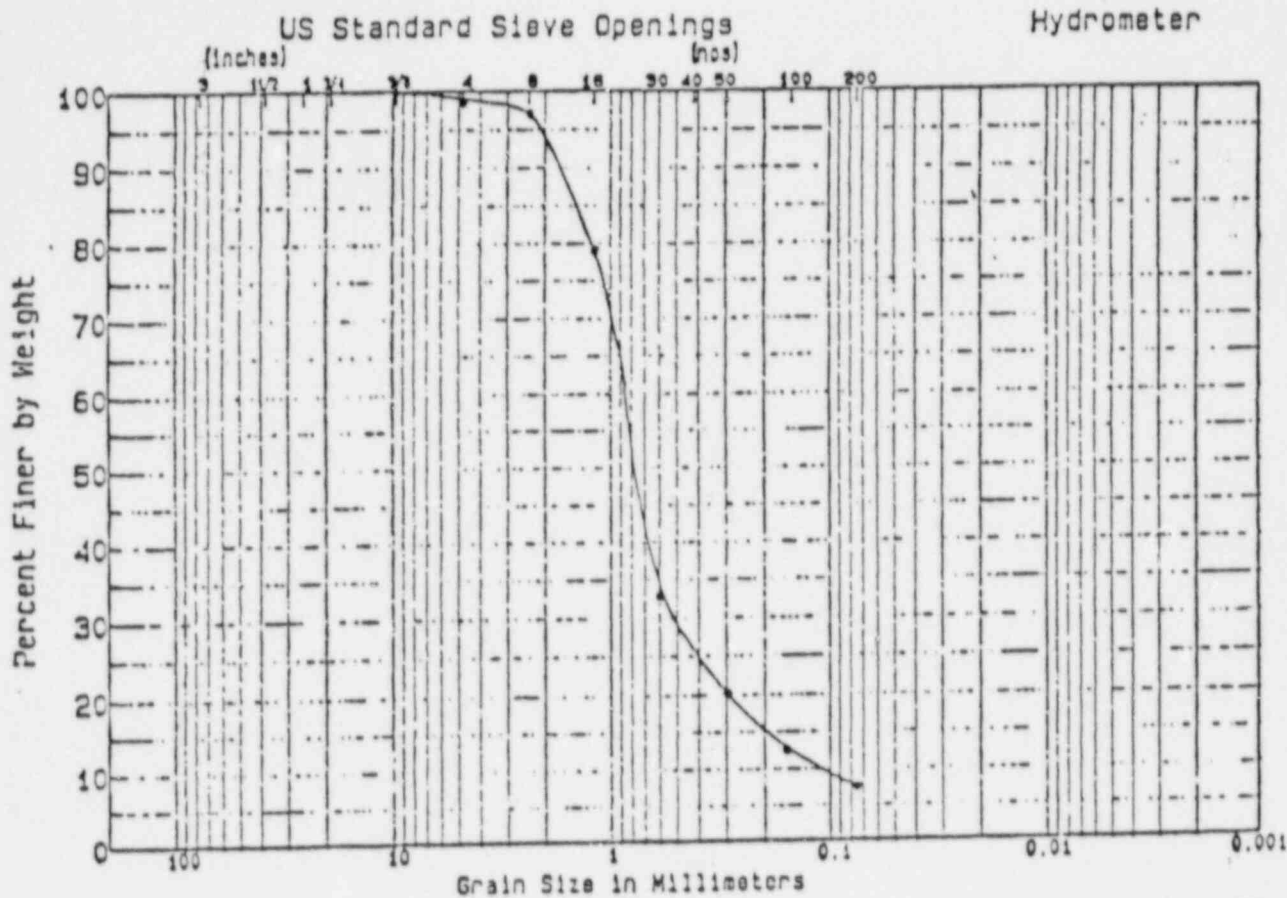
Reviewed By: CM

Date: 5-1-07

PARTICLE SIZE ANALYSIS

Project: DEQ AML 15-3
 Job No.: 3947-CM
 Client: Hydro-Engineering

Test Date: 4-28-87
 Tested By: GDS



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay
---------	---------------	-------------	-------------	-------------	-----------	------	------

Unified Soil Classification System (ASTM D2487)

Sample No.: 800u;SS3
 Sampled By: -
 Source: -

Soil Description: Fine to
medium SAND, little silt.

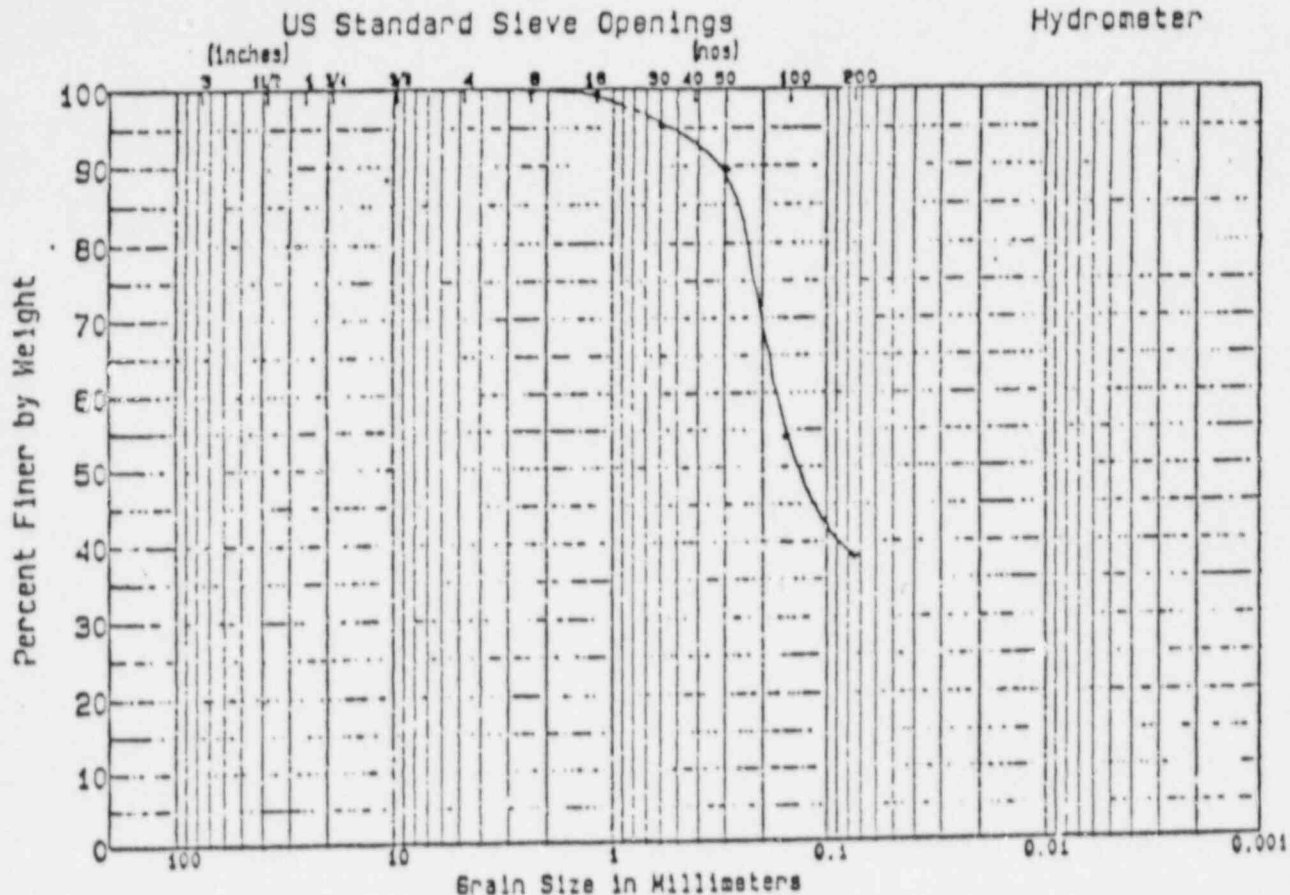
Percent Gravel: 1.3
 Percent Sand: 91.2
 Percent Silt & Clay: 7.5

Reviewed By: [Signature]
 Date: 5-1-87

PARTICLE SIZE ANALYSIS

Project: DEQ AML 15-3
 Job No.: 3947-CM
 Client: Hydro-Engineering

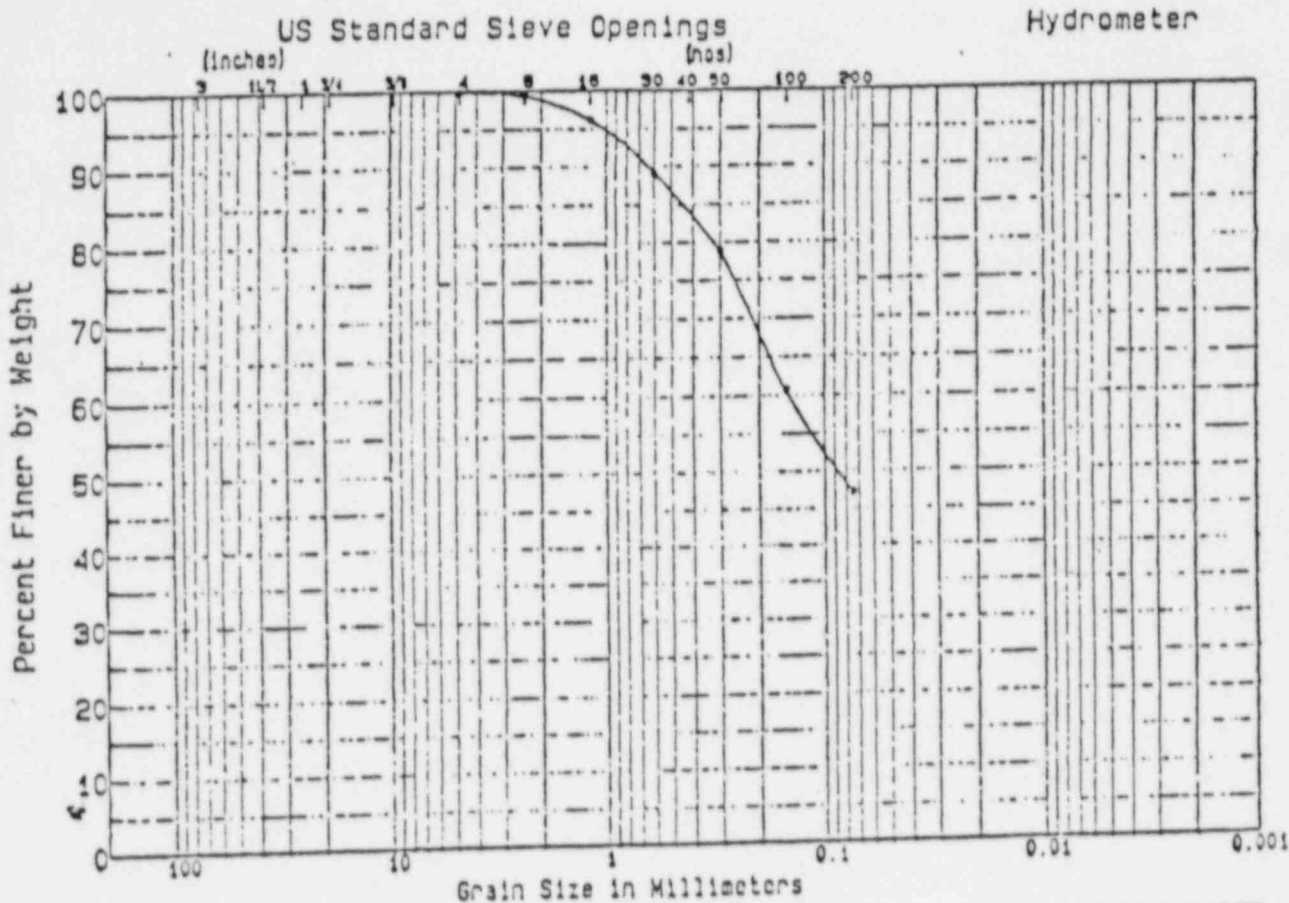
Test Date: 4-28-87
 Tested By: GDS



PARTICLE SIZE ANALYSIS

Project: DEQ AML 15-3
 Job No.: 3947-CM
 Client: Hydro-Engineering

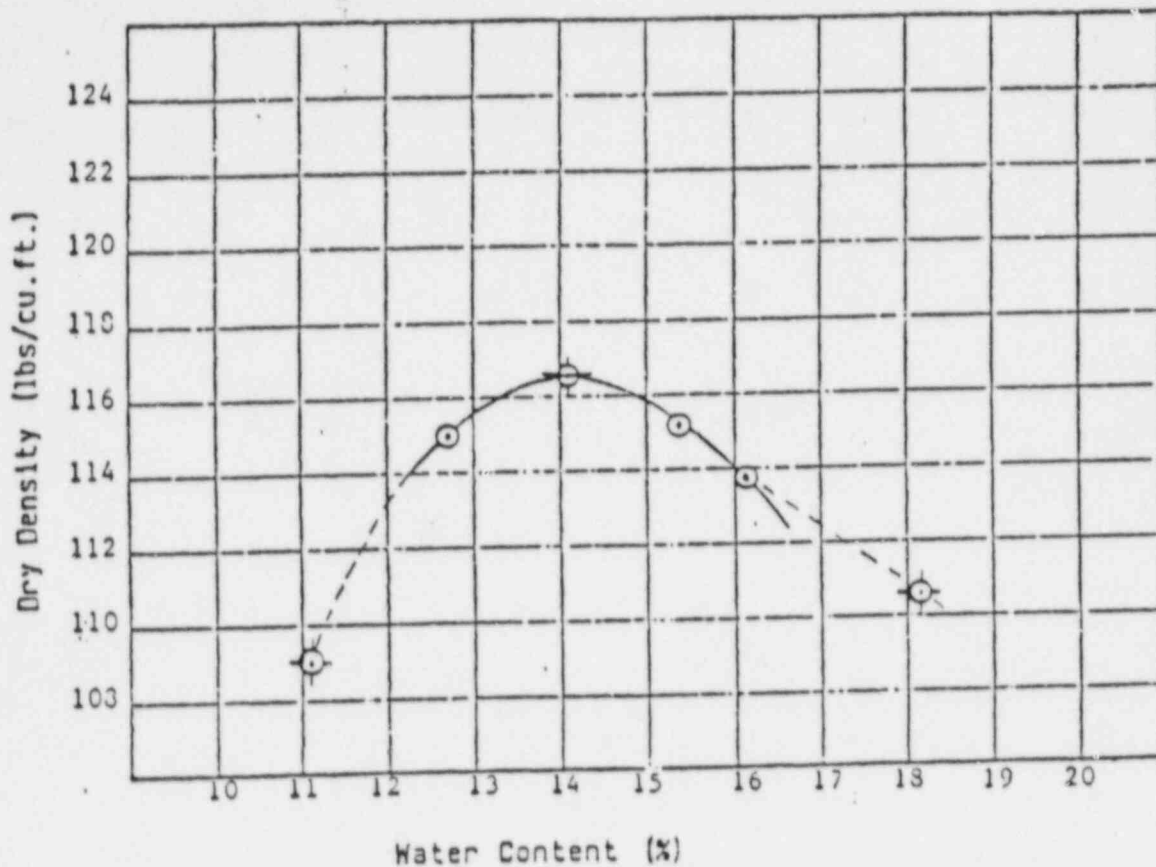
Test Date: 4-24-87
 Tested By: CDS



MOISTURE-DENSITY ANALYSIS

Project: DEQ AML 15-3
 Job No.: 3947-CM
 Client: Hydro-Engineering

Test Date: 4-29-87
 Tested By: GDS
 Test Method: ASTM D-698



Soil Description: _____

Sample No.: 702u; 0-40'

Sampled By: _____

Source: _____

% passing #200 sieve: -

Optimum Water Content: 14.1 %

Liquid Limit: -

Max. Dry Density: 116.4 lbs/cu.ft.

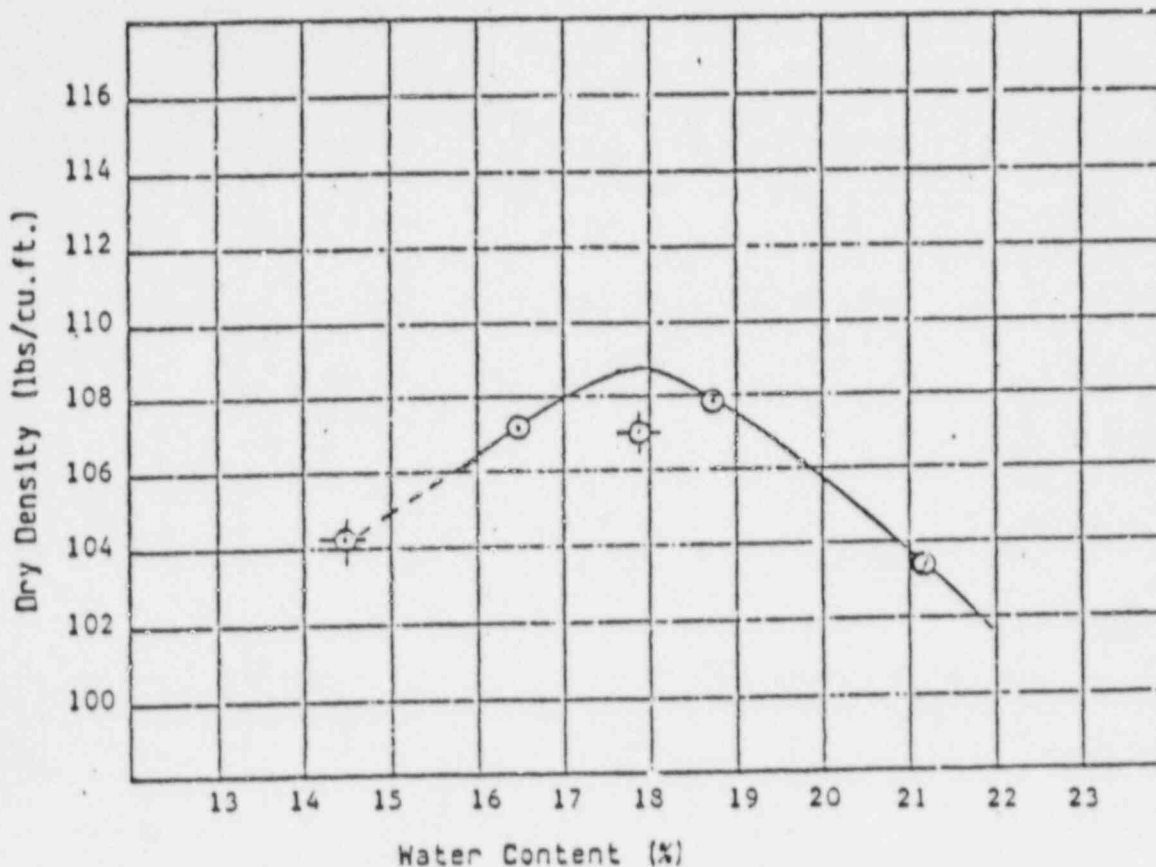
Plasticity Index: -

⊗ Data from permeability testing

MOISTURE-DENSITY ANALYSIS

Project: DEQ AML 15-3
 Job No.: 3947-CM
 Client: Hydro-Engineering

Test Date: 4-29-87
 Tested By: GDS
 Test Method: ASTM D-698



Soil Description: _____

Sample No.: RS47;0-30'

Sampled By: _____

Source: _____

% passing #200 sieve: _____

Optimum Water Content: 17.9 %

Liquid Limit: _____

Max. Dry Density: 108.8 lbs/cu.ft.

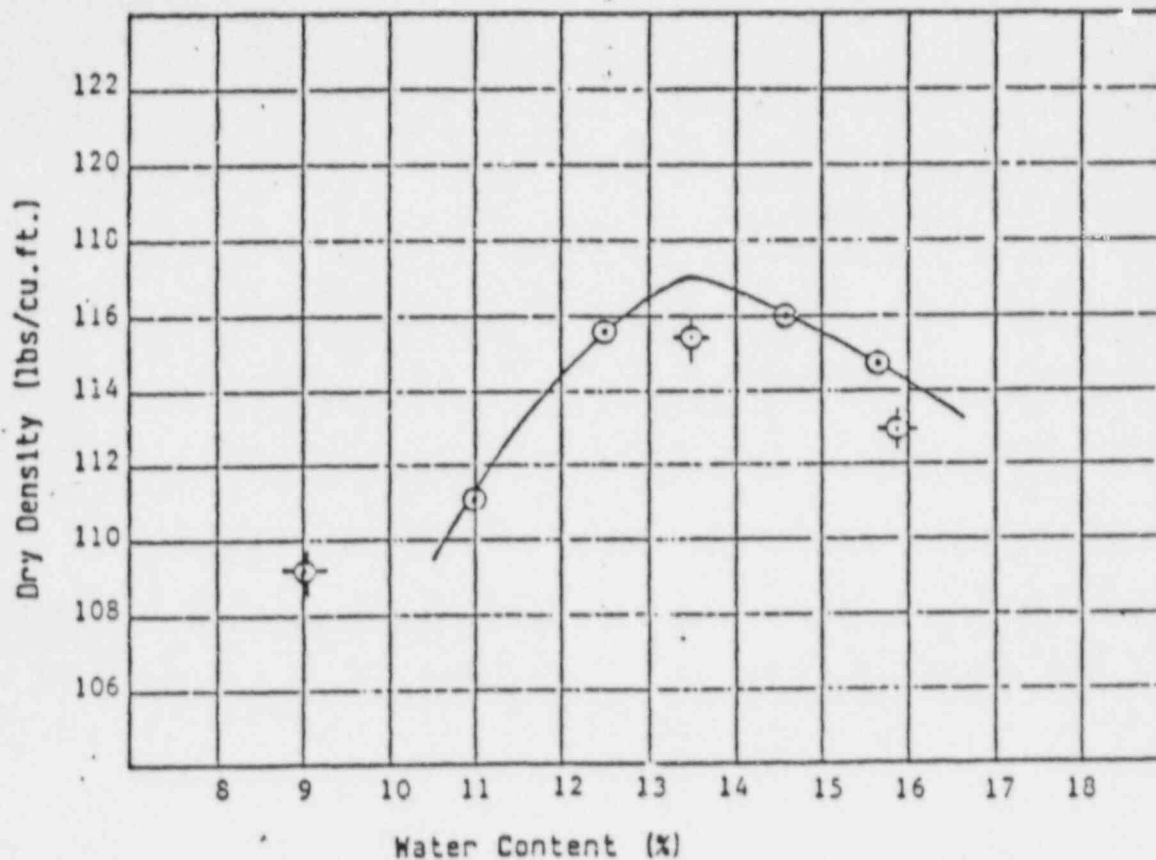
Plasticity Index: _____

⊗ Data from permeability testing

MOISTURE-DENSITY ANALYSIS

Project: DEQ AML 15-3
 Job No.: 3947-CM
 Client: Hydro-Engineering

Test Date: 4-29-37
 Tested By: GDS
 Test Method: ASTM D-698



Soil Description: _____

Sample No.: 302-303 Composite; 0-25'

Sampled By: _____

Source: _____

% passing #200 sieve: _____

Optimum Water Content: 13.5 %

Liquid Limit: _____

Max. Dry Density: 117.0 lbs/cu.ft.

Plasticity Index: _____

⊗ Data from permeability testing

UNITED STATES DEPARTMENT OF ENERGY
Albuquerque, New Mexico

**Uranium Mill Tailings
Remedial Action Project
(UMTRAP-AML)
Spook, Wyoming**

SPK

Information for Bidders

Preliminary Design for Review

Volume II

April 1988



MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

UMTRA PROJECT - SPOOK
INFORMATION TO BIDDERS
PRELIMINARY DESIGN FOR REVIEW
VOLUME II OF II

APRIL 1988

UMTRA PROJECT - SPOOK
INFORMATION TO BIDDERS

PRELIMINARY DESIGN FOR REVIEW

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INFORMATION TO BIDDERS

3) SURFACE AND GROUND WATER DATA (Reference 1)

3.5 GROUNDWATER

3.5.1 Hydrostratigraphy

This section presents a summary of the hydrogeologic conditions at the Spook site. Groundwater occurs in two zones below the Spook tailings site within the Wasatch Formation. These two water-bearing units are separated by an aquitard consisting of a thick, laterally extensive silty shale unit. Locations of existing and DOE-installed wells are shown on Figure 3.8. Hydrogeologic cross section locations and cross sections are shown as Figures 3.9 through 3.11.

The upper hydrostratigraphic unit, the upper sand, consists of moderately cemented, coarse-grained sandstone with minor amounts of erratically occurring silty shale lenses. This upper unit varies between 70 and 140 feet in thickness with an average thickness of 110 feet. Groundwater occurs under unconfined conditions at depths between 85 and 105 feet below land surface, except below the bottom of the excavated pit where groundwater occurs 30 feet below the base of the proposed stabilized pile.

The middle hydrostratigraphic unit, the middle shale, is composed of a silty shale and functions as an aquitard underlying the upper hydrostratigraphic unit. This middle hydrostratigraphic unit consists of between 50 and 65 feet of well-consolidated silty shales and shales.

The lower hydrostratigraphic unit, the lower sand, consists of moderately cemented, coarse-grained sandstone. This unit occurs between 160 and 180 feet below land surface and is of an undetermined total thickness. Groundwater occurs under confined conditions and exhibits a potentiometric surface slightly lower in elevation than the potentiometric surface of the upper hydrostratigraphic unit.

3.5.2 Groundwater movement

The water table in the upper sand ranges from 30 feet below the base of the proposed stabilized pile (existing pit floor) to near 105 feet below the unexcavated land surface. As shown on Figure 3.12, this unconfined groundwater flows generally north-eastward and eastward under a hydraulic gradient averaging 0.007 foot per foot.

Groundwater flow within the middle shale and lower sand is not as well understood, but appears to flow generally south-westward. These deeper flow regimes are to be more completely characterized following completion of the proposed second-phase drilling program. Preliminary calculated hydraulic characteristics of the three hydrostratigraphic units are presented in Table 3.2.

3.5.3 Water quality

Background-water quality for the three hydrostratigraphic units has not yet been established. The EPA Primary Drinking Water Standards for mercury, nitrate, and selenium were exceeded by groundwater samples from one or more monitor wells, as were the EPA Secondary Drinking Water Standards for manganese, sulfate, and total dissolved solids. As seen in Table 3.3, groundwater samples from one existing well exceed the EPA Secondary Drinking Water Standards for iron and total dissolved solids (TDS). Background-water quality and the extent of milling-related contamination will be determined following the proposed second-phase drilling program and the completion of the analyses of required groundwater samples. Figure 3.13 shows concentrations of selected chemical constituents and Table 3.4 lists the complete chemical analyses, by well, for the initial groundwater sampling.

3.5.4 Water use

One registered well (SPK01-900/State of Wyoming #617) and one unregistered well (SPK01-901) are within the designated site boundaries. These wells are equipped with electric submersible pumps and are used intermittently to supply water for livestock. An additional registered well (SPK01-903/State of Wyoming #19973) and an unregistered well (SPK01-902) are within the general vicinity of the Spook tailings site. Well 903 is artesian and well 902 is equipped with an electric submersible pump; both wells supply water for livestock.

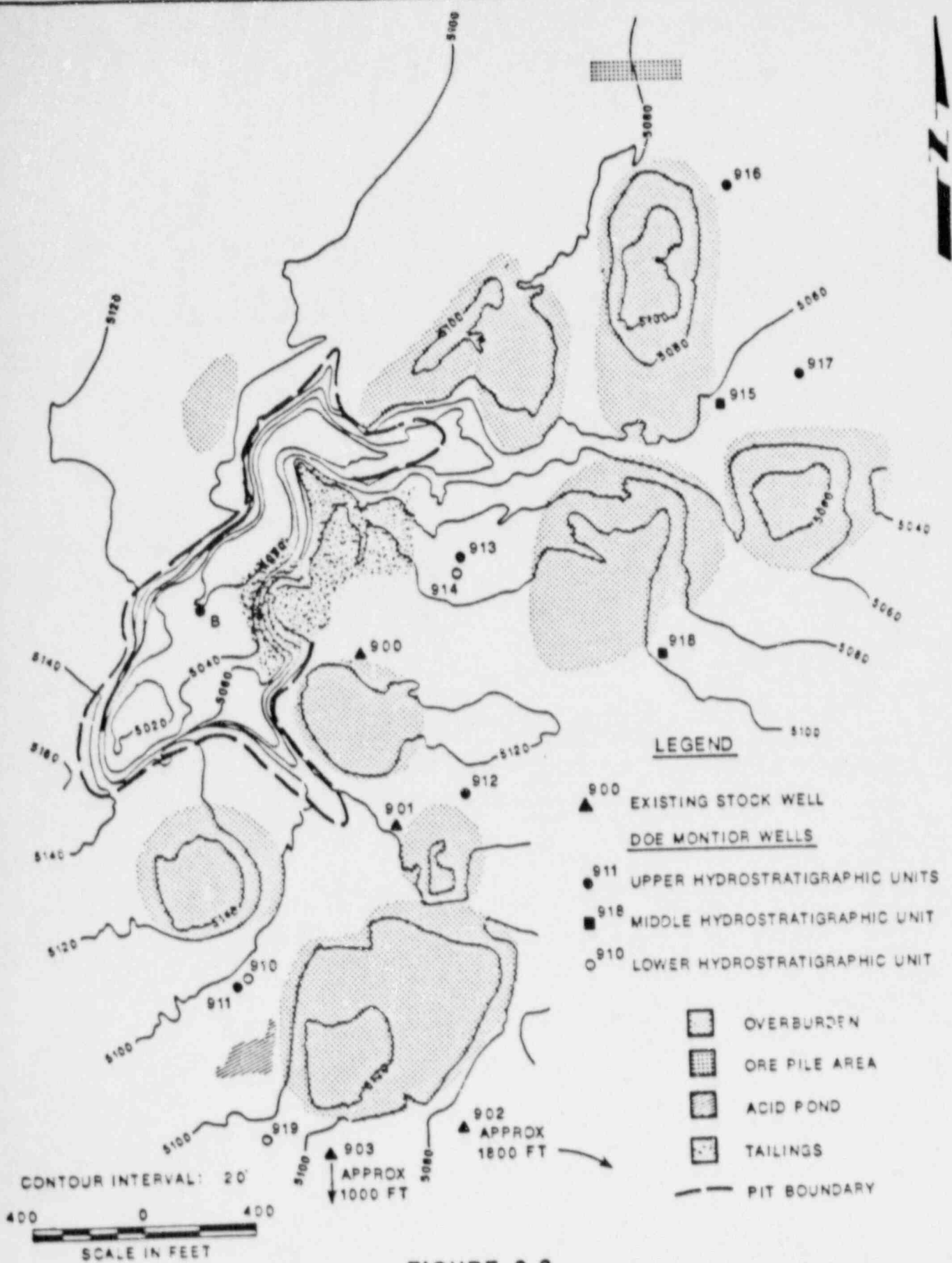


FIGURE 3.8
DOE GROUNDWATER SAMPLING LOCATIONS
SPOOK SITE - CONVERSE COUNTY, WYOMING

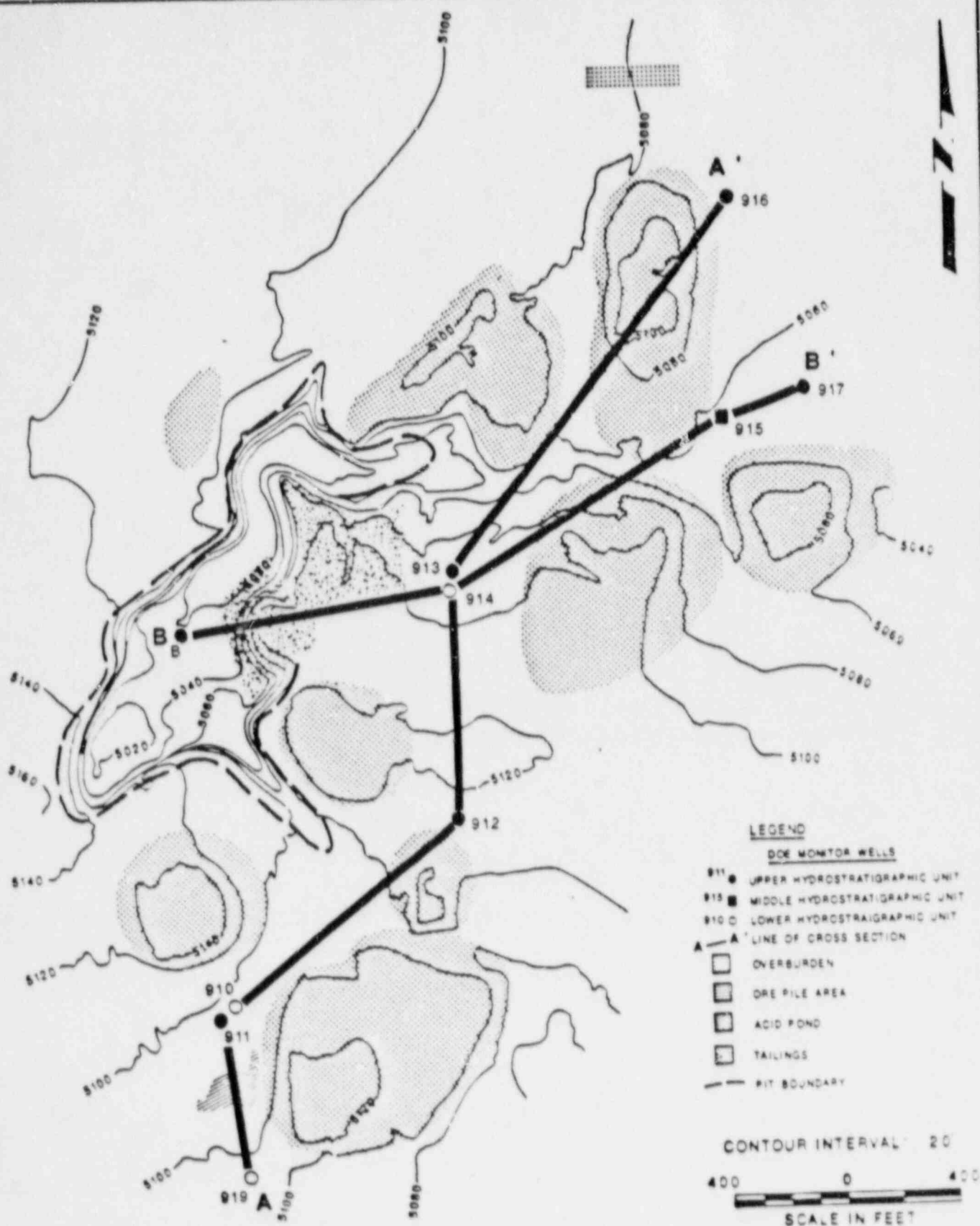


FIGURE 3.9
LOCATION OF HYDROGEOLOGIC CROSS SECTIONS
SPOOK SITE - CONVERSE COUNTY, WYOMING

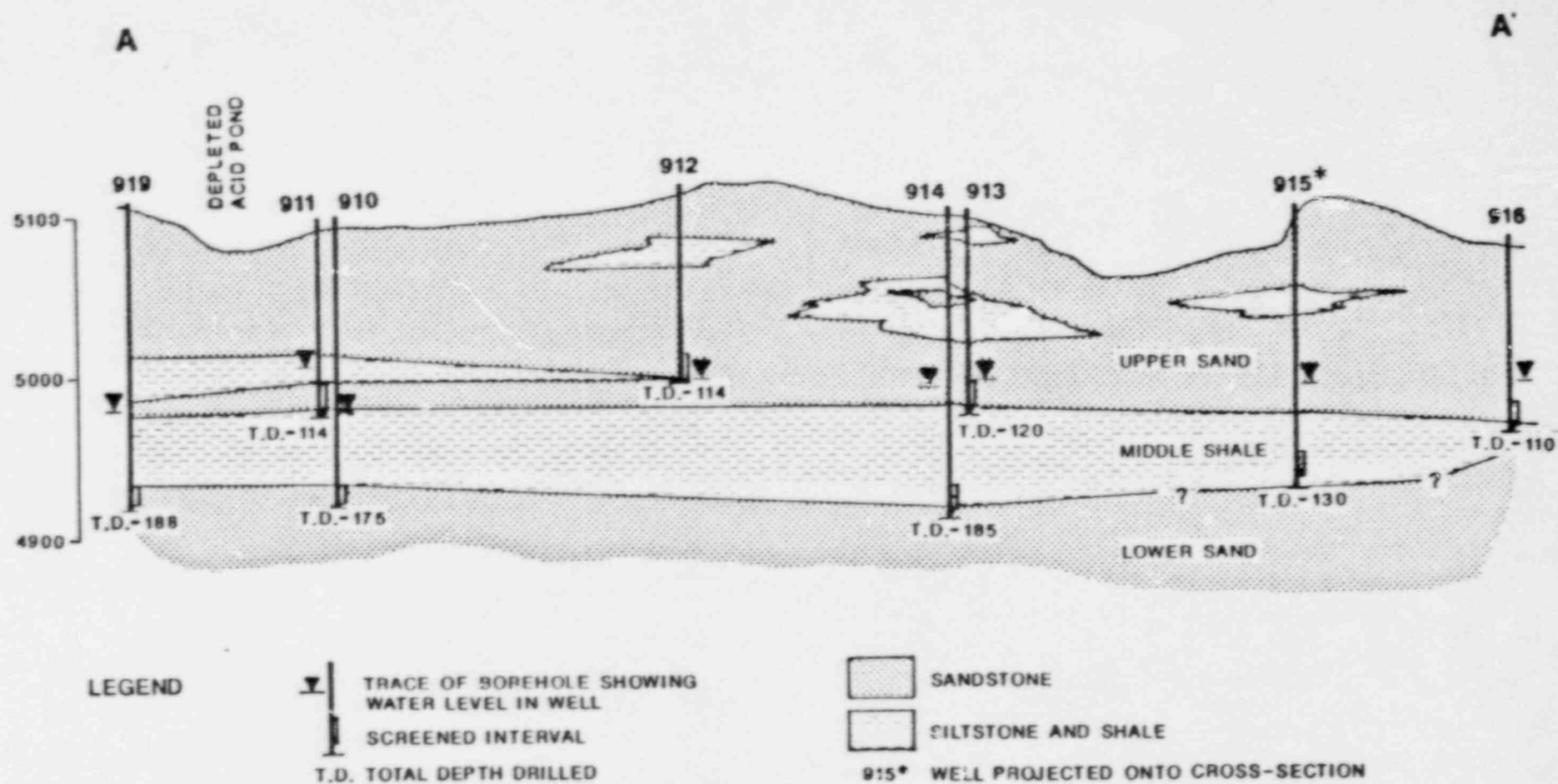


FIGURE 3.10
HYDROGEOLOGIC CROSS SECTION A-A',
SPOOK SITE - CONVERSE COUNTY, WYOMING

LEGEND



TRACE OF BOREHOLE SHOWING
WATER LEVEL IN WELL



SCREENED INTERVAL

T.D. TOTAL DEPTH DRILLED



TAILINGS AND/OR BACKFILL

SANDSTONE

SILTSTONE AND SHALE

913* WELL PROJECTED ONTO CROSS-SECTION

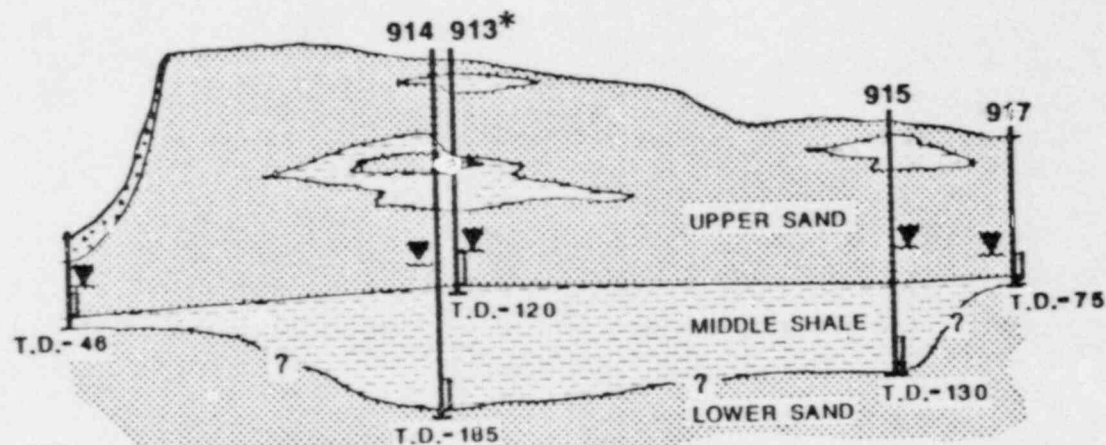
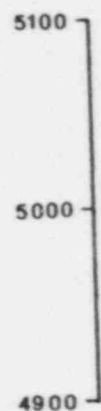


FIGURE 3.11

HYDROGEOLOGIC CROSS SECTION B-B',
SPOOK SITE - CONVERSE COUNTY, WYOMING

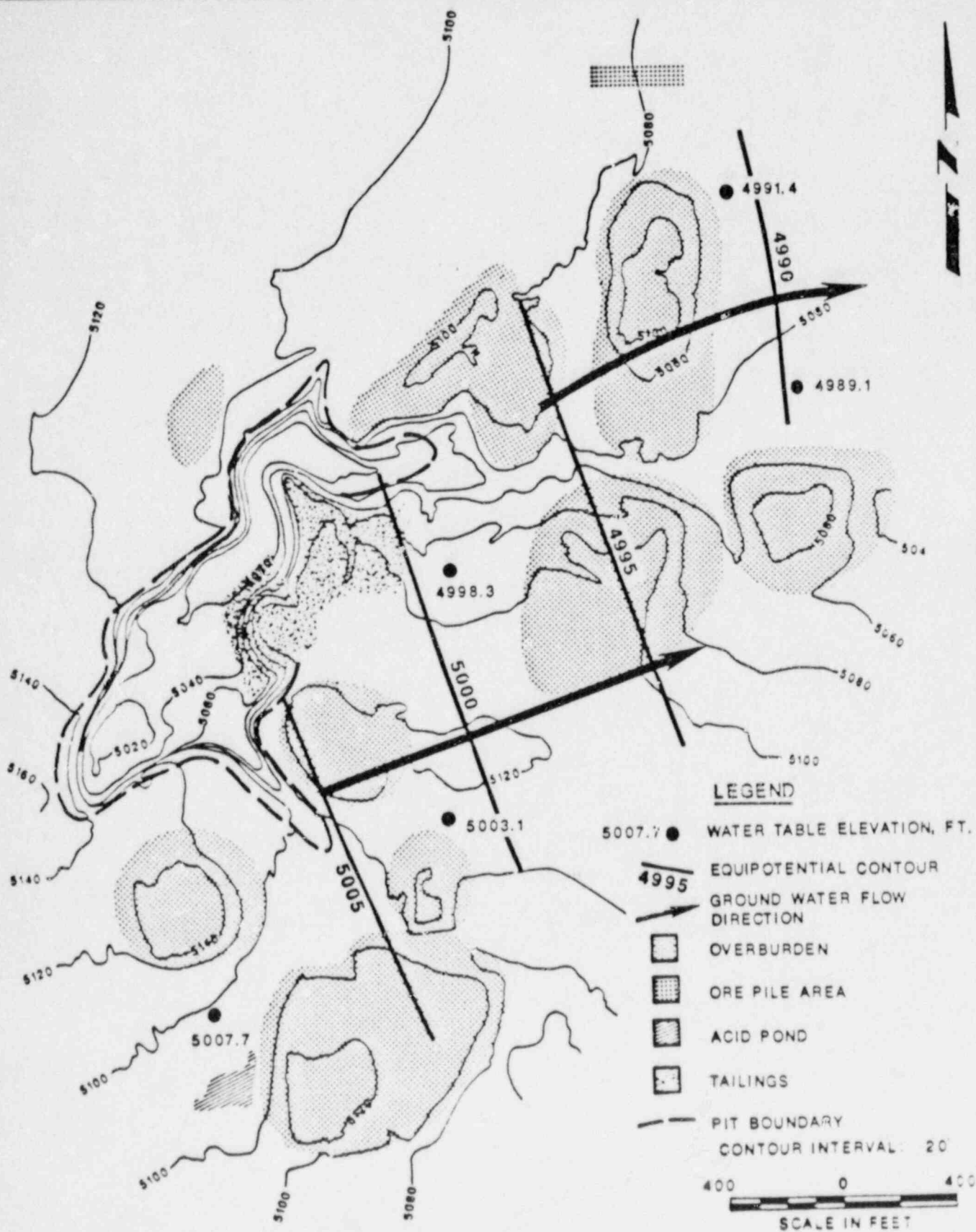


FIGURE 3.12
GROUNDWATER FLOW DIRECTION WITHIN THE UPPER
HYDROSTRATIGRAPHIC UNIT (UNIT A), FEBRUARY, 1987,
SPOOK SITE
CONVERSE COUNTY, WYOMING

Table 3.2 Preliminary calculated hydraulic characteristics, Spook site, Wyoming

Hydrostratigraphic unit well ID	Test method					Mean value (ft/yr)
	Bouwer-Rice (ft/yr)	Hvorslev (ft/yr)	Skibitske (ft/yr)	Ferris-Knowles (ft/yr)	C-B-P (ft/yr)	
Upper sand						
911	62.1	103.4	NA	NA	NA	(3.0x10 ⁻⁴ cm/sec) 318.9
912	50.5	ND	NA	NA	NA	
913	614.6	ND	NA	NA	NA	
916 820.4	1235.1	NA	NA	NA	NA	
917	ND	1662.4	NA	NA	NA	
Middle shale						
915	NA	NA	34.6	40.3	ND	(3.6x10 ⁻⁵ cm/sec) 37.3
Lower sand						
910	NA	NA	131.5	136.1	244.3	(3.2x10 ⁻⁴ cm/sec) 338.0
919	NA	NA	500.0	2016.9	ND	

NA = Not applicable.

ND = Not determined.



Table 3.3 Exceedences of EPA Drinking Water Standards, Spook site, Wyoming

EPA primary standard	Existing	Upper sand	Middle shale	Lower sand
Arsenic (0.5 mg/l)				
Barium (1.0 mg/l)				
Cadmium (0.01 mg/l)				
Chromium (0.05 mg/l)				
Gross alpha (15 pCi/l)				
Lead (0.05 mg/l)				919
Mercury (0.0002 mg/l)		911, 913, 916		910
Nitrate (45 mg/l)				
pH (6.5 to 8.5)				
Radium-226 and Radium-228 (5.0 pCi/l)		913, 916, 917	915, 918	919
Selenium (0.01 mg/l)				
Silver (0.05 mg/l)				
EPA secondary standard				
Chloride (250 mg/l)				
Copper (1.0 mg/l)				
Iron (0.3 mg/l)	900	911		910
Manganese (0.05 mg/l)		911, 913, 916	918	910
Sulfate (250 mg/l)				
Total dissolved solids (TDS) (500 mg/l)	900	911, 913, 916, 917	918	910
Zinc (5.0 mg/l)				

^aProposed.

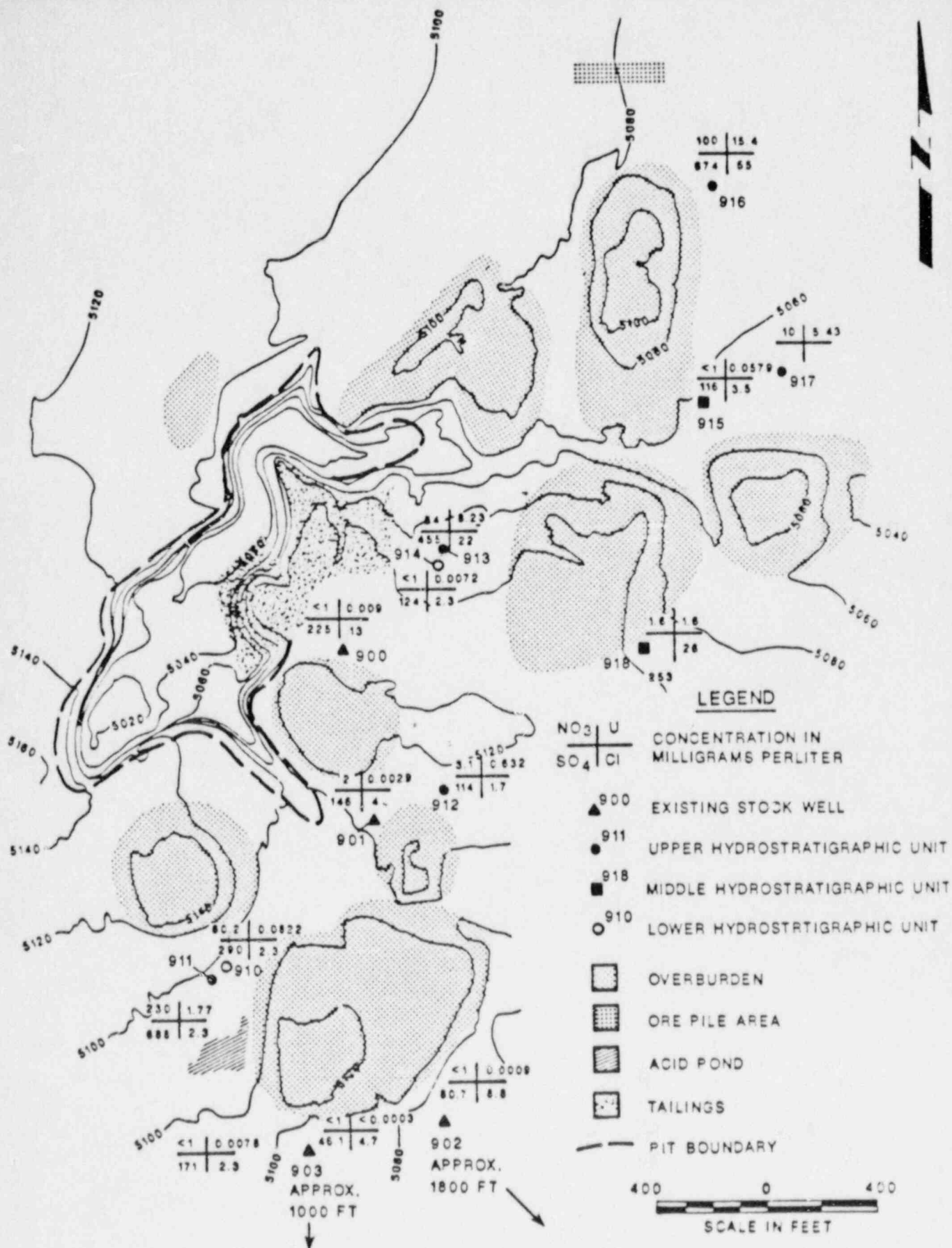


FIGURE 3.13
CONCENTRATION OF SELECTED CHEMICAL CONSTITUENTS AT THE SPOOK SITE - CONVERSE COUNTY, WYOMING

LOCATION ID - SAMPLE ID AND LOG DATE						
		944-04 02/17/87	942-04 02/18/87	943-04 02/18/87	946-04 02/20/87	947-04 02/19/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE +/- UNCERTAINTY	PARAMETER VALUE +/- UNCERTAINTY	PARAMETER VALUE +/- UNCERTAINTY	PARAMETER VALUE +/- UNCERTAINTY	PARAMETER VALUE +/- UNCERTAINTY
ALKALINITY	MG/L CaCO ₃	210.	192.	274.	297.	340.
ALUMINUM	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
AMMONIUM	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
ANTIMONY	MG/L	< 0.003	< 0.003	< 0.007	< 0.003	< 0.004
ARSENIC	MG/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
BARIUM	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
CADMIUM	MG/L	< 0.001	< 0.001	< 0.001	< 0.005	< 0.001
CALCIUM	MG/L	204.	40.	198.	286.	136.
CHLORIDE	MG/L	2.3	1.7	22.	55.	21.
CONDUCTANCE	UMHO/CM	1350.	375.	700.	1150.	700.
COPPER	MG/L	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01
FLUORIDE	MG/L	0.3	0.3	0.3	0.3	0.3
IRON	MG/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
LEAD	MG/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
MAGNESIUM	MG/L	48.3	5.25	39.4	70.9	28.6
MANGANESE	MG/L	0.40	0.02	0.03	0.03	< 0.01
MERCURY	MG/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
MOLYBDENUM	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
NITRATE	MG/L	230.	3.1	84.	100.	10.
PH		7.49	7.34	6.98	6.97	7.34
PHOSPHATE	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
POTASSIUM	MG/L	15.5	4.00	9.42	10.5	8.38
SELENIUM	MG/L	0.004	< 0.001	3.80	1.15	2.71
SILICA	MG/L	14.	20.	19.	19.	22.
SILVER	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
SODIUM	MG/L	208.	75.0	111.	27.2	18.4
SULFATE	MG/L	688.	114.	455.	674.	149.
TEMPERATURE	C - DEGREE	10.0	10.5	12.0	11.5	10.5
TOTAL SOLIDS	MG/L	1370.	348.	1020.	1920.	764.
URANIUM	MG/L	1.77	0.632	0.23	15.4	5.43
ZINC	MG/L	0.030	0.001	0.076	0.018	0.025
CATION/ANION						
BALANCE, %		2.83	4.29	3.84	3.53	2.41

LOCATION ID - SAMPLE ID AND LOG DATE																					
		940-04		02/47/R7		940-02		02/47/R7		940-03		02/47/R7		940-04		02/47/R7		940-05		02/47/R7	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE +/- UNCERTAINTY		PARAMETER VALUE +/- UNCERTAINTY		PARAMETER VALUE +/- UNCERTAINTY		PARAMETER VALUE +/- UNCERTAINTY		PARAMETER VALUE +/- UNCERTAINTY		PARAMETER VALUE +/- UNCERTAINTY		PARAMETER VALUE +/- UNCERTAINTY		PARAMETER VALUE +/- UNCERTAINTY		PARAMETER VALUE +/- UNCERTAINTY		PARAMETER VALUE +/- UNCERTAINTY	
ALKALINITY	MG/L	444.		444.		444.		444.		444.		444.		444.		444.		444.		444.	
ALUMINUM	MG/L	0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4	
AMMONIUM	MG/L	0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4	
ANTHRONY	MG/L	0.003		0.003		0.003		0.003		0.003		0.003		0.003		0.003		0.003		0.003	
ARSENITE	MG/L	0.004		0.004		0.004		0.004		0.004		0.004		0.004		0.004		0.004		0.004	
BARIUM	MG/L	0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4	
BORON	MG/L	-		-		-		-		-		-		-		-		-		-	
CADMIUM	MG/L	0.004		0.004		0.004		0.004		0.004		0.004		0.004		0.004		0.004		0.004	
CALCIUM	MG/L	56.3		56.3		56.3		56.3		56.3		56.3		56.3		56.3		56.3		56.3	
CHLORIDE	MG/L	2.3		2.3		2.3		2.3		2.3		2.3		2.3		2.3		2.3		2.3	
CUMULANCE	UMPH/LCM	525.		525.		525.		525.		525.		525.		525.		525.		525.		525.	
COPPER	MG/L	0.04		0.04		0.04		0.04		0.04		0.04		0.04		0.04		0.04		0.04	
FLUORIDE	MG/L	0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3	
IRON	MG/L	0.03		0.03		0.03		0.03		0.03		0.03		0.03		0.03		0.03		0.03	
LEAD	MG/L	0.004		0.004		0.004		0.004		0.004		0.004		0.004		0.004		0.004		0.004	
MANGANESE	MG/L	42.4		42.4		42.4		42.4		42.4		42.4		42.4		42.4		42.4		42.4	
MERCURY	MG/L	0.06		0.06		0.06		0.06		0.06		0.06		0.06		0.06		0.06		0.06	
MERCURY	MG/L	0.0002		0.0002		0.0002		0.0002		0.0002		0.0002		0.0002		0.0002		0.0002		0.0002	
NITRATE	MG/L	0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4	
NITRATE	MG/L	60.2		60.2		60.2		60.2		60.2		60.2		60.2		60.2		60.2		60.2	
PH	SH	8.54		8.54		8.54		8.54		8.54		8.54		8.54		8.54		8.54		8.54	
PHOSPHATE	MG/L	0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4	
POTASSIUM	MG/L	8.65		8.65		8.65		8.65		8.65		8.65		8.65		8.65		8.65		8.65	
SELENIUM	MG/L	0.002		0.002		0.002		0.002		0.002		0.002		0.002		0.002		0.002		0.002	
SILICA	MG/L	43.		43.		43.		43.		43.		43.		43.		43.		43.		43.	
SODIUM	MG/L	0.04		0.04		0.04		0.04		0.04		0.04		0.04		0.04		0.04		0.04	
SODIUM	MG/L	407.		407.		407.		407.		407.		407.		407.		407.		407.		407.	
SODIUM	MG/L	290.		290.		290.		290.		290.		290.		290.		290.		290.		290.	
TEMPERATURE	C - DEGREE	42.0		42.0		42.0		42.0		42.0		42.0		42.0		42.0		42.0		42.0	
TOTAL SOLIDS	MG/L	545.		545.		545.		545.		545.		545.		545.		545.		545.		545.	
URANIUM	MG/L	0.0072		0.0072		0.0072		0.0072		0.0072		0.0072		0.0072		0.0072		0.0072		0.0072	
ZINC	MG/L	0.075		0.075		0.075		0.075		0.075		0.075		0.075		0.075		0.075		0.075	
CATION/ANION BALANCE, %		4.85		4.85		4.10		4.10		4.08		4.10		4.10		4.10		4.10		4.10	

LOCATION ID - SAMPLE ID AND LOG DATE						
		944-01 02/18/87	944-02 02/18/87	944-03 02/18/87	944-04 02/18/87	944-05 02/18/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE +/- UNCERTAINTY	PARAMETER VALUE +/- UNCERTAINTY	PARAMETER VALUE +/- UNCERTAINTY	PARAMETER VALUE +/- UNCERTAINTY	PARAMETER VALUE +/- UNCERTAINTY
ALKALINITY	MG/L CALCD	190.	190.	190.	190.	190.
ALUMINUM	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
AMMONIUM	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
ANTHRONY	MG/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
ARSENIC	MG/L	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
BARIUM	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
CALCIUM	MG/L	41.1	41.6	41.6	41.6	41.6
CHLORIDE	MG/L	2.3	2.2	2.5	2.5	2.5
CONDUCTANCE	UMHO/CM	280.	280.	280.	280.	280.
COPPER	MG/L	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
FLUORIDE	MG/L	0.3	0.3	0.3	0.3	0.3
IRON	MG/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
LEAD	MG/L	0.004	0.004	0.004	0.004	0.004
MAGNESIUM	MG/L	5.44	5.50	5.38	5.38	5.38
MANGANESE	MG/L	0.03	0.03	0.03	0.03	0.03
MERCURY	MG/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
MOLYBDENUM	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
NITRATE	MG/L	9.4	9.3	9.2	9.2	9.2
PH	SI	8.18	8.18	8.18	8.18	8.18
PHOSPHATE	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
POTASSIUM	MG/L	4.24	4.23	4.25	4.24	4.25
SELENIUM	MG/L	< 0.004	0.011	0.009	0.009	0.007
SILICA	MG/L	14.	14.	14.	14.	14.
SILVER	MG/L	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
SODIUM	MG/L	84.8	84.7	84.6	84.8	84.7
SULFATE	MG/L	124.	125.	125.	125.	125.
TEMPERATURE	C - DEGREE	11.0	11.0	11.0	11.0	11.0
TOTAL SOLIDS	MG/L	346.	348.	347.	346.	347.
THALLIUM	MG/L	0.0072	0.0068	0.0082	0.0074	0.0069
ZINC	MG/L	0.006	0.009	0.007	0.010	0.008
CATION/ANION BALANCE, %		1.24	1.28	1.30	1.23	1.26

IDENTIFICATION - SAMPLE ID AND LOG DATE

PARAMETER	UNIT OF MEASURE	945-04 02/20/87		948-04 02/20/87		949-04 02/19/87	
		PARAMETER VALUE +/- UNCERTAINTY	PARAMETER VALUE +/- UNCERTAINTY	PARAMETER VALUE +/- UNCERTAINTY	PARAMETER VALUE +/- UNCERTAINTY	PARAMETER VALUE +/- UNCERTAINTY	PARAMETER VALUE +/- UNCERTAINTY
ALKALINITY	MG/L CaCO_3	427		247		450	
ALUMINUM	MG/L	0.4		0.4		0.4	
AMMONIUM	MG/L	0.4		0.4		0.5	
ANTIMONY	MG/L	0.003		0.003		0.003	
ARSENIC	MG/L	0.004		0.004		0.004	
BARIUM	MG/L	0.4		0.4		0.4	
BORON	MG/L						
CADMIUM	MG/L	0.004		0.004		0.002	
CALCIUM	MG/L	46.0		439		55.0	
CHLORIDE	MG/L	3.5		26		2.3	
CONDUCTANCE	UMHO/CM	320		450		340	
COPPER	MG/L	0.04		0.04		0.04	
FLUORIDE	MG/L	0.3		0.2		0.3	
IRON	MG/L	0.03		0.03		0.14	
LEAD	MG/L	0.004		0.043		0.040	
MANGANESE	MG/L	7.37		22.9		40.4	
MERCURY	MG/L	0.03		0.04		0.03	
MOLYBDENUM	MG/L	0.0002		0.0002		0.0003	
NITRATE	MG/L	0.2		0.4		0.4	
PH	SI	0.4		4.6		0.8	
PHOSPHATE	MG/L	7.68		7.28		7.07	
POTASSIUM	MG/L	0.4		0.4		0.4	
SELENIUM	MG/L	5.49		8.96		7.54	
SILICA	MG/L	0.022		4.40		0.014	
SODIUM	MG/L	46		20		20	
SODIUM	MG/L	39.3		0.04		0.04	
SODIUM	MG/L	416		48.6		55.4	
TEMPERATURE	C - DEGREE	40		25.3		47.4	
TOTAL SOLIDS	MG/L	340		40		44	
URANIUM	MG/L	0.0079		670		436	
ZINC	MG/L	0.043		1.60		0.0078	
				0.027		0.055	
CATION/ANION BALANCE, %		3.14		2.51		2.96	

3.6 SURFACE-WATER FEATURES

3.6.1 Spook site

The Spook site is near the head of an unnamed drainage channel which in turn is tributary to the generally east-coursing, intermittently flowing Dry Fork Cheyenne River.

Surface runoff in the immediate vicinity of the Spook site either is intercepted by the Spook pit or flows in several adjacent ephemeral streams (Figure 3.14). The channels of three such streams are blocked by stockpiled materials from mining and milling activities. One of the ephemeral streams previously flowed through what is now the northeast portion of the pit. The ephemeral stream due south of the Spook pit flows into the former acid pond where it is dammed by an overburden pile and a north-south dirt road. The ponded areas north and south of the pit show no evidence of overtopping.

The land surface adjacent to the Spook pit is moderately sloped and is characterized by ephemeral drainage. The portion of the Spook pit containing the tailings lies along an axis perpendicular to a ridge descending from the northwest to southeast. The elevation of the top of the high wall varies from about 5070 to 5160 feet above mean sea level (MSL). The southwest end of the pit is near the spine of the ridge near the watershed divide, hence, the pit has little upland watershed tributary to the tailings area. Drainage on the ridge generally is by sheet flow down relatively gentle (two to three percent) slopes, with little gully erosion evident except where the ground was disturbed by mining activities.

3.6.2 Dry Fork Cheyenne River

The Dry Fork Cheyenne River (Dry Fork) is the largest stream in the Spook site area and at its nearest is about one mile south at a nominal bed elevation of 4990 feet above MSL. The drainage area tributary to the Dry Fork in the vicinity of the site is about 140 square miles (Figure 3.15). The Dry Fork stream basin upstream of the Spook site consists of relatively flat terrain with some hilly areas in the western quarter of the basin. The basin is bordered by the Cheyenne River Divide to the north, Turner Divide to the east, Sage Creek Divide to the south, and an unimproved dirt road to the west. The stream originates from the east side of the South Fork Reservoir 12.6 aerial miles southwest from the Spook site at an elevation of 5432 feet above MSL. Several smaller streams and creeks such as the Middle Fork, Pine Gulch, North Fork, Brown Springs Creek, Phillips Creek, Martin Spring Draw, and the Cheyenne River Draw are tributary to the Dry Fork upstream of the Spook site. One branch of the South Fork flows into the west side of the South Fork Reservoir which feeds the Dry Fork. The Dry Fork drains into the Cheyenne River 40 aerial miles downstream of the Spook site.

The U.S. Geological Survey (USGS) maintained a stream gaging station on the Dry Fork from November, 1976, to September, 1980, three miles southwest of the Spook site (DOE, 1982a). During this period, runoff at this station averaged 1.12 cubic feet per second (cfs) (810 acre-feet per year), ranging from less than 0.28 cfs to more than 3.45 cfs (200 to 2500 acre-feet per year). The Dry Fork has extended periods of no flow, particularly during January, July, and August. No data on historical flows exist for the Spook site; however, there is evidence of past flooding (100 to 500 years old) on the Dry Fork. Flood deposits are seen on areal photographs on the north bank of the Dry Fork 45 feet above the present streambed level and 15 feet above the floodplain terrace.

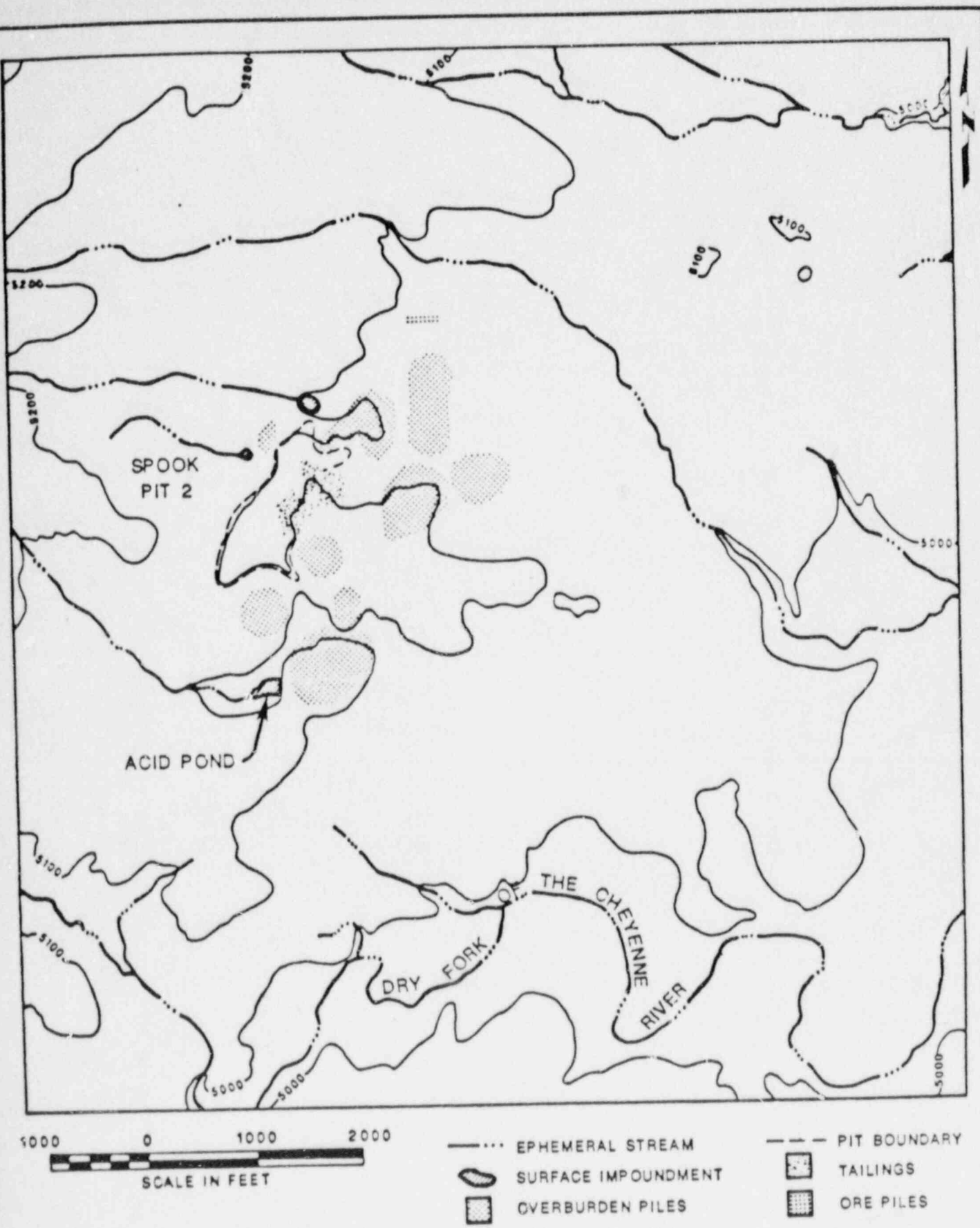


FIGURE 3.14
 EXISTING SURFACE-WATER FEATURES
 SPOOK SITE - CONVERSE COUNTY, WYOMING

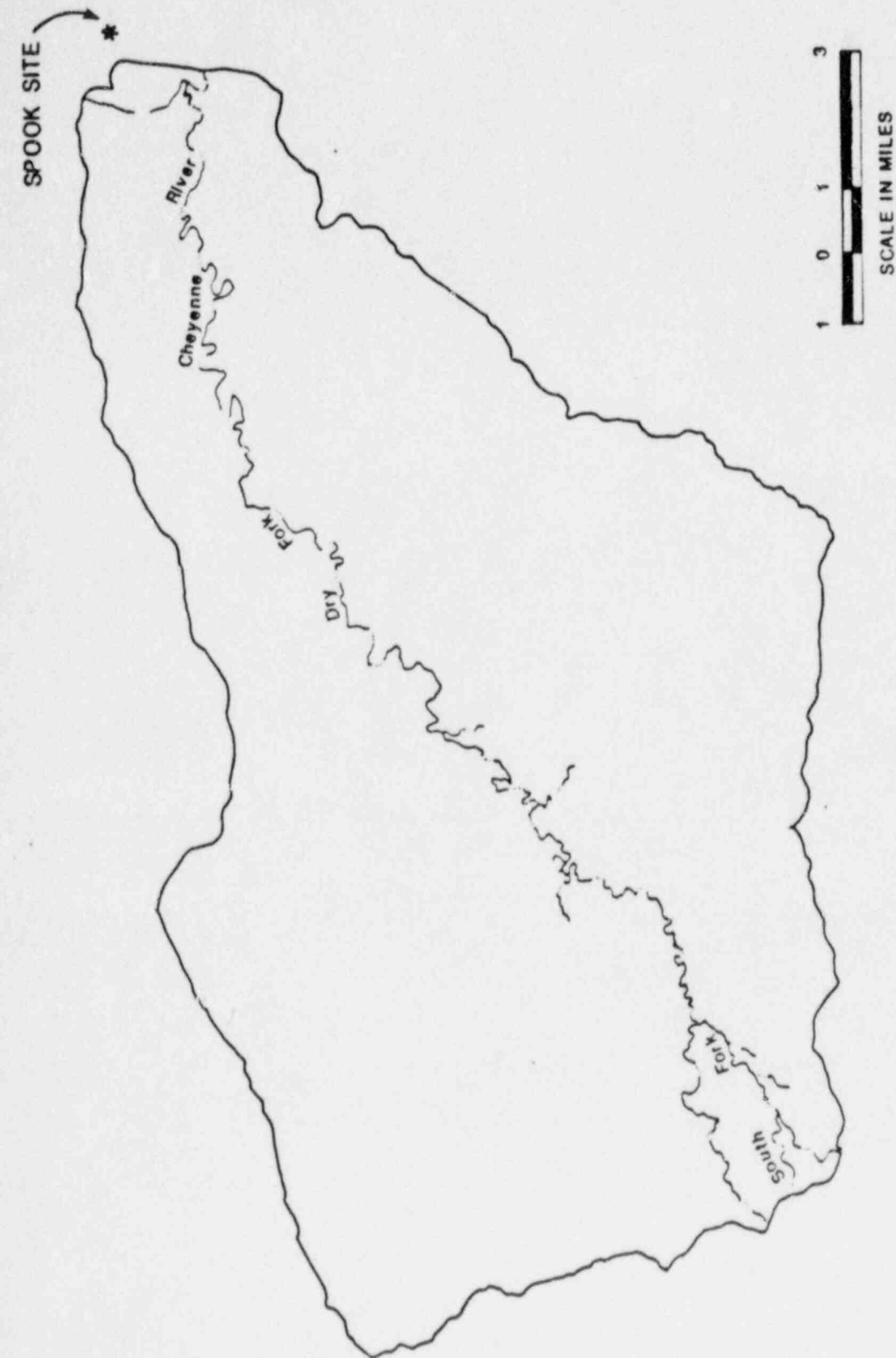


FIGURE 3.15
DRY FORK CHEYENNE RIVER WATERSHED NEAR
SPOOK SITE - CONVERSE COUNTY, WYOMING

UMTRA PROJECT - SPOOK
INFORMATION TO BIDDERS

4) METEOROLOGICAL DATA (Reference 2)

D.3.3 CLIMATE AND VEGETATION

Climatological data for the region were prepared by Kerr-McGee Nuclear Corporation for the area immediately south of the site (Kerr-McGee, 1977), and by Lane et al. (1972) and Ford, Bacon & Davis Utah Inc. (FBDU, 1981) for the site region. A 50-year rainfall of 24-hour duration would result in an estimated 3.4-to 3.8-inch rainfall at the site. The average annual precipitation in the vicinity of the Spook site is approximately 13 inches (FBDU, 1981); the range is from 7.34 inches to 16.24 inches (Kerr-McGee, 1977). Winter snows tend to have a low water content with frequent winds tending to clear the snow within a few days. The average annual snowfall from 1951 to 1975, in the Casper, Wyoming, area was 74 inches.

The mean annual wind speed from a southwesterly direction in Casper is 13.1 mph with averages in December and January of more than 16 mph (Kerr-McGee, 1977). Data from within the basin, about 15 miles south-southeast of the site, show that winds appear to be 32 to 37 percent higher and are more westerly than in Casper.

The temperature range is -30° to 105°F with an average temperature of 44°F . There are 100 to 120 days per year which are freeze-free (Lane et al., 1972). Elevation of the area is between 5000 and 5300 feet.

The vegetation type for the area is the sagebrush/grassland plant community and consists of big sagebrush, blue grama, and western wheatgrass as the dominant types. Ground cover averages about 40 to 60 percent (Kerr-McGee, 1977). Locally, riparian vegetation is found only along the Dry Fork Cheyenne River and includes cottonwood and willow trees.

Natural revegetation of mine spoils has been reported in the area with an absence of the sage, grama, and wheatgrass, but a preference for Indian ricegrass with some wild buckwheat (Kerr-McGee, 1977).



CLIMATOGRAPHY OF THE UNITED STATES NO. 20 CLIMATIC SUMMARIES FOR SELECTED SITES, 1951-80

WYOMING

CLIMATOLOGICAL SUMMARY

DEGREE DAYS

PRECIPITATION PROBABILITY

FREEZE DATA

GROWING DEGREE UNITS



NATIONAL CLIMATIC DATA CENTER
ASHEVILLE, N.C.

noaa

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION

DATA, AND INFORMATION SERVICE

NATIONAL CLIMATIC DATA CENTER
ASHEVILLE, N.C.

CLIMATOGRAPHY OF THE UNITED STATES NO. 20 (1951-80)

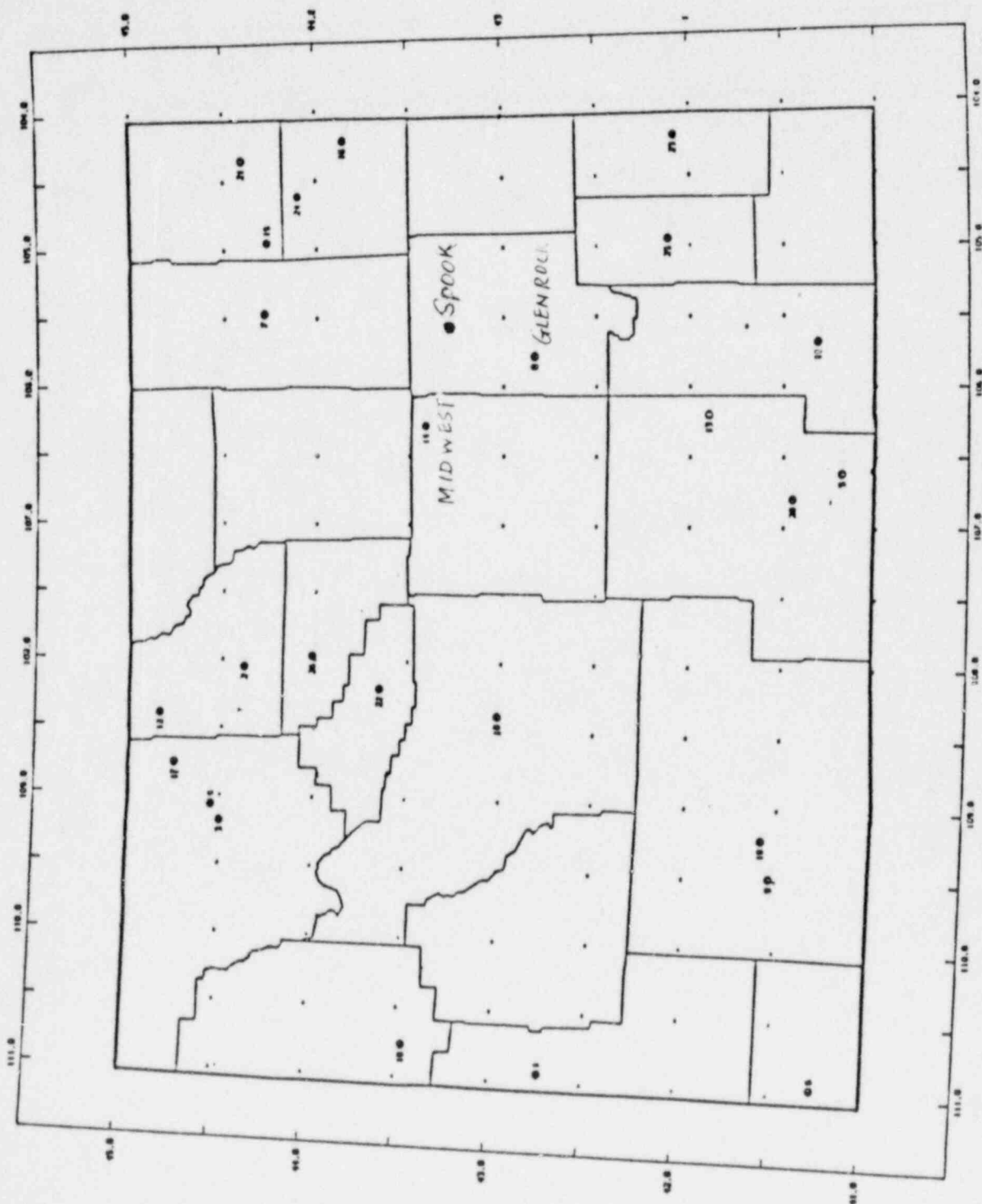
CITY NAME LIST, STATE OF:

WYOMING

NAMES ARE IN ALPHABETICAL ORDER

MAP NUMBER	ST/STAN NUMBER	CITY NAME	LAT		LONG		ELEV (FT)
			DEG	MM	DEG	MM	
1	48 0027	AFTON	42	44N	110	56W	6210
2	48 0540	BASIN	44	23N	108	03W	3837
3	48 1175	BUFFALO BILL	44	39N	107	11W	5156
4	48 1840	COOY	44	33N	107	04W	4790
5	48 3045	ENCAMPMENT	41	11N	106	37W	7387
6	48 3100	EVANSTON	41	16N	110	57W	6780
7	48 3855	GILLETTE	44	17N	105	28W	4556
8	48 3950	GLENROCK	42	59N	105	47W	4918
9	48 4065	GREEN RIVER	41	32N	107	27W	6087
10	48 4910	JACKSON	43	28N	110	46W	6244
11	48 5415	LAMARIE	41	17N	105	41W	7266
12	48 5770	LOVELL	44	59N	108	24W	3837
13	48 6120	MEDICINE BOW	41	54N	106	12W	6570
14	48 6195	MIDWEST	43	25N	106	17W	4840
15	48 6395	MURCROFT	44	16N	104	57W	4275
16	48 6660	NECASTLE	43	51N	104	13W	4265
17	48 7380	POWELL	44	45N	108	46W	4378
18	48 7760	RIVERTON	43	01N	108	23W	4954
19	48 7840	ROCK SPRINGS	41	35N	107	13W	6367
20	48 7990	SARATOGA	41	27N	106	48W	6790
21	48 8705	SUNDANCE	44	24N	104	21W	4750
22	48 8880	TERMINOPLIS	43	37N	108	12W	4313
23	48 8995	TORRINGTON	42	05N	104	13W	4078
24	48 9205	UPTON	44	06N	104	37W	4261
25	48 9615	WHEATLAND	42	07N	104	57W	4638
26	48 9770	WORLAND	44	01N	107	58W	4061

CLIMATOGRAPHY OF THE UNITED STATES NO. 20
 CLIMATE OF CITIES, STATE OF
WYOMING
 PERIOD OF RECORD: 1951-80



CLIMATOLOGICAL SUMMARY

PERIOD: 1951-80
ELEVATION: 4348 FT

MONTH	TEMPERATURES												PRECIPITATION TOTALS, INCHES												HEATING DEGREE DAYS		COOLING DEGREE DAYS	
	MEANS						EXTREMES						PRECIPITATION						PRECIPITATION						MONTHLY		MONTHLY	
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	JAN	FEB
JAN	37.1	41.6	47.2	50.4	58.4	69.3	77.2	80.6	87.5	87.5	84.7	80.6	1.221	0.972	0.936	0.600	0.315	0.084	0.251	0.185	0.193	0.404	0.873	1.110	0.05	0.03	0.05	0.03
FEB	41.6	47.2	50.4	58.4	69.3	77.2	80.6	87.5	87.5	84.7	80.6	80.6	0.972	0.936	0.600	0.315	0.084	0.251	0.185	0.193	0.404	0.873	1.110	0.03	0.08	0.03	0.05	0.03
MAR	47.2	50.4	58.4	69.3	77.2	80.6	87.5	87.5	84.7	80.6	80.6	80.6	0.936	0.600	0.315	0.084	0.251	0.185	0.193	0.404	0.873	1.110	0.03	0.08	0.03	0.05	0.03	0.03
APR	50.4	58.4	69.3	77.2	80.6	87.5	87.5	84.7	80.6	80.6	80.6	80.6	0.600	0.315	0.084	0.251	0.185	0.193	0.404	0.873	1.110	0.03	0.08	0.03	0.05	0.03	0.03	0.03
MAY	69.3	77.2	80.6	87.5	87.5	84.7	80.6	80.6	80.6	80.6	80.6	80.6	0.315	0.084	0.251	0.185	0.193	0.404	0.873	1.110	0.03	0.08	0.03	0.05	0.03	0.03	0.03	0.03
JUN	80.6	87.5	87.5	84.7	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	0.084	0.251	0.185	0.193	0.404	0.873	1.110	0.03	0.08	0.03	0.05	0.03	0.03	0.03	0.03	0.03
JUL	87.5	87.5	84.7	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	0.251	0.185	0.193	0.404	0.873	1.110	0.03	0.08	0.03	0.05	0.03	0.03	0.03	0.03	0.03	0.03
AUG	87.5	84.7	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	0.193	0.404	0.873	1.110	0.03	0.08	0.03	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
SEP	87.5	84.7	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	0.404	0.873	1.110	0.03	0.08	0.03	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
OCT	87.5	84.7	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	0.873	1.110	0.03	0.08	0.03	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NOV	87.5	84.7	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	1.110	0.03	0.08	0.03	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
DEC	87.5	84.7	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	0.03	0.08	0.03	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03

* FROM 1951-80 NORMALS

* ESTIMATED VALUE BASED ON

DATA FROM SURROUNDING STATIONS

* ALSO ON EARLIER DATES

DEGREE DAYS TO SELECTED BASE TEMPERATURES (F)

HEATING DEGREE DAYS

BASE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	APR
BELOW	1221	972	936	600	315	84	9	11	193	404	873	1110	6009
65	1066	832	781	450	178	26	0	0	107	343	723	955	5459
60	973	748	688	366	116	11	0	0	64	260	633	862	4723
55	931	692	626	310	82	6	0	0	45	212	573	800	4257
50	756	552	485	186	23	0	0	0	15	119	433	645	3214

COOLING DEGREE DAYS

BASE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	APR
ABOVE	0	0	0	10	82	306	552	404	201	39	0	0	1674
55	0	0	0	6	54	251	490	422	162	25	0	0	1410
50	0	0	0	0	23	176	397	329	113	12	0	0	1050
65	0	0	0	0	0	84	251	105	49	0	0	0	569
70	0	0	0	0	0	26	129	78	16	0	0	0	249

DERIVED FROM THE 1951-80 MONTHLY NORMALS

PROBABILITY THAT THE MONTHLY PRECIPITATION WILL BE
EQUAL TO OR LESS THAN THE INDICATED PRECIPITATION AMOUNT

MONTHLY PRECIPITATION INCHES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0.05	.06	.03	.15	.20	.50	.10	.15	.07	.05	.03	.03	.03
.10	.12	.08	.23	.33	.73	.29	.24	.16	.11	.16	.03	.03
.20	.20	.15	.35	.57	1.11	.58	.41	.30	.23	.29	.12	.15
.30	.27	.22	.47	.80	1.46	.86	.58	.42	.37	.43	.21	.24
.40	.34	.29	.59	1.05	1.81	1.17	.76	.55	.52	.58	.31	.24
.50	.41	.36	.72	1.33	2.19	1.50	.96	.69	.71	.74	.43	.32
.60	.50	.45	.86	1.66	2.62	1.90	1.19	.86	.93	.94	.56	.39
.70	.60	.56	1.04	2.05	3.14	2.39	1.47	1.06	1.23	1.19	.74	.47
.80	.73	.71	1.28	2.61	3.83	3.06	1.86	1.32	1.63	1.54	.90	.58
.90	.78	.94	1.66	3.51	4.93	4.17	2.49	1.76	2.33	2.11	1.33	.76
.95	1.14	1.17	2.02	4.39	5.99	5.24	3.11	2.17	3.03	2.68	1.79	.92

THESE VALUES WERE DETERMINED FROM THE INCOMPLETE GAMMA DISTRIBUTION

483950 GLENROCK, MT

DEG MIN DEG MIN
LAT: 42 50N LONG: 105 47W

PERIOD: 1951-80

FREEZE DATA

PROBABILITY OF LATER DATE IN SPRING (THRU JULY 31) THAN INDICATED(=)

	30	40	50	60	70	80	90	100
36	9/15	9/20	9/27	9/31	9/30	9/24	9/10	8/19
32	9/10	9/21	9/28	9/30	9/29	9/22	9/16	9/11
28	9/5	9/16	9/23	9/28	9/27	9/20	9/14	9/9
24	9/0	9/10	9/17	9/22	9/21	9/14	9/8	9/3
20	8/25	9/05	9/12	9/17	9/16	9/09	9/03	8/28
16	8/20	8/30	9/07	9/12	9/11	9/04	8/28	8/23

PROBABILITY OF EARLIER DATE IN FALL (BEGINNING AUG 1) THAN INDICATED(=)

	10	20	30	40	50	60	70	80	90
36	8/29	9/02	9/06	9/07	9/12	9/14	9/17	9/21	9/26
32	8/24	9/04	9/12	9/16	9/19	9/21	9/25	9/28	10/03
28	8/19	9/02	9/10	9/14	9/17	9/20	9/23	9/27	10/01
24	8/14	9/04	9/12	9/16	9/19	9/21	9/25	9/28	10/01
20	8/09	9/04	9/12	9/16	9/19	9/21	9/25	9/28	10/01
16	8/04	9/04	9/12	9/16	9/19	9/21	9/25	9/28	10/01

PROBABILITY OF LONGER THAN INDICATED FREEZE PERIOD (DAYS)

	10	20	30	40	50	60	70	80	90
36	1/24	1/17	1/12	1/7	1/3	0/29	0/25	0/20	0/17
32	1/19	1/12	1/7	1/2	1/2	1/1	1/1	1/1	1/1
28	1/14	1/7	1/2	1/2	1/2	1/1	1/1	1/1	1/1
24	1/9	1/6	1/2	1/2	1/2	1/1	1/1	1/1	1/1
20	1/4	1/4	1/2	1/2	1/2	1/1	1/1	1/1	1/1
16	0/29	0/24	0/19	0/14	0/9	0/4	0/0	0/0	0/0

PROBABILITY OF OBSERVING A TEMPERATURE AS COLD, OR COLDER, LATER, IN THE SPRING OR EARLIER IN THE FALL THAN THE INDICATED DATE.
0/00 INDICATES THAT THE PROBABILITY OF OCCURRENCE OF THRESHOLD TEMPERATURE IS LESS THAN INDICATED PROBABILITY.

GROWING DEGREE UNITS TO SELECTED BASE TEMPERATURES (F)

BASE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
40 S	16	23	68	205	476	755	1025	955	615	323	80	28	4569
45 S	16	39	107	312	788	1583	2568	3523	4138	4461	4541	4569	
50 S	4	7	28	111	330	605	870	800	471	201	32	8	3467
55 S	4	11	39	150	480	1085	1955	2755	3226	3427	3459	3467	
60 S	1	2	8	46	199	457	715	645	333	103	9	2	2520
65 S	1	3	11	57	256	713	1428	2073	2406	2509	2518	2520	
70 S	0	0	0	0	0	0	0	0	0	0	0	0	1729
75 S	0	0	0	0	0	0	0	0	0	0	0	0	1085
80 S	0	0	0	0	0	0	0	0	0	0	0	0	1085

M = MONTHLY DATA S = SUM OF MONTHLY DATA

GROWING DEGREE UNITS FOR CORN

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
50	10	19	59	160	313	471	644	604	420	251	63	18	3031
55	10	28	87	247	560	1031	1675	2279	2699	2950	3013	3031	

NOTE: FOR CORN THE BASE IS 50, AND THE DEGREE UNITS ARE ADJUSTED FOR TEMPERATURES BELOW 50 AND ABOVE 86.

OTHER CLIMATOLOGICAL DATA ARE AVAILABLE IN A VARIETY OF SUMMARIES AND FORMATS, SUCH AS THE CLIMATOGRAPHY OF THE UNITED STATES; NO. 60 - CLIMATE OF STATES; NO. 81 - MONTHLY NORMALS (AND SUPPLEMENTS); ANNUAL DEGREE DAYS TO SELECTED BASES DERIVED FROM THE 1951-80 NORMALS; AND MONTHLY PRECIPITATION PROBABILITIES. SELECTED PROBABILITY LEVELS DERIVED FROM THE 1951-80 NORMALS; NO. 84 - DAILY NORMALS; NO. 85 - DIVISIONAL NORMALS. A VARIETY OF DATA IS AVAILABLE EITHER ON MAGNETIC TAPE, MICROFICHE, OR PAPER COPY.

TO OBTAIN INFORMATION ABOUT CLIMATOLOGICAL DATA AND RELATED PUBLICATIONS, CONTACT:

DIRECTOR
NATIONAL CLIMATIC DATA CENTER
FEDERAL BUILDING
ASHEVILLE, NC 28801-2676
(FOR TELEPHONE: 1704) 258-0682



DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE
NATIONAL CLIMATIC DATA CENTER
ASHEVILLE, NC

MIDWEST, HY

PERIOD: 1951-60
ELEVATION: 4840 FT

CLIMATOLOGICAL SUMMARY

YEAR	TEMPERATURE, °F										PRECIPITATION, TOTALS, INCHES										MEAN OF MONTHLY DATA												
	JANUARY					FEBRUARY					MARCH					APRIL						MAY					JUNE						
	MEAN	MAX	MIN	RELATIVE HUMIDITY	WIND VELOCITY	MEAN	MAX	MIN	RELATIVE HUMIDITY	WIND VELOCITY	MEAN	MAX	MIN	RELATIVE HUMIDITY	WIND VELOCITY	MEAN	MAX	MIN	RELATIVE HUMIDITY	WIND VELOCITY		MEAN	MAX	MIN	RELATIVE HUMIDITY	WIND VELOCITY	MEAN	MAX	MIN	RELATIVE HUMIDITY	WIND VELOCITY		
JAN	35.5	10.9	23.2	62.4	5.3	12	0	10	30	8	1296	0	71	4.03	72	2.00	72	11	8.3	24.5	72	1	10.0	50.0	1.00	OR MORE	50.0	1.00	OR MORE	50.0	1.00		
FEB	42.0	16.3	29.2	68.4	5.0	20	0	5	27	3	1002	0	74	2.78	53	2.05	77	23	9.9	48.0	53	2	50.0	50.0	1.00	OR MORE	50.0	1.00	OR MORE	50.0	1.00		
MAR	49.3	21.1	34.7	70.4	4.0	31	0	3	28	2	939	0	86	2.78	54	1.50	54	18	8.1	24.0	53	2	50.0	50.0	1.00	OR MORE	50.0	1.00	OR MORE	50.0	1.00		
APR	53.4	30.0	44.7	69.4	5.2	27	0	0	19	0	609	0	88	5.43	73	2.00	74	20	8.4	33.0	53	8	1	50.0	50.0	1.00	OR MORE	50.0	1.00	OR MORE	50.0	1.00	
MAY	70.4	39.5	55.0	74.4	6.9	29	15	0	0	0	313	0	2.47	6.46	62	2.71	62	21	1.9	15.0	73	4	1	50.0	50.0	1.00	OR MORE	50.0	1.00	OR MORE	50.0	1.00	
JUN	81.4	47.9	64.7	70.2	7.0	26	5	0	0	0	98	0	2.01	4.67	67	2.03	67	15	1.3	3.0	62	0	1	50.0	50.0	1.00	OR MORE	50.0	1.00	OR MORE	50.0	1.00	
JUL	90.6	54.3	72.5	70.6	7.3	17	33	7	0	0	10	242	1.23	3.17	73	2.59	77	27	1.0	0	0	0	1	50.0	50.0	1.00	OR MORE	50.0	1.00	OR MORE	50.0	1.00	
AUG	88.6	52.2	70.4	70.6	7.9	5	30	16	0	0	14	182	0.91	2.95	53	2.69	53	02	0	0	0	2	1	50.0	50.0	1.00	OR MORE	50.0	1.00	OR MORE	50.0	1.00	
SEP	78.6	42.1	60.4	68.4	7.0	7	17	4	3	0	168	50	0.77	3.19	73	1.32	63	03	3	6.4	65	0	1	50.0	50.0	1.00	OR MORE	50.0	1.00	OR MORE	50.0	1.00	
OCT	66.0	32.9	49.5	69.4	5.7	1	2	0	15	0	481	0	0.81	2.59	71	1.86	62	06	2.9	11.0	71	0	1	50.0	50.0	1.00	OR MORE	50.0	1.00	OR MORE	50.0	1.00	
NOV	47.2	21.7	34.5	76	5.3	14	26	0	25	2	915	0	0.73	1.49	58	1.15	73	03	8.1	17.1	50	0	1	50.0	50.0	1.00	OR MORE	50.0	1.00	OR MORE	50.0	1.00	
DEC	38.9	15.3	27.1	64.4	8.0	17	36	0	8	29	4	1175	0	0.76	2.51	73	1.84	73	25	9.0	25.0	78	0	1	50.0	50.0	1.00	OR MORE	50.0	1.00	OR MORE	50.0	1.00
YEAR	62.2	32.0	47.2	70.6	7.9	5	36	78	31	46	30	181	19	7040		6.46	62	2.71	62	21	57	48	0	53	35	4	0	0	0	0	0	0	

FROM 1951-80 NORMALS

ESTIMATED VALUE OF DADO OF

3100 BIRCHWOOD RD. CT. 10

DEGREE DAYS TO SELECTED BASE TEMPERATURES (°C)

[illegible]

BASE	COOLING DEGREE DAYS
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96	96
97	97
98	98
99	99
100	100

ABOVE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNU
55	0	0	0	13	76	303	543	477	204	36	0	0	1648
57	0	0	0	0	46	247	403	435	165	23	0	0	1395
60	0	0	0	0	18	176	309	322	116	11	0	0	1031
65	0	0	0	0	0	89	242	182	50	0	0	0	563
70	0	0	0	0	0	30	123	75	17	0	0	0	249

DERIVED FROM THE 1951-80 MONTHLY NORMALS

PROBABILITY THAT THE MONTHLY PRECIPITATION WILL BE EQUAL TO OR LESS THAN THE INDICATED PRECIPITATION AMOUNT

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
05	.07	.10	.20	.39	.39	.44	.11	.03	.09	.05	.15	.12
10	.12	.16	.28	.56	.60	.62	.25	.15	.15	.10	.21	.18
20	.21	.26	.40	.83	.95	.92	.46	.27	.28	.20	.32	.23
30	.31	.37	.51	1.07	1.30	1.19	.64	.40	.41	.31	.42	.33
40	.42	.47	.63	1.32	1.65	1.45	.82	.54	.56	.44	.52	.50
50	.54	.59	.74	1.58	2.03	1.74	1.02	.63	.73	.53	.63	.62
60	.68	.73	.88	1.88	2.48	2.06	1.25	.88	.93	.77	.77	.76
70	.86	.91	1.04	2.24	3.01	2.44	1.52	1.13	1.18	1.09	.83	.93
80	1.11	1.14	1.25	2.71	3.74	2.95	1.89	1.43	1.52	1.32	1.03	1.15
90	1.52	1.52	1.58	3.46	4.91	3.75	2.43	1.96	2.03	1.86	1.40	1.52
95	1.92	1.89	1.90	4.17	6.04	4.51	3.05	2.48	2.66	2.46	1.69	1.87

THESE VALUES WERE DETERMINED FROM THE INCOMPLETE GAMMA DISTRIBUTION.

PEAL00: 195,1-80

CONVERTING DEGREE UNITS TO SELECTED BASE TEMPERATURES (°F)

PROBABILITY OF LATER DATE IN SPRING (14TH JULY 31) THAN INDICATED (1)

PROBABILITY OF EARLIER DATE IN FALL (BEGINNING AUG 1) THAN INDICATED (1)

1 10 20 30 40 50 60 70 80 90

PROBABILITY OF LONGER THAN INDICATED FREEZE FREE PERIOD (DAYS)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----

* PROBABILITY OF OBSERVING A TEMPERATURE AS COLD, OR COLDER, LATER

IN THE SPRING OR EARLIER IN THE FALL THAN THE INDICATED DATE.

TEMPERATURE IS LESS THAN INDICATED PROBABILITY.

TO OBTAIN INFORMATION ABOUT CLIMATOLOGICAL DATA AND RELATED PUBLICATIONS,
CONTACT:

ASHEVILLE, NC



00000004 AM - 27700000-00000000-00000000

UMTRA PROJECT - SPOOK
INFORMATION TO BIDDERS

5) RADIOLOGIC CHARACTERIZATION

Processing Site

Acid Pond

RADIOLOGIC CHARACTERIZATION

Processing Site

Reference 1

RADIOLOGIC CHARACTERIZATION OF THE
SPOOK, CONVERSE COUNTY, WYOMING, URANIUM
MILL TAILINGS REMEDIAL ACTION PROJECT SITE

JULY 24, 1987

Prepared for:

U.S. Department of Energy
UMTRA Project Office
Albuquerque Operations Office
Albuquerque, New Mexico

Prepared by:

Jacobs-Weston Team
Technical Assistance
Contractor to the UMTRA Project
Albuquerque, New Mexico

Work performed under Contract No. DE-AC0482-AL-14086

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1. Jacobs-Weston sampling locations, tailings piles and mill yard, Spook, Wyoming
2. Jacobs-Weston sampling locations, extended area, Spook, Wyoming

1.0 INTRODUCTION

The Jacobs-Weston Team, Technical Assistance Contractor (TAC) to the U.S. Department of Energy for the Uranium Mill Tailings Remedial Action (UMTRA) Project, conducted a radiologic characterization of the Spook uranium mill tailings site in Converse County, Wyoming. The purpose of the characterization was to define the areal and volume extent of uranium mill tailings contamination at the Spook site in preparation for the proposed remedial action at the site in 1989. The field activities of this characterization were conducted from November 20 through 22, 1986.

2.0 BACKGROUND

2.1 SITE DESCRIPTION AND HISTORY

The Spook mill site and tailings piles are in Converse County, 48 miles northeast of Casper, 31 miles northeast of Glenrock, and 36 miles northwest of Douglas, Wyoming (Figure 2.1). The site is among rolling hills at an elevation of about 5100 feet above sea level in the Cheyenne River drainage basin. Vegetation is sagebrush and native grasses, with cottonwood trees along the creek bottoms.

The tailings piles are situated on the eastern edge of the Spook pit, from which the source ore for the mill was mined. The surveyed area includes the tailings piles, the mill yard to the southeast of the tailings piles, the areas of potential windblown contamination east of the tailings piles, and the acid disposal pond south of the main site (Figure 2.2). The tailings piles have not been stabilized, and exhibit both sheet and gully erosion.

The Wyoming Mining and Milling Company operated on the Spook site. The site is owned by Richard T. Hornbuckle, Pearl R. Hornbuckle, Kirkwood T. Hornbuckle, and Brent B. Hornbuckle. Western Nuclear, Inc., a subsidiary of Phelps Dodge Corporation, is presently the operational controller for the property. Sequoyah Fuels, a subsidiary of Kerr-McGee, controls the mineral rights along the eastern boundary of the site.

The Spook upgrader mill became operational in 1962 and ran until June, 1965. Ore from the Spook mine averaged 0.12 percent U_3O_8 and about 187,000 tons were processed. Most of the ore was acid-leached and the resulting uranium slurry was trucked 165 miles to the Western Nuclear Mill at Jeffrey City, Wyoming, for further processing; some ore was shipped directly to the mill at Jeffrey City.

2.2 PREVIOUS SURVEYS

A number of different surveys were previously performed at the Spook site under contracts with the U.S. Atomic Energy Commission, the U.S. Environmental Protection Agency, and the U.S. Department of Energy. Surveys were conducted by Oak Ridge National Laboratory; Ford, Bacon & Davis Utah Inc.; and Mountain States Research and Development, among others (DOE, 1982; FBDO, 1981; ORNL, 1980). Results of these previous studies, along with additional data collected by the TAC, were utilized for this characterization.

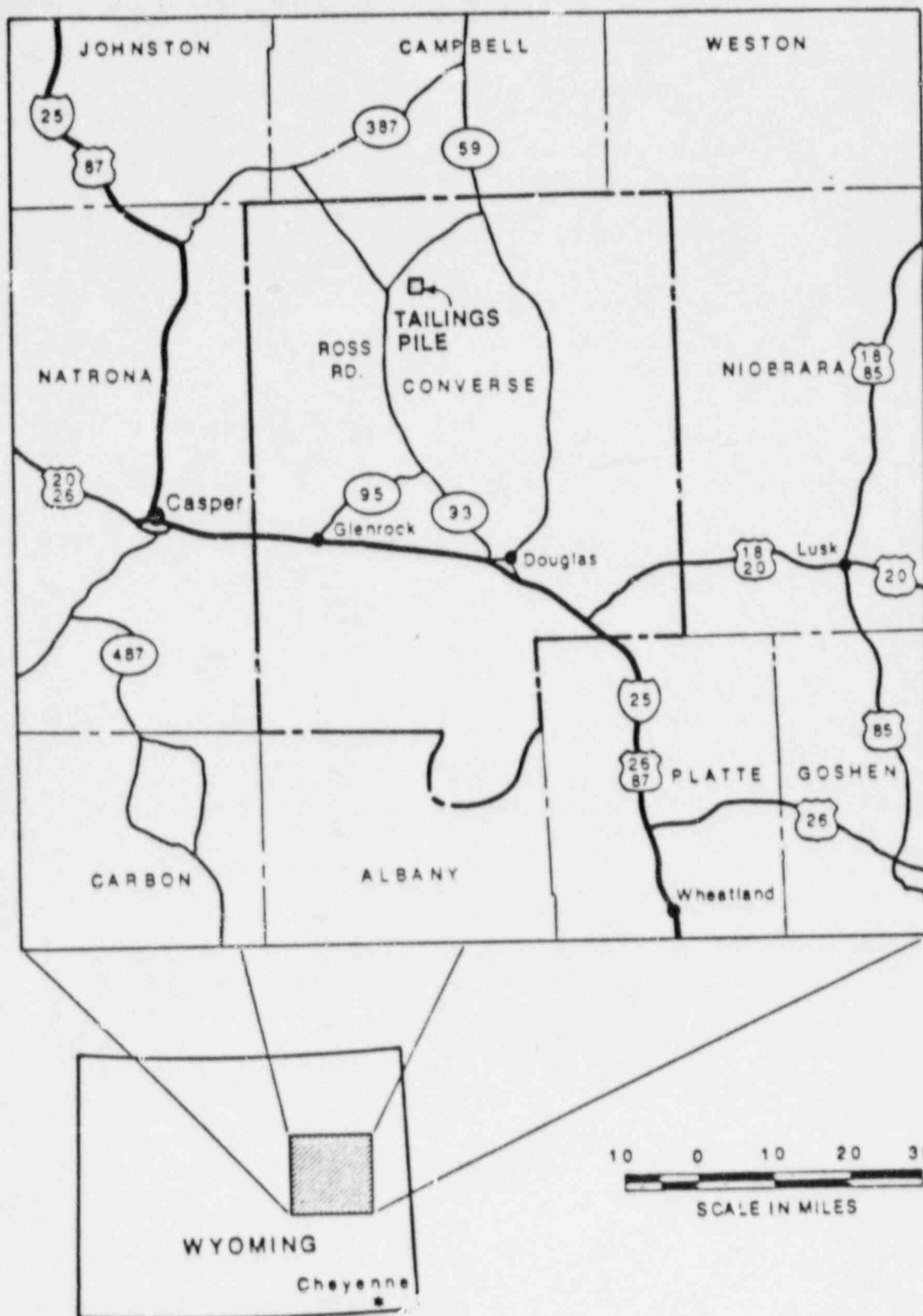


FIGURE 2.1
SPOOK SITE LOCATION,
CONVERSE COUNTY, WYOMING

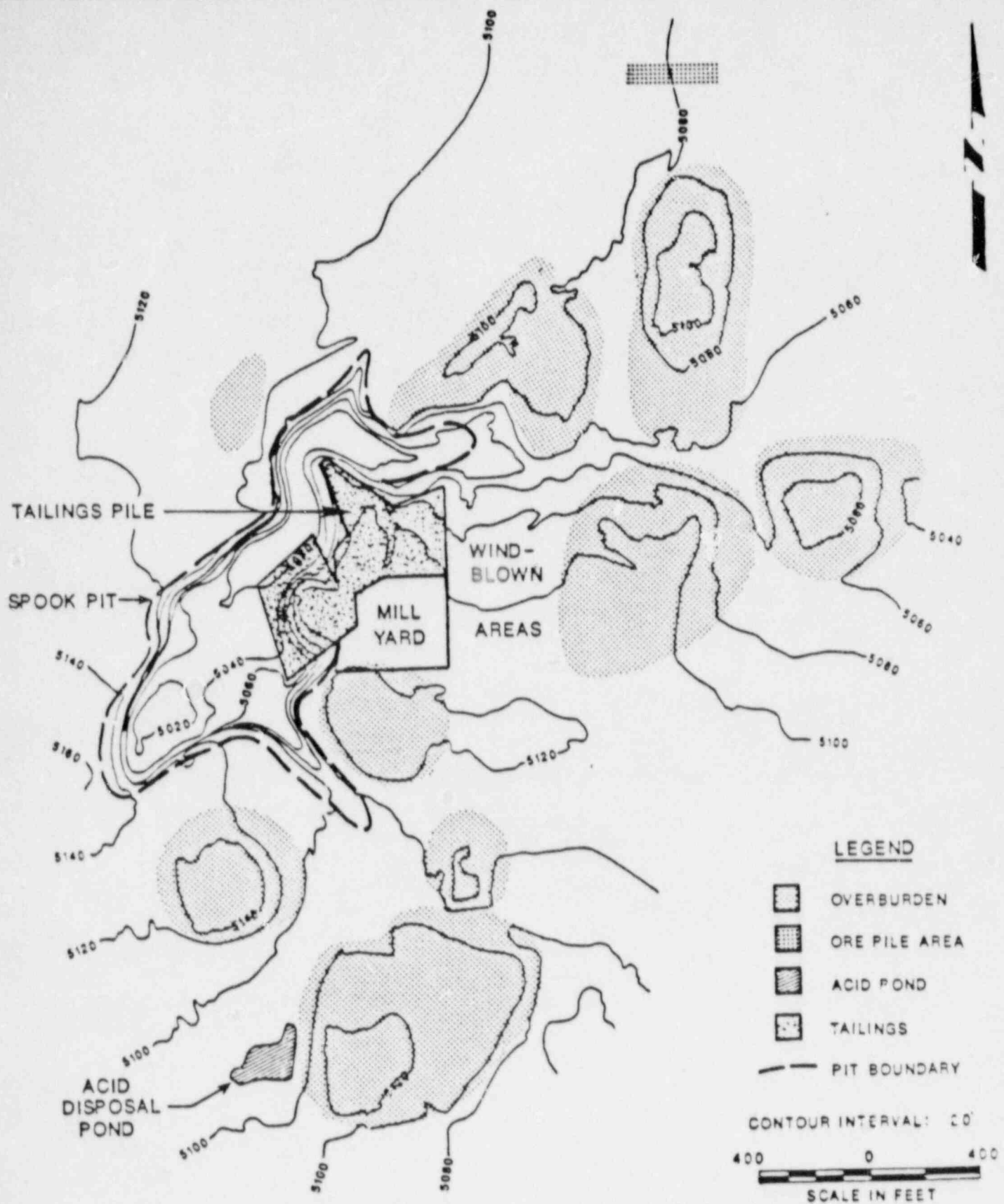


FIGURE 2.2
SPOOK SITE - CONVERSE COUNTY, WYOMING

3.0 METHODS

The characterization efforts were focused on soil sampling to better define the extent of tailings contamination on the site. Procedures contained in Section 10 of the Albuquerque Operations Manual of Jacobs Engineering Group Inc., relating to field sampling, were followed in these sampling efforts (JEG, 1986). In addition, all activities were conducted in compliance with the Spook site health and safety plan and the UMTRA Project health and safety plan (TAC, 1986; DOE, 1986).

3.1 PHYSICAL LAND SURVEY

The physical survey of sampling locations for this characterization was carried out in two phases. The first phase was a rough survey using a compass and pacing off distances on foot. After sampling had been completed, a formal physical survey was performed to tie all sampling points to the horizontal and vertical control stations established on the Spook site (Inberg-Miller Engineers, 1987). These physical surveys were only performed for the TAC sampling locations. The locations drilled by Mountain States Research and Development were, in general, no longer marked and thus could not be surveyed.

3.2 SOIL SAMPLING AND ANALYSIS

3.2.1 Background characterization

Surface sampling locations SPK-127, SPK-128, SPK-130, SPK-131, and SPK-132 were sampled as background locations. All of these locations are within 0.5 mile of the tailings pile, and in the generally upwind direction from the piles. Samples were taken at depths of zero to 0.5 foot and 0.5 to one foot and were analyzed for Ra-226 and total uranium (converted to U-238).

3.2.2 Radiological parameters

In this characterization effort, two different sets of samples were utilized. First, archived samples from the previous boreholes of the Mountain States Research and Development (MSRD) assessment of the uranium content of the tailings piles were analyzed for Ra-226. These samples were, in general, 2.5-foot core samples. In addition, measurement results for uranium were obtained from the MSRD report (DOE, 1982). Composite subpile samples, below the physical interface, were analyzed for Th-230 and heavy metals. The descriptions of the composite samples are as follows:

- Location 261 - first 2.5-foot layer below quad A physical interface (quads are described in DOE, 1982).
- 262 - second 2.5-foot layer below quad A.
- 263 - first 2.5-foot layer below quad B.

- 264 - second 2.5-foot layer below quad B.
- 265 - third 2.5-foot layer below quad B.
- 266 - first 2.5-foot layer below quads C and D.
- 267 - second 2.5-foot layer below quads C and D.
- 268 - third 2.5-foot layer below quads C and D.
- 269 - first 2.5-foot layer below quad D.
- 270 - second 2.5-foot layer below quad D.
- 271 - third 2.5-foot layer below quad D.

The second set of soil samples was collected during the TAC characterization. These samples were collected from test pits and surface locations and were all analyzed for Ra-226 and total uranium concentrations. Test pit samples were 0.5- and one-foot samples, while surface samples were 0.5-foot samples. In addition, Th-230 analyses were completed for a number of random samples and for samples where process liquids were thought to be present. All of the analyses were performed by UNC Technical Services, Inc. (UNC, 1987).

3.2.3 Radon emanation fraction

Thirty of the samples collected were analyzed to measure the radon emanation fraction, or fractional-free radon. Twenty of these samples were taken in the tailings piles, with the other ten samples taken from the windblown contamination area. These measurements were made by UNC Technical Services, Inc., and Rogers and Associates Engineering Corporation (UNC, 1987; Rogers, 1987).

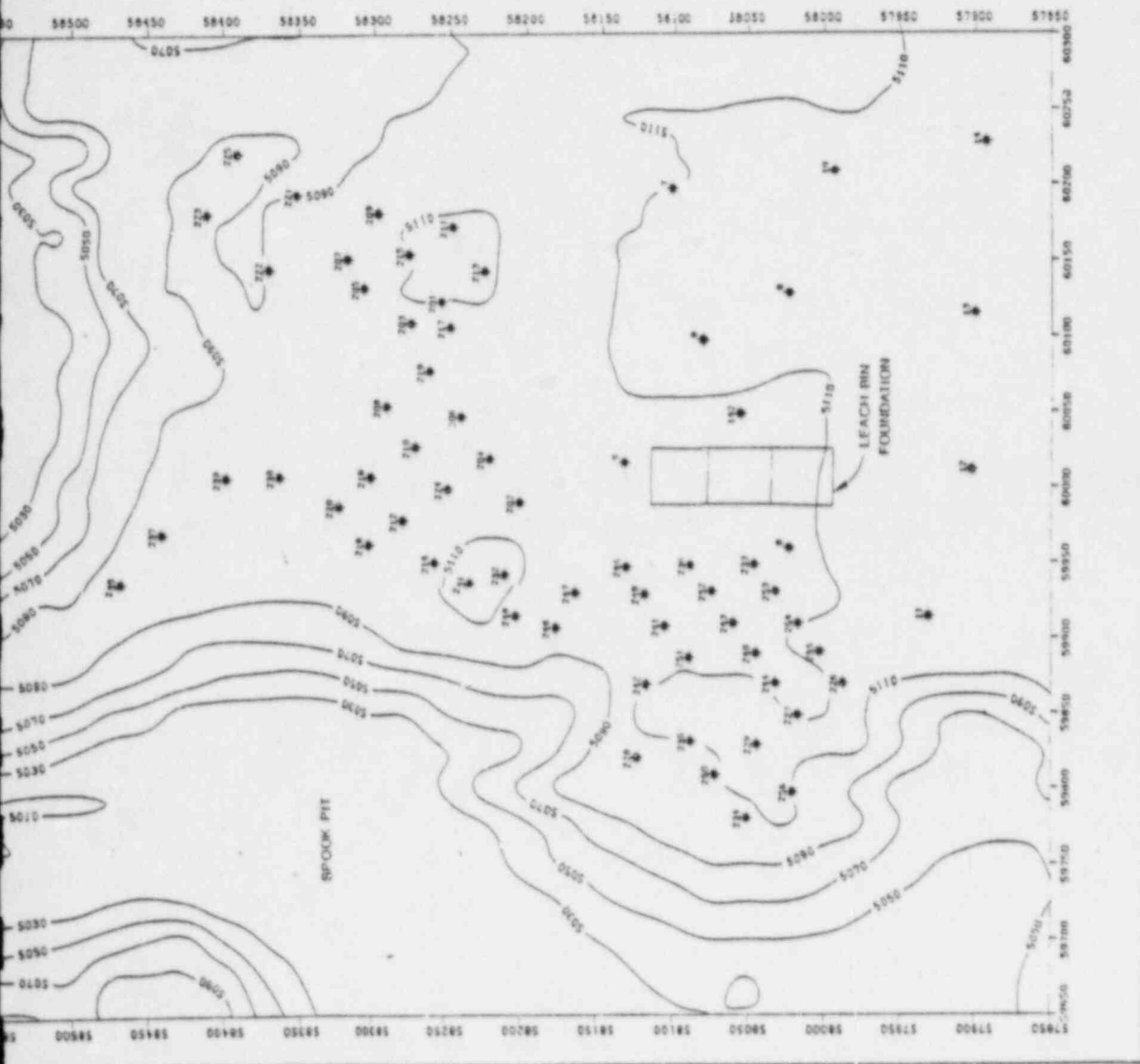


PLATE 1
JACOBS-WESTON
SAMPLING LOCATIONS
TAILINGS PILES AND MILL YARD
SPOOK SITE
CONVERSE COUNTY, WYOMING

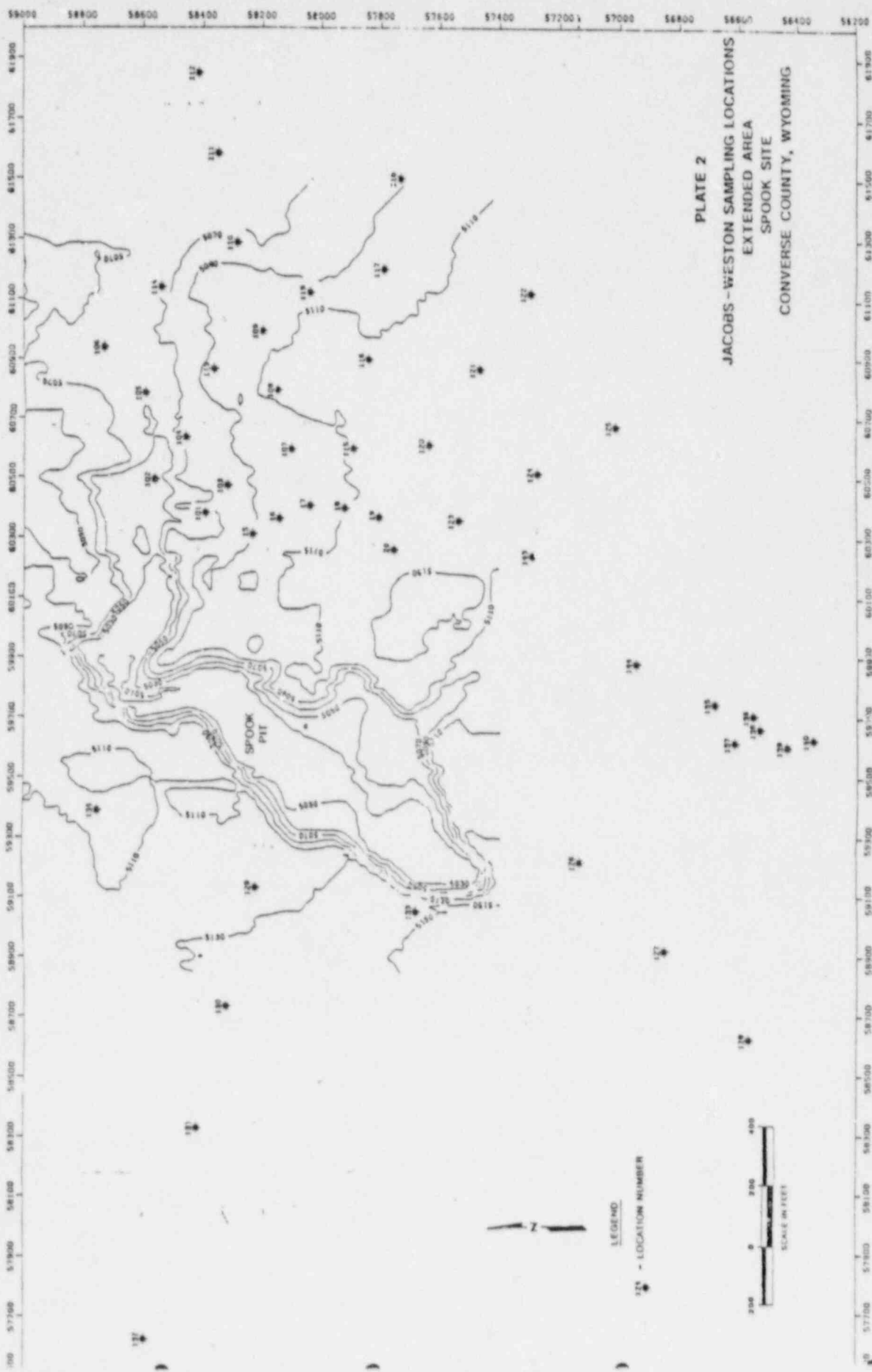


PLATE 2
JACOBS-WESTON SAMPLING LOCATIONS
EXTENDED AREA
SPOOK SITE
CONVERSE COUNTY, WYOMING

LEGEND
12N - LOCATION NUMBER



4.0 ANALYSES RESULTS

4.1 PHYSICAL LAND SURVEY

Results of the physical survey of sampling locations are given for each location in Tables A.1, A.2, and A.3, Appendix A, Measurement Results, in feet north and east coordinates. The coordinates for the test pit and surface sampling locations were provided by Inberg-Miller Engineers (Inberg-Miller Engineers, 1987). The coordinates for the MSRD boreholes (Locations SPK-201 to 256) were estimated from the MSRD report (DOE, 1982), and are estimated to be accurate within 20 feet. The sampling locations are plotted in Plates 1 and 2, Spook Sampling Locations, contained in the back of this report.

4.2 SOIL SAMPLING ANALYSES

Results of the various radiological and chemical analyses of the soil samples were provided by UNC Technical Services, Inc., and Rogers and Associates Engineering Corporation (UNC, 1987; Rogers, 1987). Results of uranium measurements were converted into equivalent values of U-238, for direct comparisons with Ra-226 concentrations. The ratio of Ra-226 to U-238 is simply the Ra-226 results (pCi/g) divided by the U-238 results (pCi/g).

4.2.1 Background characterization

Results of the background soil sample analyses are provided in Table A.1, Appendix A, Measurement Results. The average background radionuclide concentrations were 1.5 pCi/g Ra-226 and 0.82 pCi/g U-238.

4.2.2 Radiological parameters

Results of the surface soil sample (locations SPK-15, 16, 18 through 20, and 101 through 144) analyses are provided in Table A.2, Appendix A, Measurement Results. Results of the test pit sample (locations SPK-1 through 14, 17, 21, and 22) analyses, MSRD borehole sample (locations SPK-201 through 256) analyses, and analyses of composites of MSRD samples (locations SPK-261 through 271) are given in Table A.3, Appendix A. Results of the metal analyses for the MSRD composite samples are given in Table A.4, Appendix A.

4.2.3 Radon emanation fraction

Results of the measurements of radon emanation fraction are given in Tables A.5 and A.6, Appendix A. The average radon emanation fractions are 0.32 for the tailings samples, and 0.60 for the windblown samples.

5.0 SUMMARY

Based on the results of this characterization survey, the areal and volumetric extents of tailings contamination on the Spook site may be determined. The radium to uranium ratios were provided to aid in distinguishing tailings contamination from mining-related contamination.

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UNC (UNC Technical Services, Inc.), 1987. Unpublished radiological data, Spook site, data prepared in November 1986, January 1987, and February, 1987, by UNC Technical Services, Inc., Chemistry Laboratory, Grand Junction, Colorado, for the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico (available at the UNC office in Grand Junction, Colorado).

APPENDIX A

MEASUREMENT RESULTS

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Table A.1 Radiological measurements at background locations,
Spook, Wyoming

Location	North (ft)	East (ft)	Depth (ft)	Ra-226 (pCi/g)	Th-230 (pCi/g)	U-238 (pCi/g)
127	56848.9	58922.5	0-0.5	1.7	-	1.00
			0.5-1	1.6	-	0.67
128	56561.7	58623.3	0-0.5	1.5	-	0.33
			0.5-1	1.4	-	0.67
130	58321.5	58733.7	0-0.5	1.2	-	0.67
			0.5-1	1.3	-	0.67
131	58421.6	58328.2	0-0.5	1.4	-	1.84
			0.5-1	1.6	-	1.00
132	58598.5	57622.3	0-0.5	1.9	4.43	0.67
			0.5-1	1.7	-	0.67
Average				1.5	-	0.82

Table A.2 Soil sample assay report site: Spook, Wyoming

LOCATION ID	NORTH COORDINATE (FT.)	EAST COORDINATE (FT.)	SAMPLE DEPTH (FT.)	SOIL SAMPLE ASSAY						RADIUM-226 TO URANIUM-230	
				RA-226 (PCI/G)			URANIUM-238 (PCI/G)			RATIO	
				04	02	03	04	02	03		
045	58237.5	60340.9	0.5 1.0 1.5	259.40 31.70 40.70	234.00 - -	- - -	- - -	- - -	- - -	26.05 6.35 3.67	9.40 5.30 2.90
046	58445.4	60364.0	0.5 1.0 1.5	40.20 14.20 49.70	38.80 - 49.90	- - -	- - -	- - -	- - -	8.02 2.00 2.67	4.90 7.40 7.90
048	57924.4	60400.3	0.5 1.0 1.5	48.60 32.00 45.20	28.20 - -	- - -	- - -	- - -	- - -	26.05 3.67 2.67	4.50 8.70 46.90
049	57805.0	60369.8	0.5 1.0 1.5	163.80 29.70 48.60	127.40 - -	- - -	- - -	- - -	- - -	66.80 3.67 4.68	2.20 8.40 4.00
020	57753.4	60262.4	0.5 1.0 1.5	423.60 146.10 43.40	118.50 - -	- - -	- - -	- - -	- - -	42.08 45.42 47.03	2.90 3.20 2.50
404	58396.3	60384.2	0.5 1.0 1.5	425.50 71.10 47.40	432.00 - -	- - -	- - -	- - -	- - -	46.03 50.77 40.75	8.00 1.40 4.20
402	58565.9	60492.9	0.5 1.0 1.5	46.00 21.30 24.00	- - -	- - -	- - -	- - -	- - -	3.67 5.34 5.04	4.40 4.00 4.80
403	58322.5	60472.4	0.5 1.0 1.5	60.50 40.40 9.40	79.40 - -	- - -	- - -	- - -	- - -	43.03 3.34 4.67	5.40 3.40 5.60
404	58460.9	60632.4	0.5 1.0 1.5	44.50 16.00 46.50	- - -	- - -	- - -	- - -	- - -	3.34 3.67 4.68	13.30 9.80 9.90
405	58598.4	60785.9	0.5 1.0	58.40 47.60	- -	- -	- -	- -	- -	21.74 8.02	2.50 5.90
											0.07

Table A.2 Soil sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	NORTH COORDINATE (FT.)	EAST COORDINATE (FT.)	SAMPLE DEPTH (FT.)	SOIL SAMPLE ASSAY										RADIUM-226 TO URANIUM-238	
				RA-226 (PCI/G)			TH-230 (PCI/G)			URANIUM-238 (PCI/G)				RA110	
				04	02	03	04	02	03	04	02	03	04		
			4.0	427.20	434.30	-	-	-	-	54.44	50.77	-	54.44	2.50	
407	58404.9	60594.6	0.5	58.00	-	-	-	-	-	23.74	-	-	23.74	2.40	
			4.0	29.00	-	-	-	-	-	46.70	-	-	46.70	4.00	
			4.5	34.40	-	-	-	-	-	8.35	-	-	8.35	4.10	
408	58453.2	60794.8	0.5	43.30	-	-	-	-	-	4.67	-	-	4.67	8.00	
			1.0	5.50	-	-	-	-	-	2.00	-	-	2.00	2.80	
409	58204.5	60993.4	0.5	47.60	-	-	-	-	-	3.34	-	-	3.34	3.80	
			4.0	48.90	-	-	-	-	-	3.04	-	-	3.04	6.30	
			4.5	49.50	24.50	-	-	-	-	4.68	4.34	-	4.68	4.50	
410	58284.8	61287.2	0.5	44.40	-	-	-	-	-	2.67	-	-	2.67	4.20	
414	58348.3	61583.0	0.5	43.50	45.80	-	-	-	-	40.07	40.02	-	40.07	4.50	
			4.0	84.60	-	-	-	-	-	20.37	-	-	20.37	4.00	
412	58445.6	64850.4	0.5	20.40	-	-	48.40	-	-	3.67	-	-	3.67	5.50	
			4.0	22.70	-	-	-	-	-	4.34	-	-	4.34	5.70	
			4.5	23.40	-	-	-	-	-	6.04	-	-	6.04	3.90	
413	58368.3	60865.7	0.5	45.40	-	-	-	-	-	4.68	-	-	4.68	3.30	
			4.0	34.50	-	-	-	-	-	46.70	-	-	46.70	4.90	
414	58540.5	61139.0	0.5	43.40	-	-	-	-	-	7.35	-	-	7.35	5.90	
			4.0	39.20	-	-	-	-	-	5.68	-	-	5.68	6.90	
415	57894.3	60598.2	0.5	36.70	44.30	-	-	-	-	45.03	-	-	45.03	2.70	
			4.0	29.00	26.50	-	-	-	-	2.34	2.00	-	2.34	42.00	
			4.5	22.30	-	-	-	-	-	4.67	-	-	4.67	43.40	
416	57844.0	60899.4	0.5	47.70	-	-	-	-	-	4.04	-	-	4.04	3.00	
			4.0	45.70	-	-	-	-	-	4.67	-	-	4.67	9.10	
417	57708.2	61199.6	0.5	5.40	-	-	-	-	-	2.67	-	-	2.67	4.90	
			4.0	4.90	-	-	-	-	-	.67	-	-	.67	2.80	
418	57733.8	61500.7	0.5	3.40	-	-	-	-	-	4.67	-	-	4.67	4.90	

Table A.2 Soil sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	NORTH COORDINATE (+/-)	EAST COORDINATE (+/-)	SAMPLE DEPTH (ft.)	SOIL SAMPLE ASSAY						URANIUM-238 (PC1/G)			RADIUM-226 TO URANIUM-238		
				RA-226 (PC1/G)			TH-230 (PC1/G)			URANIUM-238 (PC1/G)			RATIO		
				04	02	03	04	02	03	04	02	03	04	02	03
			4.0	2.40	-	-	-	-	-	-	4.00	-	-	-	2.40
419	58035.7	64422.7	0.5 4.0	9.60 41.30	8.60	-	-	-	-	-	2.34 2.67	2.34	-	-	3.90 4.20
420	57636.6	60609.2	0.5 4.0 4.5	23.30 8.70 8.90	47.40	-	-	-	-	-	6.35 2.67 4.34	-	-	-	3.20 3.30 6.60
424	57465.4	60866.5	0.5 4.0	6.60 3.30	6.30	-	-	-	-	-	2.67 4.00	3.34	-	-	2.40 3.30
422	57293.7	64424.9	0.5 4.0	34.50 9.10	-	-	-	-	-	-	7.35 4.67	-	-	-	4.70 5.90
423	57537.5	60358.9	0.5 4.0 4.5	74.70 5.60 7.20	56.40	-	-	-	-	-	29.06 5.68 6.04	-	-	-	2.30 4.00 4.20
424	57274.9	60546.3	0.5 4.0	85.00 8.30	-	-	-	-	-	-	54.78 44.36	-	-	-	4.60 6.60
425	57044.5	60672.6	0.5 4.0	443.40 99.00	443.20	-	-	-	-	-	42.08 29.06	38.44	-	-	3.60 3.40
426	57437.0	59220.2	0.5 4.0	3.70 4.70	-	-	-	-	-	-	2.00 4.34	-	-	-	4.90 4.30
427	56848.9	58922.5	0.5 4.0	4.70 4.60	-	-	-	-	-	-	4.00 6.67	-	-	-	4.70 2.40
428	56564.7	58623.3	0.5 4.0	4.50 4.40	-	-	-	-	-	-	3.33 6.67	-	-	-	4.50 2.40
429	58276.6	59434.4	0.5 4.0	4.60 4.10	-	-	-	-	-	-	4.34 4.00	-	-	-	4.20 4.30
430	58324.5	58733.7	0.5	4.20	-	-	-	-	-	-	6.67	-	-	-	4.10

Table A.2 Soil sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	NORTH COORDINATE (FT.)	EAST COORDINATE (FT.)	SAMPLE DEPTH (FT.)	RA-226(PCL/G)				TH-230(PCL/G)				URANIUM-238(PCL/G)				RATIO	RADIUM-226 TO URANIUM-238
				---SAMPLE ID---				---SAMPLE ID---				---SAMPLE ID---					
				04	02	03	01	04	02	03	01	04	02	03	01		
			1.0	1.30	-	-	-	-	-	-	-	-	-	-	-	1.90	
434	58421.6	58328.2	0.5 1.0	1.40 1.60	1.40 -	-	-	-	-	-	-	2.00 1.00	1.67 -	-	-	.80 1.60	
432	58598.5	57622.3	0.5 1.0	1.90 1.70	-	-	4.43 -	-	-	-	-	-.67 -.67	-	-	-	2.80 2.50	
433	57682.3	59051.4	0.5 1.0	1.40 1.70	1.50 -	-	-	-	-	-	-	1.00 1.00	-.67 -	-	-	1.70 1.70	
434	58754.6	59390.9	0.5 1.0	1.40 1.40	-	-	-	-	-	-	-	1.00 1.00	-	-	-	1.40 1.40	
435	56682.0	59746.9	0.5 1.0 1.5	2.50 3.60 3.40	-	-	4.62 22.60 8.41	-	-	-	-	1.3 1.3 1.00	-	-	-	1.90 2.70 3.40	
436	56551.0	59708.0	0.5 1.0 1.5	131.80 339.90 241.90	-	-	109.00 261.00 343.00	-	-	-	-	5.68 9.35 2.67	-	-	-	23.20 36.30 90.60	
437	56590.7	59638.1	0.5 1.0 1.5	4.50 2.40 2.80	1.80 -	-	3.06 6.35 7.08	-	3.05 -	-	-	1.34 1.67 -.67	2.67 -	-	-	.80 1.40 4.20	
438	56528.5	59663.0	0.5 1.0 1.5	39.60 42.70 7.50	-	-	481.00 480.00 463.00	-	-	-	-	11.02 10.35 6.01	-	-	-	3.60 1.20 1.20	
439	56437.8	59604.1	0.5 1.0 1.5	45.00 653.60 869.20	-	-	49.20 190.00 250.00	-	-	-	-	3.34 3.34 4.01	-	-	-	4.50 195.70 246.70	
440	56399.0	59627.7	0.5 1.0 1.5	49.30 2.90 4.60	-	-	46.30 3.46 3.72	-	-	-	-	2.67 1.00 1.67	-	-	-	7.20 2.90 2.70	
441	58055.2	60040.9	0.5	74.70	-	-	75.70	-	-	-	-	13.69	-	-	-	5.40	

Table A.2 Soil sample assay report site: Spook, Wyoming (Concluded)

LOCATION ID	NORTH COORDINATE (+/-)	EAST COORDINATE (+/-)	SAMPLE DEPTH (ft.)	RA-226(PCI/G)			SOIL SAMPLE ASSAY TH-230(PCI/G)			URANIUM-238(PCI/G)			RADIUM-226 TO URANIUM-238 RATIO
				---SAMPLE ID---			---SAMPLE ID---			---SAMPLE ID---			
				04	02	03	04	02	03	04	02	03	
442	58055.2	60048.9	0.5	289.80	-	-	-	-	-	58.45	-	-	4.90
			4.0	341.20	-	-	-	-	-	29.06	-	-	44.70
			4.5	39.30	39.00	-	-	-	-	273.08	277.22	-	.40
443	57288.4	60244.5	0.5	8.00	8.30	-	2.77	-	-	4.67	3.04	-	3.50
			4.0	9.70	-	-	9.48	-	-	3.35	-	-	2.90
			4.5	3.60	-	-	3.68	-	-	4.67	-	-	2.40
444	56945.9	59879.9	0.5	45.20	-	-	-	-	-	6.04	-	-	2.50
444	56945.9	59879.9	4.0	35.50	-	-	-	-	-	48.37	48.37	-	4.90

Table A.3 Borehole/test pit sample assay report site: Spook, Wyoming

LOCATION ID	NORTH COORDINATE (FT.)	EAST COORDINATE (FT.)	SAMPLE DEPTH (FT.)	BURNHILL/DUST PIT SAMPLE ASSAY				URANIUM-238 P-1/G				RADIUM-226 P-1/G			
				RA-226 P-1/G				U-238 P-1/G				U-238 P-1/G			
				04	02	03	04	02	03	04	02	03	04	02	03
004	58063.8	59796.9	4.00	299.70	-	-	-	-	-	29.06	-	-	10.34	-	-
			2.00	303.00	-	-	-	-	-	-	-	-	-	-	-
			3.00	395.03	-	-	-	-	-	-	-	-	42.35	-	-
			5.00	359.00	430.40	-	-	-	-	35.74	35.74	-	-	-	-
			5.00	525.00	-	-	-	-	-	-	-	-	-	-	-
			6.00	554.00	-	-	-	-	-	49.37	-	-	25.44	-	-
			7.00	692.40	-	-	-	-	-	-	-	-	-	-	-
002	58273.5	60000.2	8.00	463.00	-	-	-	-	-	-	-	-	-	-	-
			9.00	386.00	-	-	-	-	-	35.74	-	-	43.64	-	-
			10.00	522.00	-	-	-	-	-	-	-	-	-	-	-
			4.00	466.00	-	-	-	-	-	-	-	-	-	-	-
			2.00	434.00	-	-	-	-	-	-	-	-	-	-	-
			3.00	525.60	-	-	-	-	-	29.06	-	-	48.07	-	-
			4.00	343.00	-	-	-	-	-	-	-	-	-	-	-
003	57666.7	60425.7	5.00	390.00	-	-	-	-	-	-	-	-	-	-	-
			6.00	673.90	-	-	-	-	-	29.06	-	-	46.34	-	-
			7.00	427.00	-	-	-	-	-	-	-	-	-	-	-
			8.00	636.00	-	-	-	-	-	-	-	-	-	-	-
			9.00	679.80	-	-	-	-	-	440.22	-	-	6.47	-	-
			10.00	543.00	-	-	-	-	-	-	-	-	-	-	-
			4.00	90.40	-	-	-	-	-	54.77	-	-	4.74	-	-
004	57474.3	60369.4	2.00	64.70	-	-	-	-	-	64.79	-	-	4.00	-	-
			3.00	465.80	-	-	-	-	-	76.82	-	-	2.46	-	-
			4.00	285.00	-	-	-	-	-	40.20	-	-	2.85	-	-
			5.00	80.20	80.90	-	-	-	-	66.80	70.44	-	4.48	-	-
			4.00	82.80	-	-	-	-	-	-	-	-	-	-	-
			2.00	57.70	-	-	-	-	-	426.92	-	-	.65	-	-
			3.00	84.30	-	-	-	-	-	460.37	-	-	.36	-	-
005	58432.9	60047.6	4.00	427.30	428.80	-	-	-	-	47.09	47.76	-	9.03	-	-
			2.00	423.70	-	-	-	-	-	31.09	-	-	2.79	-	-
			3.00	3.80	-	-	-	-	-	3.67	-	-	4.04	-	-
			4.00	2.90	-	-	-	-	-	3.68	-	-	.81	-	-
			5.00	2.90	-	-	-	-	-	8.02	-	-	.36	-	-
			4.00	49.50	-	-	-	-	-	2.57	-	-	6.89	-	-
			2.00	2.00	-	-	-	-	-	2.00	-	-	4.00	-	-
006	58079.2	60078.7	4.00	4.70	-	-	-	-	-	4.67	-	-	4.02	-	-
			2.00	-	-	-	-	-	-	-	-	-	-	-	-

Table A.3 Borehole/test pit sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	MURCH COORDINATE (11.1)	EAST COORDINATE (11.1)	SAMPLE LAPTH (11.1)	Borehole / test pit sample assay				Borehole / test pit sample assay				Borehole / test pit sample assay		9.50106-2260 PCL/G3	
				H6 2260 PCL/G3		H6 2260 PCL/G3		H6 2260 PCL/G3		H6 2260 PCL/G3		H6 2260 PCL/G3			
				04	02	03	04	02	03	04	02	03	04		02
007	58404.7	60490.2	3.00	4.50	-	-	-	-	-	-	-	4.00	-	-	4.50
			4.00	4.70	-	-	-	-	-	-	-	4.00	-	-	4.70
			5.00	43.60	-	-	-	-	-	-	-	2.00	-	-	6.80
			4.00	3.20	-	-	-	-	-	-	-	2.00	-	-	4.60
			2.00	4.50	-	-	-	-	-	-	-	2.00	-	-	4.75
008	58023.0	59960.4	3.00	4.00	-	-	-	-	-	-	-	-	-	2.50	
			4.00	3.20	-	-	-	-	-	-	-	-	-	2.70	
			5.00	4.50	-	-	-	-	-	-	-	-	-	2.70	
			4.00	4.50	-	-	-	-	-	-	-	-	-	2.70	
			3.00	4.50	-	-	-	-	-	-	-	-	-	2.70	
009	58023.4	60429.0	4.00	43.80	-	-	-	-	-	-	-	-	-	5.90	
			3.00	3.20	-	-	-	-	-	-	-	-	-	4.92	
			2.00	2.00	4.40	-	-	-	-	-	-	-	-	4.93	
			3.00	4.70	-	-	-	-	-	-	-	-	-	4.73	
			4.00	4.40	-	-	-	-	-	-	-	-	-	4.04	
010	58993.6	60509.4	4.00	32.50	-	-	-	-	-	-	-	-	-	40.73	
			3.00	4.30	-	-	-	-	-	-	-	-	-	4.78	
			2.00	4.50	-	-	-	-	-	-	-	-	-	4.44	
			3.00	32.90	-	-	-	-	-	-	-	-	-	42.32	
			4.00	463.30	-	-	-	-	-	-	-	-	-	4.36	
011	58930.9	59944.4	4.00	45.00	-	-	-	-	-	-	-	-	-	7.50	
			3.00	24.00	-	-	-	-	-	-	-	-	-	6.76	
			2.00	4.40	-	-	-	-	-	-	-	-	-	4.04	
			3.00	4.50	-	-	-	-	-	-	-	-	-	4.94	
			4.00	40.30	-	-	-	-	-	-	-	-	-	4.40	
012	58502.6	60044.0	4.00	44.50	-	-	-	-	-	-	-	-	-	2.50	
			3.00	26.70	70.50	-	-	-	-	-	-	-	-	3.92	
			2.00	4.50	-	-	-	-	-	-	-	-	-	4.32	
			3.00	2.00	-	-	-	-	-	-	-	-	-	4.23	
			4.00	2.60	-	-	-	-	-	-	-	-	-	4.26	
013	58900.4	60445.5	4.00	469.60	475.50	-	-	-	-	-	-	-	-	2.48	
			3.00	4.50	-	-	-	-	-	-	-	-	-	4.44	
			2.00	4.70	-	-	-	-	-	-	-	-	-	4.72	
			3.00	39.50	-	-	-	-	-	-	-	-	-	4.72	
			4.00	4.50	-	-	-	-	-	-	-	-	-	4.72	

Table A.3 Borehole/test pit sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	NORTH COORDINATE (T1,)	EAST COORDINATE (T1,)	SAMPLE LA PTH (T1,)	R6-226(PCT/G)				R20134E/HST P14 SAMPLE ASSAY				URANIUM 230(PCT/G)				RADIUM-226(PCT/G)	
				ID----				ID----				ID----				ID----	
				04	02	03	04	01	02	03	04	01	02	03	04	06110	10
			4.00	20.40	19.40	-	-	-	-	-	-	3.04	3.34	-	-	6.47	-
014	57692.8	60228.6	5.0	430.50	-	-	-	-	-	-	-	43.32	-	-	-	3.42	-
			4.00	26.00	-	-	-	-	-	-	-	9.02	-	-	-	2.66	-
			2.00	53.00	-	-	-	-	-	-	-	47.03	-	-	-	3.46	-
			3.00	7.69	-	-	-	-	-	-	-	4.67	-	-	-	4.55	-
			4.00	2.60	-	-	-	-	-	-	-	2.24	-	-	-	4.44	-
017	58037.9	60400.4	5.0	29.90	-	-	-	-	-	-	-	44.36	-	-	-	2.63	-
			4.00	70.50	-	-	-	-	-	-	-	2.00	-	-	-	46.25	-
			2.00	33.50	-	-	-	-	-	-	-	4.67	-	-	-	20.06	-
			3.00	45.60	-	-	-	-	-	-	-	2.00	-	-	-	22.50	-
			4.00	46.50	-	-	-	-	-	-	-	3.67	-	-	-	4.50	-
024	58254.4	60169.8	4.00	394.00	-	-	-	-	-	-	-	-	-	-	-	-	-
			2.00	407.00	-	-	-	-	-	-	-	42.08	-	-	-	9.67	-
			3.00	268.00	-	-	-	-	-	-	-	-	-	-	-	-	-
			4.00	305.00	-	-	-	-	-	-	-	-	-	-	-	-	-
			5.00	444.00	-	-	-	-	-	-	-	32.40	-	-	-	42.69	-
022	56454.2	59692.9	4.00	504.00	-	-	-	-	-	-	-	-	-	-	-	-	-
			2.00	49.00	-	-	-	-	-	-	-	-	-	-	-	-	-
			3.00	8.50	-	-	-	-	-	-	-	-	-	-	-	-	-
			4.00	5.40	5.30	-	-	-	-	-	-	-	-	-	-	-	-
			5.00	5.70	-	-	-	-	-	-	-	-	-	-	-	-	-
204	58256.0	60424.0	7.00	5.30	-	-	-	-	-	-	-	-	-	-	-	-	-
			4.00	504.00	-	-	-	-	-	-	-	3.67	-	-	-	436.54	-
			2.00	49.00	-	-	-	-	-	-	-	2.34	-	-	-	24.28	-
			3.00	8.50	-	-	-	-	-	-	-	4.50	-	-	-	3.50	-
			4.00	5.40	5.30	-	-	-	-	-	-	4.00	4.00	-	-	5.20	-
202	58209.0	5999	5.00	5.70	-	-	-	-	-	-	-	4.00	-	-	-	5.70	-
			7.00	5.30	-	-	-	-	-	-	-	4.67	-	-	-	3.47	-
			2.00	49.00	-	-	-	-	-	-	-	-	-	-	-	-	-
			3.00	8.50	-	-	-	-	-	-	-	-	-	-	-	-	-
			4.00	5.40	5.30	-	-	-	-	-	-	-	-	-	-	-	-
201	58256.0	60424.0	7.00	5.30	-	-	-	-	-	-	-	-	-	-	-	-	-
			4.00	504.00	-	-	-	-	-	-	-	-	-	-	-	-	-
			2.00	49.00	-	-	-	-	-	-	-	-	-	-	-	-	-
			3.00	8.50	-	-	-	-	-	-	-	-	-	-	-	-	-
			4.00	5.40	5.30	-	-	-	-	-	-	-	-	-	-	-	-
202	58209.0	5999	5.00	5.70	-	-	-	-	-	-	-	-	-	-	-	-	-
			7.00	5.30	-	-	-	-	-	-	-	-	-	-	-	-	-
			2.00	49.00	-	-	-	-	-	-	-	-	-	-	-	-	-
			3.00	8.50	-	-	-	-	-	-	-	-	-	-	-	-	-
			4.00	5.40	5.30	-	-	-	-	-	-	-	-	-	-	-	-

Table A.3 Borehole/test pit sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	NORTH COORDINATE (UTM)	EAST COORDINATE (UTM)	SAMPLE DEPTH (FT)	BOREHOLE/TEST PIT SAMPLE ASSAY												POTASSIUM-226PCT/G3 TO URANIUM-238PCT/G3
				R6 226PCT/G3				TH-230PCT/G3				URANIUM-238PCT/G3				
				04	02	03	03	04	02	03	03	04	02	03		
203	58226.0	60440.0	7.50	441.90	-	-	-	-	-	-	-	-	-	-	-	-
			40.00	443.50	-	-	-	-	-	-	-	-	-	-	-	-
			42.50	-	-	-	-	-	-	-	27.73	-	-	-	-	2.74
			45.00	7.50	2.20	-	-	-	-	-	.85	-	-	-	-	3.33
			47.50	4.90	-	-	-	-	-	-	.57	-	-	-	-	9.29
			50.00	2.60	-	-	-	-	-	-	-	-	.20	-	-	
204	58224.0	60520.0	2.50	384.20	-	-	-	-	-	-	-	-	-	-	-	-
			7.50	342.50	-	-	-	-	-	-	-	-	-	-	-	-
			40.00	429.30	-	-	-	-	-	-	-	-	-	-	-	-
			50.00	544.50	-	-	-	-	-	-	-	-	-	-	-	-
			22.50	-	-	-	-	-	-	-	20.38	-	-	-	-	6.84
205	58207.0	60433.0	2.50	3.50	-	-	-	-	-	-	-	-	-	-	8.07	8.85
			7.50	4.40	5.40	-	-	-	-	-	.57	-	-	-	-	8.85
			27.50	40.50	-	-	-	-	-	-	.57	-	-	-	-	8.85
											4.43	-	-	-	-	-
											-	-	-	-	-	-
206	58243.0	60448.0	2.50	474.70	454.00	-	-	-	-	-	-	-	-	-	-	-
			40.00	479.40	-	-	-	-	-	-	-	-	-	-	-	9.30
			45.00	5.30	-	-	-	-	-	-	.57	-	-	-	-	1.48
			47.50	3.70	-	-	-	-	-	-	2.83	-	-	-	-	-
			20.00	2.70	-	-	-	-	-	-	-	-	-	-	-	-
207	58207.0	60433.0	2.50	403.20	476.20	-	-	-	-	-	-	-	-	-	-	-
			5.00	346.80	-	-	-	-	-	-	-	-	-	-	-	-
			45.00	476.70	-	-	-	-	-	-	-	-	-	-	-	-
			47.50	424.80	-	-	-	-	-	-	-	-	-	-	-	-
			22.50	400.40	-	-	-	-	-	-	-	-	-	-	-	-
208	58243.0	60448.0	2.50	403.40	-	-	-	-	-	-	-	-	-	-	-	-
			27.50	3.20	-	-	-	-	-	-	-	-	-	-	-	-
			32.50	42.60	-	-	-	-	-	-	-	-	-	-	-	-
			35.00	57.50	-	-	-	-	-	-	-	-	-	-	-	-
			37.50	20.50	-	-	-	-	-	-	-	-	-	-	-	-
209	58110.0	60452.0	2.50	356.50	-	-	-	-	-	-	-	-	-	-	-	-
			7.50	440.70	-	-	-	-	-	-	-	-	-	-	-	-
			47.50	649.50	-	-	-	-	-	-	-	-	-	-	-	-
			45.00	3.80	-	-	-	-	-	-	-	-	-	-	-	-
			47.50	429.50	425.60	-	-	-	-	-	-	-	-	-	-	-
210	58110.0	60452.0	2.50	23.50	-	-	-	-	-	-	-	-	-	-	-	-
			27.50	4.90	-	-	-	-	-	-	-	-	-	-	-	-
			25.00	2.40	-	-	-	-	-	-	-	-	-	-	-	-
			27.50	-	-	-	-	-	-	-	-	-	-	-	-	-
			45.00	474.60	450.40	-	-	-	-	-	-	-	-	-	-	-

Table A.3 Borehole/test pit sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	NORTH COORDINATE (FT.)	EAST COORDINATE (FT.)	SAMP- LE DEPTH (FT.)	R6-2261 PCL/G3				URGH106-230 PCL/G3				R6110-2261 PCL/G3			
				SAMPLE ID				SAMPLE ID				SAMPLE ID			
				04	02	03	04	02	03	04	02	03	04	02	03
208	58292.0	60055.0	47.50	434.90	-	-	-	-	-	-	-	-	47.26	-	-
			27.50	-	-	-	-	-	-	-	-	-	4.44	-	2.44
			30.00	3.40	-	-	-	-	-	-	-	-	4.70	-	49.53
			32.50	33.70	-	-	-	-	-	-	-	-	2.26	-	49.07
			35.00	43.40	-	-	-	-	-	-	-	-	-	-	-
209	58297.0	60482.0	2.50	193.00	-	-	-	-	-	-	-	-	-	-	-
			40.00	476.70	-	-	-	-	-	-	-	-	-	-	-
			45.00	529.00	-	-	-	-	-	-	-	-	-	-	-
			70.00	-	-	-	-	-	-	-	-	-	32.26	-	4.06
			72.50	3.00	-	-	-	-	-	-	-	-	2.03	-	4.15
			25.00	3.70	-	-	-	-	-	-	-	-	.85	-	4.35
			27.50	2.30	-	-	-	-	-	-	-	-	4.70	-	-
			7.50	505.50	-	-	-	-	-	-	-	-	-	-	-
			5.00	397.50	-	-	-	-	-	-	-	-	-	-	-
			7.50	449.30	-	-	-	-	-	-	-	-	-	-	-
240	58273.0	60028.0	40.00	408.50	-	-	-	-	-	-	-	-	-	-	-
			45.00	434.90	-	-	-	-	-	-	-	-	-	-	-
			47.50	523.50	-	-	-	-	-	-	-	-	-	-	-
			20.00	543.40	-	-	-	-	-	-	-	-	-	-	-
			25.00	449.50	-	-	-	-	-	-	-	-	-	-	-
			27.50	430.70	452.40	-	-	-	-	-	-	-	34.53	-	4.24
			30.00	42.00	-	-	-	-	-	-	-	-	4.34	-	9.08
			32.50	40.40	44.20	-	-	-	-	-	-	-	4.98	-	20.53
			35.00	22.00	-	-	-	-	-	-	-	-	3.68	-	5.98
			2.50	443.00	-	-	-	-	-	-	-	-	-	-	-
241	58248.0	60473.0	40.00	535.40	-	-	-	-	-	-	-	-	-	-	-
			20.00	-	-	-	-	-	-	-	-	-	23.77	-	-
			22.50	4.70	-	-	-	-	-	-	-	-	3.68	-	.16
			25.00	2.30	-	-	-	-	-	-	-	-	.28	-	8.21
			27.50	3.00	-	-	-	-	-	-	-	-	.85	-	3.53
			2.50	394.40	445.50	-	-	-	-	-	-	-	-	-	-
			5.00	347.40	-	-	-	-	-	-	-	-	-	-	-
			40.00	454.50	-	-	-	-	-	-	-	-	-	-	-
			42.50	906.40	-	-	-	-	-	-	-	-	-	-	-
			45.00	454.40	-	-	-	-	-	-	-	-	-	-	-
242	58284.0	59979.0	47.50	459.40	-	-	-	-	-	-	-	-	37.63	-	5.05
			20.00	3.40	-	-	-	-	-	-	-	-	4.70	-	4.07
			22.50	3.70	-	-	-	-	-	-	-	-	.28	-	44.94
			25.00	2.20	-	-	-	-	-	-	-	-	.85	-	2.59
			7.50	574.40	-	-	-	-	-	-	-	-	-	-	-

Table A.3 Borehole/test pit sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	BIRTH COORDINATE Easting Northing	SAMPLE DEPTH ft	RAD-226 PUL/G				BIO-238 PUL/G				BIO-238 PUL/G				RAD-226 PUL/G
			04	02	03	04	02	03	04	02	03	04	02	03	
243	58227.0	60444.0	2.50	494.00	504.30	-	-	-	-	-	-	-	-	-	-
		60444.0	2.50	494.00	504.30	-	-	-	-	-	-	-	-	-	-
		60444.0	2.50	494.00	504.30	-	-	-	-	-	-	-	-	-	-
		60444.0	2.50	494.00	504.30	-	-	-	-	-	-	-	-	-	-
		60444.0	2.50	494.00	504.30	-	-	-	-	-	-	-	-	-	-
244	58260.0	59954.0	2.50	454.00	-	-	-	-	-	-	-	-	-	-	-
		59954.0	2.50	454.00	-	-	-	-	-	-	-	-	-	-	-
		59954.0	2.50	454.00	-	-	-	-	-	-	-	-	-	-	-
		59954.0	2.50	454.00	-	-	-	-	-	-	-	-	-	-	-
		59954.0	2.50	454.00	-	-	-	-	-	-	-	-	-	-	-
245	58277.0	60455.0	2.50	363.30	-	-	-	-	-	-	-	-	-	-	-
		60455.0	2.50	363.30	-	-	-	-	-	-	-	-	-	-	-
		60455.0	2.50	363.30	-	-	-	-	-	-	-	-	-	-	-
		60455.0	2.50	363.30	-	-	-	-	-	-	-	-	-	-	-
		60455.0	2.50	363.30	-	-	-	-	-	-	-	-	-	-	-
246	58303.0	59963.0	2.50	433.30	-	-	-	-	-	-	-	-	-	-	-
		59963.0	2.50	433.30	-	-	-	-	-	-	-	-	-	-	-
		59963.0	2.50	433.30	-	-	-	-	-	-	-	-	-	-	-
		59963.0	2.50	433.30	-	-	-	-	-	-	-	-	-	-	-
		59963.0	2.50	433.30	-	-	-	-	-	-	-	-	-	-	-
247	58307.0	60407.0	2.50	467.70	-	-	-	-	-	-	-	-	-	-	-
		60407.0	2.50	467.70	-	-	-	-	-	-	-	-	-	-	-
		60407.0	2.50	467.70	-	-	-	-	-	-	-	-	-	-	-
		60407.0	2.50	467.70	-	-	-	-	-	-	-	-	-	-	-
		60407.0	2.50	467.70	-	-	-	-	-	-	-	-	-	-	-
248	58307.0	60407.0	2.50	467.70	-	-	-	-	-	-	-	-	-	-	-
		60407.0	2.50	467.70	-	-	-	-	-	-	-	-	-	-	-
		60407.0	2.50	467.70	-	-	-	-	-	-	-	-	-	-	-
		60407.0	2.50	467.70	-	-	-	-	-	-	-	-	-	-	-
		60407.0	2.50	467.70	-	-	-	-	-	-	-	-	-	-	-

Table A.3 Borehole/test pit sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	NORTH COORDINATE (F.T.)	EAST COORDINATE (F.T.)	SAMPLE LAPIN (F.T.)	RADIUM-226 (PCT/G)				POTASSIUM-40 (PCT/G)				URANIUM-238 (PCT/G)				RADIUM-226 (PCT/G)
				04	02	03	SAMPLE ID	04	02	03	SAMPLE ID	04	02	03	SAMPLE ID	
			7.50	442.50	-	-	-	-	-	-	-	32.35	-	-	-	-
			20.50	-	-	-	-	-	-	-	-	6.54	-	-	-	9.35
			22.50	60.90	-	-	-	-	-	-	-	4.58	-	-	-	4.97
			25.00	3.50	-	-	-	-	-	-	-	.28	-	-	-	44.79
			27.50	3.30	-	-	-	-	-	-	-	-	-	-	-	-
249	58264.0	60078.0	2.50	49.40	-	-	-	-	-	-	-	5.38	-	-	-	9.43
			5.00	2.20	-	-	-	-	-	-	-	.85	-	-	-	2.59
			7.50	3.40	-	-	-	-	-	-	-	4.43	-	-	-	2.74
220	58323.0	59988.0	2.50	387.50	-	-	-	-	-	-	-	-	-	-	-	-
			40.00	405.00	-	-	-	-	-	-	-	-	-	-	-	-
			45.00	549.70	-	-	-	-	-	-	-	-	-	-	-	-
			20.00	444.00	477.20	-	-	-	-	-	-	36.24	-	-	-	-
			22.50	-	-	-	-	-	-	-	-	9.50	-	-	-	.27
			25.00	2.70	-	-	-	-	-	-	-	2.55	-	-	-	4.40
			27.50	2.80	-	-	-	-	-	-	-	4.98	-	-	-	4.09
			30.00	8.40	-	-	-	-	-	-	-	-	-	-	-	-
224	58352.0	60494.0	2.50	84.40	-	-	-	-	-	-	-	8.77	-	-	-	9.62
			5.00	24.40	-	-	-	-	-	-	-	3.40	-	-	-	6.35
			7.50	6	-	-	-	-	-	-	-	2.26	-	-	-	3.67
222	58374.0	60445.0	2.50	457.60	-	-	-	-	-	-	-	44.03	-	-	-	44.45
			5.00	446.50	-	-	-	-	-	-	-	9.34	-	-	-	45.69
			7.50	3.90	-	-	-	-	-	-	-	3.44	-	-	-	4.54
			40.00	504.70	-	-	-	-	-	-	-	2.26	-	-	-	4.96
			42.50	44.00	-	-	-	-	-	-	-	-	-	-	-	-
223	58411.0	60481.0	2.50	429.70	-	-	-	-	-	-	-	30.85	-	-	-	.25
			5.00	7.60	-	-	-	-	-	-	-	4.44	-	-	-	2.77
			7.50	3.90	-	-	-	-	-	-	-	.57	-	-	-	884.74
			40.00	504.70	-	-	-	-	-	-	-	.85	-	-	-	43.08
			42.50	44.00	-	-	-	-	-	-	-	-	-	-	-	-
224	58752.0	60003.0	2.50	394.60	-	-	-	-	-	-	-	-	-	-	-	-
			5.00	450.40	-	-	-	-	-	-	-	32.26	-	-	-	-
			45.00	-	-	-	-	-	-	-	-	2.26	-	-	-	.85
			47.50	2.00	4.00	-	-	-	-	-	-	4.43	-	-	-	3.36
			22.50	3.80	-	-	-	-	-	-	-	-	-	-	-	-
225	58594.0	60222.0	2.50	460.70	107.20	-	-	-	-	-	-	39.67	-	-	-	7.08
			5.00	347.20	-	-	-	-	-	-	-	.57	-	-	-	6.84
			7.50	3.50	-	-	-	-	-	-	-	-	-	-	-	-

Table A.3 Borehole/test pit sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	BORTH COORDINATE	E651 COORDINATE	SAMPLE DEPTH (ft.)	RAD-226 PCL/G				BGR-238 PCL/G				BGR-235 PCL/G				RAD-226 PCL/G
				04	02	03	10	04	02	03	10	04	02	03	10	
226	59080.0	59070.0	10.00	3.60	-	-	-	-	-	-	-	0.85	-	-	-	4.24
			12.50	3.40	-	-	-	-	-	-	-	1.14	-	-	-	2.94
			2.50	17.30	-	-	-	-	-	-	-	2.83	-	-	-	6.44
227	59047.0	59049.0	5.50	3.40	-	-	-	-	-	-	-	0.85	-	-	-	3.65
			7.50	369.40	-	-	-	-	-	-	-	-	-	-	-	-
			5.00	304.00	-	-	-	-	-	-	-	-	-	-	-	-
			7.50	360.00	368.40	-	-	-	-	-	-	-	-	-	-	-
			45.00	400.60	-	-	-	-	-	-	-	-	-	-	-	-
			17.50	402.00	-	-	-	-	-	-	-	20.30	-	-	-	17.03
228	58423.0	59070.0	20.00	403.50	-	-	-	-	-	-	-	45.66	-	-	-	2.01
			23.20	45.60	-	-	-	-	-	-	-	94.24	-	-	-	1.1
			2.50	293.40	-	-	-	-	-	-	-	-	-	-	-	-
			5.00	372.60	-	-	-	-	-	-	-	-	-	-	-	-
			7.50	54.50	-	-	-	-	-	-	-	-	-	-	-	-
			22.50	509.40	-	-	-	-	-	-	-	-	-	-	-	-
			25.00	356.40	-	-	-	-	-	-	-	-	-	-	-	-
			27.50	442.50	444.90	-	-	-	-	-	-	-	-	-	-	-
			50.00	336.00	-	-	-	-	-	-	-	-	-	-	-	-
			55.00	585.00	-	-	-	-	-	-	-	-	-	-	-	-
229	58044.0	59079.0	57.50	575.50	-	-	-	-	-	-	-	-	-	-	-	-
			65.00	497.50	-	-	-	-	-	-	-	-	-	-	-	-
			77.50	474.00	-	-	-	-	-	-	-	-	-	-	-	-
			82.50	-	-	-	-	-	-	-	-	30.85	-	-	-	6.24
			85.00	24.70	-	-	-	-	-	-	-	1.40	-	-	-	4.94
			85.60	46.70	-	-	-	-	-	-	-	3.40	-	-	-	-
			2.50	262.20	-	-	-	-	-	-	-	-	-	-	-	-
			7.50	390.90	-	-	-	-	-	-	-	-	-	-	-	-
			40.00	533.40	-	-	-	-	-	-	-	-	-	-	-	-
			47.50	493.00	-	-	-	-	-	-	-	-	-	-	-	-
230	58000.0	59034.0	20.00	576.40	-	-	-	-	-	-	-	-	-	-	-	-
			27.50	459.90	-	-	-	-	-	-	-	-	-	-	-	-
			47.50	300.40	-	-	-	-	-	-	-	25.47	-	-	-	6.95
			55.00	-	-	-	-	-	-	-	-	1.44	-	-	-	-
			57.70	9.10	-	-	-	-	-	-	-	-	-	-	-	-
230	58000.0	59034.0	2.50	323.20	-	-	-	-	-	-	-	-	-	-	-	-
			5.00	513.50	-	-	-	-	-	-	-	-	-	-	-	-
			10.00	596.40	-	-	-	-	-	-	-	-	-	-	-	-
			30.00	462.70	-	-	-	-	-	-	-	-	-	-	-	-
			37.50	404.00	-	-	-	-	-	-	-	-	-	-	-	-
230	58000.0	59034.0	42.50	354.00	-	-	-	-	-	-	-	-	-	-	-	-

Table A.3 Borehole/test pit sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	NORTH COORDINATE (F.T.)	EAST COORDINATE (F.T.)	SAMPLE DEPTH (F.T.)	RAD-226(PCL/G)				BOL-129 F/T-51 PTE SAMPLE ASSAY				URGE-238(PCL/G)				RAD-226(PCL/G)			
				RA-226(PCL/G)				BOL-129 F/T-51 PTE SAMPLE ID---				URGE-238(PCL/G)				RAD-226(PCL/G)			
				04	02	03	03	04	02	03	03	04	02	03	03	04	02	03	03
231	58236.0	59937.0	45.00	399.20	402.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			60.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			2.50	373.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			40.00	533.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
232	58243.0	59943.0	20.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			22.50	96.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			25.00	6.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			27.50	5.63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
233	58046.0	59949.0	2.50	450.40	447.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			42.50	633.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			45.00	547.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			47.50	269.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
234	58054.0	59760.0	20.00	24.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			22.50	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			2.50	368.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			5.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
235	58060.0	59937.0	7.50	6.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			8.00	4.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			2.50	347.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			7.50	400.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
236	58054.0	59760.0	40.00	557.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			42.50	650.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			47.50	483.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			50.00	452.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
237	58054.0	59760.0	25.00	478.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			32.50	397.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			42.50	483.20	558.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			45.00	449.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
238	58054.0	59760.0	47.50	405.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			52.50	474.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			62.50	366.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			67.50	513.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
239	58054.0	59760.0	70.00	554.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			77.50	560.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			87.50	400.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			94.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
240	58054.0	59760.0	2.50	409.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			42.50	265.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			45.00	3.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			47.50	44.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A.3 Borehole/test pit sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	NORTH COORDINATE (E.T.)	EAST COORDINATE (E.T.)	SAMPLE DEPTH (F.T.)	RADIOUM-226 (PCL/G)				RADIOUM-226 (PCL/G)				RADIOUM-226 (PCL/G)				RADIOUM-226 (PCL/G)
				86-226 (PCL/G)				86-226 (PCL/G)				86-226 (PCL/G)				
				04	02	03	04	02	03	04	02	03	04	02	03	
			48.50	6.40	-	-	-	-	-	-	-	-	-	-	-	3.59
236	58089.0	59949.0	2.50	408.70	-	-	-	-	-	-	-	-	-	-	-	49.03
			5.00	72.00	-	-	-	-	-	-	-	-	-	-	-	5.34
			7.50	4.70	-	-	-	-	-	-	-	-	-	-	-	4.46
			9.00	4.40	-	-	-	-	-	-	-	-	-	-	-	4.32
237	58441.0	59970.0	2.50	444.70	-	-	-	-	-	-	-	-	-	-	-	-
			7.50	565.20	-	-	-	-	-	-	-	-	-	-	-	7.95
			42.50	402.70	-	-	-	-	-	-	-	-	-	-	-	3.34
			45.00	224.50	244.00	-	-	-	-	-	-	-	-	-	-	2.07
			47.50	6.40	-	-	-	-	-	-	-	-	-	-	-	2.29
			20.00	3.50	-	-	-	-	-	-	-	-	-	-	-	-
238	58363.0	60008.0	2.50	554.30	-	-	-	-	-	-	-	-	-	-	-	-
			7.50	611.60	-	-	-	-	-	-	-	-	-	-	-	-
			40.00	530.60	-	-	-	-	-	-	-	-	-	-	-	-
			42.50	317.40	-	-	-	-	-	-	-	-	-	-	-	-
			45.00	509.00	-	-	-	-	-	-	-	-	-	-	-	-
			47.50	385.50	357.60	-	-	-	-	-	-	-	-	-	-	7.77
			20.00	4.50	-	-	-	-	-	-	-	-	-	-	-	.80
			22.50	7.40	6.60	-	-	-	-	-	-	-	-	-	-	2.04
			25.00	5.40	-	-	-	-	-	-	-	-	-	-	-	.83
239	58398.0	60007.0	2.50	606.70	-	-	-	-	-	-	-	-	-	-	-	-
			5.00	610.40	-	-	-	-	-	-	-	-	-	-	-	-
			47.50	105.40	-	-	-	-	-	-	-	-	-	-	-	40.52
			20.00	450.00	-	-	-	-	-	-	-	-	-	-	-	12.62
			22.50	0.00	-	-	-	-	-	-	-	-	-	-	-	4.04
			25.00	6.40	-	-	-	-	-	-	-	-	-	-	-	2.83
240	58045.0	59850.0	2.50	428.40	378.60	-	-	-	-	-	-	-	-	-	-	-
			5.00	257.40	-	-	-	-	-	-	-	-	-	-	-	6.50
			5.00	445.40	-	-	-	-	-	-	-	-	-	-	-	42.75
241	58405.0	59908.0	2.50	384.50	-	-	-	-	-	-	-	-	-	-	-	-
			5.00	-	-	-	-	-	-	-	-	-	-	-	-	-
			7.50	44.20	-	-	-	-	-	-	-	-	-	-	-	6.04
			40.00	7.50	-	-	-	-	-	-	-	-	-	-	-	6.73
242	58447.0	59869.0	2.50	540.80	-	-	-	-	-	-	-	-	-	-	-	-
			5.00	359.50	-	-	-	-	-	-	-	-	-	-	-	-
			7.50	522.80	-	-	-	-	-	-	-	-	-	-	-	-

Table A.3 Borehole/test pit sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	NORTH COORDINATE (FT.)	EAST COORDINATE (FT.)	SAMPLE DEPTH (FT.)	BUREAU OF LANDS TEST PIT SAMPLE 05568				BUREAU OF LANDS TEST PIT SAMPLE 05568				RADIUM-226 (PCT/G)	
				RO-226 (PCT/G)		URANIUM-238 (PCT/G)		URANIUM-235 (PCT/G)		URANIUM-235 (PCT/G)		RADIUM-226 (PCT/G)	
				04	02	03	04	02	03	04	02	03	04
			42.50	274.70	-	-	-	-	-	27.17	-	-	40.44
			44.20	3.99	-	-	-	-	-	4.43	-	-	3.45
243	58060.0	59940.9	2.50	536.20	-	-	-	-	-	-	-	-	-
			5.00	450.40	-	-	-	-	-	43.30	-	-	40.40
			7.00	404.70	-	-	-	-	-	42.73	-	-	8.22
244	58032.0	59870.0	2.50	-	-	-	-	-	-	28.02	-	-	5.94
			3.20	40.40	-	-	-	-	-	4.70	-	-	-
245	58432.0	59948.0	2.50	442.30	-	-	-	-	-	62.03	-	-	7.04
			5.00	444.60	-	-	-	-	-	46.43	-	-	6.92
			7.50	5.00	-	-	-	-	-	5.7	-	-	40.48
			40.00	47.00	49.70	-	-	-	-	2.55	-	-	7.20
246	58477.0	59907.9	2.50	678.90	-	-	-	-	-	-	-	-	-
			40.00	-	-	-	-	-	-	54.79	-	-	-
			42.50	466.00	-	-	-	-	-	44.89	-	-	43.96
			45.00	2.50	-	-	-	-	-	5.7	-	-	3.39
			47.50	3.20	-	-	-	-	-	.85	-	-	3.76
247	58464.0	59920.0	2.50	452.60	-	-	-	-	-	-	-	-	-
			7.50	538.70	475.60	-	-	-	-	-	-	-	-
			40.00	-	-	-	-	-	-	42.45	-	-	-
			42.50	409.40	-	-	-	-	-	8.24	-	-	43.33
			45.00	2.00	-	-	-	-	-	2.55	-	-	4.40
			47.50	44.30	-	-	-	-	-	4.53	-	-	9.70
248	58203.0	59935.0	2.50	434.20	-	-	-	-	-	-	-	-	-
			5.00	574.70	-	-	-	-	-	-	-	-	-
			42.50	368.00	-	-	-	-	-	39.04	-	-	7.40
			45.00	237.30	-	-	-	-	-	24.79	-	-	40.89
			47.50	444.00	-	-	-	-	-	8.39	-	-	11.47
			20.00	6.80	-	-	-	-	-	.85	-	-	8.09
249	58448.0	59929.0	2.50	543.60	-	-	-	-	-	-	-	-	-
			5.00	-	-	-	-	-	-	43.19	-	-	-
			7.50	412.00	462.50	-	-	-	-	9.62	-	-	43.26
			40.00	43.30	-	-	-	-	-	4.64	-	-	9.43
250	58022.0	59869.0	2.50	376.70	383.60	-	-	-	-	-	-	-	-
			10.00	454.40	-	-	-	-	-	-	-	-	-

Table A.3 Borehole/test pit sample assay report site: Spook, Wyoming (continued)

[illegible]

Table A.3 Borehole/test pit sampling assay report site: Spook, Wyoming (Concluded)

LOCATION ID	NORTH COORDINATE (FT.)	EAST COORDINATE (FT.)	SAMPLE DEPTH (FT.)	Borehole 275.4 P.T. Sample Assay				Borehole 230 P.C.I/G				Ratio U/Pu
				BA-2754 P.C.I/G	BA-2754 P.C.I/G	BA-2754 P.C.I/G	BA-2754 P.C.I/G	UR-230 P.C.I/G	UR-230 P.C.I/G	UR-230 P.C.I/G	UR-230 P.C.I/G	
				01	02	03	04	01	02	03	04	
261	-	-	9.99	40.60	-	-	42.60	-	-	-	-	-
262	-	-	85.60	46.70	-	-	9.45	-	-	-	-	-
263	-	-	9.99	453.70	-	-	93.20	-	-	-	-	-
264	-	-	9.99	20.40	-	-	9.05	-	-	-	-	-
265	-	-	9.99	5.70	-	-	5.24	-	-	-	-	-
266	-	-	9.99	424.70	-	-	72.40	-	-	-	-	-
267	-	-	9.99	40.60	-	-	6.77	-	-	-	-	-
268	-	-	9.99	3.60	-	-	3.63	-	-	-	-	-
269	-	-	9.99	44.40	-	-	8.50	-	-	-	-	-
270	-	-	9.99	422.40	-	-	78.90	-	-	-	-	-
271	-	-	9.99	45.70	-	-	42.50	42.50	-	-	-	-

Table A.4 Results of metals analyses, Spook, Wyoming

Location number	Metal results (ug/g)						
	Cr	Cu	V	Mn	Se	As	Ba
261	28.	21.	81.	131.	35.	<2.0	610.
262	23.	16.	144.	97.	14.	<2.0	660.
263	15.	<10.	66.	112.	39.	2.8	594.
264	15.	<10.	29.	96.	<2.0	2.8	528.
265	37.	14.	65.	103.	<2.0	3.8	491.
266	24.	<10.	76.	328.	19.	2.6	559.
267	33.	12.	56.	166.	<2.0	3.1	556.
268	31.	11.	78.	136.	<2.0	3.2	600.
269	23.	<10.	49.	136.	<2.0	3.1	630.
270	24.	<10.	86.	142.	17.	3.3	526.
271	23.	<10.	39.	135.	<2.0	3.0	628.
	Zn	Pb	Cd	Hg	Fe	Mo	
261	19.	24.	<0.30	<0.50	1.39	<10.	
262	21.	23.	<0.30	<0.50	1.19	<10.	
263	21.	22.	<0.30	<0.50	0.76	<10.	
264	19.	21.	<0.30	<0.50	0.75	<10.	
265	53.	20.	<0.30	<0.50	1.48	<10.	
266	30.	22.	<0.30	<0.50	1.06	<10.	
267	48.	22.	<0.30	<0.50	1.60	<10.	
268	42.	23.	<0.30	<0.50	1.36	<10.	
269	35.	24.	<0.30	<0.50	1.12	<10.	
270	31.	23.	<0.30	<0.50	1.06	<10.	
271	31.	22.	<0.30	<0.50	1.02	<10.	

Table A.5 Results of radon emanation fraction measurements,
tailings samples, Spook, Wyoming

Location number	Depth ^a (ft)	Moisture (% dry weight)	Ra-226 (pCi/g)	Emanation fraction
SPK-001	2	11.3	381	0.37
001	3	12.2	395	0.36
001	5	13.3	525	0.34
001	6	14.9	551	0.27
001	8	13.8	464	0.38
001	9	14.3	386	0.26
SPK-002	1	12.5	466	0.21
002	2	11.6	441	0.21
002	4	10.1	414	0.29
002	5	11.3	390	0.26
002	7	14.6	427	0.34
002	8	13.2	436	0.36
002	10	13.7	513	0.39
SPK-021	1	11.5	394	0.29
021	3	10.1	268	0.37
021	4	10.3	305	0.38
021	6	13.4	390	0.34
021	7	13.8	360	0.31
021	9	14.3	376	0.34
021	10	14.2	364	0.28
Average	--	--	--	0.32

^aDepths are to bottom of one-foot-thick samples.

Table A.6 Results of radon emanation fraction measurements,
windblown samples, Spook, Wyoming

Location number	Depth ^a (ft)	Moisture (% dry weight)	Ra-226 (pCi/g)	Emanation fraction
SPK-015	0.5	11.54	245.1	0.56
SPK-016	0.5	12.02	39.5	0.58
SPK-018	0.5	10.96	38.4	0.54
SPK-019	0.5	12.66	145.6	0.67
SPK-020	0.5	10.01	121.1	0.61
SPK-101	0.5	11.25	128.8	0.58
SPK-103	0.5	11.80	70.0	0.61
SPK-115	0.5	10.27	40.3	0.61
SPK-120	0.5	13.42	20.4	0.61
SPK-123	0.5	11.66	65.6	0.63
Average	--	--	--	0.60

^aDepths are to bottom of one-half-foot thick samples.

Table D.2.2 Summary of locations and depths to 5 pCi/g measured on the Spook site, Wyoming

Location ID	North coordinate (ft)	East coordinate (ft)	Depth to 5 pCi/g (ft)
		60017.6	2.50
	58132.9	60098.7	0.50
5	58079.2	60198.2	0.50
6	58101.7	59960.1	3.50
7	58023.0	60129.0	0.50
8	58023.1	60209.4	5.00
9	57993.6	59914.4	2.50
10	57930.9	60011.8	3.50
11	57902.6	60115.5	5.00
12	57900.4	60228.6	3.50
13	57892.8	60310.9	2.00
14	58237.5	60364.0	5.00
15	58145.4	60408.1	5.00
16	58037.9	60400.3	5.00
17	57921.4	60369.8	2.00
18	57805.0	60262.1	2.00
19	57753.1	59692.9	>20.00
20	56454.2	60381.2	0.50
22	58396.3	60492.9	0.00
101	58565.9	60472.4	2.00
102	58322.5	60632.1	2.50
103	58460.9	60785.9	0.00
104	58598.4	60939.7	0.00
105	58733.8	60594.6	0.00
106	58104.9	60794.8	0.00
107	58153.2	60993.4	0.00
108	58201.5	61287.2	0.00
109	58284.8	61583.0	0.00
110	58348.3	61850.1	0.00
111	58415.6	60865.7	0.00
112	58368.3	61139.0	0.00
113	58540.5	60598.2	2.50
114	57894.3	60899.4	2.00
115	57841.0	61199.6	0.00
116	57788.2	61500.7	0.00
117	57733.8	61122.7	0.00
118	58035.7	60609.2	2.00
119	57636.6	60866.5	0.00
120	57465.1	61121.9	0.00
121	57293.7	60358.9	0.00
122	57537.5	60516.3	0.00
123	57271.9	60672.6	0.00
124	57011.5		
125			

Table D.2.2 Summary of locations and depths to 5 pCi/g measured on the Spook site, Wyoming (Continued)

Location ID	North coordinate (ft)	East coordinate (ft)	Depth to 5 pCi/g (ft)
126	57137.0	59220.2	0.00
127	56848.9	58922.5	0.00
128	56561.7	58623.3	0.00
129	58226.6	59131.4	0.00
130	58321.5	58733.7	0.00
131	58421.6	58328.2	0.00
132	58598.5	57622.3	0.00
133	57682.3	59051.4	0.00
134	58754.6	59390.9	0.00
135	56682.0	59746.9	2.00
136	56551.0	59708.0	3.00
137	56590.7	59638.1	2.00
138	56528.5	59663.0	5.00
139	56437.8	59604.1	10.00
140	56399.0	59627.7	1.00
142	58055.2	60048.9	2.50
143	57288.4	60241.5	0.00
144	56945.9	59879.9	0.00
201	58256.0	60124.0	33.50
202	58204.0	59991.0	13.00
203	58276.0	60110.0	31.00
204	58224.0	60020.0	15.50
205	58307.0	60133.0	38.50
206	58243.0	60048.0	23.00
207	58318.0	60152.0	36.00
208	58292.0	60055.0	20.50
209	58297.0	60182.0	36.00
210	58273.0	60028.0	20.50
211	58248.0	60173.0	18.00
212	58281.0	59979.0	20.50
213	58227.0	60144.0	15.50
214	58260.0	59951.0	15.50
215	58277.0	60155.0	28.50
216	58303.0	59963.0	20.50
217	58250.0	60107.0	3.00
218	58302.0	60008.0	23.00
219	58264.0	60078.0	3.00
220	58323.0	59988.0	23.00
221	58352.0	60194.0	8.00
222	58371.0	60145.0	11.00
223	58411.0	60181.0	13.50
224	58252.0	60000.0	15.50
225	58391.0	60222.0	5.50

Table D.2.2 Summary of locations and depths to 5 pCi/g measured on the Spook site, Wyoming (Concluded)

Location ID	North coordinate (ft)	East coordinate (ft)	Depth to 5 pCi/g (ft)
226	57988.0	59870.0	3.00
227	58017.0	59849.0	18.50
228	58123.0	59820.0	86.10
229	58044.0	59829.0	58.20
230	58088.0	59831.0	60.50
231	58236.0	59937.0	28.00
232	58213.0	59943.0	20.50
233	58046.0	59949.0	8.00
234	58051.0	59780.0	100.00
235	58468.0	59937.0	19.40
236	58089.0	59949.0	5.50
237	58441.0	59970.0	15.50
238	58363.0	60008.0	25.50
239	58398.0	60007.0	25.50
240	58045.0	59890.0	7.50
241	58105.0	59908.0	10.50
242	58117.0	59869.0	13.00
243	58060.0	59910.0	9.00
244	58032.0	59870.0	3.70
245	58132.0	59948.0	10.50
246	58177.0	59907.0	13.00
247	58164.0	59930.0	18.50
248	58203.0	59915.0	20.50
249	58118.0	59929.0	10.50
250	58072.0	59809.0	84.00
251	58089.0	59887.0	10.00
252	58074.0	59931.0	8.90
253	58032.0	59931.0	8.40
254	58017.0	59910.0	4.40
255	58003.0	59891.0	3.50
256	58021.0	59797.0	81.00

Table D.2.5 Radon diffusion coefficients for uranium tailings, Spook site, Wyoming

Sample	Max. dry density (g/cc)	Specific gravity	Optimum moisture (% dry wt)	Test moisture (% dry wt)	As tested dry density (g/cc)	Diffusion coefficient (sq cm/s)	Saturation (fraction)	Porosity (fraction)
SPK-01-001	1.87	2.69	13.9	6.5	1.69	2.8E-02	0.30	0.37
				11.7	1.69	1.6E-02	0.53	0.37
				16.2	1.70	2.7E-03	0.75	0.37
SPK-01-021	1.89	2.68	13.8	5.2	1.70	2.7E-02	0.24	0.36
				10.0	1.70	1.3E-02	0.46	0.37
				15.2	1.71	2.3E-03	0.74	0.35

RADIOLOGIC CHARACTERIZATION

Acid Pond

Reference 4

DATE 03/10/82

BY dws oxd

SUBJECT SUMMARY OF
SPUR ACID POND
BOREHOLE LOCATIONSSHEET NO 1 of 1
JOB NO QSC1152210

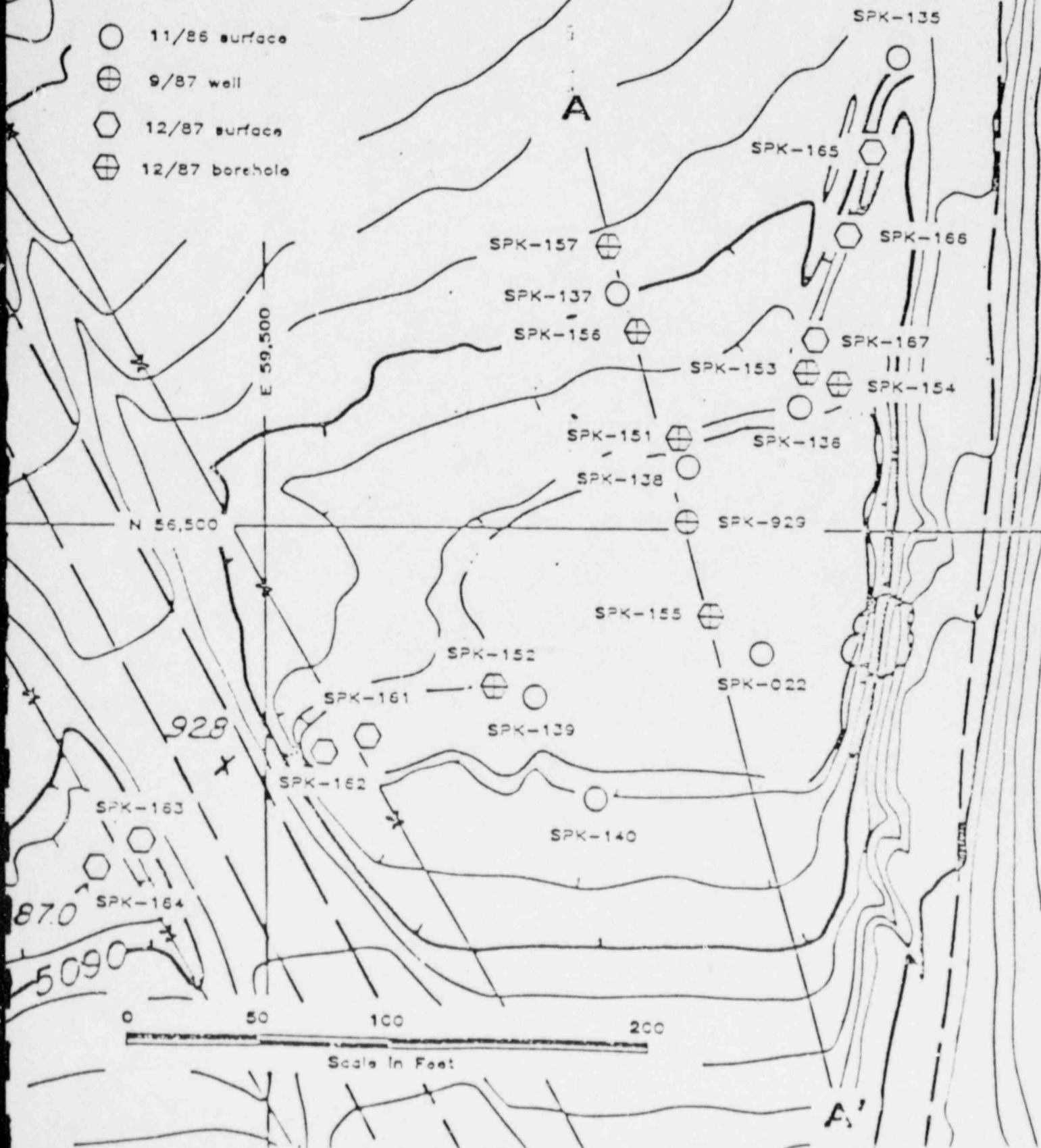
Borehole	North Coordinate (ft)	East Coordinate (ft)	Elevation (ft)
151	56,534.5	59,650.6	~5086
152	56,440.4	59,538.8	
153	56,562.7	59,709.9	
154	56,558.0	59,722.3	
155	56,466.1	59,670.9	~5082.5
156	56,576.2	59,643.4	~5089
157	56,608.5	59,632.8	~5091
929	56,502.8	59,663.1	5033.0

well 929 was surveyed and its coordinates should be accurate to standard survey accuracy. Boreholes 151 through 157 were surveyed by pacing distances and measuring angles from well 929, and should be accurate to less than five feet or so.

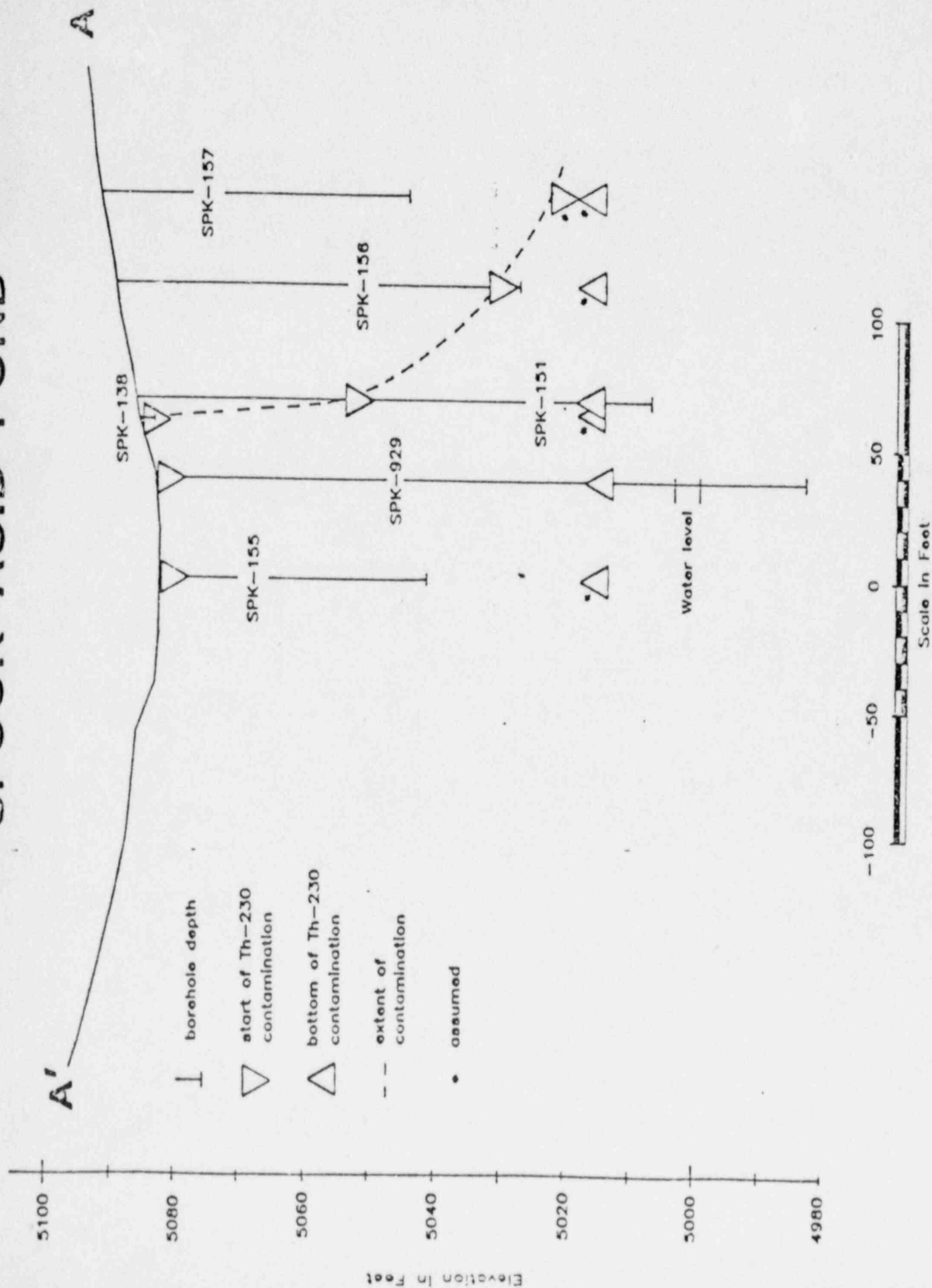
SPOOK ACID POND

5100

- 11/86 surface
- ⊕ 9/87 well
- ⬡ 12/87 surface
- ⊞ 12/87 borehole



SPOOK ACID POND



dwg 3/16/28

SPOOK ACID POND CHARACTERIZATION

LOCATION	DEPTH (ft)	TH-230 (pCi/g)	RA-226 (pCi/g)
=====			
SPK-151	0 - 2	3	5
	2 - 4	3	1
	4 - 6	4	2
	6 - 8	4	
	8 - 10	5	
	10 - 12	3	
	12 - 14	2	
	14 - 16	4	
	16 - 18	5	
	18 - 20	3	
	25 - 27	2	
	30 - 32	1	
	35 - 37	600	< 80
	40 - 42	888	< 80
	45 - 47	28	< 80
	50 - 52	308	< 100
	55 - 57	10	< 120
	60 - 62	201	< 100
	62 - 64	398	< 60
	67 - 69	21	< 60
	72 - 74	34	< 100
	77 - 79	6	< 80
SPK-152	0 - 2	174	371
	2 - 4	290	111
	4 - 6	226	29
	6 - 8	250	
	8 - 10	201	
SPK-153	0 - 2	178	101
	2 - 4	202	5
	4 - 6	929	12
	6 - 8	559	
	8 - 10	761	
SPK-154	0 - 2	25	45
	2 - 4	1	1
	4 - 6	1	1
	6 - 8	4	
	8 - 10	3	
SPK-155	0 - 2	179	526
	2 - 4	208	145
	4 - 5	238	63
	5 - 7	195	46
	7 - 8	158	< 200
	8 - 10	203	< 180
	10 - 13	219	< 120
	13 - 15.5	1090	< 200
	15.5 - 18.5	1373	< 200
	18.5 - 21.5	1191	< 200

27 - 29	1015	< 200
31.5 - 34	384	< 60
34 - 36.5	1034	< 60
36.5 - 39	113	< 60
39 - 41.5	87	< 60

SPK-156	0 - 2	2	2
	2 - 4	6	2
	4 - 6	2	1
	6 - 8	4	< 50
	8 - 10	2	< 50
	10 - 12	1	< 50
	12 - 14	2	< 50
	14 - 16	2	< 50
	16 - 18	1	< 50
	18 - 20	1	< 50
	25 - 27	1	< 50
	30 - 32	2	< 50
	35 - 37	1	< 50
	40 - 42	1	< 50
	45 - 47	1	< 50
	50 - 52	1	< 50
	55 - 57	3	< 50
	60 - 62	592	< 50

SPK-157	0 - 2	2	2
	2 - 4	3	1
	4 - 6	3	2
	6 - 8	3	< 50
	8 - 10	2	< 50
	10 - 12	1	< 50
	12 - 14	3	< 50
	14 - 16	2	< 50
	16 - 18	1	< 50
	18 - 20	2	< 50
	24 - 26	1	< 50
	30 - 32	2	< 50
	35 - 37	1	< 50
	40 - 42	3	< 50
	45 - 47	4	< 50

SPK-929	63 - 70	30
	70 - 80	2
	80 - 90	2
	90 - 100	2

SPK-161	0 - 0.5	6	7
SPK-162	0 - 0.5	15	12
SPK-163	0 - 0.5	6	7
SPK-164	0 - 0.5	6	6
SPK-165	0 - 0.5	20	14
SPK-166	0 - 0.5	7	7
SPK-167	0 - 0.5	28	31

Table A.3 Borehole/test pit sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	NORTH COORDINATE (F.T.)	EAST COORDINATE (F.T.)	SAMPLE DEPTH (F.T.)	R6-226(PCI/U)				UR-230(PCI/U)				URANIUM-238(PCI/U)				RADIUM-226(PCI/U)
				04	02	03	04	02	03	04	02	03	04	02	03	
			4.00	20.40	49.40	-	-	-	-	3.04	3.34	-	-	-	-	6.47
044	57692.8	60228.6	.50	438.50	-	-	-	-	-	44.42	-	-	-	-	-	3.42
			4.00	24.00	-	-	-	-	-	9.02	-	-	-	-	-	2.66
			2.00	53.00	-	-	-	-	-	47.03	-	-	-	-	-	3.46
			3.00	7.60	-	-	-	-	-	4.67	-	-	-	-	-	4.55
			4.00	2.60	-	-	-	-	-	2.34	-	-	-	-	-	4.44
047	58037.9	60408.4	.50	29.90	-	-	-	-	-	44.36	-	-	-	-	-	2.63
			4.00	20.50	-	-	-	-	-	2.00	-	-	-	-	-	44.25
			2.00	33.50	-	-	-	-	-	4.67	-	-	-	-	-	20.06
			3.00	44.60	-	-	-	-	-	2.00	-	-	-	-	-	22.30
			4.00	46.50	-	-	-	-	-	3.67	-	-	-	-	-	4.50
024	58254.4	60469.8	4.00	394.00	-	-	-	-	-	-	-	-	-	-	-	-
			2.00	407.00	-	-	-	-	-	42.00	-	-	-	-	-	9.67
			3.00	268.00	-	-	-	-	-	-	-	-	-	-	-	-
			4.00	305.00	-	-	-	-	-	-	-	-	-	-	-	-
			5.00	414.00	-	-	-	-	-	32.40	-	-	-	-	-	42.69
			6.00	390.00	-	-	-	-	-	-	-	-	-	-	-	-
			7.00	360.00	-	-	-	-	-	-	-	-	-	-	-	-
			8.00	443.50	-	-	-	-	-	45.42	-	-	-	-	-	9.76
			9.00	376.00	-	-	-	-	-	-	-	-	-	-	-	-
			10.00	364.00	-	-	-	-	-	-	-	-	-	-	-	-
022	56454.2	59692.9	4.00	504.00	-	-	-	-	-	244.00	-	-	-	-	-	436.54
			2.00	49.00	-	-	-	-	-	250.00	-	-	-	-	-	24.28
			3.00	8.50	-	-	-	-	-	165.00	-	-	-	-	-	0.90
			4.00	5.10	5.30	-	-	-	-	450.00	473.00	-	-	-	-	5.20
			5.00	5.70	-	-	-	-	-	320.00	-	-	-	-	-	5.70
			7.00	5.30	-	-	-	-	-	295.00	-	-	-	-	-	3.47
			-	-	-	-	-	-	-	-	-	-	-	-	-	-
204	58256.0	60424.0	2.50	400.50	-	-	-	-	-	-	-	-	-	-	-	-
			5.00	462.50	-	-	-	-	-	-	-	-	-	-	-	-
			40.50	403.00	-	-	-	-	-	-	-	-	-	-	-	-
			42.50	490.90	-	-	-	-	-	-	-	-	-	-	-	-
			22.50	3.00	-	-	-	-	-	-	-	-	-	-	-	-
			25.00	-	-	-	-	-	-	-	-	-	-	-	-	-
			27.50	8.00	6.50	-	-	-	-	29.74	-	-	-	-	-	4.62
			30.00	24.90	-	-	-	-	-	4.70	-	-	-	-	-	25.76
			32.50	22.50	-	-	-	-	-	85	-	-	-	-	-	9.02
202	56204.0	59994.0	2.50	457.50	-	-	-	-	-	-	-	-	-	-	-	-
			5.00	454.40	-	-	-	-	-	-	-	-	-	-	-	-

Table A.2 Soil sample assay report site: Spook, Wyoming (Continued)

LOCATION ID	NORTH COORDINATE (F.T.)	EAST COORDINATE (F.T.)	SAMPLE DEPTH (F.T.)	SOIL SAMPLE ASSAY										RADIUM-226 TO URANIUM-238	
				RA-226 (PCI/B)		TH-230 (PCI/B)		URANIUM-238 (PCI/B)		RATIO					
				04	02	03	04	02	03	04	02	03	04	02	03
			1.0	1.30	-	-	-	-	-	-	-	-	.67	-	-
431	58424.6	58328.2	0.5 1.0	4.40 4.60	4.40	-	-	-	-	2.00 1.00	4.67	-	-	-	-
432	58598.5	57622.3	0.5 1.0	4.90 4.70	-	-	4.43	-	-	.67 .67	-	-	-	-	-
433	57682.3	59054.4	0.5 1.0	4.40 4.70	4.50	-	-	-	-	1.00 1.00	.67	-	-	-	-
434	58754.6	59390.9	0.5 1.0	4.40 4.40	-	-	-	-	-	1.00 1.00	-	-	-	-	-
435	56682.0	59746.9	0.5 1.0 1.5	2.50 3.60 3.40	-	-	4.62 22.60 0.44	-	-	1.34 1.34 1.00	-	-	-	-	-
436	56554.0	59708.0	0.5 1.0 1.5	434.80 339.90 244.90	-	-	409.00 263.00 343.00	-	-	5.68 9.35 2.67	-	-	-	-	-
437	56590.7	59638.4	0.5 1.0 1.5	4.50 2.40 2.80	4.80	-	3.06 4.35 7.08	3.05	-	1.34 1.67 .67	2.67	-	-	-	-
438	56528.5	59663.0	0.5 1.0 1.5	39.60 42.20 7.50	-	-	484.00 480.00 463.00	-	-	44.02 40.35 6.04	-	-	-	-	-
439	56437.8	59604.4	0.5 1.0 1.5	45.00 653.60 669.20	-	-	49.20 498.00 250.00	-	-	3.34 3.34 4.04	-	-	-	-	-
440	56399.0	59627.7	0.5 1.0 1.5	49.30 2.90 4.60	-	-	46.30 3.16 3.72	-	-	2.67 1.00 1.67	-	-	-	-	-
441	58055.2	60048.9	0.5	74.70	-	-	75.70	-	-	43.69	-	-	-	-	-

UMTRA PROJECT - SPOOK
INFORMATION TO BIDDERS

6) GEOLOGY, GEOMORPHOLOGY AND SEISMICITY (Reference 1)

D.3.2 GEOLOGIC SETTING

D.3.2.1 Previous work

The geology and structure of the study region is covered by several published maps. U.S. Geological Survey maps by Hodson et al. (1973), and a series of maps by the Wyoming Geological Survey (Case and Boyd, 1984a, b, c; Case, 1986a-e) depict the regional geology and the engineering geology for the state (seismicity, suspected active faults, and unstable areas). The Geologic Atlas and Mineral Resources of Converse County by Lane et al. (1972) provides a series of maps with a compilation of previous work in the region.

Local geologic and mineral conditions were reported by Sharp and Gibbons (1964). The mining area, which includes the Spook site, is discussed in an unpublished report by Pioneer Nuclear (1978). There are numerous oil, gas, coal, and uranium resource reports for the region. Most significant among these are several guidebooks published by the Wyoming Geological Association, and maps by Harris et al. (1985) and Stephenson et al. (1984) for the Wyoming Geological Survey. Environmental reports by Kerr-McGee Corp. for the Powder River Basin Mill site (1977) and the NRC's report for the nearby Bear Creek Project (1977) provide useful characterization of local geologic conditions.

References for faults and other structures were found in maps by DeBruin (1985), Swenson et al. (1976), Blackstone (1949), and Denson and Horn (1976). Site-specific information was provided by Ford, Bacon & Davis Utah Inc. (FBDU, 1981). A preliminary study of site area geomorphic conditions with design for drainage reconstruction was provided in an unpublished 1987 report by Hydro-Engineering, the consultant for the State of Wyoming Abandoned Mine Lands (AML) Program (1987a).

D.3.2.2 Physiographic setting

The Spook site is in the southern part of the Powder River Basin at the western edge of the Great Plains Physiographic Province (Hunt, 1967), and is illustrated in Figure D.3.1. The basin is bounded on the west by the north-south trending alignment of the middle Rocky Mountains. A buried segment, the Casper Arch, forms a gap in the mountains so that the Wyoming Basin Province, west of the arch, appears to merge with the Great Plains.

Drainage and elevation

The average elevation of the site is 5100 feet above mean sea level (MSL) with the surrounding area having a range of 5000 to 5300 feet elevation. The site is near the Dry Fork Cheyenne River in the upper reach of the Cheyenne River Basin (Figure D.3.2). The Cheyenne River trends eastward into South Dakota draining a basin in Wyoming that includes half of Converse County, most of Niobrara and Weston Counties, and a portion of Campbell County. The northern and west central areas of the basin are drained by the northerly flowing Powder River and the Bell Forche River systems.

The site is about 32 miles (51 km) above the confluence of Dry Fork and Antelope Creek which unite to form the Cheyenne River at that point, and about 20 miles (32 km) below the head of Dry Fork. The Dry Fork basin above the site drains an area of about 130 square miles. The site sub-basin, a tributary to Dry Fork, extends through the site to its head, about 0.75 mile upslope of the site, and converges with the Dry Fork about 1.5 miles downslope.

D.3.2.3 Regional stratigraphy

Stratigraphy of the site region, based on logs of oil and gas wells from the Bear Creek and Dry Creek Fields (Wyoming Geological Assoc., 1981) and from descriptions in the geologic map of Hodsen et al., 1973, is described in Table D.3.1. The stratigraphic column is shown in Figure D.3.3.

Where present, Quaternary surficial deposits consist of Holocene soil with very thin windblown deposits and minor fluvial deposits in the upland area including the site area. Floodplain and contemporary alluvial deposits occur in the major drainages. Typically, Pleistocene sands and gravel deposits are found in deeper channel deposits.

Bedrock underlying the site region and most of the central portion of the Powder River Basin consists of the Wasatch Formation, a fresh-water deposit of lenticular sandstone with interbedded shale and coal. Meandering channel deposits of fine-grained sediment with organic shales are known to persist over many miles and are more predictable than the lenticular shales (Kerr-McGee, 1977). The youngest formation known to have been deposited in this region of the basin, the White River Formation, has been removed by erosion along with the upper part of the Wasatch.

Elsewhere in the Powder River Basin, the Wasatch Formation is known for having thick, persistent coal beds. Near Buffalo, Wyoming, in the western part of the Powder River Basin, the Healy Coal Bed has a thickness of 220 feet (Specht et al., 1979).

The Wasatch Formation is underlain by the Fort Union Formation, which is very similar in appearance. The contact of these two formations is reported on well logs 10 miles south of the site at a depth of 480 feet. However, Sharp and Gibbons (1964) indicate that it may occur at a depth of about 300 feet beneath the site. Both the Wasatch and Fort Union Formations contain coal and uranium deposits which have been mined throughout the Powder River Basin.

Three members of the Fort Union Formation make up the remainder of the Tertiary section: the Tongue River, the Lebo Shale, and the Tullock Members. The nearest oil well logs have reported the Tongue River Member below the Wasatch; however, the Tongue River loses its distinctive characteristics and is described as part of the Lebo Shale Member in the site region. The nearest mapped outcrop of the Fort Union Formation is indicated to be the Lebo Shale Member.

The Cretaceous/Tertiary boundary is marked by igneous intrusives and volcanics primarily in the Black Hills. One notable outcrop there is the volcanic plug of Devils Tower. There are no intrusives within the basin, and the Tertiary eruptions are represented only by ash and bentonite deposits included in the basin sediments.

Cretaceous rocks form the bulk of the sedimentary units of the Powder River Basin with a combined thickness of over 8000 feet. The thicker sand strata form important oil and gas reservoirs throughout the Powder River Basin wherever there are stratigraphic or structural traps. Prominent formations (in economic terms) are the Mesaverde, Frontier, Muddy, and Dakota Sandstone Formations.

Jurassic and Triassic-aged strata account for approximately 1500 feet of basin deposits, while the combined thickness of Paleozoic rocks, from Permian to Cambrian ages, consists of less than 800 feet. Precambrian granitic and metamorphic rocks form the basement complex.

D.3.2.4 Regional structural setting

The Powder River Basin is both a structural and a topographic basin. It is bounded on the northwest by the Bighorn Mountains, on the southwest by the Casper Arch, on the south by the Laramie Range and Hartville Uplift, and on the east by the Black Hills Uplift (Plate D.3.1 and Figure D.3.4). The northern extent is bounded by the Miles City Arch in Montana. The Hartville Uplift, like the Casper Arch, is a buried segment of the middle Rocky Mountains.

The Powder River Basin is strongly asymmetric, with the north-south-trending basement axis about 15 miles from the western edge and 70 to 80 miles from the eastern edge. From the Black Hills, the basement structure slopes fairly uniformly westward toward the basin axis where Mesozoic and Cenozoic rocks have a combined thickness of over 15,000 feet. On the western edge near the Bighorn Mountains, the Paleozoic and Mesozoic strata have been folded in a narrow belt of steeply dipping, locally overturned rocks (Hodson et al., 1973). Gentle folds within the younger rocks of the basin trend parallel to the main basin axis.

Precambrian basement rocks, which occur at depths of over 16,000 feet in the Powder River Basin, are exposed in the surrounding uplift structures. The basement rocks are exposed at elevations of 13,000 feet in the Bighorn Mountains, over 7000 feet in the Laramie Range, and at elevations of 4500 to 5000 feet in the Hartville Uplift and Black Hills. None are exposed in the buried Casper Arch, however.

Structural history

Throughout most of Paleozoic time, Precambrian rocks of the middle Rocky Mountain region were exposed as islands, as evidenced by the thinness or total lack of deposits of that

age (Thornbury, 1967). Faulting and uplift were active processes in the ancestral Rockies during Pennsylvanian and Permian time. Subsequent erosion of these uplifts resulted in peneplanal surfaces on the Precambrian rocks in the Colorado Front Range and in the Laramie Range. Uplift and faulting resumed by the end of the Cretaceous when the coastal margin retreated from the region. At the beginning of the Tertiary, the Powder River Basin, which had accumulated up to 9000 feet of coastal marine sediment, was subsiding at about the same rate as sediment was being deposited. Erosion of older Cretaceous rocks in the uplifted areas provided the source of this sediment (Seeland, 1982; Curry, 1971).

The Laramide Orogeny, which was named for the Laramie Mountains and affected broad areas of the western United States, began as early as Late Cretaceous in many areas. However, there is no evidence for it in the site region until the Paleocene (Seeland, 1982). In the site region, the Laramide Orogeny commenced during deposition of the Tullock Member of the Fort Union Formation, reached its peak during the deposition of the upper Fort Union-lower Wasatch, and ended abruptly before Oligocene time. During Oligocene time, White River volcanic deposits buried the exposed Precambrian core of the Laramie Range (Curry, 1971). Volcanic activity in the Yellowstone area is thought to be the source of the ash deposits and continued through the Miocene into the Pliocene (Budai and Cummings, 1984). After the Oligocene, the uplifted areas subsided causing moderate tilting of the Powder River Basin toward the west.

In the Late Pliocene, regional uplift resumed and has continued to the present, leading to a general rise in elevation of several thousand feet, initiating massive erosion and establishing the modern drainage system (Curry, 1971). Raines and Santos (1980) theorized from their study of lineaments that deflection of the basin synclinal structure occurred after the stream system was established. The alignment of the surface axis of this down warping extends through the site area. Three sets of joints or fractures that occur near the site were mapped by Sharp and Gibbons (1964) and are discussed in detail in Section D.3.4, Site Geology.

Principal structures adjacent to the Powder River Basin

The Laramie Range has the largest exposure of Precambrian igneous and metamorphic rock in the region. The metasedimentary rocks are so strongly metamorphosed and deformed that their age relative to the Laramie batholith and granitic rocks of the central metamorphic complex is not clear (Seeland, 1982). Figure D.3.5 shows the north end of the Laramie Range in thrust fault contact with the Powder River Basin boundary. A similar relationship exists at the Bighorn Mountain fault boundary on the west side of the basin.

The Hartville Uplift connecting the Laramie Range and the Black Hills consists of a pair of asymmetrical anticlines and the intervening syncline (Seeland, 1982). Precambrian metasedimentary rocks exposed here are similar to those found in the Laramie Range. The uplift occurred during the Tertiary and contributed a small quantity of sedimentary material to the Powder River Basin.

Basement rocks in the Bighorn Mountains were exposed during the Eocene (Blackstone, 1949). Strong tilting of conglomerates indicates uplift continued at least until the end of the Eocene. The steep, eastward face of the Bighorn range is a result of westward thrust faulting and is marked by overturned beds and asymmetric folding along the boundary of the basin (Blackstone, 1949). The Bighorn Mountains are considered to be anticlinal structures similar to the Uinta Mountain Arch, Owl Creek Range, and Wind River Range. These features may have resulted from tectonic stresses caused by eastward movement of the Colorado Plateau crustal block toward the Canadian Shield during Laramide time. These uplift and basin structures described above, formed as a result of the north-south compression, were part of the "Wyoming Couple" as described by Sales (1969).

D.3.2.5 Regional geomorphology

The site region encompasses the Powder River Basin, the Casper Arch, and the northern Laramie Mountains (Plate D.3.1). The Spook site lies on the eastern side of the axis of the Powder River Basin and has relatively uncomplicated geology. The land surface is generally flat; locally, it consists of low-relief, rounded hills and ridges forming drainage divides between shallowly incised meandering streams.

Geomorphic processes acting on the site region reflect the semi-arid climate. Dendritic stream patterns indicate that initial drainage was little influenced by structure or variation in rock type. Since the erosion of more than 1000 feet of overlying rock formation, subtle effects on the drainage system were caused by a broad regional subsidence in the basin with the axis of the synclinal development trending north-northwest through the site.

Raines and Santos (1980) have theorized from their study of lineaments that the Cheyenne River System predates this axial subsidence. There is evidence that streams of this system flowed across newly forming sags and became more incised across the downstream or east side of the surface axis. The fracture patterns which reflect this stress tend to result in some minor control over drainage features. There are some minor structural folds with anomalous dips, but the

regional dip is toward the north-northwest and averages about 1.5 degrees. Since the bedding plane contacts are not prominent in the stratigraphy, and where the lithologic types vary substantially over relatively short distances, the control of stratigraphy over the drainage system is erratic and minimal.

There are no slopes in this region which are greater than 15 percent, and none that are susceptible to slope failure (Case and Boyd, 1984c). The soils are described as dark- and light-colored soil on upland plains, terraces, and fans which are usually moist in some parts during the summer (BLM, 1984).

Soils at the site consist of alluvium and eolian sediments. Generally, the soil-bedrock contact suggests an erosional surface on bedrock with stream-cut channels. The soil reflects an origin of eolian deposits reworked by alluvial processes. The soil structure appears as very poorly developed with only one prominent paleosol in a soil cover ranging from three to 30 feet thick over the subbasin. Thin deposits of windblown sand are on some slopes but are more indicative of the disturbed area than is found locally in natural areas. Windblown deposits are common in the North Platte River valley 30 miles south of the site, but show little influence in the rolling upland surface of the site area.

Fluvial processes constitute the main geomorphic controls on the landscape. The alluvial fill within stream channels reflects cycles of deposition and incision during the Quaternary. The regional geomorphic process of stream aggradation-degradation cycles will continue to be the main control on landform development in the Spook area.

It is thought that most of the drainage development occurred as a dendritic pattern across the basin interior in Late Pliocene which was incised by a major uplift that resulted in removal of several hundred feet of younger sediment (Raines and Santos, 1980). The young appearance of the soil indicates it is probably less than 10,000 years old and suggests that the regional relief was stabilized during Pleistocene time.

D.3.4 SITE GEOLOGY

The exposures of bedrock and surface features are shown on Plate D.3.2. Geologic cross sections showing stratigraphy and structure are presented as Figures D.3.6 and D.3.7. The plate and figures were developed from field reconnaissance, borehole logs, aerial photographs, and from previous work of Sharp and Gibbons (1964) and Pioneer Nuclear (1978).

The disposal site is at the bottom of the Spook pit. The sandstone bedrock wall of the pit (80 to 100 feet high) is vertical with no evidence of instability due to fracturing or slope failures. Bedrock is overlain by four to 30 feet of soil and is exposed only in a few places on the surface along the drainage divide and in the lower drainage area as well as in the pit. The Spook pit is at the south side of the small west-to-east drainage basin, extending from the drainage divide to the lowest part of an ephemeral stream basin. The pit presently crosses and intercepts the drainage channels.

The most significant geologic feature of the site is a very shallow synclinal structure whose axis is also the surface axis of the southern Powder River Basin. Sharp and Gibbons (1964) also show fractures associated with this flexure (Figure D.3.7). Although these authors have presented these as faults on the cross section, they have also defined them as crestal tension fractures and surficial breaks with no offset. Since there is no evidence for offset, these features are considered in the RAP as joints.

The features are difficult to recognize in the field; however, they are easily seen in an enlarged site photograph. Their reflection of bedrock joints through the soil cover suggests Holocene activity.

One of these joints northwest of the Spook pit is on a N 45° W trend which, if continued, would intercept the south end of the pit approximately 100 feet from the tailings pit disposal site. However, the joint trace's nearest visible approach to the site is about 800 feet; it appears intermittently along a single straight-line trace about 3000 feet long. The pit wall area in line with the joint trace does not show any evidence of jointing or offset. There is a small, filled channel near a likely interception point; however, its 10-foot-deep soil filling shows no dissection of the visible bedding. There is no apparent disturbance of the rock strata in the pit walls at this or any other point.

The nearest approach of the next closest joint set is about 2600 feet northeast of the disposal site showing the same N 45° W trend, but appearing as a 300-foot-wide zone of parallel lineations. This set of joints appears to terminate at the subbasin drainage 3300 feet due east of the site where bedrock outcrop shows medium to closely-spaced jointing. A third joint set lies further to the northeast.

The joint pattern of the site appears to be part of a broader pattern associated with the synclinal trend. Raines and Santos (1980) studied a regional pattern of fractures based on computer enhanced satellite photographs. The alignment of the overall pattern allowed them to plot the surface axis through this region. Figure D.3.8 shows the lineaments of Raines and Santos plotted relative to the syncline surface axis. The three joint sets closest to the site are highlighted.

The site area is underlain by the Eocene Wasatch Formation, a buff-colored arkosic sandstone with lenticular deposits of conglomerate and siltstone, interbedded with carbonaceous shale and coal (DeBruin, 1985). Channel fillings of shale, mudstone, and coarse conglomeratic sand are exposed in the pit walls. Petrified wood "log jams" are exposed in the small drifts off the pit area. The attitude of bedding within the sandstone unit is distorted by irregular microstructures near channel fillings which result from differential consolidation of the fine-grained sediments and also by cross bedding and cut-and-fill depositional structures. The best indicator of the overall general attitude of bedding is the upper contact of a thick shale-siltstone unit that underlies the pit. This 75-foot-thick shale unit was encountered in test borings beneath the irregularly surfaced pit bottom (elevation 5010 to 5030 feet), and apparently forms an aquiclude at this horizon. This unit has been mapped in a cross section by Pioneer Nuclear, Inc. as continuous to the north with a slight northerly dip. The unconfined water table will be 30 feet below the tailings pile.

Because of the moderate thickness of the Wasatch Formation and the slight regional dip of the bedding, the Wasatch is exposed for many miles north and south of the site. The nearest outcrop of the underlying Paleocene-aged Fort Union Formation is about four to five miles east of the site.

D.3.5 MINERAL AND OTHER RESOURCES

Information on the history of mineral resource development at the Spook site was obtained from published articles of the Wyoming Geological Association Guidebook (1976); the Geological Survey of Wyoming (Lane et al., 1972) and Environmental Reports and Engineering Assessments compiled by the U.S. Nuclear Regulatory Commission (NRC) and the U.S. Department of Energy (DOE).

Known economic mineral deposits in the Spook site region include uranium ores, coal, oil and gas, and other nonfuel metallic mineral resources. Of these, only uranium has been exploited in the site area.

D.3.6 SEISMOTECTONIC SETTING

The site lies in a relatively stable basin within the Middle Rocky Mountains structural province. The surrounding structures are Laramide uplifts and basins. The structures, faults, and earthquake epicenters for the site region are shown on Plate D.3.1. In this region, the Laramide Orogeny did not begin until the Paleocene and ended abruptly before Oligocene time. Vertical movement amounted to 10,000 feet of uplift in the Laramie Range and 14,000 feet of subsidence in the Powder River Basin (Love, 1960). The Laramide Orogeny resulted from eastward movement of the Colorado Plateau subplate resulting in a north-south compression in the Central Wyoming region. Uplift was accompanied by eastward thrust faulting at the uplift basin boundaries and synclinal down warping of the basins. Faulting continues to the present in the uplifts while the basins are typically stable (Sales, 1969). Broad, gentle synclinal folding has occurred in the Powder River Basin and other central Wyoming basins during the Pleistocene (Raines and Santos, 1980; Eaton, 1979; Love, 1960).

The seismotectonic source region, as defined by Algermissen et al. (1982), is used for the study. The authors have assigned a separate seismotectonic province to the Powder River Basin, which is bordered on the west and south by the middle Rocky Mountains source region and on the east by the Black Hills Uplift Province. Smith and Sbar (1974) show this basin is outside the Western United States Seismic Province and separate from the Middle Rocky Mountain Province.

Case (1986b) has mapped suspected active faults in Wyoming. Plate D.3.1 shows these normal faults trending east-west in the area west of the Casper Arch and northeast-southwest-trending in the Hartville Uplift.

Gable and Hatton (1980) indicate that the site region has experienced an average rate of movement of less than one meter per 10,000 years over the past 10 million years, a lower rate than most regions in the Rocky Mountains. This is based partly on displacement of faults in the Hartville Uplift south of the site region which has been on the order of 500 to 1000 meters. Also, approximately 1000 meters of displacement has occurred in the Sweetwater Arch of the Wyoming Basin west of the site region. Some of this movement may have occurred within the last two million years.

The largest recorded earthquakes for the Powder River Basin occurred in 1967 and 1984, with magnitudes of (M_b) 4.5 to 5.1, respectively. These were in the central part of the basin at a distance of 57 km to 120 km north of the site (NGDC/NOAA, 1986). The largest recorded earthquakes in the surrounding uplift structures includes an $M_L=5.5$ that occurred in 1984 on the west side of the Laramie Range at a distance of 32 km from the Spook site, and the 1894 earthquake near Casper, Wyoming, of $MMI=VIII$ (or $M_L=5.7$) 66 km from the site. The most seismically active areas are in the north end of the Laramie Range; the Casper Arch, near Casper, Wyoming; and the frontal fault of the Bighorn Mountains. Of these locations, only the

Uranium

Uranium deposits in the site region occur in the upper sandstone units of the Paleocene Fort Union and Eocene Wasatch Formations. Smaller, less extensive deposits occur in pre-Tertiary rocks. Uranium in the Wasatch Formation has been mined extensively and explored on a north-south trend for miles on either side of the site. Exploration and development activity which surged in the mid-sixties reached a peak in 1969, and maintained a modest level through 1975 (Glass, 1976). This level of activity has gradually declined so that at present, only one of the open pit mines throughout the Powder River Basin is producing by in-situ processes (Figure D.3.9). This last open pit mine is the Highland Mine and is 12 miles southeast of the site. Bear Creek Mine, just three miles northeast of the Spook site, has recently proposed to conduct heap-leaching operations (GSW, 1987).

Kerr-McGee has delineated an ore body adjacent to the Spook site which extends beneath the Hardy property to the north. The possible impacts resulting from encroachment from operations bordering the Spook site are addressed in Section D.3.7.2.

Coal

The oldest coal-bearing strata identified in the basin are in the Mesaverde Group, Fox Hills, and Lance Formations of Late Cretaceous age. The aerial extent of the Cretaceous sediments define the coal-bearing region of the basin; however, the thickest and most important coal beds are in the Fort Union and Wasatch Formations of Tertiary age. Individual coal beds range in thickness from 50 to 100 feet (15 to 30 m) and realistic estimates of quantities are reported to be several hundred billion tons (NRC, 1977).

Coal is currently being produced from open-pit mines in the Spook site region, the closest of which is nine miles (5.6 km) northwest of the site in Sections 10, and 15, R.73W, T.38N (Figure 3.9). The coal deposits, which were discovered in 1972, range from one to 2.5 feet (0.3 to 0.7 m) in thickness at depths of 53 to 293 feet (16 to 89 m) (NRC, 1977). During characterization of the Spook site by the DOE, thin (0.5- to one-foot) coal beds were encountered at depths of 110 to 120 feet (33.5 to 36.5 m). These discontinuous coal beds which were encountered below the water table are most likely not the "H coal of Wegermann" described by Sharp and Gibbons (1964) as extending beneath the Spook site (Figure D.3.7). Glass (1976) has not included the Spook site within a potentially strippable coal resource area. It appears that the small amount of coal present is of no economic value.

Oil and gas

The history of oil and gas development in Converse County dates back to the late 1800s (Lane et al., 1972). To date, as many as 30 separate oil fields have been developed and total production has exceeded 150 million barrels of oil. Most of the oil and gas in the Powder River Basin is contained in clastic sandstones and siltstones of Cretaceous age (Lane et al., 1972). The most important producing fields in the region are the Big Muddy, South Glenrock, South Cole Creek, and Cole Creek fields, which have accounted for 90 percent of the total production in Wyoming (Lane et al., 1972).

Figure D.3.10 shows the Spook site relative to the local oil and gas structure. The fields along the western margin of the basin where dips are steeper, are predominantly associated with closure on structural traps. Oil traps on the eastern margin, where dips are less, are predominantly stratigraphic in nature. Occurrences of oil and gas are aligned roughly parallel with the northwest-southeast trending basin axis. The Brush Creek Field is the nearest producing field relative to the Spook site, 3.5 miles (5.6 km) to the southeast. Potential oil and gas resources have not been discovered in the site area to date.

Other mineral resources

Numerous scattered deposits of metallic mineral resources including copper, tungsten, chromium, and iron occur in the Laramie Mountains 100 miles to the south of the site. These deposits are primary in nature and are associated with granitic igneous and mafic metasedimentary rocks of Precambrian age. Besides the resources discussed above, there are no other known resources in the Spook site area (Lane et al., 1972).

Casper activity is considered within the 65-km site region (NGDC/NOAA, 1986). The closest epicenter to the site is an $M_L=3.0$ (MMI=III) at a distance of 35 km southwest of the site.

The seismic activity in the Powder River Basin appears to lie primarily near the boundary between the basin and the surrounding uplift structures. Hidden frontal faults that have been identified near the Bighorn Mountains are also associated with seismic activity (Hinrichs et al., 1982). Alignments of epicenters near the basin boundary at Casper suggest that hidden boundary faults are also the source of the recorded seismicity at this location.

The only faults with surface expression which have been mapped as suspected active faults are in the Hartville Arch south-southeast of the site, and in the Wyoming Basin region west of the Casper Arch (Case, 1986b). None of these are within the 65-km (40-mile) radius site region. The hidden faults which bound the Powder River Basin and the northernmost mapped active faults in the Hartville Uplift are expected to account for most of the felt motion at the site.

Studies for dam sites in Wyoming by the U.S. Bureau of Reclamation have assigned magnitudes of $M_s=6.5$ to 7.0 for the Wind River Fault in the Wyoming Basin and random Maximum Credible Earthquake of $M_L=6.5$ for the Middle Rocky Mountain source. Both of these features are located at sufficient distance from the site to preclude significant impact from associated seismicity.

Review of seismic data for the Powder River Basin

An epicentral compilation for use in derivation of seismic parameters for the site region was obtained for this study from the NGDC/NOAA (1986) earthquake data file. The complete listing is presented in Addendum D1 of Appendix D. The compilation search was conducted for a radius of 320 km generally between latitudes 102° to 109° West and between longitudes 40° to 46° North, covering western Wyoming and portions of South Dakota, Nebraska, Colorado, and Montana.

Tables D.3.2 and D.3.3 were compiled from this list. Table D.3.2 lists instrumentally-located earthquakes (since 1963) of magnitude 4.0 or greater. Table D.3.3 lists historical earthquakes of Intensity III or greater prior to 1963.

The nearest epicenter to the site is $M_L=3.0$ at a 35-km distance positioned southwest of the site near the boundary of the basin. The nearest macro event is an $M_D=4.8$ occurring north of the site within the basin at a distance of 57 km (35 miles). Only four epicenters have been located within the 65-km (40-mile) site radius, one of which may be a duplicate. Beyond the 65-km (40-mile) site region and within the Powder River Basin proper, there are only four other events in the magnitude range 4.3 to 5.1. None of these events appear to be associated with a specific known fault.

The largest event within the 200-km (124-mile) radius is the historical 1897 event of $MMI=VII$ (approximately equal to $M_L=5.7$) in the Casper Arch at a distance of 66 km (41 miles). The largest instrumentally-recorded event (since 1963) within 200 km was an $M_L=5.5$ event in 1994 at a distance of 92 km from the site in the Laramie Range south of the site.

Areas in the region surrounding the site that have been associated with recurring seismicity are: (1) the north end of the Laramie Range, centered 80 to 90 km due south of the site; (2) the Hanna Basin, about 175 km southwest of the site; and (3) the eastern Black Hills of South Dakota, 160 to 220 km northeast of the site. The greatest earthquake felt in the site region is the 1959 magnitude 7.7 earthquake at Hebgen Lake, Montana in the Yellowstone Park region, a distance of about 300 miles, and a subsequent aftershock of magnitude 6.4 in 1975. The estimated acceleration from this event, felt at the site, would be $<0.01g$.

Fault description

All known mapped faults within the site region and structures are shown in Plate D.3.1. Based on patterns of recurring seismicity and occasional mapped faults dissecting Tertiary sediments, it is apparent that a buried system of boundary faults separates the Powder River Basin from the surrounding uplifted structures of the Middle Rocky Mountains (Big Horn Mountains, Casper Arch, and Laramie Range) and the Black Hills and Hartville Uplifts. Faults mapped at the surface along the Rocky Mountain's front occur either at the contact of Paleozoic rocks along the Powder River boundary or between this boundary and the basement axis of the basin, a zone about 15 miles wide.

This southern boundary of the basin is marked by a zone of thrust faults along the north side of the Laramie Range. These faults translate into normal faults with increasing distance away from the outcrop of Paleozoic and Precambrian rocks of the uplifted structure. One of these faults is depicted in the cross section shown on Figure D.3.5. An inferred buried fault is mapped along the trace of the Basin boundary extending parallel to the Hartville Uplift (Hodson et al., 1973) and indicates that a similar extension could be inferred for the southern Black Hills boundary.

Based on historic seismic data, recent DOE field reconnaissance, and the work of Case (1986b), five fault groups have been identified. The crustal lineations identified by Raines and Santos (1980) are considered lineaments associated with the synclinal flexure which passes under the site. The five fault groups are shown on Plate D.3.1 and are described as follows:

Fault Group 1: Kaycee, Wyoming, Fault group. This group of three parallel faults lies along the boundary between the Casper Arch and the Powder River Basin. The longest mapped segment is seven miles long (Hodson et al., 1973) and is approximately 60 miles from the site. The epicenter of a 1965 earthquake lies in line with this trend eight miles southeast of the mapped fault. This is considered to be a capable fault based on the apparent associated seismicity although there are no reports of offset of Quaternary deposits. Blackstone (1949) describes the faults as a transverse zone that separates the middle and southern segments of the Bighorn Mountains and enters the Powder River Basin. Exposures of Precambrian rocks are limited south of this zone.

Fault Group 2: Edgerton, Wyoming, Fault Groups. Two groups of 25 east-west-trending faults are approximately centered on Edgerton, Wyoming. These faults are short segments at right angles to the boundary of the Powder River Basin. The longest segment is mapped by Hodson et al. (1973) as being seven miles long at a distance of 35 miles from the site. No historical or instrumentally-located earthquake epicenters are thought to have been directly associated with this group and there are no reports of offsets of Quaternary deposits. The faults are suspect, however, because they are positioned on the Casper Arch-Powder River Basin boundary. On this basis, the faults are considered capable.

Fault Group 3: Casper Vicinity Faults. The only mapped faults in this area are the east-west frontal thrust faults of the Laramie Range. However, the epicenters of several earthquakes are well north of these faults between the basin axis and the broad bulge of the basin boundary. For the purpose of this report, it is assumed that a buried system of capable faults runs parallel to the basin axis trending north-northwest, with segment lengths not exceeding 12 miles. The nearest approach to the site is 22 miles.

Fault Group 4: Deer Creek Fault. This fault system consists of a system of east-west-trending thrust faults that mark the boundary of the exposed Precambrian rocks of the north end of the Laramie Range and coincide with the alignment of the southern boundary of the Powder River Basin. None of the segments dissect Quaternary alluvium. The inferred trace of the thrust fault is mapped as a normal fault in the vicinity of Douglas, Morton, and near Lance Creek, where the fault turns northerly with the basin boundary. This system is considered to be noncapable. Nearby seismic activity is considered here to be attributed to Fault Group 3.

Fault Group 5: Lance Creek Fault Group. Lying near the Powder River Basin boundary, this group of three normal faults appears to be a transition between the northeast-trending Hartville Uplift and the north-trending Black Hills Uplift. There have been only two earthquakes recorded near the trend of the two short easterly faults, both in 1964 with a magnitude of 4.5. The closest approach of these faults to the site is about 56 miles. The maximum segment length of this fault group is 12 miles.

Another fault which may be considered part of this group, is a 38-mile-long, north-northeast-trending fault listed by Case (1986b) as a "suspected active fault." This is the nearest fault to the site, at a distance of 95 km, so designated by Case (1986b). The trend of the fault is diagonal to the trend of the Hartville Uplift. Earthquake epicenters have not been directly associated with this fault but are located in the vicinity.

The assessment of the maximum earthquake (ME) potential and peak horizontal acceleration resulting from the ME of each designated capable fault is shown in Table D.3.4. This table indicates the highest expected PHA is 0.16g, originating from the Casper vicinity faults.

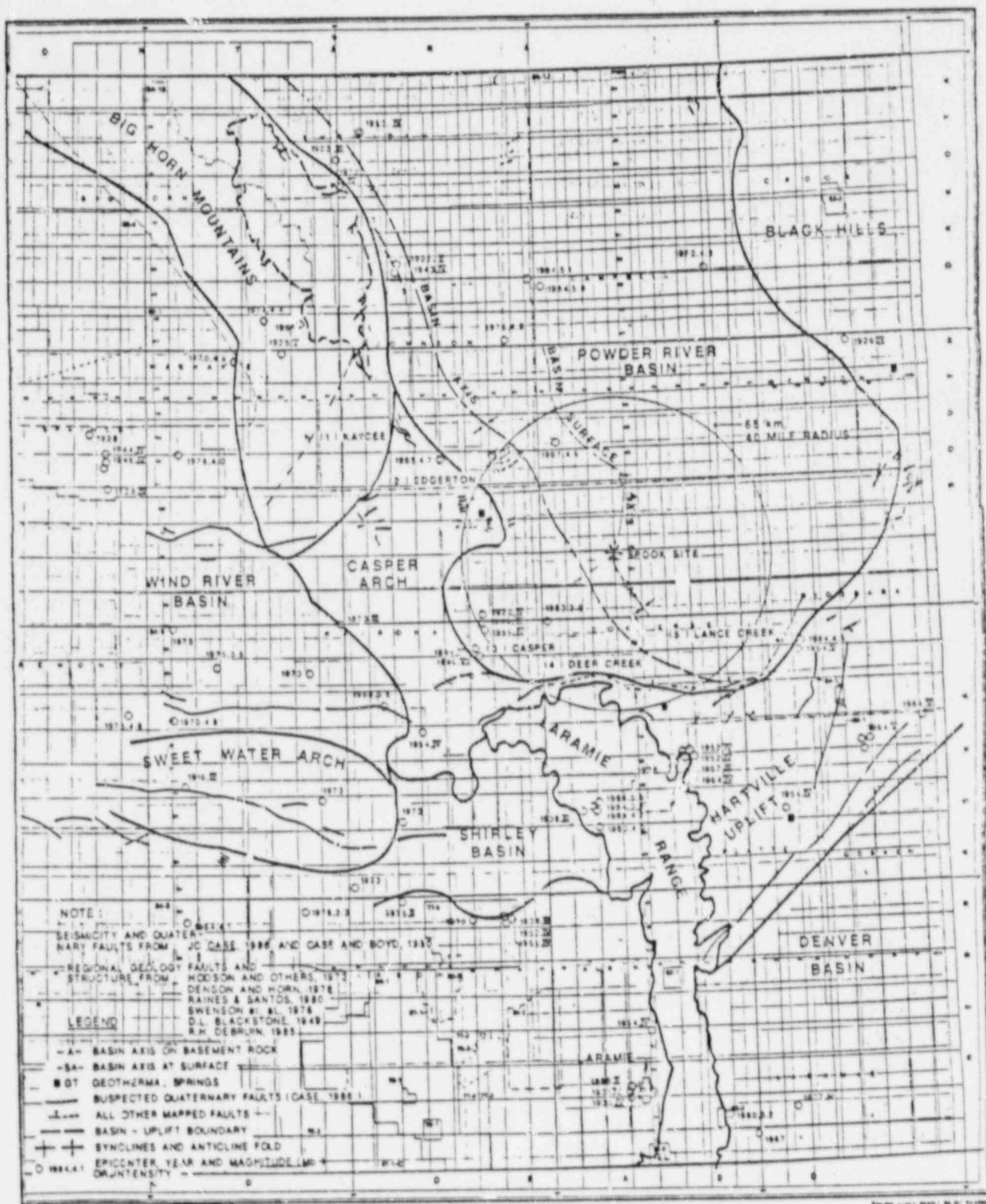
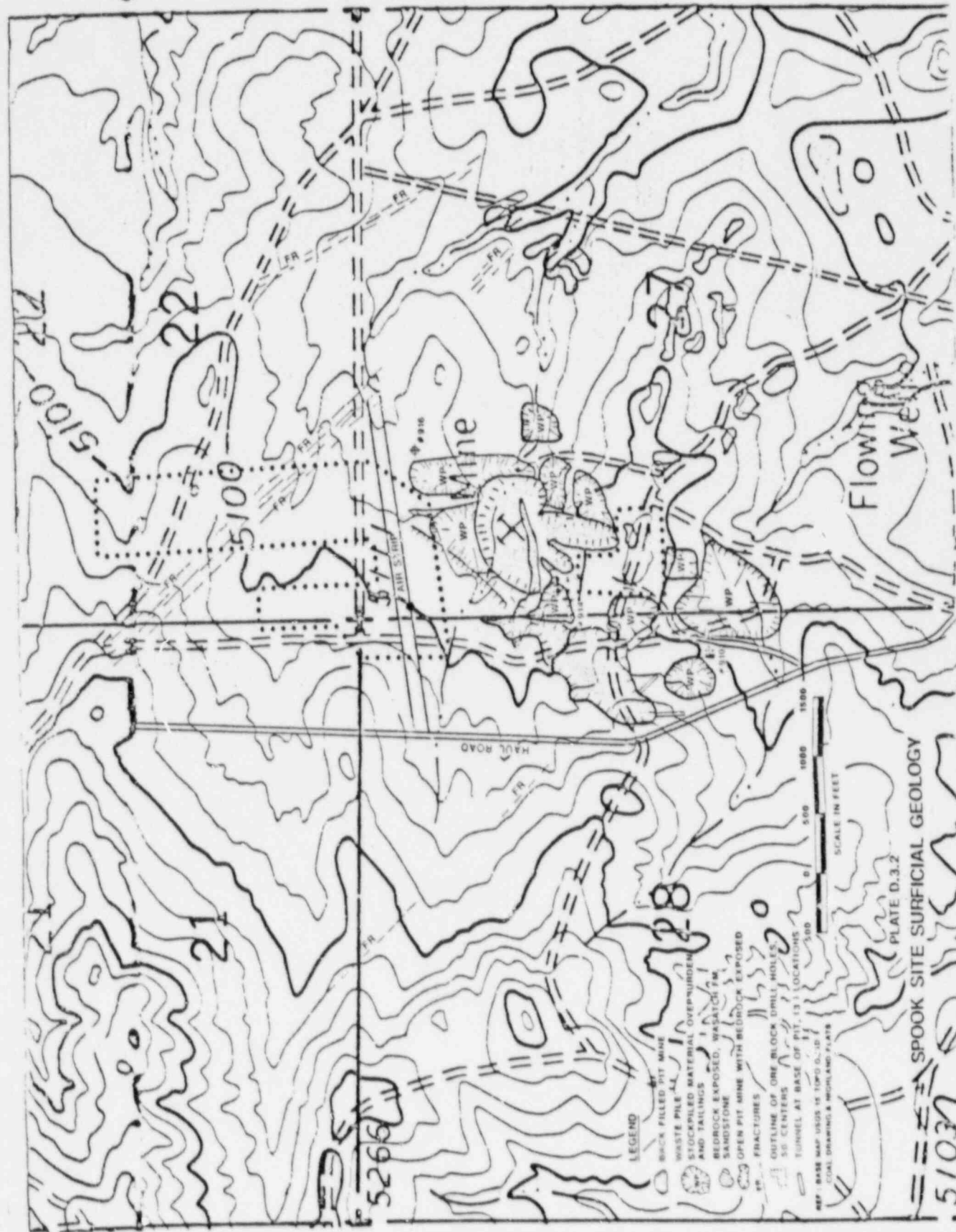


PLATE D.3.1
 SEISMICITY AND QUATERNARY FAULT MAP
 FOR SPOOK SITE REGION

43° 15'

738N



LEGEND

- BACK FILLED PIT MINE
- WASTE PILE
- STOCKPILED MATERIAL OVERBURDEN AND TAILINGS
- BEDROCK EXPOSED, WASATCH FM SANDSTONE
- OPEN PIT MINE WITH BEDROCK EXPOSED
- FRANCHISES
- OUTLINE OF ONE BLOCK DRILL HOLES
- 50 CENTERS
- TUNNEL AT BASE OF PIT, 13 LOCATIONS
- REF. BASE MAP USGS 15 TOPO G.D. 1960
- COAL DRAWING & MIDLAND PLATS

SCALE IN FEET



PLATE D.3.2

SPOOK SITE SURFICIAL GEOLOGY

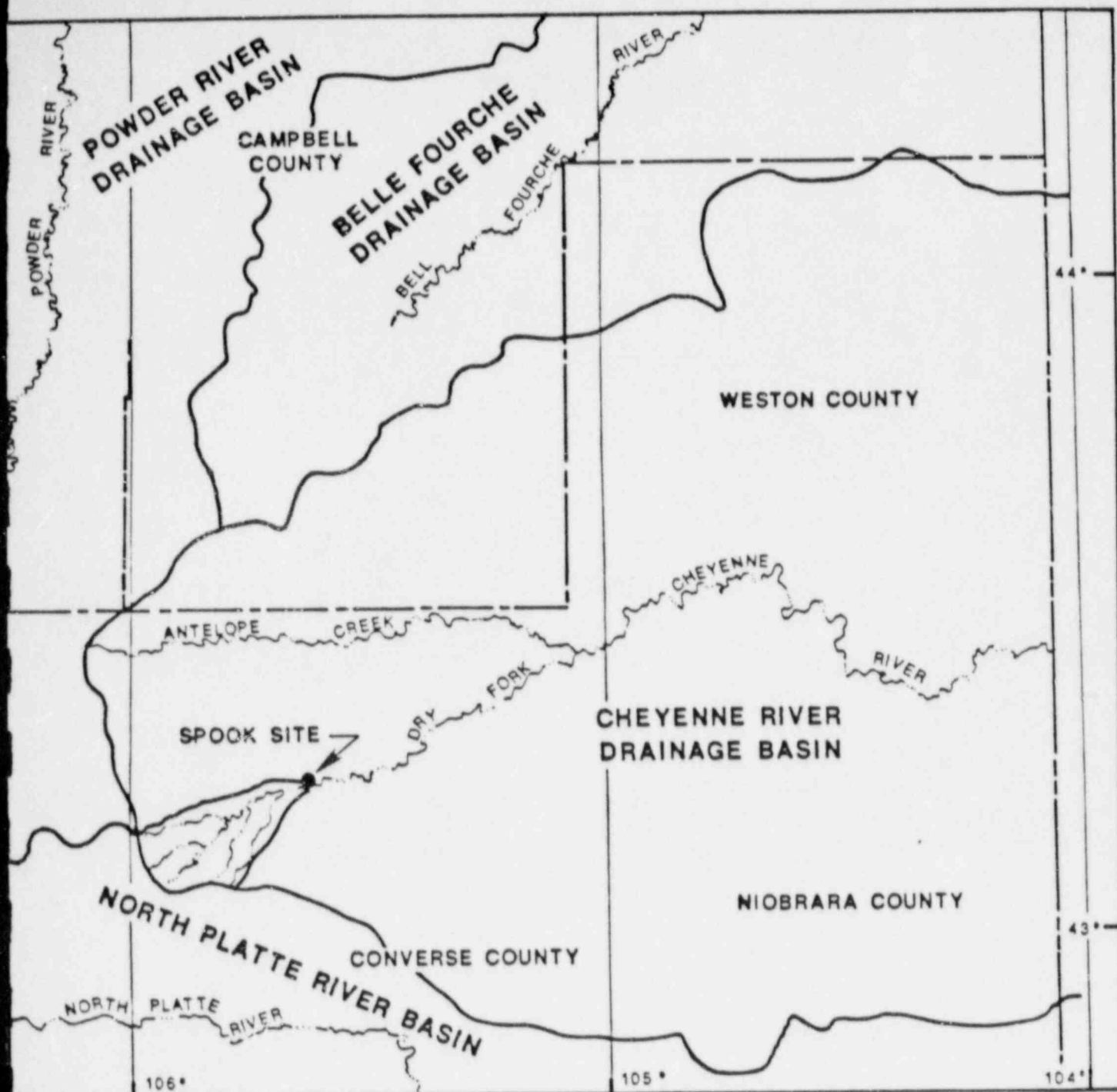
5103



FROM: C.B. HUNT, 1967

0 50 100 200 MILES

FIGURE D.3.1
PHYSIOGRAPHIC MAP OF SPOOK SITE REGION (GREAT PLAINS PROVINCE)
SPOOK SITE - CONVERSE COUNTY, WYOMING



NOTE: DETAIL DRAINAGE SHOWN ONLY
FOR SUBBASIN ABOVE THE SITE.

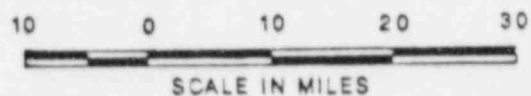


FIGURE D.3.2
DRAINAGE SYSTEMS IN THE SPOOK SITE REGION
CONVERSE COUNTY, WYOMING

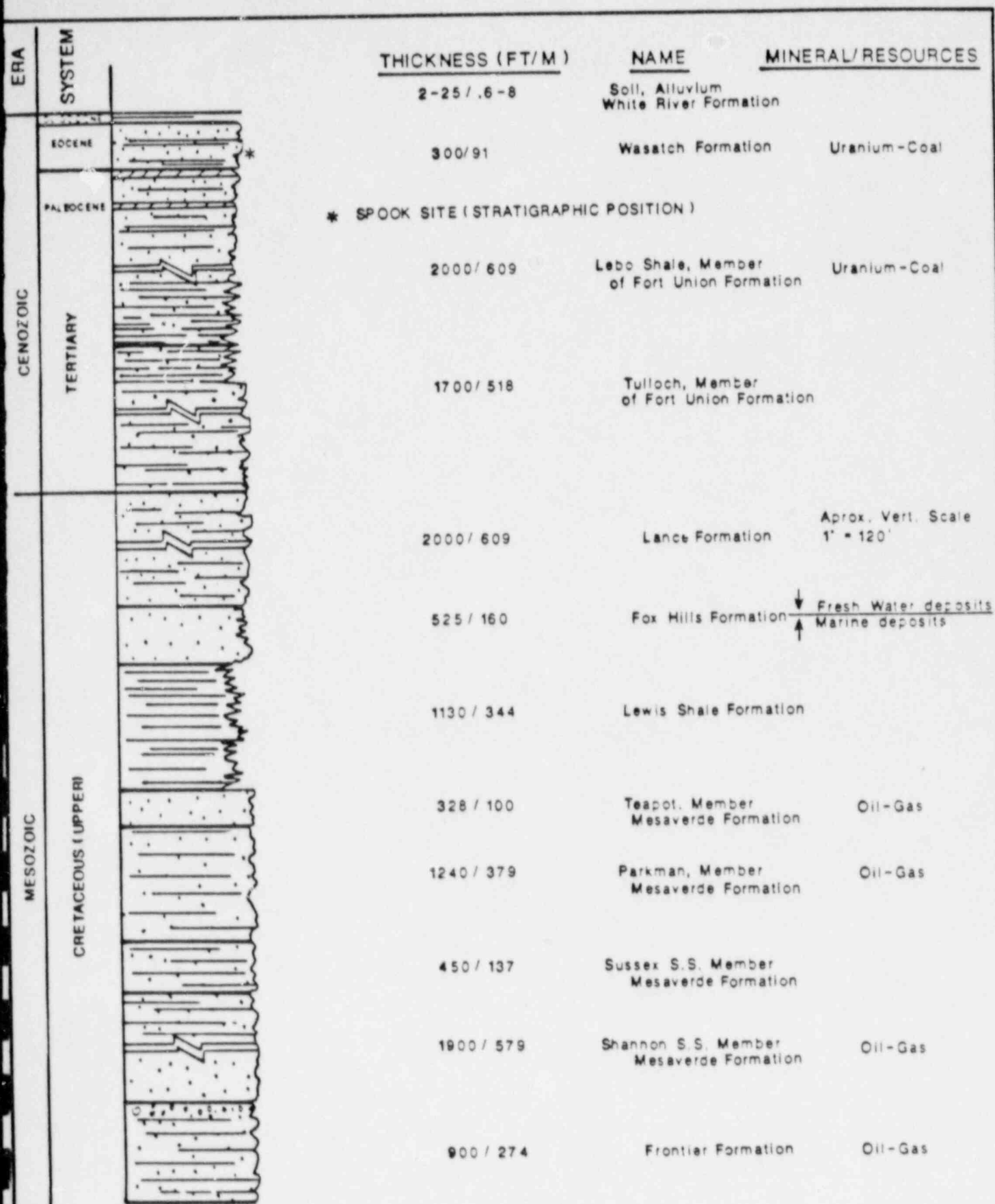
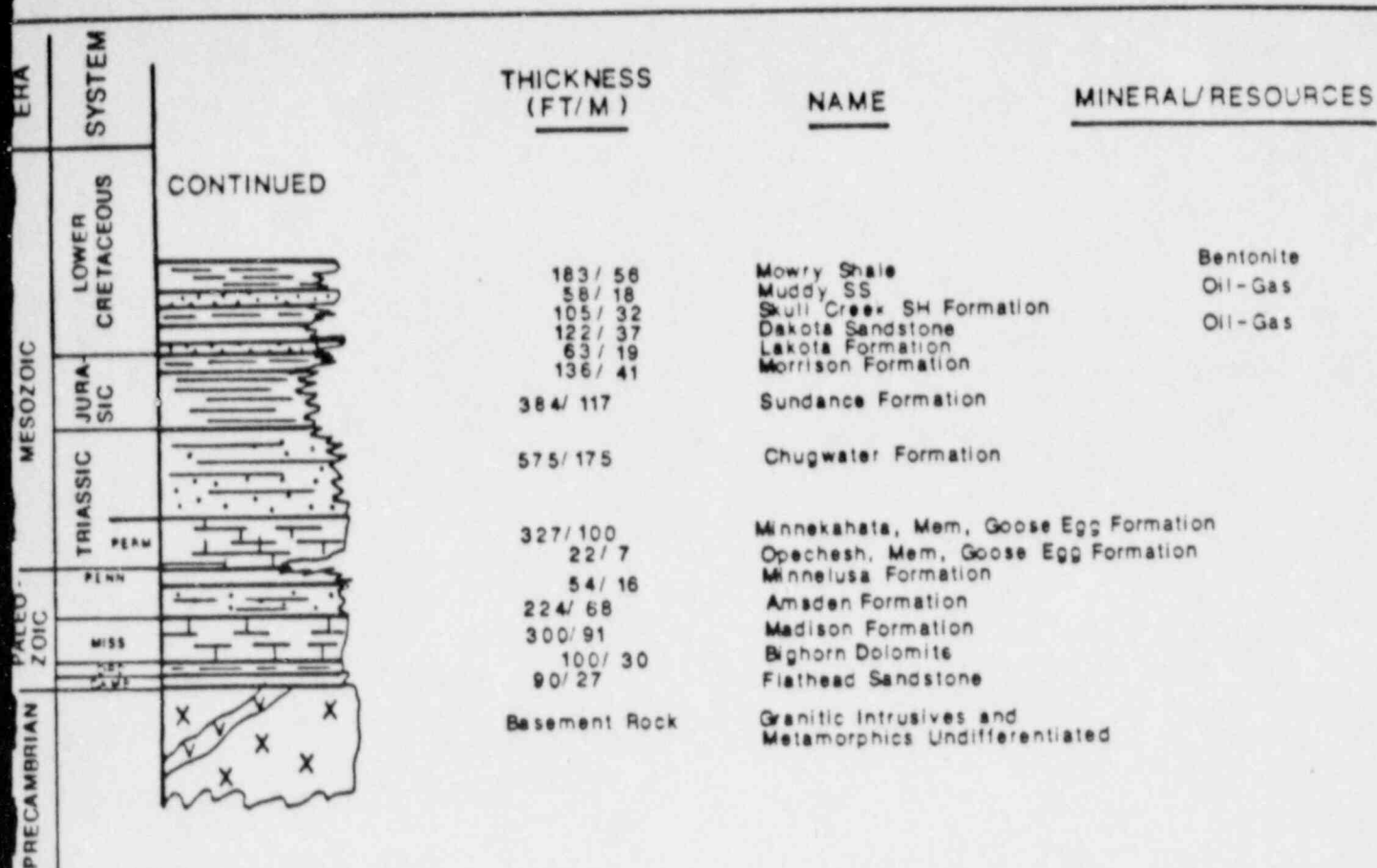


FIGURE D.3.3
STRATIGRAPHIC COLUMN OF
SPOOK SITE REGION
CONVERSE COUNTY, WYOMING



REFERENCE:

LOCAL THICKNESS OF TERTIARY AND UPPER CRETACEOUS ROCK FROM CURRY (1971), FROM SELECTED LOGS OF GAS AND OIL WELLS LOCATION 6 TO 12 MILES FROM SITE. THICKNESS OF FORMATIONS BELOW TEAPOT MEMBER FROM WYOMING GEOL. ASSOC. (1981) POWDER RIVER BASIN SYMPOSIUM VOL. 1 AND 2. BASED ON OIL AND GAS WELL LOGS FROM: BEAR CREEK FIELD AND DRY CREEK FIELD LOCATION 6 AND 12 MILES FROM SITE. ROCK FORMATION DESCRIPTIONS FROM: HODSON, et al., (1973); AND SEELAND (1982)

FIGURE D.3.3
STRATIGRAPHIC COLUMN OF
SPOOK SITE REGION
CONVERSE COUNTY, WYOMING (CONC.)

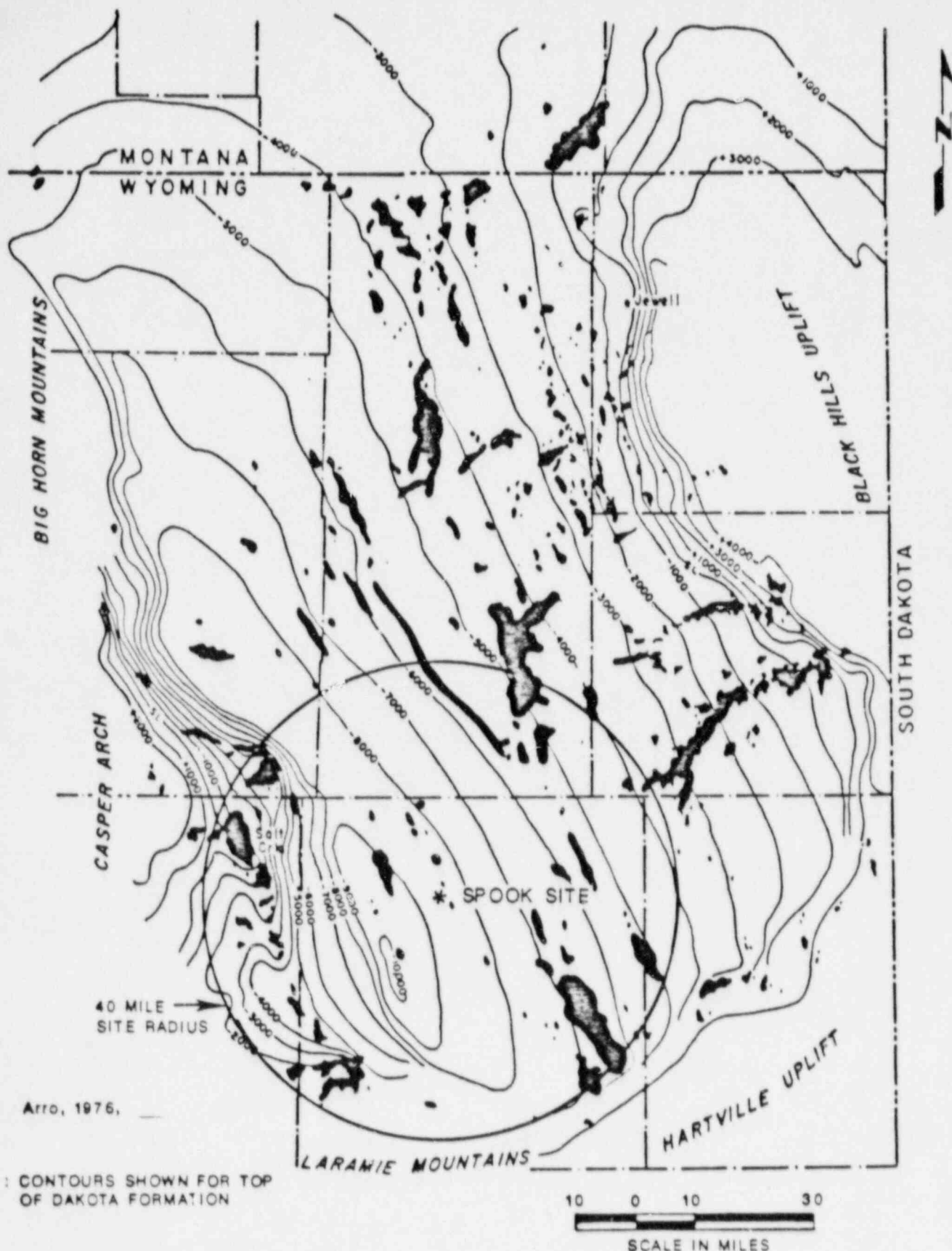


FIGURE D.3.4
STRUCTURAL CONTOUR MAP OF POWDER RIVER BASIN SHOWING
SPOOK SITE LOCATION - CONVERSE COUNTY, WYOMING

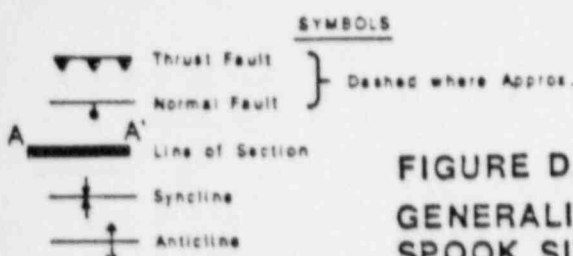
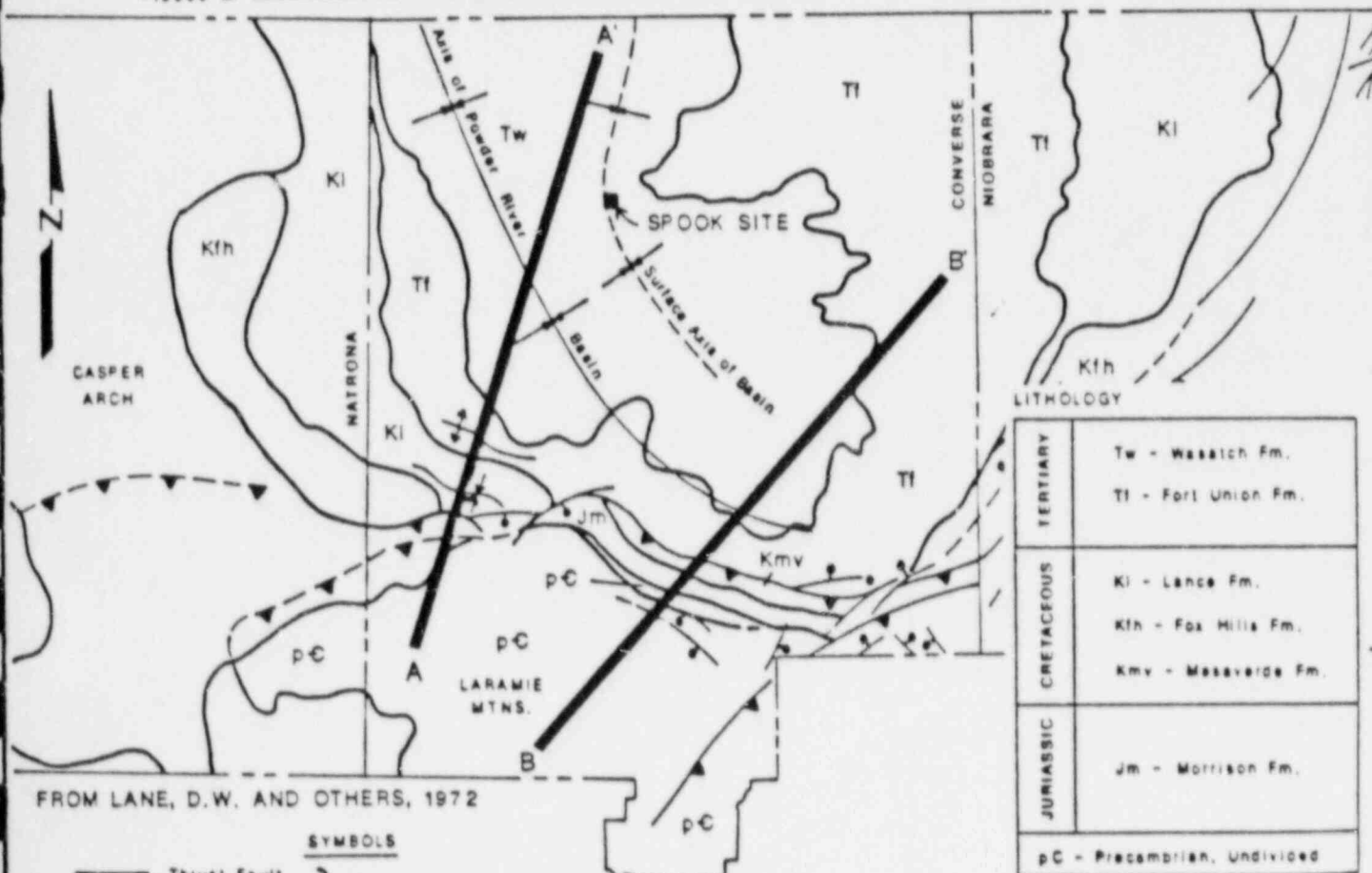
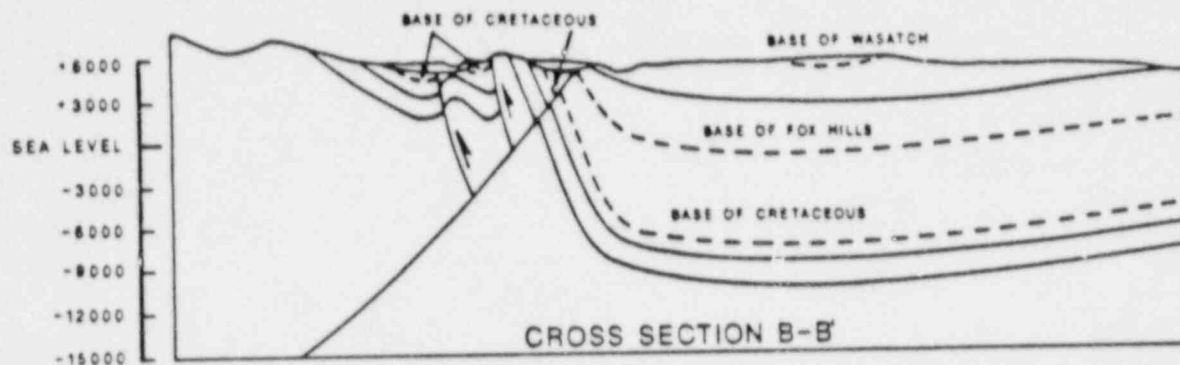
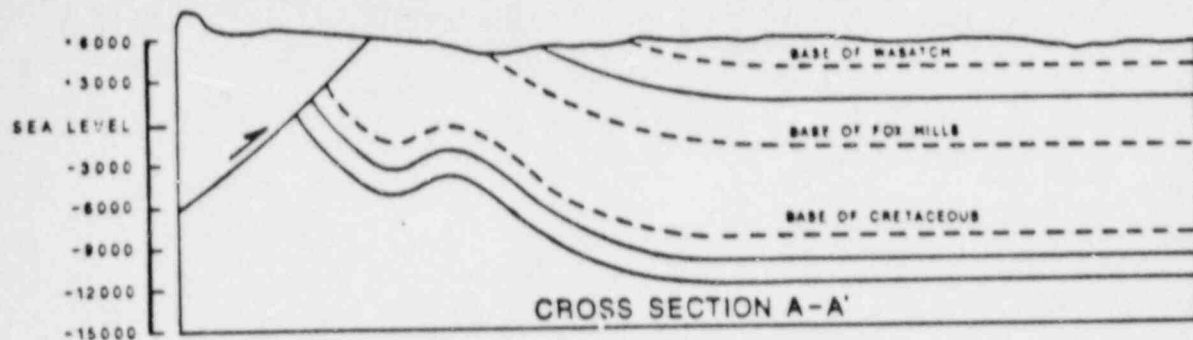


FIGURE D.3.5
GENERALIZED GEOLOGIC MAP AND CROSS SECTIONS
SPOOK SITE - CONVERSE COUNTY, WYOMING

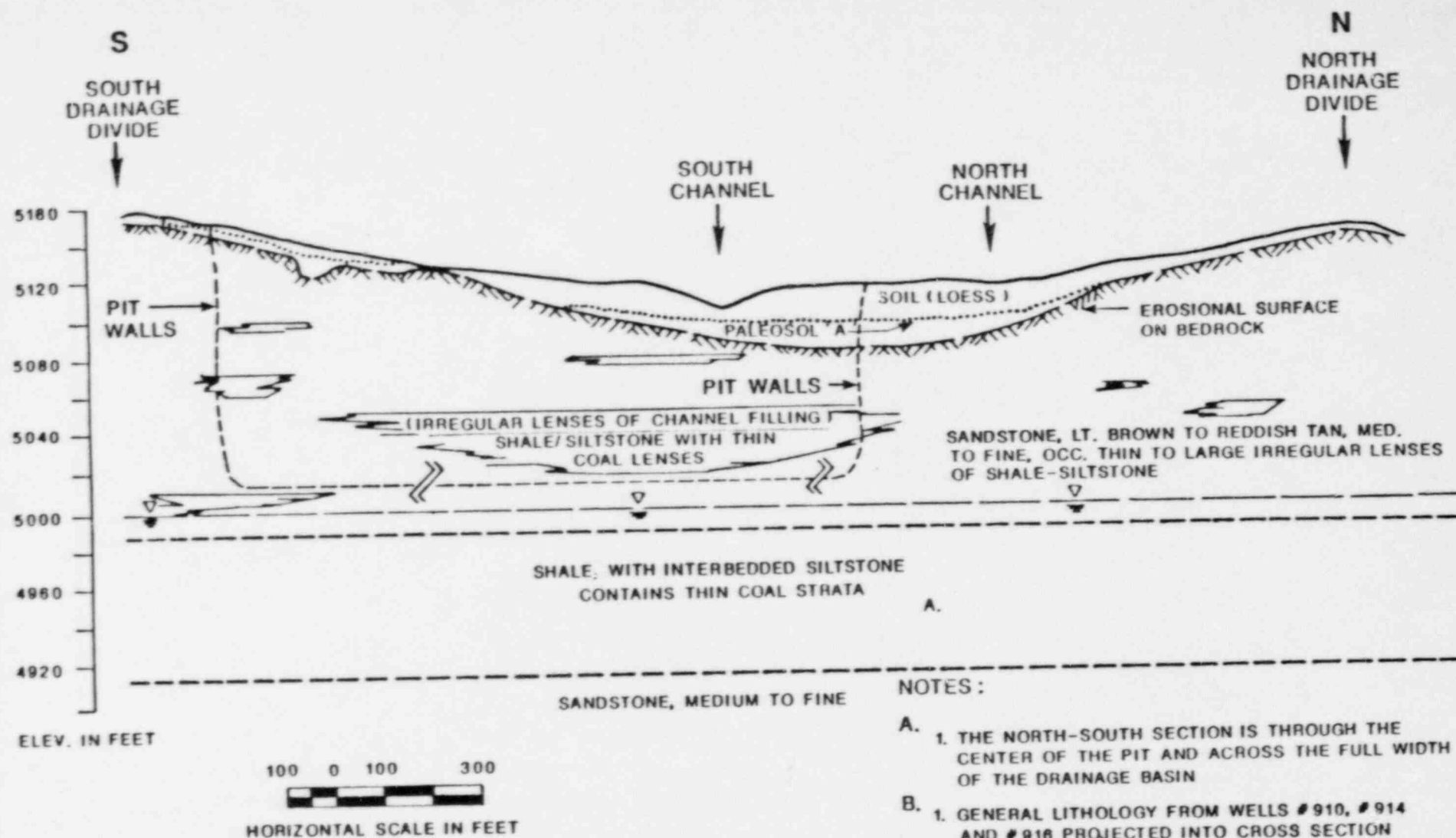


FIGURE D.3.6
GENERALIZED GEOLOGIC CROSS SECTION
SPOOK SITE - CONVERSE COUNTY, WYOMING

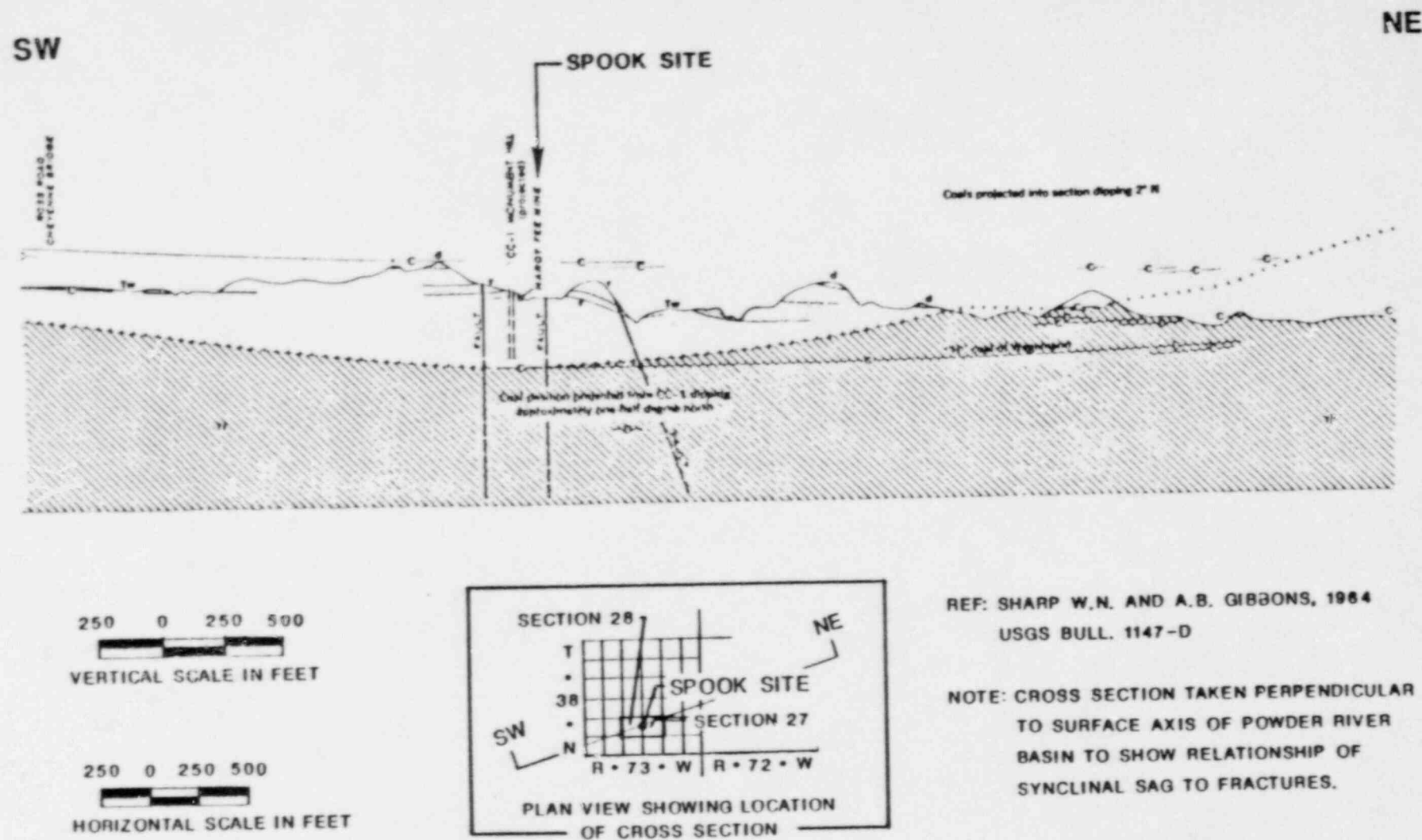
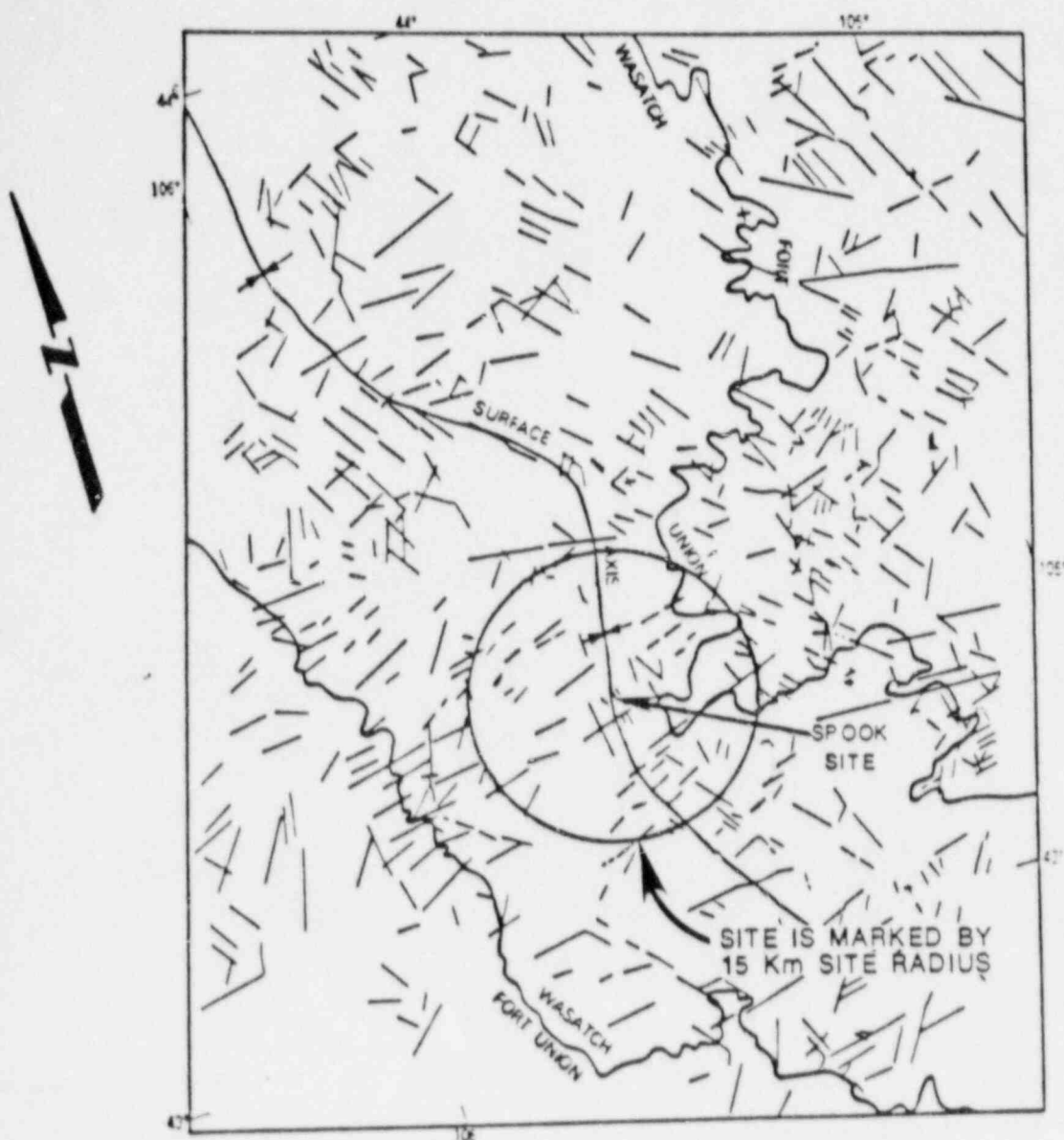


FIGURE D.3.7

CROSS SECTION THROUGH SITE SHOWING LOCAL STRUCTURE AND COAL BEDS

SPOOK SITE - CONVERSE COUNTY, WYOMING



FROM RAINES AND SANTOS 1980

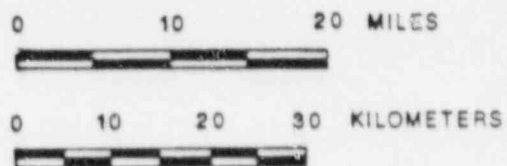
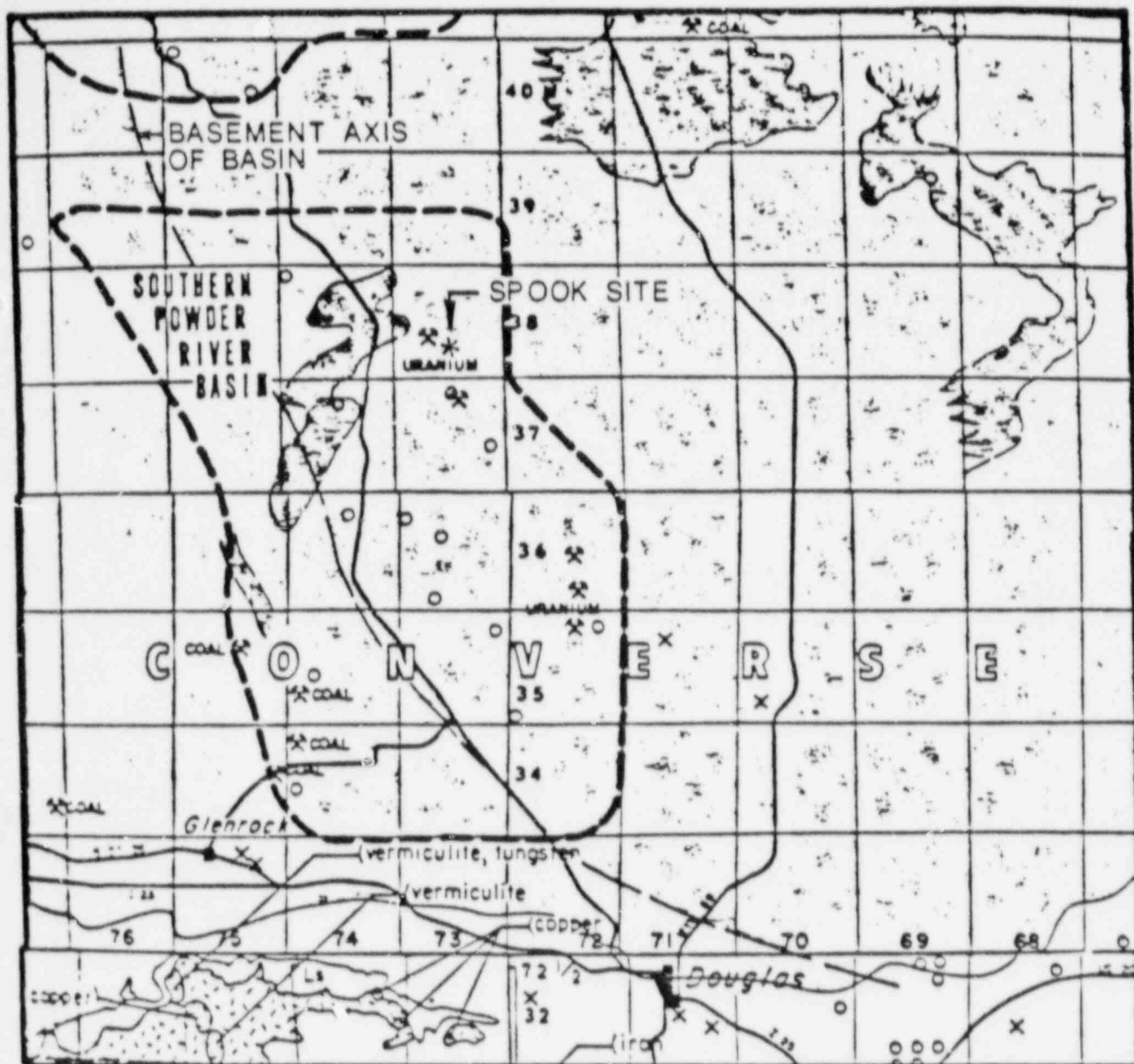


FIGURE D.3.8
LINEAMENT MAP SHOWING FRACTURE PATTERN ASSOCIATED
WITH SURFACE AXIS OF POWDER RIVER BASIN
SPOOK SITE - CONVERSE COUNTY, WYOMING



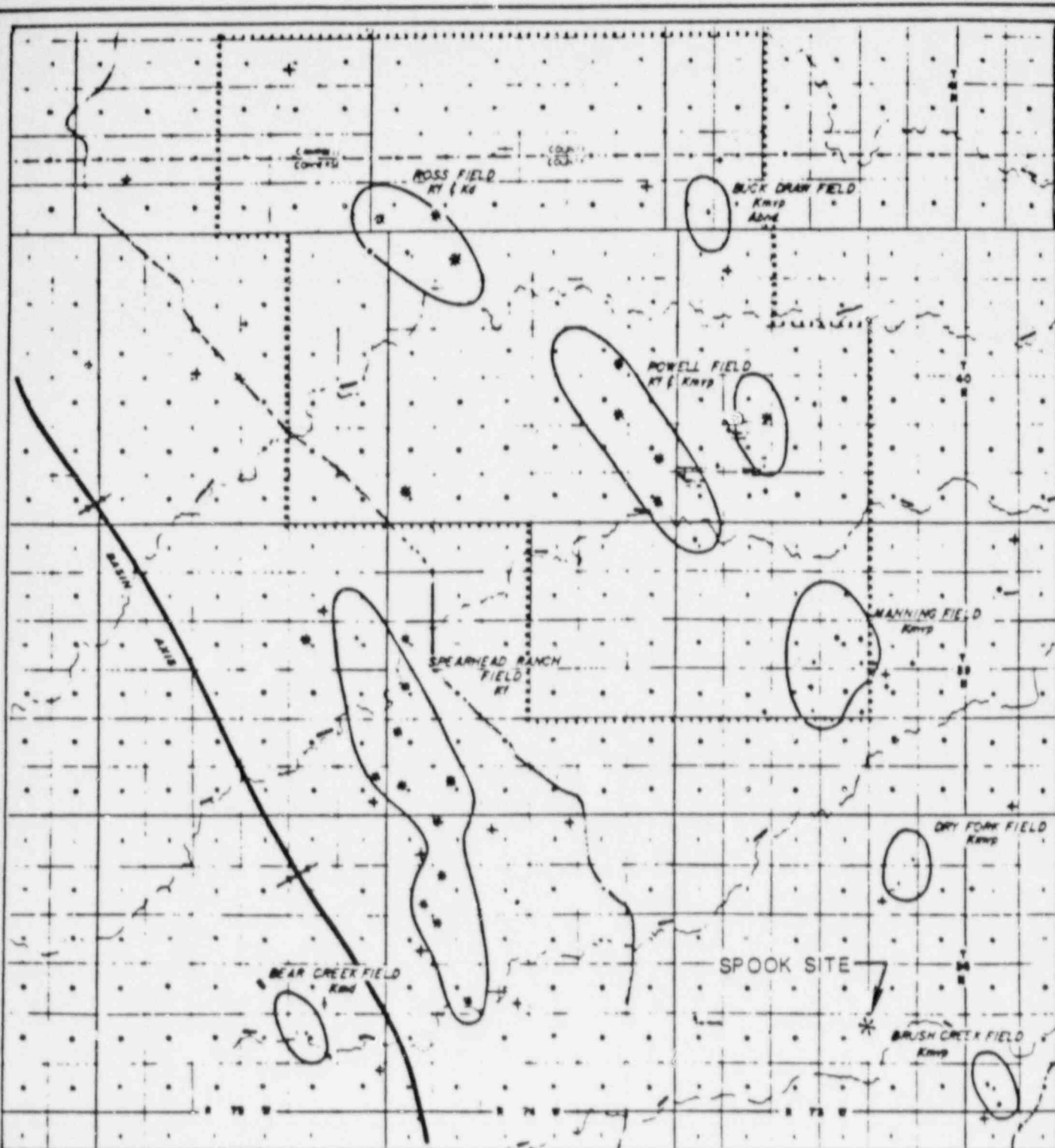
REF: LANE, D.W., AND OTHERS, 1972
 GEOL. SURVEY OF WYOMING.

LEGEND

- URANIUM OCCURRENCE
- ✕ OPEN PIT MINE
- COAL RESOURCES



FIGURE D.3.9
 MINES AND MINERALS MAP OF CONVERSE COUNTY
 SPOOK SITE
 CONVERSE COUNTY, WYOMING



REF : HANDO, 1976

FIGURE D.3.10

LOCATION OF SITE RELATIVE TO LOCAL OIL-GAS STRUCTURES
SPOOK SITE
CONVERSE COUNTY, WYOMING

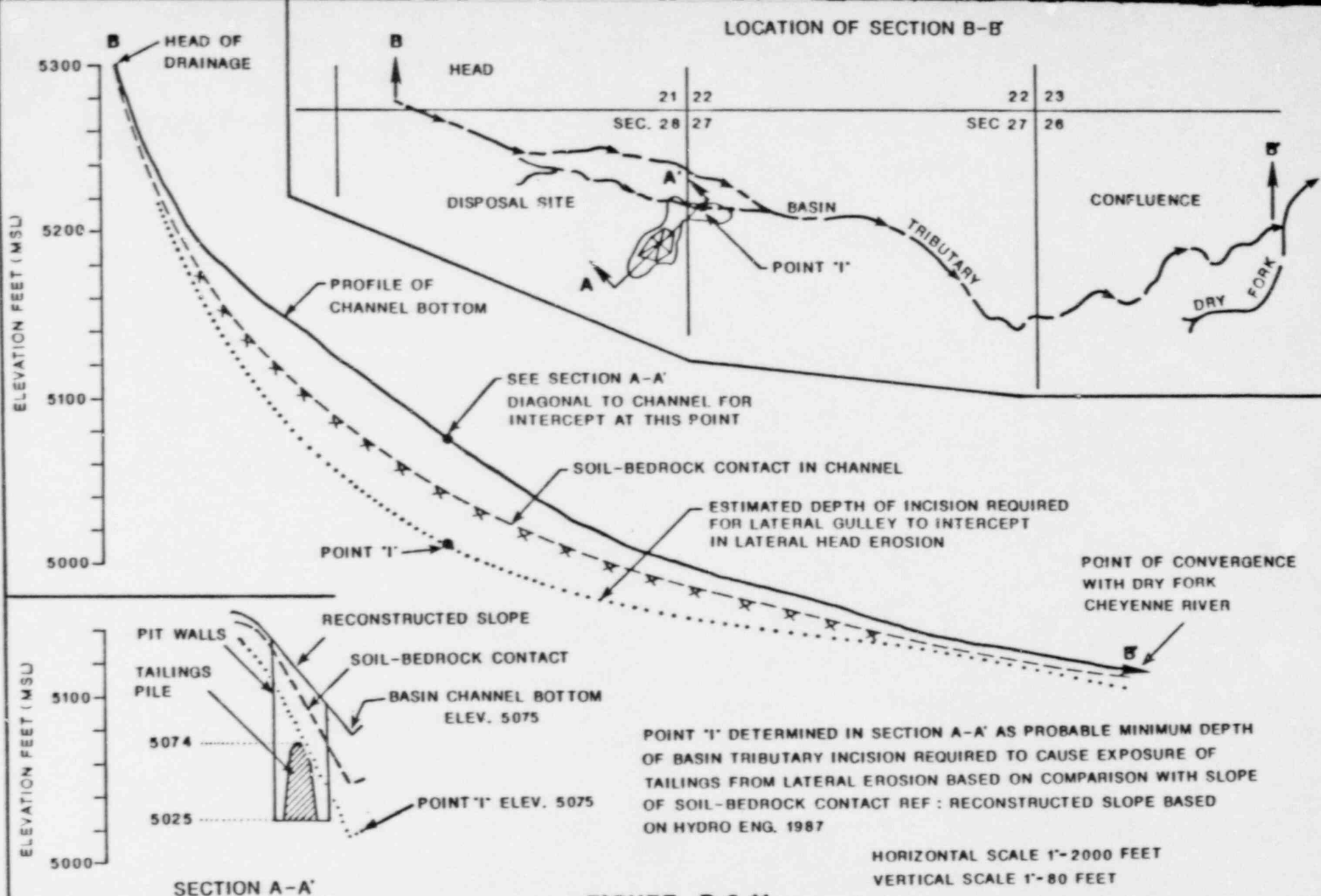


FIGURE D.3.11

**SITE SUBBASIN DRAINAGE PROFILE AND RELATIONSHIP OF BEDROCK DEPTH TO CHANNEL INCISION
SPOOK SITE - CONVERSE COUNTY, WYOMING**

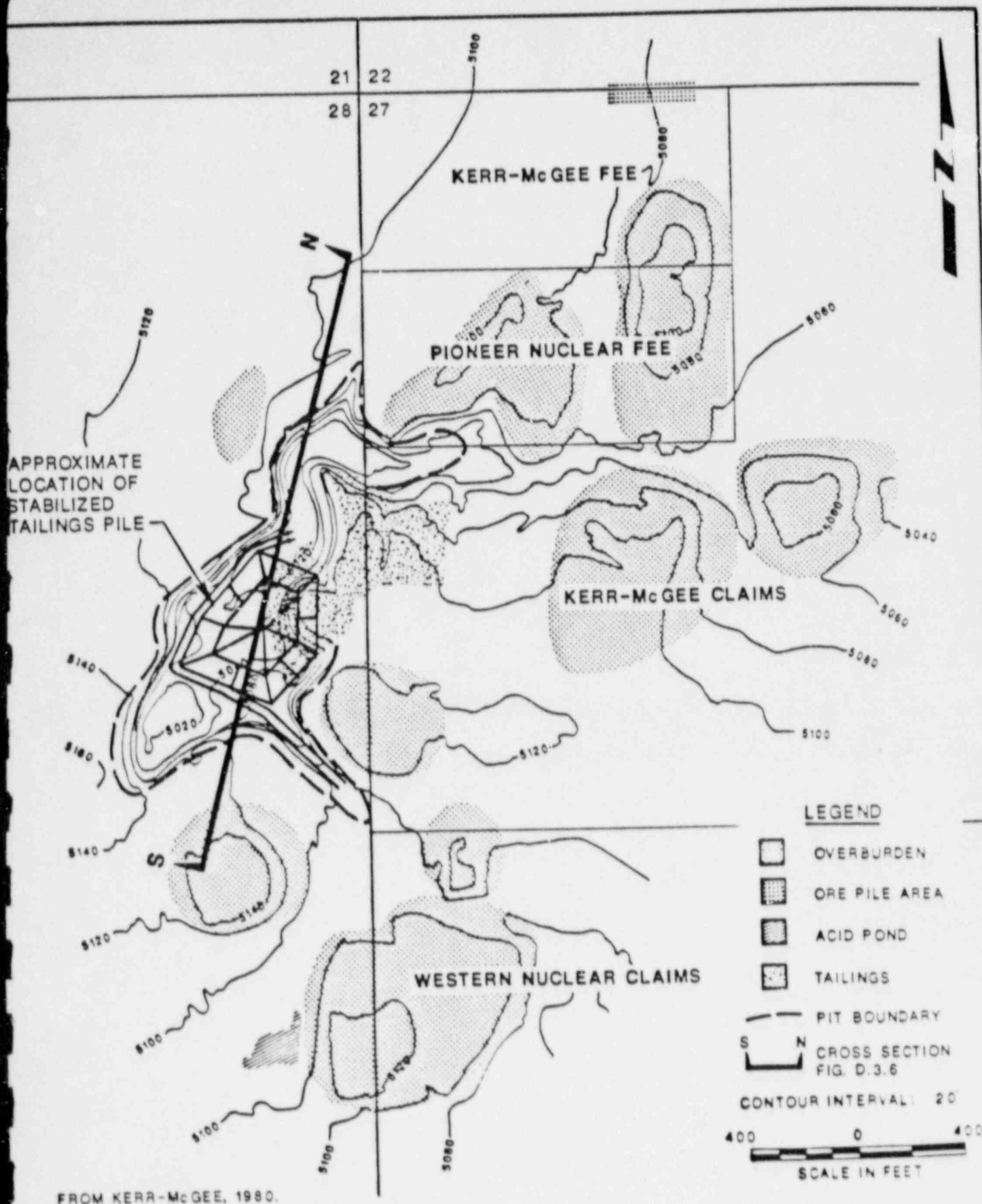


FIGURE D.3.12
MINERAL CLAIM AND FEE AREAS AT THE
SPOOK SITE - CONVERSE COUNTY, WYOMING

Table D.3.1 Description of stratigraphic units in the Spook site area of the Powder River Basin, Wyoming

Age	Unit	Approximate thickness in site region (ft/meter)	Description
Eocene, Lower Tertiary	Wasatch Formation	300/91	Predominantly buff sandstone containing interbedded light and dark-colored shales. Contains red and pink shale bands throughout, which help distinguish it from the underlying Fort Union. The sandstone is slightly- to well-cemented. Clinker beds of red shale are exposed in outcrops in coal horizons. Fossil channels are filled with well-cemented medium sand to fine shale. The channels, in some cases, may be traceable for miles. There are several mineable coal beds in the formation which occur within the shale members. Uranium ore is associated with shaley coal lenses. The Wasatch Formation was deposited in a fresh water marsh environment with alternating sequences of meandering streams. The sand is arkosic and derived from the Laramie and Black Hill Mountains highlands. Groundwater in the Wasatch is soft and usually high in sodium. Prominent shale beds form confining layers which cause artesian conditions.
Paleocene Lower Tertiary	Fort Union Formation	3700/1127	The Lebo Shale Member exposed in the eastern part of the county is a dark-colored shale with interbedded sandstone that resembles the Wasatch Formation. There is disagreement on the actual contact in the site region. The Tongue Member prominent in the north as the upper-most member is locally considered part of the Lebo Shale Member. The Fort Union is typically described as buff to white and brown sandstone containing interbedded carbonaceous and arenaceous shale and coal. The sandstone varies from

Table D.3.1 Description of stratigraphic units in the Spook site area of the Powder River Basin, Wyoming (Continued)

Age	Unit	Approximate thickness in site region (ft/meter)	Description
Paleocene Lower Tertiary	Fort Union Formation (Continued)		well-cemented, to soft and massive bedded. The depositional environment was in fresh water marshes with inland lakes. The Fort Union, like the Wasatch Formation, contains thick sub-bituminous and uranium ore deposits.
Upper Cretaceous	Lance Formation	2000/609	Fine to medium sandstone with interbedded shale and claystone. May be as much as 3000 feet thick in southern Converse County.
	Fox Hills Sandstone	525/160	Predominantly fine- to medium-grained sandstone containing thin beds of sandy shale. This formation is not differentiated from the Lance Formation in the western part of the basin.
	Lewis Shale	1130/344	Shale with some lenses of fine-grained sandstone. Grades into the Pierre shale toward the south and east part of the basin. Noted for beds of bentonite.
	Mesaverde Formation	3900/1190	In Converse County, it consists of four prominent members: Teapot, Parkman, Sussex, and Shannon. Known for oil and gas production. Contains some coal particularly in the north part of the basin. The formation thins toward the north and generally consists of sandstone, massive- to thin-bedded, some shale and sandy shale. The Teapot and

Table D.3.1 Description of stratigraphic units in the Spook site area of the Powder River Basin, Wyoming (Continued)

Age	Unit	Approximate thickness in site region (ft/meter)	Description
Upper Cretaceous (Continued)	Mesaverde Formation (Continued)		Parkman are described as buff-white to tan, laminated and bioturbated sandstones representing prodelta marine sequence. The Sussex may be missing from this area. The Shannon Member is characterized as a thin-bedded to cross-bedded, very fine-grained sandstone or silty sandstone.
	Frontier Formation	900/274	Consists of a sandstone with conglomerate member at the top, with mostly black shale with thin sandstone beds in lower part. Thickens toward the south part of the basin.
Lower Cretaceous	Mowry Shale	183/56	Hard siliceous shale in upper part, soft shale in lower part. Thickness increases northward. Contains abundant layers of bentonite. Weathers to silver-gray. Outcrops may show oil staining.
	Muddy Sandstone	58/18	Merges with Thermopolis Shale Formation found in Black Hills. Medium-grained sandstone and interbedded shale. The formation shows transgressive shoreline sequences with fluvial sandstone interbedded with marine sandbar sand and shale. It is an important oil reservoir.
	Skull Creek Shale Formation	105/32	Dark gray to black shale with thin beds of sandstone and siltstone. Sometimes referred to as the "Dakota Silt" and may be traced into upper part of the Dakota Formation.

Table D.3.1 Description of stratigraphic units in the Spook site area,
of the Powder River Basin, Wyoming (Continued)

Age	Unit	Approximate thickness in site region (ft/meter)	Description
Lower Cretaceous (Continued)	Dakota Sandstone	122/37	Medium-grained sandstone recognized in oil well logs by some, but considered absent by others. It is most likely that the formation can be correlated locally with the Muddy SS, Skull Creek, and Lakota Formations.
	Lakota Formation	63/14	Sandstone and conglomerated sandstone with shale. Rapid lateral lithology changes. Fluvial in nature, it is unconformable with the underlying Morrison Formation.
Jurassic	Morrison and Sundance Formation	520/158	The Morrison Formation is vari-colored claystone with interbedded fine sandstone. The Sundance Formation consists of green-gray shale with yellow-gray glauconitic sandstone with minor oolitic limestone.
Triassic	Chugwater Formation	575/175	Dark red siltstone, sandstone, and shale. Missing in western basin. The Alcova Limestone Member is present only in this southwest portion of the basin. Widely identified as the "Wyoming Redbeds."
Triassic- Permian	Goose Egg Formation	349/107	Mapped as both Permian and Triassic, it is comprised of the Minnekahta and Opechesh Members. The thin lower Opechesh Member consists of interbedded red shale, gypsum sandstone dolomite. The predominant upper Minnekahta Member is a thin-bedded limestone and dolomitic limestone. The formation becomes thinner toward the north.

Table D.3.1 Description of stratigraphic units in the Spook site area,
of the Powder River Basin, Wyoming (Concluded)

Age	Unit	Approximate thickness in site region (ft/meter)	Description
Permian- Pennsylvanian	Minelusa Formation	54/16	Interbedded sandstone, sandy dolomite, and limestone with local beds of gypsum. It is present in the Black Hills and Hartville Uplift.
Pennsylvanian	Amsden	224/68	The formation is characterized by rapid change in lithology, laterally and vertically. It consists of sandstone, shale and dolomite, some limestone. It is missing at the south edge of basin.
Mississippian	Madison Limestone Formation	300/91	Dolomite and limestone, massive- to thin-bedded. Fractured and cavernous in some areas. The beds dip steeply in the central part of the basin where it is found at great depths.
Ordovician	Big Horn Dolomite Formation	100/30	Massive- to thin-bedded dolomite locally may overlay basal sandstone.
Cambrian	Flathead Sandstone	90/27	Composed of red and gray quartzitic fine to coarse sandstone. It thickens toward the north.
Precambrian Basement			Granite intrusives and metamorphics. Metasediments are strongly metamorphosed and cannot be differentiated.

Ref. Seeland (1982); Hodson et al. (1973); Curry (1971); Peterson (1956).

Table D.3.2 Earthquakes of magnitude >4.0 since 1963 in northeast Wyoming; 200-km site radius

Date			Time			Location		Site distance	Depth	Magnitude				Intensity
Y	M	D	Hr	Min	Sec	Lat(N)	Long(W)	(km)	(km)	Mb	Ms	Other	Local	
Pre-1963			Historical			43.016	105.955							
1954	10	03	15			43.600	105.400	47 (NW of Glenrock)		No intensity or mag. reported				
1967	05	11	21	15	06.6	43.662	105.899	57 (NW of Glenrock, Pine Ridge)	33N	4.8				
1964	04	01	04	50		42.500	105.400	79 (Flank of Laramie Range)						IV
1964	08	22	03	28	11.1	42.900	104.700	80 (Flank of Laramie Range)	33	4.5				V
1965	06	03	19	30	25.8	43.600	106.500	85 (Vicinity, synclinal axis Powder River Basin)	33	4.7				
1984	10	18	15	30	23.0	42.375	105.720	92 (SE of Casper, Laramie Mts.)	33N	5.4	5.1		5.5	VI
1984	10	18	15	57	37.3	42.365	105.805	94 (SE of Casper, Laramie Mts.)	33	4.5			4.2	
1976	09	03	04	18	16.2	44.041	106.154	104 (Powder River Basin)	10	4.8			4.2	
1983	02	13	13	44	44.0	42.232	105.729	108 (Powder River Basin)	5				4.0	IV
1984	05	29	20	18	32.6	44.232	105.965	118 (Powder River Basin)	18	5.0				V
1984	09	08	00	59	31.1	44.240	106.019	120 (Powder River Basin)	20	5.1				V
1972	02	18	11	43	38.1	44.292	105.116	128 (Powder River Basin)	5	4.3				
1973	06	17	01	17	34.1	42.821	107.170	134 (E of Casper, Casper Arch)	10					
1973	12	26	23	01	15.1	42.276	106.715	137 (S of Casper, Sweetwater Arch)	0					

Table D.3.2 Earthquakes of magnitude >4.0 since 1963 in northeast Wyoming; 200-km site radius (Continued)

Date			Time			Location		Site distance (km)	Depth (km)	Magnitude				Intensity
Y	M	D	Hr	Min	Sec	Lat(N)	Long(W)			Mb	Ms	Other	Local	
1964	03	28	03			42.700	104.000	142 (E of Casper, Hartville Uplift)						V
1973	05	29	21	34	13.1	42.366	107.104	154 (SW of Casper, Sweetwater Arch)	33					
1975	05	16	05	57	01.5	43.238	103.681	155 (Southwestern South Dakota)	5					IV
1973	08	17	23	58	04.4	41.921	106.375	156 (Laramie Basin)	10					
1966	04	13	05	58	02.1	44.200	107.100	164 (Big Horn Mts.)	33					
1975	07	11	16	39	22.1	41.977	106.731	164 (Laramie Basin)	5					
1973	11	21	22	02	38.5	42.044	106.967	170 (Hanna Basin)	0					
1973	05	30	21	45	16.7	41.874	106.657	171 (Rawlins Uplift)	33					
1973	08	17	20	09	08.9	41.920	106.765	171 (Rawlins Uplift)	10					
1964	03	24	06	12		43.500	103.500	173 (SW, South Dakota)		4.2				V
1973	06	01	21	22	21.3	41.879	106.708	173 (Hanna Basin)	5					
1973	04	13	21	17	52.6	41.852	106.680	174 (Hanna Basin)	10					
1973	08	03	21	47	52.0	41.900	106.800	175 (Hanna Basin)		4.1				V
1974	09	19	13	36	11.4	44.110	107.380	175 (Big Horn Mts.)	10	4.4				V
1970	12	12	15	57	19.1	43.953	107.545	178 (Big Horn Basin)	15	4.9				

Table D.3.2 Earthquakes of magnitude >4.0 since 1963 in northeast Wyoming; 200-km site radius (Concluded)

Date			Time			Location		Site distance	Depth	Magnitude				Intensity
Y	M	D	Hr	Min	Sec	Lat(N)	Long(W)	(km)	(km)	Mb	Ms	Other	Local	
1975	12	30	23	12	46.0	42.981	107.864	185 (Wind River Basin)	5					
1978	06	06	21	23	34.7	43.632	107.826	186 (Big Horn Basin)	5	4.0				
1976	10	27	10	54	36.7	41.946	107.218	192 (Hanna Basin)	5					
1973	04	22	06	07	12.4	42.635	107.85	194 (Sweetwater Arch)	33	4.8				

Table D.3.3 Historical earthquakes of MMI=III or greater; 200-km site radius

Date			Time			Location		Site distance	Intensity
Y	M	D	Hr	Min	Sec	Lat(N)	Long(W)	(km)	
1897	11	14				42.900	106.300	66 (Vicinity Casper)	VII
1894	06	25				42.800	106.300	72 (Vicinity Casper)	V
1922	10	26	01	20		42.800	106.300	72 (Vicinity Casper)	IV
1942	12	11	11	15		42.800	106.300	72 (Vicinity Casper)	IV
1948	08	27	21			42.800	106.300	72 (Vicinity Casper)	IV
1947	04	14	19	30		42.500	105.800	79 (Laramie Mts.)	
1952	08	22	03	05		42.500	105.300	82 (Laramie Mts.)	IV
1952	09	02	21			42.500	105.300	82 (Laramie Mts.)	
1957	01	06	02			42.500	105.300	82 (Laramie Mts.)	III
1954	01	24	01	58		42.500	106.600	113 (Casper Arch)	IV
1942	02	25	14	10		42.500	104.300	131 (Hartville Uplift)	V
1943	09	06	15			44.300	106.700	151 (Powder River Basin)	IV
1952	08	29	03			41.900	106.200	153 (Laramie Basin)	IV
1955	05	22	12	30		41.800	106.200	163 (Laramie Basin)	IV
1943	05	16	18	40		43.400	103.500	171 (Black Hills Area, SD)	
1924	12	30	22	10		43.500	103.500	173 (Black Hills Area, SD)	IV

Table D.3.3 Historical earthquakes of MMI=III or greater; 200-km site radius (Concluded)

Date			Time			Location		Site distance	Intensity
Y	M	D	Hr	Min	Sec	Lat(N)	Long(W)	(km)	
1924	12	30	22	15		43.500	103.500	173 (Black Hills Area, SD)	IV
1924	12	30	22	20		43.500	103.500	173 (Black Hills Area, SD)	IV
1924	12	30	22	30		43.500	103.500	173 (Black Hills Area, SD)	IV
1936	10	30	10	30		43.500	103.500	173 (Black Hills Area, SD)	IV
1941	05	25	06	25		43.500	103.500	173 (Black Hills Area, SD)	V
1943	05	16	19	40		43.500	103.500	173 (Black Hills Area, SD)	IV
1943	05	16	20	40		43.500	103.500	173 (Black Hills Area, SD)	IV
1928	11	18	13	45		44.100	103.700	183 (Black Hills Area, SD)	V
1938	03	24	13	11		42.700	103.400	187 (Black Hills Area, SD)	IV
1954	01	20	20	50	01.0	41.500	105.500	189 (Laramie Basin)	V
1925	11	18	01	50		44.600	107.000	192 (Big Horn Mts.)	V
1920	07	14	23			43.200	103.200	194 (Black Hills, SD)	III
1952	11	14				44.100	103.500	196 (Black Hills Area, SD)	IV
1952	11	15				44.100	103.500	196 (Black Hills Area, SD)	IV

Table D.3.4 Assessment of capable faults for determination of design earthquake, Spook site, Wyoming

Fault name	Length mi (km)	Distance miles (km)	Maximum earthquake magnitude M_{sb}	Site Peak horizontal acceleration, g (Campbell, 1981)
Kaycee, WY, Group Basin Boundary	7 (11.3)	60 (96)	6.8	0.040
Edgerton, WY, Group Basin Boundary	7 (11.3)	35 (56)	6.8	0.082
Casper Vicinity ^a Basin Boundary	12 (19.3)	22 (35)	7.0	0.165
Lance Creek Fault ^a Basin Boundary	12 (19.3)	56 (90)	7.0	0.05

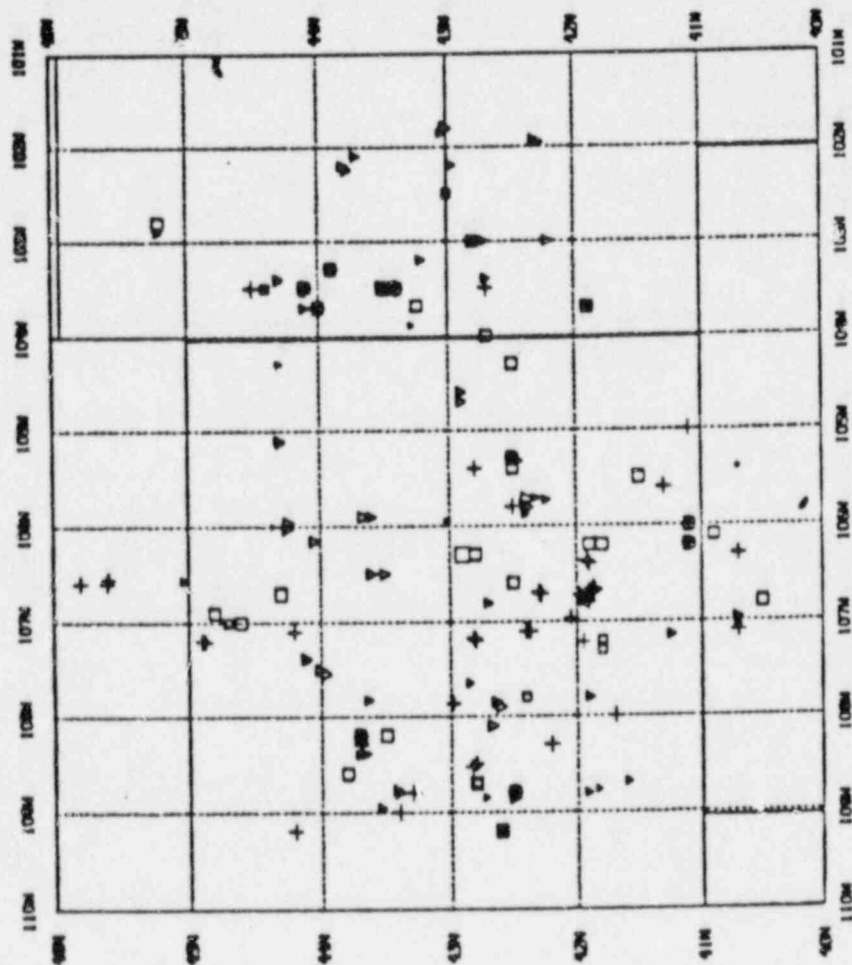
^aAssumed segment length based on length of boundary surface faults.

^bBased on the relationship of $M_s = 6.02 + 0.729 \log (L)$.

ADDENDUM D1

HISTORICAL AND INSTRUMENTALLY-LOCATED
EARTHQUAKE EPICENTRAL DATA WITHIN A 320-KM
RADIUS OF THE SPOOK SITE, WYOMING
(SOURCE: NGDC/NOAA EARTHQUAKE DATA FILE)

SEISMICITY MAP



MAGNITUDES
 4.0 ▽
 5.0 ▽
 6.0 ▽
 7.0 ▽

INTENSITIES
 I-III □
 IV-VI □
 VII-IX □
 X-XII □

216 EARTHQUAKES PLOTTED
 NO INTENSITY OR MAGNITUDE +
 NATIONAL GEOPHYSICAL DATA CENTER / NOAA BOULDER, CO 80303

[illegible][illegible]

1970-1971 1972-1973 1974-1975 1976-1977 1978-1979 1980-1981 1982-1983 1984-1985 1986-1987 1988-1989 1990-1991 1992-1993 1994-1995 1996-1997 1998-1999 2000-2001 2002-2003 2004-2005 2006-2007 2008-2009 2010-2011 2012-2013 2014-2015 2016-2017 2018-2019 2020-2021 2022-2023 2024-2025 2026-2027 2028-2029 2030-2031 2032-2033 2034-2035 2036-2037 2038-2039 2040-2041 2042-2043 2044-2045 2046-2047 2048-2049 2050-2051 2052-2053 2054-2055 2056-2057 2058-2059 2060-2061 2062-2063 2064-2065 2066-2067 2068-2069 2070-2071 2072-2073 2074-2075 2076-2077 2078-2079 2080-2081 2082-2083 2084-2085 2086-2087 2088-2089 2090-2091 2092-2093 2094-2095 2096-2097 2098-2099 2100-2101 2102-2103 2104-2105 2106-2107 2108-2109 2110-2111 2112-2113 2114-2115 2116-2117 2118-2119 2120-2121 2122-2123 2124-2125 2126-2127 2128-2129 2130-2131 2132-2133 2134-2135 2136-2137 2138-2139 2140-2141 2142-2143 2144-2145 2146-2147 2148-2149 2150-2151 2152-2153 2154-2155 2156-2157 2158-2159 2160-2161 2162-2163 2164-2165 2166-2167 2168-2169 2170-2171 2172-2173 2174-2175 2176-2177 2178-2179 2180-2181 2182-2183 2184-2185 2186-2187 2188-2189 2190-2191 2192-2193 2194-2195 2196-2197 2198-2199 2200-2201 2202-2203 2204-2205 2206-2207 2208-2209 2210-2211 2212-2213 2214-2215 2216-2217 2218-2219 2220-2221 2222-2223 2224-2225 2226-2227 2228-2229 2230-2231 2232-2233 2234-2235 2236-2237 2238-2239 2240-2241 2242-2243 2244-2245 2246-2247 2248-2249 2250-2251 2252-2253 2254-2255 2256-2257 2258-2259 2260-2261 2262-2263 2264-2265 2266-2267 2268-2269 2270-2271 2272-2273 2274-2275 2276-2277 2278-2279 2280-2281 2282-2283 2284-2285 2286-2287 2288-2289 2290-2291 2292-2293 2294-2295 2296-2297 2298-2299 2300-2301 2302-2303 2304-2305 2306-2307 2308-2309 2310-2311 2312-2313 2314-2315 2316-2317 2318-2319 2320-2321 2322-2323 2324-2325 2326-2327 2328-2329 2330-2331 2332-2333 2334-2335 2336-2337 2338-2339 2340-2341 2342-2343 2344-2345 2346-2347 2348-2349 2350-2351 2352-2353 2354-2355 2356-2357 2358-2359 2360-2361 2362-2363 2364-2365 2366-2367 2368-2369 2370-2371 2372-2373 2374-2375 2376-2377 2378-2379 2380-2381 2382-2383 2384-2385 2386-2387 2388-2389 2390-2391 2392-2393 2394-2395 2396-2397 2398-2399 2400-2401 2402-2403 2404-2405 2406-2407 2408-2409 2410-2411 2412-2413 2414-2415 2416-2417 2418-2419 2420-2421 2422-2423 2424-2425 2426-2427 2428-2429 2430-2431 2432-2433 2434-2435 2436-2437 2438-2439 2440-2441 2442-2443 2444-2445 2446-2447 2448-2449 2450-2451 2452-2453 2454-2455 2456-2457 2458-2459 2460-2461 2462-2463 2464-2465 2466-2467 2468-2469 2470-2471 2472-2473 2474-2475 2476-2477 2478-2479 2480-2481 2482-2483 2484-2485 2486-2487 2488-2489 2490-2491 2492-2493 2494-2495 2496-2497 2498-2499 2500-2501 2502-2503 2504-2505 2506-2507 2508-2509 2510-2511 2512-2513 2514-2515 2516-2517 2518-2519 2520-2521 2522-2523 2524-2525 2526-2527 2528-2529 2530-2531 2532-2533 2534-2535 2536-2537 2538-2539 2540-2541 2542-2543 2544-2545 2546-2547 2548-2549 2550-2551 2552-2553 2554-2555 2556-2557 2558-2559 2560-2561 2562-2563 2564-2565 2566-2567 2568-2569 2570-2571 2572-2573 2574-2575 2576-2577 2578-2579 2580-2581 2582-2583 2584-2585 2586-2587 2588-2589 2590-2591 2592-2593 2594-2595 2596-2597 2598-2599 2600-2601 2602-2603 2604-2605 2606-2607 2608-2609 2610-2611 2612-2613 2614-2615 2616-2617 2618-2619 2620-2621 2622-2623 2624-2625 2626-2627 2628-2629 2630-2631 2632-2633 2634-2635 2636-2637 2638-2639 2640-2641 2642-2643 2644-2645 2646-2647 2648-2649 2650-2651 2652-2653 2654-2655 2656-2657 2658-2659 2660-2661 2662-2663 2664-2665 2666-2667 2668-2669 2670-2671 2672-2673 2674-2675 2676-2677 2678-2679 2680-2681 2682-2683 2684-2685 2686-2687 2688-2689 2690-2691 2692-2693 2694-2695 2696-2697 2698-2699 2700-2701 2702-2703 2704-2705 2706-2707 2708-2709 2710-2711 2712-2713 2714-2715 2716-2717 2718-2719 2720-2721 2722-2723 2724-2725 2726-2727 2728-2729 2730-2731 2732-2733 2734-2735 2736-2737 2738-2739 2740-2741 2742-2743 2744-2745 2746-2747 2748-2749 2750-2751 2752-2753 2754-2755 2756-2757 2758-2759 2760-2761 2762-2763 2764-2765 2766-2767 2768-2769 2770-2771 2772-2773 2774-2775 2776-2777 2778-2779 2780-2781 2782-2783 2784-2785 2786-2787 2788

SOURCE	VR	WC	CA	TIME		SEC	LAT	LOCATION		DEPT- NM	MR	OTHER	LCC-L	INT MAX	DISVNO	R-E	2-N	DISTANCE NM
				MM	SS			LONG										
PDE	1254	02	12	06	13	32.7	41.0	N	107.3	33	4.1			IV	460	460	5	211
1---US	1254	02	13	06	13	32.7	41.0	N	107.3	33	4.1			IV	460	460	C	211
PDE	1272	12	03	13	47	10.7	43.0	N	103.1	20	4.1			V	450	450	10	211
1---US	1272	12	03	13	47	10.7	43.0	N	103.1	20	4.1			V	450	450	10	211
PDE	1272	12	03	13	47	10.7	43.0	N	103.1	20	4.1			V	450	450	10	211
1---US	1272	12	03	13	47	10.7	43.0	N	103.1	20	4.1			V	450	450	10	211
PDE	1272	12	03	13	47	10.7	43.0	N	103.1	20	4.1			V	450	450	10	211
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PDE	1272	12	03	13	47	10.7	43.0	N	103.1	20	4.1			V	450	450	10	211
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UMTRA - SPOOK
PRELIMINARY DESIGN FOR REVIEW
INFORMATION FOR REVIEWERS
Revision 1
APRIL 1988

INFORMATION FOR REVIEWERS

TABLE OF CONTENTS

- A. Overview of Design and Supporting Documents
- B. Responses to NRC and State Comments on Draft Remedial Action Plan
- C. Revised Section 4 of Remedial Action Plan
- D. Analysis of Changes from dRAP Design
- E. Open Issues

A. OVERVIEW OF DESIGN AND SUPPORTING DOCUMENTS

1. Supporting Documents

Supporting documents utilized for the Preliminary Design for Review are limited in number and contain modest data resources. The basic document referenced for site conditions and design parameters was the draft RAP dated July, 1987. Additional data has been derived from the State of Wyoming Report of Investigation, Abandoned Mined Lands Program 15-3 dated August 1987. Information is also presented from the recent drilling and testing program on the Acid Pond area (late 1987, early 1988). Following is a list of the documentation (these documents are not included in this Preliminary Design for Review package):

- a) Remedial Action Plan and Site Conceptual Design for Stabilization of the Inactive Uranium Mill Tailings Site at Spook, Wyoming, Draft, July, 1987, UMTRA-DOE/AL 050515.0000.
- b) Report of Investigation, Abandoned Mined Lands Program 15-3, August, 1987 and Letter to Jacobs Engineering from Hydro-Engineering dated 18 August, 1987.
- c) Letter to MK-F from Jacobs Engineering Group Inc., dated 22 March, 1988. Contains results of previous drilling programs and lab analyses as well as lithographic logs and cross-sections based on that information.
- d) Meeting Notes for Spook On-Board or Status Meetings on 30 October, 1987, 19 January, 1988, and 15-16 March, 1988.

The meeting notes contain references to mutually agreed upon design criteria and approaches, which impacted the development of project design. The notes and pertinent data from the other sources are reproduced in the Information to Bidders.

2. Project Design

The basic concept for UMTRA project design is to place contaminated material on a prepared uncontaminated foundation in the bottom of Spook Pit and cover it with a low-permeability layer. The Pit would then be backfilled and the area regraded under the State of Wyoming AML program. As presently constituted the remedial action is structured as a cooperative endeavor under the UMTRA and AML programs.

A foundation area for the tailings embankment will be prepared in the Spook Pit. Essentially, this will consist of excavating and filling to provide a smooth, firm foundation area at approximately El. 5020, well above the ground water level. The tailings embankment will be constructed in layers compacted to 90% of maximum Standard Proctor density, and the more contaminated materials will be placed in the lower layers. The footprint will be roughly hexagonal in shape, the side slopes will be 1 vertical on two horizontal and the top slopes will be about 6%. The embankment will be covered by 1.5 feet of low permeability material, compacted to 95% density; this layer will resist percolation of water into the tailings embankment. The mine drifts in the walls of Spook Pit would be backfilled as part of the basic design. This would complete the DOE/UMTRA portion of Spook remedial action.

The State of Wyoming Abandoned Mined Lands Program will result in total backfill of the Spook Pit and re-establishment of surface drainage through the site. The DOE/UMTRA tailings embankment will be deeply buried at the bottom of the backfill. The backfill materials will be taken from the several spoils piles in the site area, containing mining wastes from pit excavation. Backfill will be a selective process resulting in materials with greater than 20 pCi/gm of radium-226 being buried in the lower levels of Spook Pit. The upper 18 or more feet of backfill will have materials with less than or equal to 0.2 or 0.1 ppm of Se and 5.0 pCi/gm of Ra-226 or less. Regrading of the pit backfill and site area will be designed to minimize the possibility of erosion and the entire disturbed area will be revegetated.

B. RESPONSES TO NRC AND STATE COMMENTS ON DRAFT REMEDIAL ACTION PLAN

Comments on the draft Remedial Action Plan from NRC and MKE are on record. Our records reveal no written response from TAC. MKE comments were discussed with TAC during the On-Board Meetings and substantial agreement was reached on all items of particular concern.

C. REVISED SECTION 4 OF REMEDIAL ACTION PLAN

Since changes from the dRAP are relatively few and generally not of major design significance, and are discussed in the following section, a revised Section 4 is not submitted with this Information for Reviewers package.

Changes will also be made in construction facilities as presented in the dRAP. As is explained in detail in the discussion included with the design calculations, all runoff from contaminated areas now discharges into the Spook Pit, and this condition will be maintained during construction. This will eliminate the need for collection ditches and a retention basin.

The Preliminary Design for Review construction sequence is based on the assumption that both the DOE/UMTRA program and the State/AML program will be constructed by the same subcontractor and portions of both may be constructed concurrently. This will alter the DOE/RAC and the State/AML construction sequences as developed in the dRAP. The construction schedule will also be developed differently; details of this schedule will be developed in more detail during the final design stage.

D. ANALYSIS OF CHANGES FROM dRAP DESIGN

1. General

The proposed Remedial Action as developed in the draft RAP was a two-phased program starting with the stabilization of the pile in place in Spook Pit, and followed by backfill of the pit under the State of Wyoming AML program. The Remedial Action Plan as presented in the Preliminary Design for Review is a two-unit construction program, which will be constructed by a single Subcontractor and may be constructed concurrently.

2. Analysis

Changes from the dRAP are relatively few and consist primarily of dimensional changes. One feature described in dRAP which will not be constructed is the high-permeability layer which was to overlie the low-permeability layer capping the tailings embankment. This feature was eliminated as being unnecessary, since the backfill will consist primarily of sandy materials.

Other changes from the dRAP, which depend on design details and not on changes in design criteria, are listed below (they may change for final design):

<u>Feature</u>	<u>dRAP</u>	<u>Preliminary Design</u>
Pile Base	4.6 acres	4.9 acres
Average Depth	31 feet	36 feet
Maximum Depth	49 feet	56 feet
Backfill Average	48 feet	48 feet
Final Restriction	30.8 acre	Undecided
Topslopes	2-4%	3-10%
Base Elevation	30' above G.L.	15' above G.L.
Secondary Settlement	0.25 feet	0.4-0.5 feet

E. OPEN ISSUES

Remedial action for the acid pond and adjacent affected area has not been formulated to date. Limited characterization investigations were performed prior to preparation of the dRAP. More comprehensive characterization investigations were performed in late 1987 and early 1988. The data resulting from this program are presented in the Information to Bidders.

The investigation program has disclosed that the acid pond is a distinct problem area, stemming from processing operations, but removed physically from the Spook Remedial Action site. Consideration has been given to handling it as a Vicinity Property. Remedial Action for the acid pond is not addressed in this Preliminary Design for Review package. Additional characterization investigations are planned for this Spring, and the acid pond remedial action will be addressed as an issue either in the Final Design or as a Vicinity Property.

TABLE A.1
LIST OF DOCUMENTS IN
PRELIMINARY DESIGN SUBMISSION

- I. Information for Reviewers (1 Volume)
 - A. Overview of Design and Supporting Documents*
 - B. Responses to WRC and State Comments on Draft Remedial Action Plan
 - C. Revised Section 4 of Remedial Action Plan
 - D. Analysis of Changes from dRAP Design
 - E. Open Issues
- II. Subcontract Documents (1 Volume)
 - A. Bid Schedule
 - B. Special Conditions
 - C. Specifications
 - D. Drawings
- III. Information for Bidders (2 Volumes)
- IV. Supporting Calculations and Reports (2 volumes)
 - A. Permanent Facilities⁺
 - B. Temporary Facilities
 - C. Quantity Estimates
 - D. Reports

*"Roadmap" to design and supporting documents.

⁺Critical to meeting EPA Standards

TABLE A.2
RELATIONSHIP BETWEEN DESIGN DETAILS AND CRITERIA
AND SUPPORTING CALCULATIONS AND REPORTS

<u>Design Detail or Criteria</u>	<u>Calculation Mo. +</u>	<u>Title</u>	<u>Remarks</u>
4.3.3* Pile Location	---	Draft RAP	Stabilized in place in the Spook Pit.
4.3.4 Pile Layout	---	Draft RAP	Top of pile slopes at 3% to 10%. Side slopes at 2:1.
	7-715-05	Contaminated Material - Excavation Volume	Base of embankment covers 4.9 acres.
	7-765-00	Tailings Embankment - Earthwork Quantities	
4.3.5 State AML Program Reclamation	---	Report of Investigation, Abandoned Mined Lands Program 15-3	Spook Pit is backfilled under State/AML Programs concurrent with construction of the tailings pile.
	---	State/AML Calculations	
4.3.6 Mine Tunnel Reclamation	---	Draft RAP	Backfill with granular material.
4.3.7 Foundation Preparation	7-705-00	Foundation Preparation Excavation	A level, compacted foundation provided at EL. 5020.
4.3.8 Placement of Tailings	---	Draft RAP	Most contaminated material will be placed first. Assumed material with a Ra-226/Ur-238 ratio greater than 4.8 is tailings.
	7-710-00	Radiological Data	
4.3.9 Geomorphology	---	Draft RAP	State/AML pit backfill and surface drainage restoration provides long term stability against wind and water erosion and surface settling.
	---	Report of Investigation, AML Program 15-3	
	---	State/AML Calculations	

* Subsection Mo. in Section 4 of the Draft RAP.

+ Reports and State/AML Calculations are identified by title only.

<u>Design Detail or Criteria</u>	<u>Calculation No. +</u>	<u>Title</u>	<u>Remarks</u>
4.3.10 Geology and Seismicity	---	Draft RAP	Seismic aspects not of concern since tailings embankment construction and State/APL backfill operations are concurrent.
4.3.11 Hydrogeology	---	Draft RAP	Bottom of stabilized pile is approx. 15 feet above ground water level. Pile is covered with a low-permeability layer.
4.3.12 Surface Water	7-750-00	Site Hydrology	Final Site Drainage by State/APL Program.
	7-755-00	Site Drainage	Drainage from contaminated areas will be directed into Spook Pit during construction, same as existing site conditions.
	---	State/APL Calculations	
4.3.13 Geotechnical	7-730-00	Settlement	Total settlement at top of APL backfill is approx. 12.3 inches, of which 4.8 inches is long term settlement.
4.3.14 Low-Permeability Layer	---	Draft RAP	Thickness of 1.5 feet with Hydraulic Conductivity of between 1×10^{-7} and 1×10^{-8} cm/sec. or less. The State/APL backfill placed over the low-permeability layer will be a high permeability granular material (not specifically addressed in the APL preliminary design).
4.3.15 Radon Barrier	7-720-01	Radon Barrier	Calculations indicate that no radon barrier layer required.

<u>Design Detail or Criteria</u>	<u>Calculation No.</u> +	<u>Title</u>	<u>Remarks</u>
4.4 Construction	—	Draft RAP	LMTRA construction of the tailings embankment will run concurrently with the State APL backfilling of the Spool Pit. All structures will be demolished and placed in the tailings pile.

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: General 1, Integration of UMTRCA and AML Activities

NRC Staff are concerned regarding the affect AML program activities may have on the ability of proposed remedial action for Spook to meet UMTRA requirements. While the draft RAP refers to the AML design, it is not clear what aspects of the AML design will be relied on to meet UMTRA requirements, or that adverse impacts have been evaluated and considered in DOE's design.

DOE needs to describe the relationship between the UMTRCA and AML program designs and address the following questions: (continued)

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: General 1, Integration of UMTRCA and AML Activities

How does DOE plan to assure that the AML activities are conducted as specified in the design, and not adversely impact the stabilized tailings pile?

SECTION 2

Response: General By: E. Banks
Date: February 4, 1988

The AML preliminary design will be incorporated into the DOE preliminary design. Construction specifications for the AML work will be similar to those of the DOE portion of the project. The QA procedures for AML items which may adversely impact the stabilized tailings pile, such as compaction requirements for the overburden, will meet the requirements established for the UMTRA Project.

Plans for Implementation:

The QA procedures and design features of the AML activities will be presented in the AML construction specifications. The UMTRA specifications will highlight the additional QA procedures needed above and beyond those required by the AML Program.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____
Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: General 1(b), Integration of UMTRCA and AML Activities
(Continued)

Low- and high-permeability layers. How will the interface between the
low- and high-permeability layers be constructed to ensure that there is a
path for water collected in the high-permeability layer will flow away
from the tailings? How will DOE assure that placement of the high-
permeability layer does not adversely affect the stabilized pile or low-
permeability layer? What advantage does DOE plan to derive from the
high-permeability layer, if any?

SECTION 2

Response: General By: J. McBee
Date: February 2, 1988

Based on an evaluation performed subsequent to the release of the draft EA and draft RAP, the high permeability layer will be removed from the design.

Plans for Implementation:

The preliminary design will indicate that the high permeability layer has been removed from the design.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____
Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: General 1(c); Integration of UMTRCA and AML Activities

Backfill of mine tunnels. Which program is responsible for backfilling the mine tunnels and what impacts (positive or negative) could that action have on long-term stability of the tailings pile and groundwater protection?

SECTION 2

Response: General By: J. McBee
Date: February 1, 1988

DOE is responsible for backfilling the mine tunnels and the backfilling is part of the proposed remedial action. Potential negative impacts (if the tunnels were not backfilled) could occur from deterioration of the rock above the tunnels leading to progressive stoping and breakage of rock to the surface. These collapsed zones could then act as conduits for surface water infiltration to the stabilized pile.

Plans for Implementation:

The preliminary design details and construction specification will clarify the responsibility for the mine tunnels.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____
Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: General 1(d and e), Integration of UMTRCA and AML Activities

Overburden material. (c) What benefit does DOE plan to derive from the proposed AML backfill cover (i.e. radon diffusion and/or erosion protection)? Since AML is responsible for conducting this activity, how does DOE plan to assure that the backfill cover will be placed as designed? Has the concentration of radium in the cover material been considered in calculating the radon flux for design of the radon barrier?

SECTION 2

Response: General By: E. Banks/Schmidt
Date: January 26, 1988

- (d) The AML backfill cover will provide a radon barrier and erosion protection for the UMTRA tailings. The AML Program will provide QA during placement to ensure the material is placed as proposed in the final design. Where the AML QA is less than the efforts required by the DOE, the DOE will support additional QA inspection as appropriate.
- (e) The concentration of radium-226 in the (AML) cover materials were assumed to be zero in the radon barrier design calculations. This follows the EPA standards in 40CFR 192.02(b)(1) footnote 5.

Plans for Implementation:

The QA requirements for both the AML and UMTRA programs will be defined in the construction specifications.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____
Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: Geology 1, Site Erosion by Tributary Headcutting
Pages D-36 and D-37

This section of the draft RAP and Figure D.3.11 depict headcutting by tributaries which would lead to erosion of the stabilized tailings. The staff agree that lateral erosion and headcutting by tributaries of Dry Fork appear to be the only significant geomorphic hazards associated with the pit-disposal option. In the staff's opinion, however, DOE's predictions of future erosion do not appear to be based on conservative assumptions and analyses.

Figure D.3.11 shows a model of future channel headcutting into the disposal area from the site's main wash. The analysis assumes that the channel will naturally adopt a slope similar to that of the soil-bedrock contact, approximately 0.076. As a result, it shows that erosion in the main wash would need to exceed 50 feet to expose the tailings. In addition, DOE states that a resistance of the Wasatch Formation is likely to prevent erosion beyond a 35 to 40 foot depth.

The slope gradient of 0.076 is extremely steep for a channel and no justification has been provided to show that it is reasonable. Staff analysis indicates that a more shallow slope, such as 0.030, would expose the tailings with only 21 feet of downcutting in the main wash. Lateral and vertical erosion will occur entirely in backfill, will not be controlled by bedrock, and will likely result in release of the tailings earlier than anticipated from DOE's analysis.

DOE should revise the erosion protection analysis for this site using more conservative assumptions, or should justify the adequacy of the current analysis.

UMTRA DOCUMENT REVIEW FORM

SECTION 2

Response: Pages D-36 & D-37

By: G. Lindsey

Date: February 4, 1988

Figure D.3.11 was intended to show the depth of incision of the main channel and of a theoretical tributary through the pile area which would be required in order for the tailings to be exposed (Point "I"). It was not intended to represent future channel headcutting. It was a projection to show that substantial soil and bedrock incision would have to occur before the lateral channel would expose the tailings and therefore demonstrate the extreme unlikelihood that the pile would be exposed.

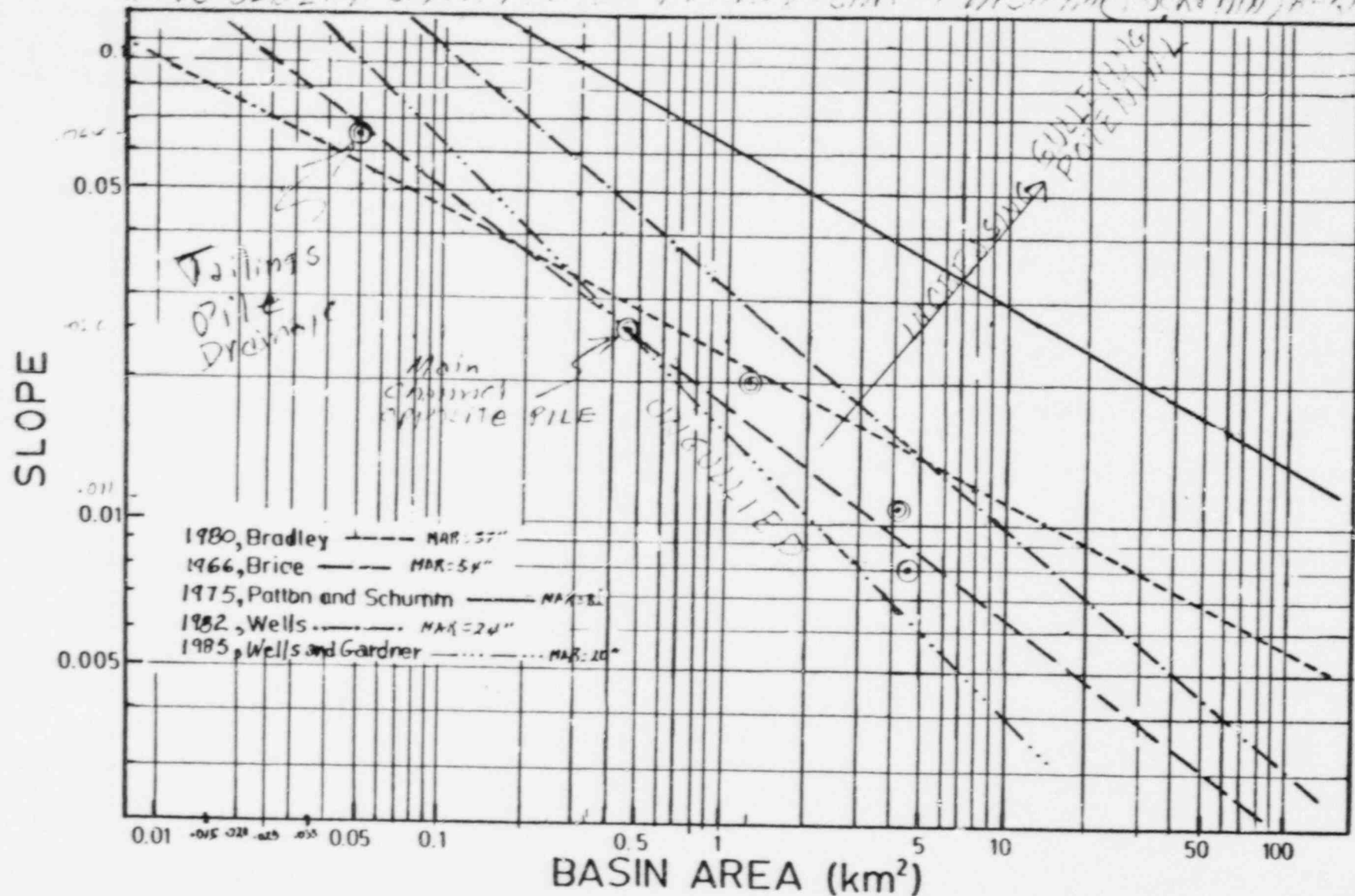
For clarification, the figure will be revised to show only that the top of the pile will be lower than the bottom of the channel, 5074 feet compared with 5075 for the channel bottom. The figure will also show that a basin tributary with a slope of .030 could not come closer than 25 feet to the top of the pile. The attached Response Figure 1 illustrates that a slope of .030 has a low gully potential and will therefore not expose the tailings pile.

From the threshold slopes on the Response Figure 1, a tributary subbasin across the covered pile (backfilled pit), with a basin area of .05 km² would be stable or ungullied with a slope of 0.050 feet/foot. The area/slope curve for the Spook basin from its confluence with Dry Fork to the lateral drainage across the disposal site is in the lower range of the thresholds shown by Response Figure 1 for basins which have substantially higher mean annual rainfall than the Spook site.

Response Figures 2A and 2B shows the basin and slope calculations for the Spook site which were used to plot the curve on Figure 1. The Report of Investigation, as referenced in the draft RAP (Hydro-Engineering, 1987), shows the design for reconstructed drainage across the site. The contouring of the pit backfill will be refined by Hydro-Engineering in their preliminary design to "blend" with the existing topography and to stay below the slope threshold velocity (i.e., maintain sheet flow across the backfilled pit) (Nelson, et. al., 1986).

Reference: Nelson, J.D., S.R. Abt, R. L. Volpe, D. Van Zyl, N. E. Hinkel and W.P. Staub, 1986. "Methodologies for Evaluating Long-Term Stability Design of Uranium Mill Tailings Impoundments," prepared for by the Division of Waste Management, U.S. DOE, Washington, DC by Colorado State University, Fort Collins, Colorado.

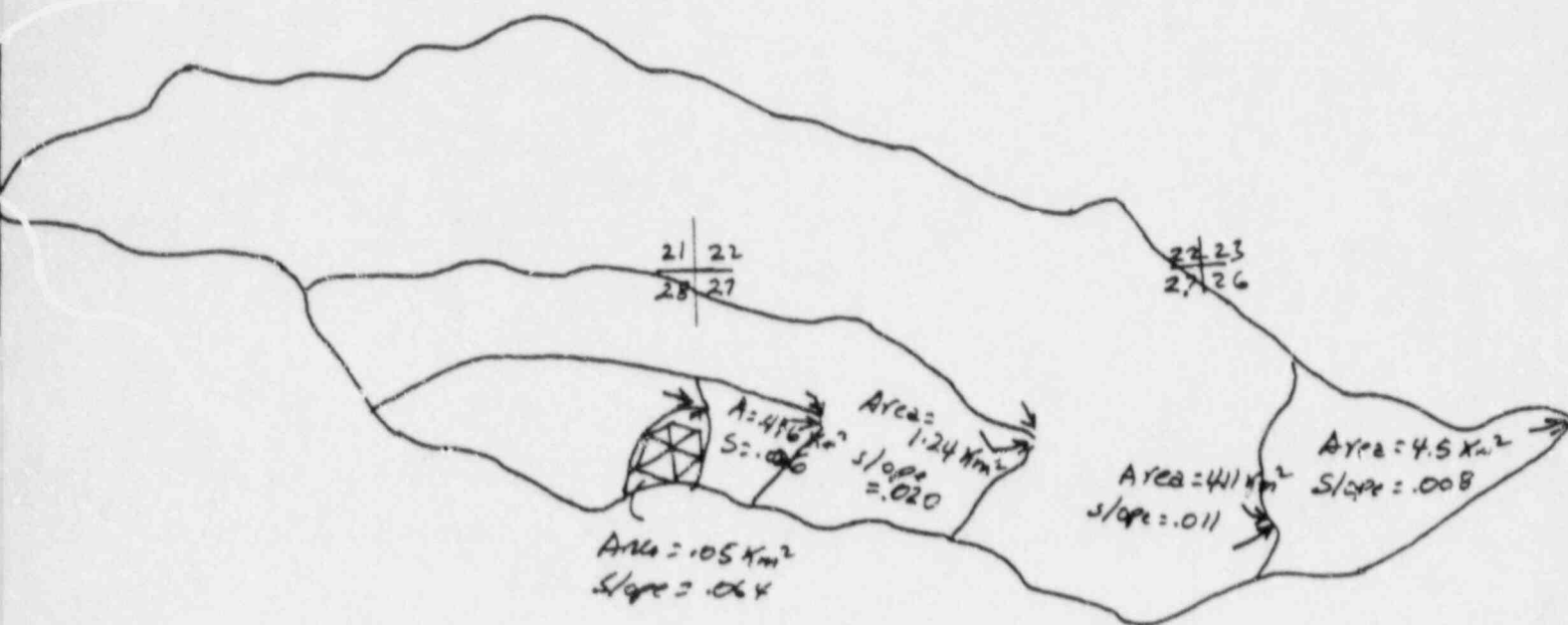
PLOT OF CROOK SITE BASIN: SLOPE VS. DRAINAGE AREA CHART FOR COMPARISON WITH
THRESHOLD LIMITS AND DISCRIMINANT FUNCTION LINES IN WESTERN (CROOK MOUNTAIN) REGION OF N.C.



Relation between valley floor slope and drainage basin area, illustrating the effect of lithology on this relationship. Lines are based on discriminant function analyses.

Modified from Wells and Gardner, 1985

RESPONSE FIGURE 1



Scale $1" = 2000 \text{ Feet}$

RESPONSE
FIGURE 2 A
SPOOK SITE
Drainage Basins

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: Surface Water Hydrology 1, Stabilization of Abandoned Mined Lands Cover

The intent of the remedial action and AML design, as presented in the draft RAP (pages 60-67), is to promote positive drainage from the cover in order to prevent ponding and limit the amount of infiltration into the tailings. The cover design, as presented in "Report of Investigation, Abandoned Mined Lands Program 15-3" (Hydro-Engineering, 1987), includes a vegetated earth cover surrounded by diversion ditches. The staff does not consider the proposed cover adequate to minimize erosion, ponding, and infiltration. Furthermore, we conclude that DOE has not demonstrated the effectiveness of the design for 1000 years with respect to stability and groundwater quality.

First, the ditches for diversion of flood flows around the pit are designed for 2.4 inches of precipitation in one hour, which is purported to be a 1000-year event. This value is apparently based on extrapolation of the precipitation data base for Wyoming, however, it is extremely doubtful that this data base is sufficient to perform the extrapolations necessary to determine a meaningful 1000-year event. In addition, it appears unlikely that the estimate actually represent a 1000-year event, based on comparison of the one-hour, 1000-year rainfall (2.4 inches) to the one-hour probable maximum precipitation (PMP), which is approximately 14 inches (see Hydrometeorological Report (HMR) 55, Plate 16). Therefore, it appears that a value much large than 2.4 inches should be adopted as the design rainfall.

SECTION 2

Response: Hydrology 1 By: J. McBee
Date: February 4, 1988

The drainage channels around the remediated area are not ditches designed to divert flood flows, but are part of reconstructed drainages to re-establish natural (pre-mine) conditions at the site (see Section 7.1.1, Hydro-Eng. 1987). The channels were designed to carry low-flow events, five-year one hour storms or less. Larger events with longer recurrence intervals will cause overbank flow but will remain in the constructed

UMTRA DOCUMENT REVIEW FORM

SECTION 2 (Concluded)

swales (Section 9.2, Hydro-Eng. 1987). The 1000-year design event has a recurrence interval significant enough to have an impact on the geomorphological evolution of ephemeral streams in the area and was used for design purposes. A large event such as the PMP will cause some erosion of the channel but by definition has an extremely long recurrence interval (on the order of one-million years). A PMF, using a PMP of 14 inches, on the nearest reconstructed drainage to the tailings pile area will not come within 400 feet laterally of the tailings under the present design. The methodologies used in estimating the 2.4 inches for the 1000-year event are common engineering practice.

Plans for Implementation:

The commentor is referred to the Report of Investigation prepared for the AML Program by Hydro-Engineering. The drainage design is discussed in detail in this document.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____

Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: Surface Water Hydrology 1, Stabilization of Abandoned Mined Lands Cover

Second, the proposed soil cover is to be protected only by vegetation. Since a vegetative cover is unlikely to be self-sustaining in the arid climate of Wyoming, the staff questions whether such a cover can prevent gullyng due to concentration of runoff during major precipitation events. The sheet flow assumption used in this design is likely to be invalid if flow concentration occurs. Gullyng will likely disrupt the cover, possibly allowing ponding, erosion, and increased infiltration in areas directly above the tailings.

SECTION 2

Response: Hydrology 1 By: E. Banks
Date: February 24, 1988

See response to comment titled, "Geology 1, Site Erosion by Tributary Headcutting," pages D-36 and D-37.

Plans for Implementation:

See "Plans for Implementation" for the referenced comment.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____
Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: Surface Water Hydrology 1, Stabilization of Abandoned Mined Lands Cover

DOE should provide a revised cover design and should justify that the design meets the EPA criteria established in 40 CFR 192. Factors that DOE needs to thoroughly address include the impacts of extreme flood events on the cover and ditches; the potential for flooding, if ditches fail; the impacts of gully growth on the integrity of the tailings pile; and the impacts of increased infiltration on groundwater. A rock cover and rock-protected diversion channels, designed in accordance with past UMTRA practice, may provide an acceptable approach.

SECTION 2

Response: Hydrology 1 By: E. Banks
Date: February 24, 1988

The impacts of flooding and erosion on the pit backfill have been addressed in previous comments (Geology 1 and Surface Water Hydrology 1). The impact of infiltration on the groundwater will be addressed in the draft EA and preliminary design.

Plans for Implementation:

None.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____
Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC
Comment: Geotechnical Engineering 1, Constructability of
Low-Permeability Cover, pages 70-73

In the draft RAP, DOE proposed to stabilize the tailings in a pile approximately 30 to 50 feet high with a side slope of 50 percent gradient (2 horizontal to 1 vertical). This pile will be covered with a 1.5 feet thick layer of low-permeability material. In order to achieve the desired permeability, DOE proposes to compact this cover material to a minimum dry density 95 percent of the maximum dry density determined using the ASTM D 698 test method. NRC staff is concerned regarding constructability of the proposed low-permeability layer.

DOE should evaluate the potential problems associated with placing the material in 6 or 8 inches thick layer, operating the compaction equipment on a 50 percent slope, and compacting the material to attain the coefficient of permeability value assumed in the design.

SECTION 2

Response: Pages 70-73 By: J. McBee
Date: February 1, 1988

Placement problems such as those described in the comment could occur. However, the AML and DOE remedial actions will be performed by one contractor. Although the actual construction sequence will be determined by the subcontractor, it is anticipated that there will be concurrent placement of the tailings, cover, and overburden materials overlying the cover. This construction scenario will ensure that the design specifications can be met.

Plans for Implementation:

None.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____

Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: Geotechnical Engineering 2, Low-Permeability Cover Material
Page 73

This section of the draft RAP states that the alluvial soil (clayey sand) available in the overburden piles at the site will be used for the low-permeability cover. There is a very little data, other than sieve analysis data, to support the draft RAP statements on the expected coefficient of permeability for this material. In addition, the draft RAP states that the low-permeability cover over the stabilized pile will have a maximum coefficient of permeability of $1E-7$ cm/sec. However, the Hydro-Engineering report on work proposed by AML indicates that the low-permeability cover material is expected to have a coefficient of permeability of $1E-6$ cm/sec (Hydro-Engineering, pages 5-12).

DOE needs to determine the actual coefficient of permeability for this material, based on appropriate laboratory and field testing, and justify the assumptions used for the design of the low-permeability cover.

SECTION 2

Response: Page 73 By: J. McBee
Date: February 3, 1988

Comment acknowledged. Geotechnical testing results of the low-permeability borrow materials were not available at the time of issuance of the draft RAP. Grain size distribution, saturated permeability, and capillary moisture tests were performed on the materials. The saturated permeability test result was 7.5×10^{-8} cm/sec at 95 percent standard Proctor compaction, which is lower than the design permeability of 1×10^{-7} cm/sec. The grain-size distribution of this sample compares well with other samples from the proposed borrow overburden pile and we feel that the design value is achievable.

Plans for Implementation:

The referenced laboratory test performed on the low-permeability borrow material will be included in the final RAP.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____
Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: Geotechnical Engineering 3, Slope Stability Evaluation,
Pages 68 and 69.

For the evaluation of slope stability, most design parameters were assigned, and conservatism of these values demonstrated, using a parametric analysis. This was noted in #SPK-06-87-U3-U1-00 (page 1-3) of the calculations provided by DOE in support of the draft RAP. Although this approach is acceptable at the draft RAP phase, these design parameters will need to be supported by test data to assure that they are adequate when used in the preliminary design.

SECTION 2

Response: Page 68 and 69 By: J. McBee
Date: February 3, 1988

The short-term slope stability analyses performed assumed that the DOE remedial action would be separate from the AML construction and the constructed pile would have 2:1 sideslopes. It has been decided between the two agencies that construction will be concurrent and performed by one contractor. Although the actual construction sequence will be determined by the contractor, we anticipate a construction scenario in which an outer zone of tailings and the low-permeability cover will be placed concurrently with the overburden backfill. Since the overburden will be placed in the pit, concurrently with the tailings and cover system, the slope stability of the tailings pile will be significantly more stable than the parametric analysis originally showed and further testing will not be required.

Plans for Implementation:

None.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____
Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: Geotechnical Engineering 4, Seismic Stability, pages 64-65

The draft RAP states that the seismic coefficient of 0.09 was assumed in evaluation of seismic slope stability, performed using the pseudo static method of analysis. However, a minimum seismic coefficient of 0.1 is recommended in the TAD (DOE, 1986, page 67). In addition, the seismic coefficient of 0.09 was calculated based on a maximum peak horizontal acceleration (PHA) of 0.16g (draft RAP, Vol. 2, page D-24), while the calculations provided in support of the draft RAP assume a seismic coefficient of 0.105 based on a PHA of 0.21g (stability calculations, page 2 of 16).

DOE should explain why a seismic coefficient has been assumed that is less conservative than that recommended in the TAD. Also the discrepancy between the PHA and seismic stability values presented in the draft RAP and supporting calculations needs to be resolved.

SECTION 2

Response: Pages 64-65 By: G. Lindsey/E. Banks
Date: February 4, 1988

The design earthquake is a floating earthquake of magnitude 6.2 at a radial distance of 15 km (9.3 miles), which results in a peak horizontal acceleration of 0.21 g. Accordingly, the seismic coefficient is derived as one-half the long-term analysis of .21 g, or .105 g.

Plans for Implementation:

The final RAP will be corrected to include the design earthquake of 0.21 g and the seismic coefficient of .105 g.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____
Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: Geotechnical Engineering 5, Stability of the East Pit Wall,
Figure 4.2, pages 70 and 81

The draft RAP does not address the sequence of moving the tailings material from the east wall of the Spook pit. The stability of the pit wall should be evaluated, especially if DOE plans to remove the tailings from the foot of the wall (i.e. material inside the pit adjoining the east wall) while the tailings remain on the top of the east wall bank.

SECTION 2

Response: Pages 70 and 81 By: J. McBee
Date: February 3, 1988

The draft RAP did not address the sequence of moving the tailings from the east wall of the Spook pit because that will be left up to the discretion of the subcontractor. Other high-walls of the Spook pit have remained vertical since mining operations and are apparently stable. However, he will be working under OSHA regulations that will ensure worker safety.

Plans for Implementation:

Ensure that the construction specifications require that OSHA regulations be observed during construction.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____
Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: Geotechnical Engineering 6, Extent of the Buffer Zone, Page 25

The draft RAP recommends acquiring a 100 foot wide buffer zone around the edges of the Spook pit to protect the stabilized pile against intrusion during future mining activities. The Hydro-Engineering report for the AML program recommends the use of benches in the pit wall (Hydro-Engineering, Figure 9-19) for placing the fill material. DOE should consider the effect this may have on the width of the buffer zone.

A statement on page D-38 of the draft RAP indicates that the proposed 100 foot buffer zone will be around the tailings impoundment rather than around the Spook pit. This discrepancy should also be clarified.

SECTION 2

Response: Page 25 By: J. McBee
Date: February 3, 1988

The 100-foot wide buffer zone discussed in the RAP was intended to be from the edges of the entire Spook pit and not just from the tailings pile boundary (DOE portion of the remedial action). The bench referred to in the Hydro-Engineering report will be approximately 20 feet or less in width at the surface and, therefore, would not affect the 100-foot buffer zone width.

However, as stated in DOE's transmittal of April 4, 1988, strategy for disposal site acquisition has changed since the draft EA and draft RAP were issued. The current plans are to acquire surface rights for most of the pit (the northern portion of the pit will not be acquired) and subsurface rights for a 200-foot buffer zone around the pit. This new strategy would be presented in the final RAP.

Plans for Implementation:

The final RAP will be revised to reflect current acquisition strategy.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____

Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: Geotechnical Engineering 7, Water Table Relative to Tailings, Figure 4.2, page 56

The draft RAP (page 36) states that the bottom of the stabilized tailings will be 30 feet above the water table. Figures 3.7, 3.10, and 3.11 show the water table to be between elevations 4980.0 and 5000.0 feet and Figure 4.2 shows the bottom of the stabilized tailings at 5025.0 feet, but does not show the water table. In contrast, Figure D.3.6 shows the water table to be approximately 10 feet below the existing pit bottom. This inconsistency needs to be resolved. In addition, the water table should be included in Figure 4.2 to show the elevation of the stabilized tailings in relation to the groundwater level.

SECTION 2

Response: Page 56 By: L. Banks
Date: February 8, 1988

The groundwater levels presented in Figure 3.7 are unsurveyed, and are therefore approximate levels as determined by the field engineer during test pit excavation. The water levels presented in Figures 3.10 and 3.11 are from three different systems, as discussed in Section 3.5, which may vary up to 20 feet. The water level in the upper system which is the closest to the tailings pile, is approximately 5005 feet (September 1987). This elevation is also presented in each of the figures. The base of the stabilized pile will be at 5025, approximately 20 feet above the water level of the upper system.

UMTRA DOCUMENT REVIEW FORM

SECTION 2

Plans for Implementation:

The water level will be added to Figure 4.2 in the final RAP. Any adjustments to the water levels as a result of additional sampling and surveying done since the draft RAP will also be included in the final RAP. The final RAP will be corrected to state the stablized tailings pile will be 20 feet above the water table, not 30 feet.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____

Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: Geotechnical Engineering 8, Geotechnical Data,
Figure 3.6, page 28

Figure 3.6 presents a cross section of the tailing stratigraphy but does not show the geotechnical data points (test pits and borings) used in its development. This figure should be revised to show these data points, and also to include the ground-water level for reference.

SECTION 2

Response: Page 28 By: J. McBee
Date: February 2, 1988

Comment acknowledged.

Plans for Implementation:

Figure 3.6 will be revised for the final RAP.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____

Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987

Document: Draft Remedial Action Plan

Commentor: NRC

Comment: Geotechnical Engineering 9,

Please include a location map of test pits 031-050.

SECTION 2

Response: _____ By: J. McBee

Date: February 2, 1988

See Figure 3.5, Page 27.

Plans for Implementation:

None.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____

Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987

Document: Draft Remedial Action Plan

Commentor: NRC

Comment: Geotechnical Engineering 9,

Please include a location map of test pits 031-050.

SECTION 2

Response: _____

By: J. McBee

Date: February 2, 1988

See Figure 3.5, Page 27.

Plans for Implementation:

None.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____

Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: Geotechnical Engineering 10, Addendum D.3

Please include ground surface elevations for the borings shown in addendum D.3.

SECTION 2

Response: Addendum D.3 By: J. McBee
Date: February 2, 1988

Ground surface elevations were not taken during the location surveys and are therefore not available. The elevations can be estimated from the location map using the topographic information.

Plans for Implementation:

None.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____
Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987
Document: Draft Remedial Action Plan
Commentor: NRC

Comment: Geotechnical Engineering 11, Page D-18

Reference is made to "10 CFR 40." Should this be 40 CFR 192?

SECTION 2

Response: Page D-18 By: E. Banks
Date: February 8, 1988

Comment acknowledged.

Plans for Implementation:

"10 CFR 40" will be changed to "40 CFR 192" in the final RAP.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____

Approved by: _____, Date: _____

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Spook, Wyoming, Date: October 16, 1987

Document: Draft Remedial Action Plan

Commentor: NRC

Comment: Geotechnical Engineering 12, Page D-55, Figure D-3.11.

On drainage profile A-A' point 1 is shown at elevation 5075. The basin channel bottom point is also shown at elevation 5075. It appears like point 1 should actually be shown at about elevation 5020, not at elevation 5075.

SECTION 2

Response: Page D-55 By: E. Banks

Date: February 4, 1988

Comment acknowledged. Figure D-3.11 will be revised and point "I" will be removed from the figure (see response to NRC comment Geology 1, "Site Erosion by Tributary Headcutting").

Plans for Implementation:

Figure D-3.11 will be corrected in the final RAP.

SECTION 3

Confirmation of Implementation:

Checked by: _____, Date: _____

Approved by: _____, Date: _____

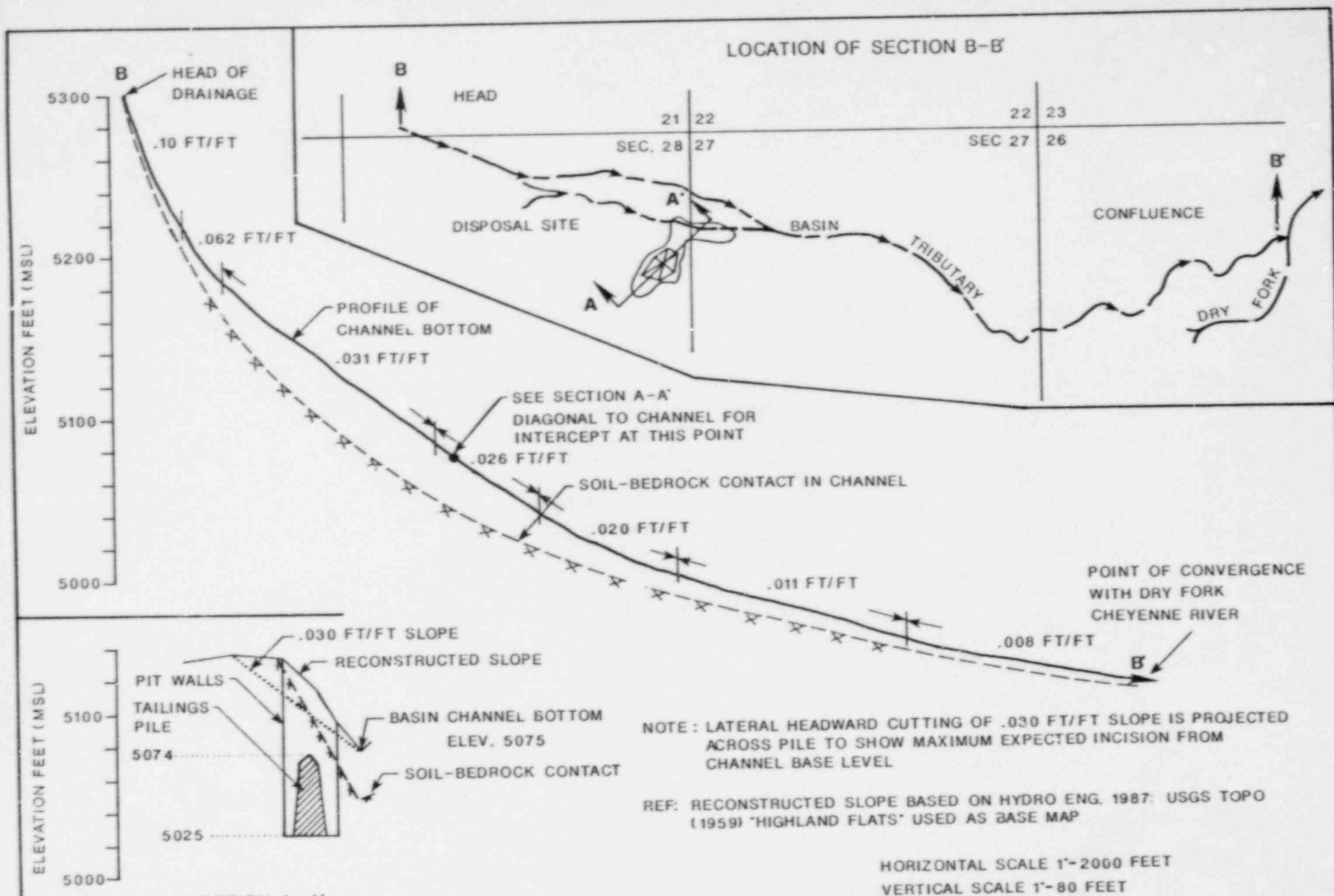


FIGURE D.3.11

SITE SUBBASIN DRAINAGE PROFILE AND RELATIONSHIP OF BEDROCK DEPTH TO CHANNEL INCISION
SPOOK SITE - CONVERSE COUNTY, WYOMING