ATTACHMENT I

Typical SEDIMOT II Inputs

For Life-of-Mine Sedimentation Ponds

Typical SEDIMOT II Input

Sediment Ponds (Life-of-Mine)

Card Code	Parameter	Input
1	Watershed Identification	--
2	Storm Type	2 (SCS Type II Storm)
	No. of Depth Time Values	2
3	Rainfall Depth (inch)	2.10 (10-yr, 24-hr storm)
	Storm Duration (hr)	24.0
	Storm Time Increment	0.1
	Max. 30 Min. Intensity	1.0
4	Number of Junctions	1
	Hydrology and Sedimentology	2 (Hydrology and Sedimentology)
5	Number of Branches per Junction	1
6	Specific Gravity	2.5
	Coeff. for Distributing	
	Sediment Load	1.5
	Submerged Bulk Specific Gravity	1.5
7	No. of Particle Size Distributions	1
	No. of Data Values per Distribution	15
8	Particle Size (1)	- -
	Particle Size (2)	- -
	Particle Size (3)	- -
	Particle Size (4)	- -
	Particle Size (5)	- -
	Particle Size (6)	- -
	Particle Size (7)	- -
	Particle Size (8)	- -
	Particle Size (9)	- -
	Particle Size (10)	- -
	Particle Size (11)	- -
	Particle Size (12)	- -
	Particle Size (13)	- -
	Particle Size (14)	- -
	Particle Size (15)	- -

Typical SEDIMOT II Input

Sediment Ponds (Life-of-Mine)

Card Code	Parameter	Input	
9	Percent Finer (1)	- -	
	Percent Finer (2)	- -	
	Percent Finer (3)	- -	
	Percent Finer (4)	- -	
	Percent Finer (5)	- -	
	Percent Finer (6)	- -	
	Percent Finer (7)	- -	
	Percent Finer (8)	- -	
	Percent Finer (9)	- -	
	Percent Finer (10)	- -	
	Percent Finer (11)	- -	
	Percent Finer (12)	- -	
	Percent Finer (13)	- -	
	Percent Finer (14)	- -	
	Percent Finer (15)	- -	
10	Number of Structures per Branch	1	
11	Travel Time Between Structures (hr)	0.0	
	Muskingums k Between Structures (hr)	0.0	
	Muskingums X Between Structures (hr)	0.0	
12	Number of Subwatersheds per Structure	1	
	Type of Sediment Control Structure	1	(Null Structure)
	Print Control Variable for Total Drainage	2	(Hydrograph)
	Print Control Variable for Between Structures	2	(Hydrograph)
	Print Option for Subwatershed	1	(Input Tables)
13	Subwatershed Area (Acres)	- - -	
	Curve Number	- - -	
	Time of Concentration	- - -	
	Travel Time (to Structure)	0.0	
	Muskingum's k (to Structure)	0.0	

Typical SEDIMOT II Input

Sediment Ponds (Life-of-Mine)

Card Code	Parameter	Input
13	Muskingum's X (to Structure)	0.0
	Hydrology Print Option	1.0 (Input Tables)
	Hydraulic Surface Conditions	- -
	Number of Flow Segments	0.0

ATTACHMENT J

Review Reports - MSHA Sedimentation

Structure N14-F

REVIEW REPORT

Sedimentation Structure

N14-F

Kayenta Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

TABLE OF CONTENTS

INTRODUCTION

Sedimentation Structure N14-F is a zoned earthen embankment, designed and constructed by Peabody Coal Company. This report reviews the hydrology and hydraulics of the structure. Geotechnical aspects were not assessed.

INSPECTION

Structure N14-F was not inspected by Dames & Moore.

SITE DESCRIPTION

LAND USE

Structure N14-F has a 376-acre tributary drainage area and is located near Moenkopi Wash at the Kayenta Mine. The watershed is classified as 100% reclaimed.

EMBANKMENT

Structure N14-F is a zoned earthen embankment classified as an MSHA structure. Physical characteristics of the embankment were not measured.

ANALYSES

STABILITY

The stability of Structure N14-F was not analyzed.

HYDROLOGY

The hydrologic analysis was completed using the U.S. Army Corps of Engineers generalized computer program HEC-1, Flood Hydrograph Package. Structure N14-F is not in series with any other structure. However, it is an MSHA structure and therefore the spillway was analyzed using the 100-year, 6-hour storm. The storage capacity of Structure N14-F was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.871	mi
2.	Elevation Difference, H	230	ft
3.	Time of Concentration, T_c	0.272	h
4.	Lag time, $0.6T_c$	0.164	h
5.	SCS Curve Number	81	
6.	Rainfall Depth, 10-year, 24-hour storm .	2.1	in.
	100-year, 6-hour storm. .	2.4	in.
7.	Drainage Area	376	acres

HYDRAULICS

The HEC-1 program was used to evaluate inflow to the sedimentation structure, outflow from the structure and the resulting water surface elevations. The initial conditions and results of the analysis are summarized in the following table.

N14-F HYDRAULICS

	Units	10-year 24-hour Storm	100-year 6-hour Storm
Initial Reservoir Volume Condition		Empty	6655.00
Inflow			
Peak Flow	cfs	310	617
Volume	acre-ft	20.37	26.01
Storage			
Peak Stage	ft	6650.14	6659.73
Spillway Elevation . .	ft	6659.70	--
Peak Storage	acre-ft	20.37	--
Storage Capacity . . .	acre-ft	61.11	--
Outflow			
Peak Flow	cfs	0	30
Embankment Crest Elevation	ft	--	6661.20
Peak Stage	ft	--	6659.73
Freeboard	ft	--	1.47
Spillway Channel			
Flow Depth	ft	--	0.03
Manning's "n"		--	0.040

Spillway Channel

The existing spillway for N14-F has a trapezoidal channel with the following dimensions:

Channel depth	1.5	ft
Channel width	350	ft
Channel length	110	ft
Side slopes (horizontal to vertical). .	50:1	
Average exit slope	0	percent

STORAGE CAPACITY

The impoundment volume-elevation curve is based on site specific surveys conducted for Peabody Coal Company's August 1984 inspection, and 1985 resurveys, where available. Additionally, the most current topographic maps available were used.

The calculations for the sediment load entering Structure N14-F were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.042
3. Slope Factor, LS 1.69
4. Cover Factor, C 0.15
5. Erosion Control Factor, P 1.0

The hydrologic analysis gives the storage volume required to contain the 10-year, 24-hour storm, and the remaining storage volume available for storing sediment. The existing storage capacity of N14-F and the results of the sediment inflow analysis are summarized in the following table.

N14-F STORAGE

Total Storage Capacity	61.11 acre-ft
10-year, 24-hour Storm Inflow	20.37 acre-ft
Available Sediment Storage Capacity . .	40.74 acre-ft
Sediment Inflow Rate	1.23 acre-ft/yr
Sediment Storage Life	33 yrs

* * *

The following appendix is attached and completes this report.

Appendix A - Hydrology and Hydraulic Calculations

APPENDIX A

HYDROLOGY AND HYDRAULIC CALCULATIONS

REVISIONS BY ___ DATE ___ TO EO ___
BY ___ DATE ___ TO EO ___

Time of Concentration

Elevation Difference = 6965 − 6658 = 307 ft. ✓

Water Course Length = 12.0(400) = 4800 ft. = 0.909 mi. ✓

$$T_c = \left(\frac{11.9\,(0.909)^3}{307}\right)^{0.385} = 0.256 \text{ hr} ✓$$

Lag Time = $0.6T_c$ = 0.154 hr. ✓

SCS Curve Number

Drainage Area (ac)	Cover Type	Hydrologic Condition	Soil Type	Weighted Curve Number
376.0	RECL	fair	EH #35	#81 (1.00)

100% EH #35

Drainage Basin Area

376.0 ACRE   0.588 SQ MILE ✓

BY ___ DATE ___
CHECKED BY RHM 11/5/85
COPY TO EO ___

Universal Soil Loss Equation

Rainfall Factor

R = 40

Soil Erodibility Factor

Soil Type = 100% EH #35 = 0.42

K = 0.42

Slope Factor

Length (ft.)	ΔElev (ft.)	Slope (%)	LS
500	25	5%	1.20 (.50)
650	120	18%	9.39 (.20)
350	25	7%	1.59 (.30)

LS = 2.96

Cover Factor

Area (ac)	Cover Type	% Cover	Canopy (%)	Weighted C
100%	Reclaimed	—	—	0.15 (1.00)

Erosion Control Factor

P = 1.0

Sediment Inflow

A = 40 (0.42) (2.96) (.15) (1.0) = 7.46 ton/acre/year

A = 7.46 $\left(\frac{1}{2047}\right)$ (376.0) (0.9) = 1.23 acre-feet/year

ATTACHMENT K

1985 Peabody Inspection of

MSHA-Sized Dams

Sediment Impoundment Name: KM-FW POND
Page: ID #1211-AB-9-0001

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			
a. Adequate grass cover?	X		
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?			N.A.
g. Any stone deterioration?			N.A.
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			
a. Adequate grass cover?	X		
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Visual depressions or bulges?		X	
g. Visual settlements?		X	
h. Is the toe drain dry?	X		
i. Are the relief wells flowing?			NA
j. Are boils present at the toe?		X	
k. Is seepage present?		X	
l. Animal burrows?		X	
4. ABUTMENT CONTACT. RIGHT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Sandy Silt
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?		X	
b. Visual differential movement?			
c. Any cracks noted?			
d. Is seepage present?			
e. Type of Material?			Sandy Silt

Sediment Impoundment Name: KM - FW POND
Page: S.I.D.# 1211-AZ-9-0001

ITEM	YES	NO	REMARKS
6. SPILLWAY NORMAL			
a. Location:			
Left abutment?			
Right abutment?			
Crest of Embankments?	X		12" CMP
b. Approach Channel: NA			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel: NA			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
d. Outflow Channel:			
Are side slopes eroding?	X		
Are side slopes sloughing?	X		
Bottom of channel eroding?	X		
Obstructed?		X	
Erosion protection?		X	
e. Weir: NA			
Condition?			
7. SPILLWAY/EMERGENCY			
a. Location:			NONE
Left abutment?			
Right abutment?			
Crest of Embankments?			
b. Approach Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
d. Outflow Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
e. Weir:			
Condition?			

ITEM	YES	NO	REMARKS
8. IMPOUNDMENT			
a. Sinkholes?		X	(Elev.) feet
b. Water present?	X		(Elev.) 6615.6 feet
c. Siltation?		X	
d. Watershed matches ~~soil~~ drainage map?	X		

9. GENERAL COMMENTS

Inflow controlled by pump.

Sediment Impoundment Name: J-7 DAM
Page: 4ID.1211-AZ-9-0003

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			
a. Adequate grass cover?	X		
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?			NA
g. Any stone deterioration?			NA
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			
a. Adequate grass cover?	X		
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Visual depressions or bulges?		X	
g. Visual settlements?		X	
h. Is the toe drain dry?	X		
i. Are the relief wells flowing?			NA
j. Are boils present at the toe?		X	
k. Is seepage present?		X	
l. Animal burrows?		X	
4. ABUTMENT CONTACT. RIGHT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?	X		≅ 5 gpm, Clear
e. Type of Material?			Sandstone Outcrop
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?	X		≅ 10 gpm, Clear
e. Type of Material?			Sandstone Outcrop

ITEM	YES	NO	REMARKS
6. SPILLWAY NORMAL			
a. Location:			
Left abutment?			3-160" CMP'S
Right abutment?			
Crest of Embankments?			
b. Approach Channel:	X		
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
c. Spillway Channel:			NA
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
d. Outflow Channel:	X		
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
e. Weir:			NA
Condition?			
7. SPILLWAY/EMERGENCY			
a. Location:			None
Left abutment?			
Right abutment?			
Crest of Embankments?			
b. Approach Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
d. Outflow Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
e. Weir:			
Condition?			

Sediment Impoundment Name: J-7 DAM
Page: 6ID 1211-AZ-9-0003

ITEM	YES	NO	REMARKS
3. IMPOUNDMENT			
a. Sinkholes?		X	(Elev.) feet
b. Water present?	X		(Elev.) 6360 feet
c. Siltation?	X		Minor; A small percentage of Capacity
d. Watershed matches ~~soil~~ drainage map?	X		

9. GENERAL COMMENTS

HAUL RD ACCESS [illegible]

Sediment Impoundment Name: *N 14-D DAM*
Page: *ID#1211-Az-9-0004*

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			
a. Adequate grass cover? *N.A.*			*Rip Rapped*
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?	X		
g. Any stone deterioration?		X	
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			
a. Adequate grass cover? *N.A.*			*Rip Rapped*
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Visual depressions or bulges?		X	
g. Visual settlements?		X	
h. Is the toe drain dry?	X		
i. Are the relief wells flowing?			*NA.*
j. Are boils present at the toe?		X	
k. Is seepage present?		X	
l. Animal burrows?		X	
4. ABUTMENT CONTACT. RIGHT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			*Sandy Silt*
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			*Sandy Silt*

Sediment Impoundment Name: N14-D DAM
Page: SID #1211-AZ-9-0004

ITEM	YES	NO	REMARKS
6. SPILLWAY NORMAL			
a. Location:			Overtopping Crest
Left abutment?		X	
Right abutment?		X	
Crest of Embankments?	X		
b. Approach Channel: NA			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	HAUL ROAD
d. Outflow Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		
e. Weir: NA			
Condition?			

ITEM	YES	NO	REMARKS
7. SPILLWAY/EMERGENCY			
a. Location:			None
Left abutment?			
Right abutment?			
Crest of Embankments?			
b. Approach Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
d. Outflow Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
e. Weir:			
Condition?			

ITEM	YES	NO	REMARKS
8. IMPOUNDMENT			
a. Sinkholes?		X	(Elev.) feet
b. Water present?	X		(Elev.) 6629.7 feet
c. Siltation?	X		Small percentage of Capacity
d. Watershed matches ~~soil~~ drainage map?	X		

9. GENERAL COMMENTS

[illegible]

Sediment Impoundment Name: N14-E DAM
Page: AID #1211-AE-9-0005

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			
a. Adequate grass cover? N.A.			Rip Rapped
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?		X	
g. Any stone deterioration?		X	
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			
a. Adequate grass cover? N.A.			Rip Rapped
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Visual depressions or bulges?		X	
g. Visual settlements?		X	
h. Is the toe drain dry?	X		
i. Are the relief wells flowing?			N.A.
j. Are boils present at the toe?		X	
k. Is seepage present?		X	
l. Animal burrows?		X	
4. ABUTMENT CONTACT. RIGHT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Sandy Silt w/some Sandstone
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Sandy Silt w/some Sand Stone.

Sediment Impoundment Name: N14-E DAM
Page: SID #1211-AZ-7-0005

ITEM	YES	NO	REMARKS
6. SPILLWAY NORMAL			
a. Location:			Over Topping Crest
Left abutment?		X	
Right abutment?		X	
Crest of Embankments?	X		
b. Approach Channel: N/A			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		[illegible]
d. Outflow Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		
e. Weir: N.A.			
Condition?			
7. SPILLWAY/EMERGENCY			
a. Location:			None
Left abutment?			
Right abutment?			
Crest of Embankments?			
b. Approach Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
d. Outflow Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
e. Weir:			
Condition?			

ITEM	YES	NO	REMARKS
8. IMPOUNDMENT			
a. Sinkholes?		X	(Elev.) feet
b. Water present?	X		(Elev.) 6667.5 feet
c. Siltation?	X		Minor, only a small percentage of Capacity
d. Watershed matches ~~soil~~ drainage map?	X		

9. GENERAL COMMENTS

[illegible] belt line across dam.

Sediment Impoundment Name: *N14-F DAM*
Page: *ID.#1211-AZ-9-0006*

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			
a. Adequate grass cover? *NA*			*Rip Rapped*
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?	X		
g. Any stone deterioration?		X	
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			
a. Adequate grass cover? *NA*			*Rip Rapped*
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Visual depressions or bulges?		X	
g. Visual settlements?		X	
h. Is the toe drain dry?		X	
i. Are the relief wells flowing?			*N.A.*
j. Are boils present at the toe?		X	
k. Is seepage present?		X	
l. Animal burrows?		X	
4. ABUTMENT CONTACT. RIGHT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			*Sand Stone OutCrop*
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			*Sand Stone Out Crop + Sandy Silt*

Sediment Impoundment Name: N14-F DAM
Page: SID#1211-AZ-7-0006

ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			
a. Location:			Overtopping Crest
Left abutment?		X	
Right abutment?		X	
Crest of Embankments?	X		
b. Approach Channel: NA.			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		[illegible]
d. Outflow Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		
e. Weir: NA.			
Condition?			

ITEM	YES	NO	REMARKS
7. SPILLWAY/EMERGENCY			
a. Location:			None
Left abutment?			
Right abutment?			
Crest of Embankments?			
b. Approach Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
d. Outflow Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
e. Weir:			
Condition?			

ITEM	YES	NO	REMARKS
8. IMPOUNDMENT			
a. Sinkholes?		X	(Elev.) feet
b. Water present?	X		(Elev.) 6640.8 feet
c. Siltation? [illegible]	X		Small Percentage of Storage Capacity
d. Watershed matches ~~soil~~ map?	X		

9. GENERAL COMMENTS

Haul [illegible]

[illegible] water [illegible]

Width ≈ 3.0 ft, [illegible] ≈ [illegible] ; depth ≈ 1.0 ft

Unknown [illegible]

Sediment Impoundment Name: *N14-G DAM*
Page: *ID,#1211-AZ-9-0007*

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			
a. Adequate grass cover?	N.A.		Rip Rapped
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?	X		
g. Any stone deterioration?		X	
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			
a. Adequate grass cover?	N.A.		Rip Rapped
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Visual depressions or bulges?		X	
g. Visual settlements?		X	
h. Is the toe drain dry?	X		
i. Are the relief wells flowing?			N.A.
j. Are boils present at the toe?		X	
k. Is seepage present?		X	
l. Animal burrows?		X	
4. ABUTMENT CONTACT. RIGHT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Sandy Silt
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Sand Stone OutCrop

Sediment Impoundment Name: *N14-G DAM*
Page: *SID.#1211-AE-9-0007*

ITEM	YES	NO	REMARKS
6. SPILLWAY NORMAL			
a. Location:			*Overtopping Crest*
Left abutment?		X	
Right abutment?		X	
Crest of Embankments?	X		
b. Approach Channel: *N/A.*			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		*HAUL ROAD.*
d. Outflow Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		
e. Weir: *N/A.*			
Condition?			
7. SPILLWAY/EMERGENCY			
a. Location:			*None*
Left abutment?			
Right abutment?			
Crest of Embankments?			
b. Approach Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
d. Outflow Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
e. Weir:			
Condition?			

Sediment Impoundment Name: N14-G DAM
Page: 6 ID. #1211-AZ-9-0007

ITEM	YES	NO	REMARKS
8. IMPOUNDMENT			
a. Sinkholes?		X	(Elev.) feet
b. Water present?	X		(Elev.) 6642.9 feet
c. Siltation?	X		Small percentage of Storage Capacity
d. Watershed matches ~~soil~~ map?	X		

9. GENERAL COMMENTS

Haul Road Crosses dam.

Sediment Impoundment Name: N14-H DAM
Page: ID#1211-AZ-9-0008

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			
a. Adequate grass cover? N/A			Rip Rapped
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?	X		
g. Any stone deterioration?		X	
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			
a. Adequate grass cover? N/A			Rip Rapped
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Visual depressions or bulges?		X	
g. Visual settlements?		X	
h. Is the toe drain dry?	X		
i. Are the relief wells flowing?			N/A
j. Are boils present at the toe?		X	
k. Is seepage present?		X	
l. Animal burrows?		X	
4. ABUTMENT CONTACT. RIGHT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Silty Sand, Carbonaceous Shale
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Shale

Sediment Impoundment Name: N14-H DAM
Page: SID 1211-AZ-9-0008

ITEM	YES	NO	REMARKS
6. SPILLWAY NORMAL			400' X 1' deep trapezoidal channel
a. Location:			Overtopping Crest
Left abutment?		X	
Right abutment?		X	
Crest of Embankments?	X		
b. Approach Channel: N/A			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		
d. Outflow Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		
e. Weir: N/A			
Condition?			

7. SPILLWAY/EMERGENCY			
a. Location:			None
Left abutment?			
Right abutment?			
Crest of Embankments?			
b. Approach Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
d. Outflow Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
e. Weir:			
Condition?			

Sediment Impoundment Name: N14-H Dam
Page: 6ID#1211-AZ-9-0008

ITEM	YES	NO	REMARKS
8. IMPOUNDMENT			
a. Sinkholes?		X	(Elev.) feet
b. Water present?	X		(Elev.) 6673.8 feet
c. Siltation?		X	No Inflow, yet.
d. Watershed matches ~~soil~~ drainage map?	X		

9. GENERAL COMMENTS

[illegible]

1. CREST			
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			
a. Adequate grass cover? NA			Riprapped
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?	X		
g. Any stone deterioration?		X	
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			
a. Adequate grass cover? NA			Riprapped
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Visual depressions or bulges?		X	
g. Visual settlements?		X	
h. Is the toe drain dry?	X		
i. Are the relief wells flowing?			NA
j. Are boils present at the toe?		X	
k. Is seepage present?		X	
l. Animal burrows?		X	
4. ABUTMENT CONTACT, RIGHT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Sandy Silt w/ Sandstone
5. ABUTMENT CONTACT, LEFT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Sandy Silt

Sediment Impoundment Name: J16-A
Page: 12/11-A3-9-2009

6. SPILLWAY/PRINCIPAL

ITEM	YES	NO	REMARKS
a. Location:		X	2-24" Decant pipes
Left abutment?		X	
Right abutment?			
Crest of Embankments?	X		
b. Approach Channel: NA			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel: NA			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
d. Outflow Channel:	X		
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		
e. Weir: NA			
Condition?			

7. SPILLWAY/EMERGENCY

ITEM	YES	NO	REMARKS
a. Location:			OVERTOPPING SPOT
Left abutment?		X	
Right abutment?		X	
Crest of Embankments?	X		
b. Approach Channel: NA			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		
d. Outflow Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		
e. Weir: NA			
Condition?			

ITEM	YES	NO	REMARKS
8. IMPOUNDMENT			
a. Sinkholes?		X	(Elev.) feet
b. Water present?	X		(Elev.) 6606.5 feet
c. Siltation?	X		Small percentage of total capacity.
d. Watershed matches ~~soil~~ drainage map?	X		

9. GENERAL COMMENTS

General Service road across dam.

[illegible] Name: J16-L
Page: 4 1211-AZ-9-0010

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			
a. Adequate grass cover?			Rip Rapped
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?	X		
g. Any stone deterioration?		X	
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			
a. Adequate grass cover?	X		
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Visual depressions or bulges?		X	
g. Visual settlements?		X	
h. Is the toe drain dry?	X		
i. Are the relief wells flowing?			N/A
j. Are boils present at the toe?		X	
k. Is seepage present?		X	
l. Animal burrows?		X	
4. ABUTMENT CONTACT. RIGHT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Sandy Silt w/some sandstone
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Sandy Silt

Sediment Impoundment Name: JI6-L DAM
Page: ID# 1211-AZ-90010

ITEM	YES	NO	REMARKS
6. SPILLWAY/PRINCIPAL			
a. Location:			16" Driscopipe (Decant)
Left abutment?		X	
Right abutment?		X	Near Rt Abutment
Crest of Embankments?	X		
b. Approach Channel: NA			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel: NA			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
d. Outflow Channel:			STILLING BASIN
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		
e. Weir: NA			
Condition?			
7. SPILLWAY/EMERGENCY			
a. Location:			
Left abutment?		X	
Right abutment?	X		Trapezoidal Rock-cut (28' wide)
Crest of Embankments?		X	
b. Approach Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		
c. Spillway Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		
d. Outflow Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		
e. Weir: NA			
Condition?			

ITEM	YES	NO	REMARKS
3. IMPOUNDMENT			
a. Sinkholes?		X	(Elev.) feet
b. Water present?	✓		(Elev.) 6550.3 feet
c. Siltation?	X		Small percentage of Storage Capacity
d. Watershed matches ~~soil~~ [illegible] map?	X		

9. GENERAL COMMENTS

ATTACHMENT L

Dam Break Analysis for Sedimentation

Ponds J28-B, J28-C, J28-D and J28-G

REPORT

Dam-Break Analysis

for

Sedimentation Structures J28-B, J28-C, J28-D, and J28-G

Kayenta Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Registered Professional Engineer (Civil)
CERTIFICATE NO.
15590
ROBERT D.
BRATHOVDE
Date Signed
ARIZONA, U.S.A.

Dames & Moore
10139-011-22

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1.0 INTRODUCTION

This report presents the results of a dam break analysis performed for Sedimentation Structures J28-B, J28-C, J28-D and J28-G at Peabody Coal Company's Kayenta Coal Mine in Navajo County, Arizona. The purpose of the analysis was to determine whether the downstream Mine Safety and Health Administration (MSHA) dams, J16-A and Reed Valley, could safely pass the floodwater resulting from postulated accidental breaches in the embankments of the respective upstream sedimentation structures.

Sedimentation Structures J28-B, J28-C, and J28-D are located upstream of MSHA Dam J16-A, and J28-G is located upstream of the Reed Valley MSHA Dam. The locations of these structures are shown on Figure 1, Vicinity Map. The MSHA structures were designed and are maintained under the regulations set forth in the Office of Surface Mining (OSM) Indian Lands Regulations, 30 CFR, Part 77. The sedimentation structures have been inspected by Dames & Moore according to regulations 30 CFR, Parts 780 and 816.

2.0 POSTULATIONS FOR DAM-BREAK ANALYSES

2.1 BREACH CHARACTERISTICS

Accidental breaches in the sedimentation structures may result from overtopping, piping, earthquakes, or foundation failure. Available techniques for dam-break analyses require information regarding the geometric and temporal characteristics of the breach. At the present time, there are no definite standards or regulations defining these characteristics of postulated breaches. For the present study, certain postulations and assumptions have been made to obtain conservative estimates of the impacts of dam-breaks on the respective MSHA structures. These are described in the following paragraphs.

The fully formed breach in an earthen dam tends to have an average width, b, in the following range (Fread, 1983):

$$H < b < 3H$$

where H = height of the dam. A value of b = 2H is supported by case histories of past breaches (Fread, 1983; Johnson and Illes, 1976). In view of this, two trapezoidal breaches with the following average widths have been analyzed for each sedimentation structure:

(i) $b = H$
(ii) $b = 2H$

The side slopes of breaches in earthen embankments have been found to be in the following range (Fread, 1983; MacDonald and Monopolis, 1984),

$$0 < z < 2$$

where z is the horizontal component of slope. A reasonable value of z for a full-depth breach is 0.5 (MacDonald and Monopolis, 1984). Accordingly, a value of $z = 0.5$ has been used for breaches in all the sedimentation structures in this study.

The time of breach development, t, in earthen dams is reported to be in the following range (Research Institute of Colorado, 1984):

$$10 \text{ minutes} < t < 3 \text{ hours.}$$

Since the time of breach development is a function of the size of the breach, different failure times have been used for different sedimentation structures in this study (MacDonald and Monopolis, 1984). The times are shown in Table 2-1.

Table 2-1

PARAMETERS USED IN DAM-BREAK ANALYSES
(Side slopes of breach 0.5H:1V)

Parameters	J28-B Crest El. 6860.50 ft	J28-C Crest El. 6815.64 ft	J28-D Crest El. 6791.10 ft	J28-G Crest El. 6805.00 ft
Scenario 1				
100-year, 24-hour Inflow Hydrograph, Negligible Spillway Discharge				
Bottom elevation of breach	6838.5 ft	6802.5 ft	6774.50 ft	6782.5 ft
Water surface elevation at which breach occurs	6860.0 ft	6815.0 ft	6790.60 ft	6804.0 ft
Bottom width of breach	10 ft	6.5 ft	8 ft	10 ft
Failure time	30 min	15 min	20 min	30 min
Initial channel condition	Dry bed	Dry bed	Dry bed	Dry bed
Scenario 2				
10-year, 24-hour Inflow Hydrograph, Negligible Spillway Discharge				
Bottom elevation of breach	6838.5 ft	6802.5 ft	6774.50 ft	6782.5 ft
Water surface elevation at which breach occurs	6960.5 ft	6815.64 ft	6791.10 ft	6805.0 ft
Bottom width of breach*	33 ft	19.71 ft	24.90 ft	33.75 ft
Failure time**	15 min	10 min	12 min	15 min
Initial water depth in channels	1 ft	1 ft	1 ft	1 ft

*Based on average breach width (b) = 2 x height of dam.
**From Figure 2, MacDonald and Monopolis, 1984.

2.2 INITIAL RESERVOIR AND CHANNEL CONDITIONS

A preliminary review of the storage and spillway capacities of Sedimentation Structures J28-B, J28-C, J28-D, and J28-G indicated that an overtopping failure of these structures up to a 100-year, 24-hour event is not possible. For the probable maximum precipitation event, overtopping failure may be postulated if the spillway is assumed to be blocked. In view of this, the following two scenarios for initial reservoir conditions have been analyzed:

1) Non-overtopping failure with 100-year, 24-hour inflow hydrograph, negligible spillway discharge, and failure commencing when the water surface elevation is less than 1.0 foot below the crest of the embankment with b = H.

   In this case, the downstream channel is assumed to be dry at the time of occurrence of the postulated breaches. This appears to be a reasonable assumption for non-overtopping, clear day breaches in structures located on ephemeral streams.

2) Overtopping failure with negligible spillway discharge and failure commencing when water surface in the reservoir is at the crest of the embankment with b = 2H. This is an extremely conservative assumption. For convenience of modeling, a 10-year, 24-hour storm is assumed to occur over the watershed of each sedimentation structure at the time of occurrences of the postulated breach.

It is unlikely that the dam-break flood wave will arrive at a particular location along the downstream channel at the same time when the runoff hydrograph from the contributing drainage area reaches that location. However, it is reasonable to expect some pre-existing flow in the downstream channel for postulated overtopping failures of dams. The annual flooding conditions of the ephemeral channels in the area indicate that the average annual floodwater depths in these channels may be approximately 1 foot. In view of this and for the sake of computational simplicity, it is assumed that all downstream channel reaches will have a flow depth of 1 foot at the time of arrival of the dam-break flood wave.

2.3 PARAMETERS USED IN DAM-BREAK ANALYSES

The numerical values of the breach parameters and hydrologic/ hydraulic conditions used in the dam-break analyses are abstracted in Table 2-1.

3.0 DAM-BREAK ANALYSES

3.1 METHODS OF ANALYSES

The HEC-1 computer program of the U.S. Army Corps of Engineers (USACE, 1981) has been used to develop the dam-break flood hydrographs for different sedimentation structures and to combine and route these hydrographs through stream channels and through the respective MSHA structures, i.e., J16-A and Reed Valley Dams.

As a conservative estimate of the peak stage and peak outflow discharge for MSHA Dam J16-A resulting from postulated breaches in Sedimentation Structures J28-B, J28-C, and J28-D, it is assumed that all the breaches occur simultaneously. Also, it is assumed that the combined dam-break flood hydrograph reaches the J16-A Reservoir at a time when the reservoir water surface elevation is at the crest of its spillway (El. 6635.0 ft). A flow chart indicating the sequence of computations for this analysis is shown in Table 3-1.

Table 3-1

SEQUENCE OF COMPUTATIONS FOR
SEDIMENTATION STRUCTURES J28-B, J28-C, AND J28-D
(J16-A WATERSHED)

1) Develop 100-year, 24-hour (Scenario 1) or 10-year, 24-hour (Scenario 2) hydrograph for the watershed of Sedimentation Structure J28-B.

2) Route this hydrograph through Sedimentation Structure J28-B with the parameters shown in Table 2-1 assuming negligible spillway outflow (i.e. a blocked spillway).

3) Route the outflow hydrograph through the natural channel (Reach 1) between Sedimentation Structure J28-B and the outlet channel for Sedimentation Structure J28-C.

4) Develop the 100-year, 24-hour or 10-year, 24-hour hydrograph for the watershed of Sedimentation Structure J28-C.

5) Route this hydrograph through Sedimentation Structure J28-C with the parameters shown in Table 2-1 assuming negligible spillway outflow (i.e. a blocked spillway).

6) Combine the two hydrographs for Sedimentation Structures J28-B and J28-C.

7) Route the combined hydrograph through the natural channel (Reach 2) between Sedimentation Structure J28-C and the outlet channel from Sedimentation Structure J28-D.

8) Develop 100-year, 24-hour, or 10-year, 24-hour hydrograph for the watershed of Sedimentation Structure J28-D.

9) Route this hydrograph through Sedimentation Structure J28-D with the parameters shown in Table 2-1 assuming negligible spillway outflow (i.e. a blocked spillway).

10) Combine this with the routed hydrograph from Sedimentation Structures J28-E and J28-C.

11) Route the combined hydrograph through the natural channel from the outlet channel of Sedimentation Structure J28-D to the inlet at Station 5+00 of J16 Diversion Channel (Reach 3).

12) Route the resulting hydrograph from Station 5+00 to Station 21+60 of J16 Diversion Channel (Reach 4).

13) Route the resulting hydrograph from Station 21+60 to Station 38+50 of J16 Diversion Channel (Reach 5).

Table 3-1 (Continued)

14) Route the resulting hydrograph from Station 38+50 to Station 57+50 of J16 Diversion Channel (Reach 6).

15) Route the resulting hydrograph through J16-A Reservoir.

Similarly, the dam-break flood hydrograph for Sedimentation Structure J28-G has been routed through the natural outlet channel for J28-G through the proposed Reed Valley Diversion Channel, and through the Reed Valley Dam. For the sake of conservatism, it is assumed that the dam-break flood reaches Reed Valley Reservoir at a time when the water surface behind the dam is at the spillway crest elevation. The sequence of computations for this case is shown in Table 3-2.

Table 3-2

SEQUENCE OF COMPUTATIONS FOR SEDIMENTATION STRUCTURE J28-G
(REED VALLEY WATERSHED)

---

1) Develop 100-year, 24-hour (Scenario 1) or 10-year, 24-hour (Scenario 2) hydrograph for the watershed of Sedimentation Structure J28-G.

2) Route this hydrograph through Sedimentation Structure J28-G with the parameters shown in Table 2-1 assuming negligible spillway outflow (i.e. a blocked spillway).

3) Route the resulting hydrograph through the natural channel from Sedimentation Structure J28-G to Station 187+30 of the proposed Reed Valley Diversion Channel (Reach 1).

4) Route the resulting hydrograph from Station 187+30 to Station 162+50 of the proposed Reed Valley Diversion Channel (Reach 2).

5) Route the resulting hydrograph from Station 162+50 to Station 99+00 of the proposed Reed Valley Diversion Channel (Reach 3).

6) Route the resulting hydrograph through Reed Valley Reservoir.

For the sake of comparison, the peak flows due to dam-break, Q_{max}, for each sedimentation structure have been estimated using the following approximate methods:

1) $Q_{max} = \frac{8}{27} b h^{1.5} g^{0.5}$ (USACE, 1977)

Where b = average breach width
h = depth of water behind the dam
g = gravitational constant

2) $Q_{max} = C Y^{2.5}$ (State of California, 1977)

Where C = 1.2 for triangular breach with 0.5H:1V side slopes
Y = depth of water in feet at one half reservoir capacity

3) The NWS Simplified Dam-Break Flood Forecasting Model (Wetmore & Fread, 1983).

Generally, the first of these approximate methods tends to give higher values of peak flows because the derivation of the equation in this method assumes instantaneous development of a full-depth breach with a width equal to that of the downstream channel (USACE, 1977). The second method (State of California, 1977) is purely empirical and is used by the Office of Emergency Services for safety assessment of dams in California.

3.2 DESCRIPTION OF INPUT

The distributions of 100-year, 24-hour, and 10-year, 24-hour precipitation events for the Kayenta Mine site used in this study are shown in Table 3-3 (NOAA, 1973).

Table 3-3

DISTRIBUTIONS OF 100-YEAR AND 10-YEAR, 24-HOUR PRECIPITATION EVENTS

Duration	100-year Precipitation (inches)	10-year Precipitation (inches)
5 min	0.56	0.35
15 min	1.09	0.68
1 h	1.92	1.20
2 h	2.08	1.34
3 h	2.19	1.43
6 h	2.40	1.6
12 h	2.75	1.8
24 h	3.05	2.1

The hydrologic characteristics of the watersheds of Sedimentation Structures J28-B, J28-C, J28-D, and J28-G used in the analyses are shown in Table 3-4.

Table 3-4

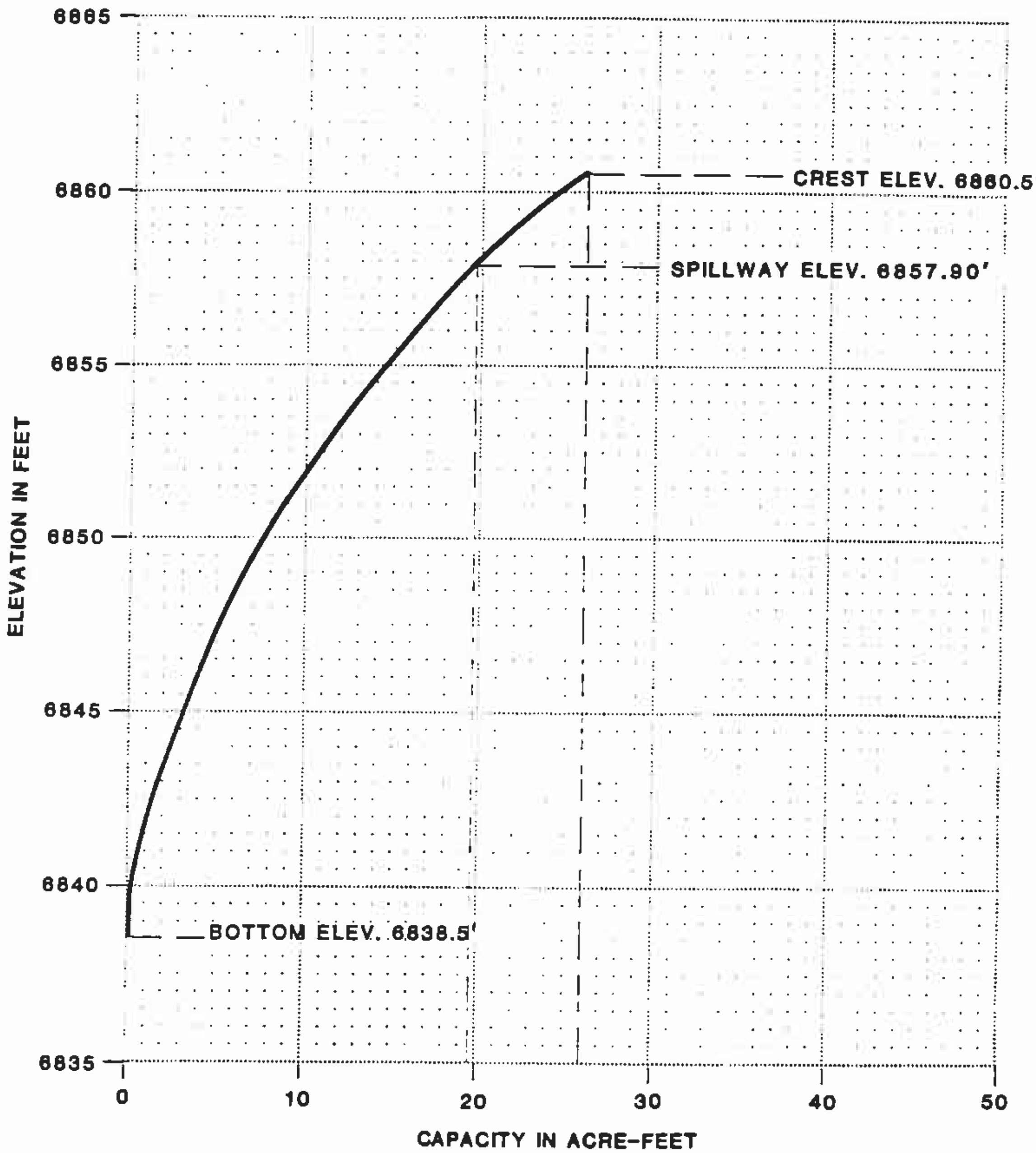
HYDROLOGIC CHARACTERISTICS OF WATERSHEDS

Parameters	Sedimentation Structure J28-B	J28-C	J28-D	J28-G
Drainage Area (sq. mi.)	0.022	0.049	0.048	0.093
SCS Curve Number	89	88	88	84
Lag Time (hour)	0.04	0.06	0.047	0.066
Storage Capacity at Failure* (Scenario 1) (acre-feet)	24.3	19.7	21.3	27.0
Storage Capacity at Failure* (Scenario 2) (acre-feet)	26.0	21.0	22.5	31.2
Surface Area at Failure* (Scenario 1) (acres)	2.6	2.8	2.4	3.6
Surface Area at Failure* (Scenario 2) (acres)	2.7	2.9	2.5	3.7

*Used for Simplified Dam-Break Flood Forecasting Model (Wetmore & Fread, 1983).

The elevation-storage curves for Sedimentation Structures J28-B, J28-C, J28-D, and J28-G are shown in Figures 2, 3, 4, and 5, respectively. The elevation-storage and spillway rating curves for the J16-A and Reed Valley Dams are shown in Figures 6, 7, 8, and 9, respectively.

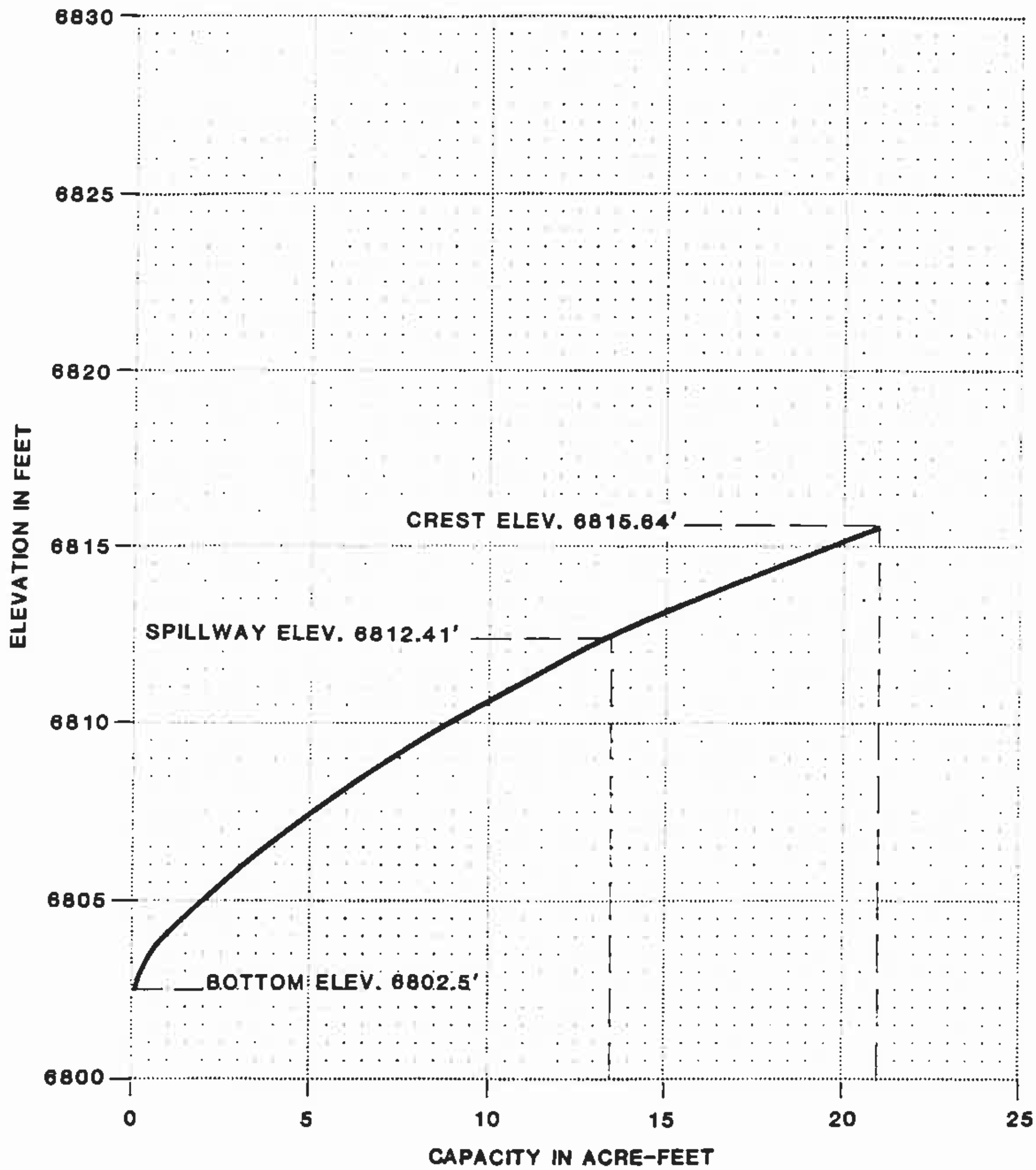
To estimate the alteration of dam-break floods by channel storage, the total channel lengths for the J16-A and Reed Valley drainages are divided into smaller channel reaches. Each of these reaches is represented by an average channel cros section obtained from 1"=400' topographic maps of the area having 10-foot contour intervals. The coordinates of these cross sections are given in the computer outputs included in Appendices A, B, C, and D. The other hydraulic characteristics for each channel reach are shown in Table 3-5.



VOLUME-ELEVATION CURVE

J28-B

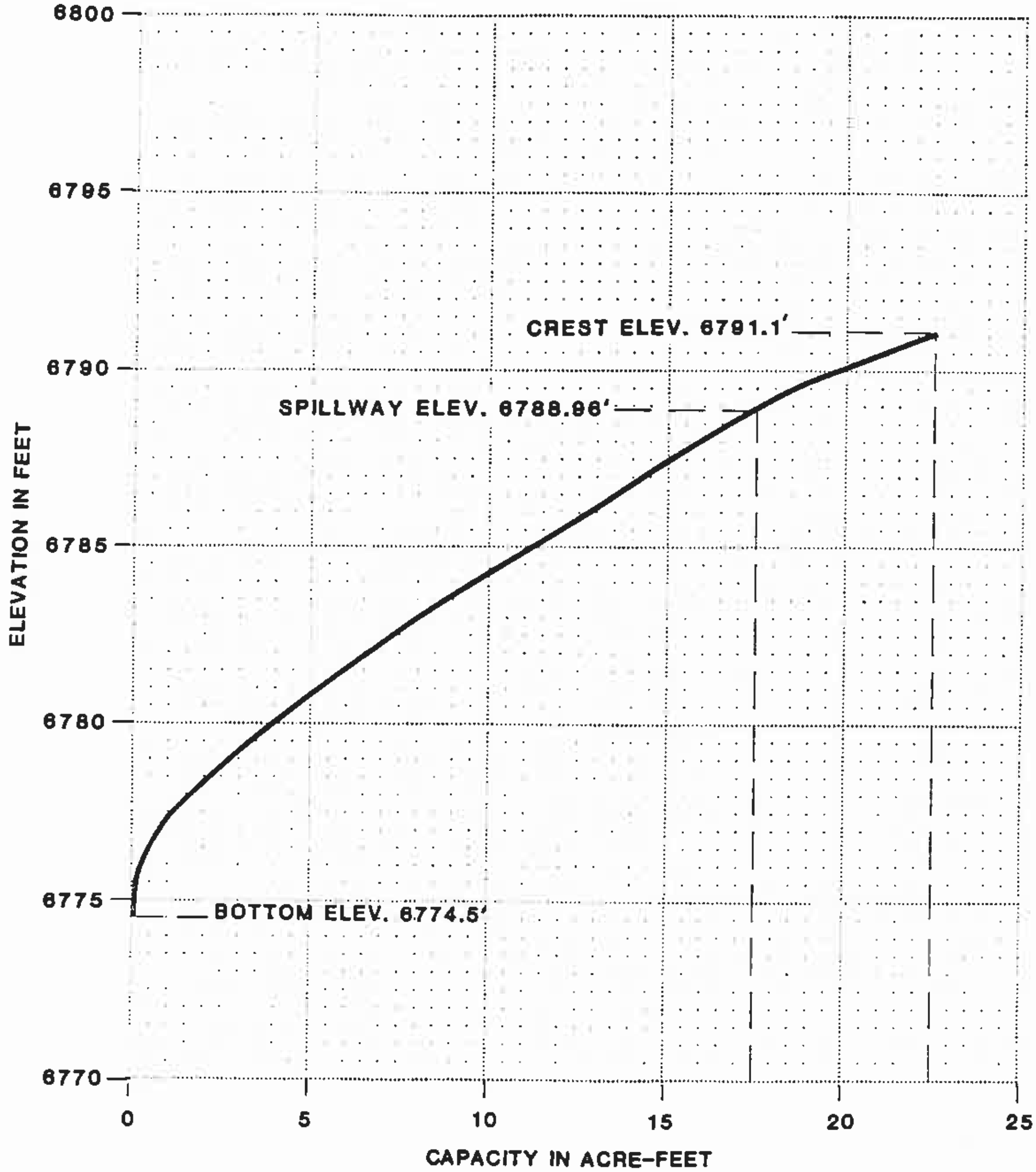
BY **Dames & Moore** Figure 2



VOLUME-ELEVATION CURVE

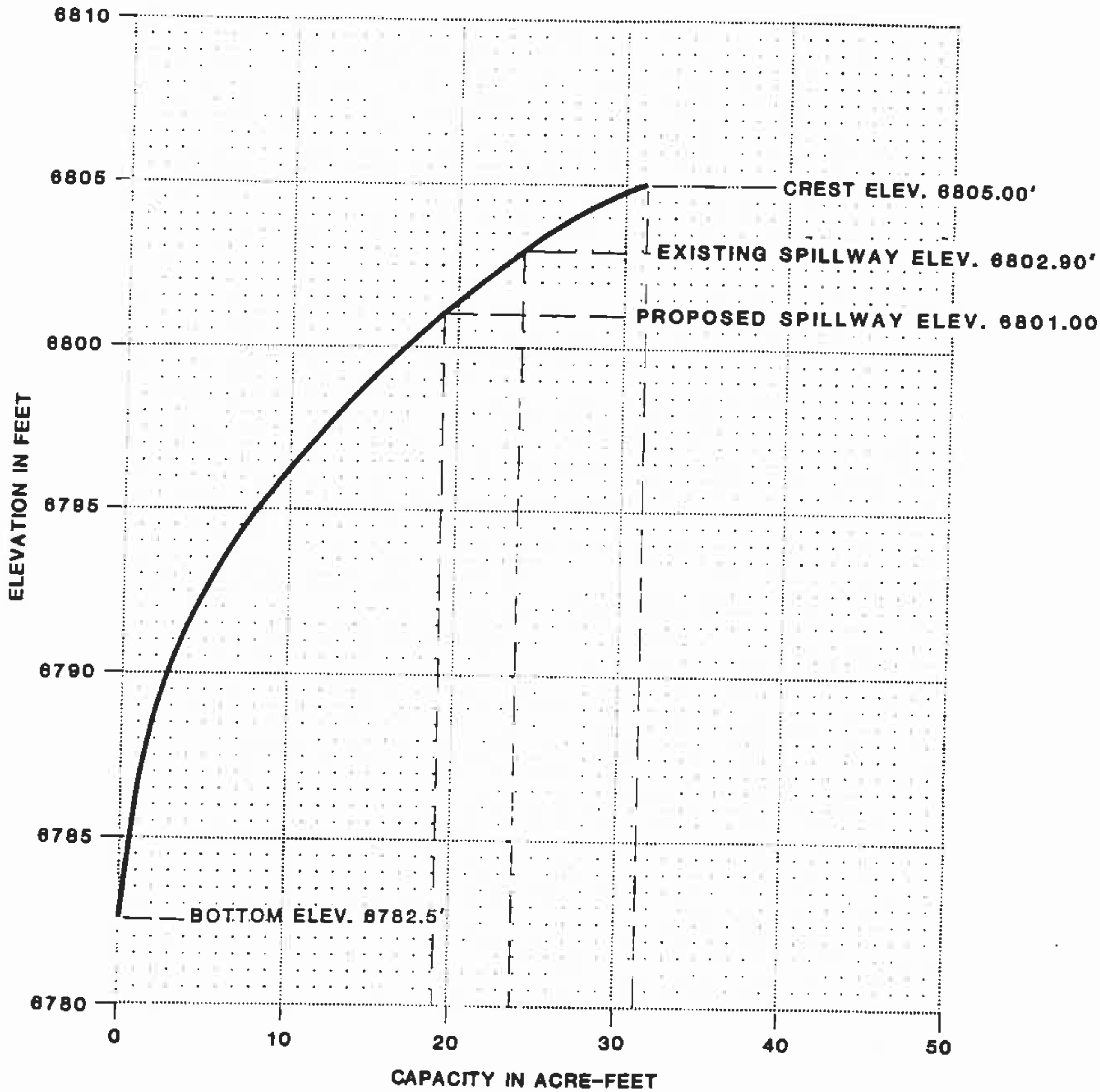
J28-C

BY **Dames & Moore** Figure 3



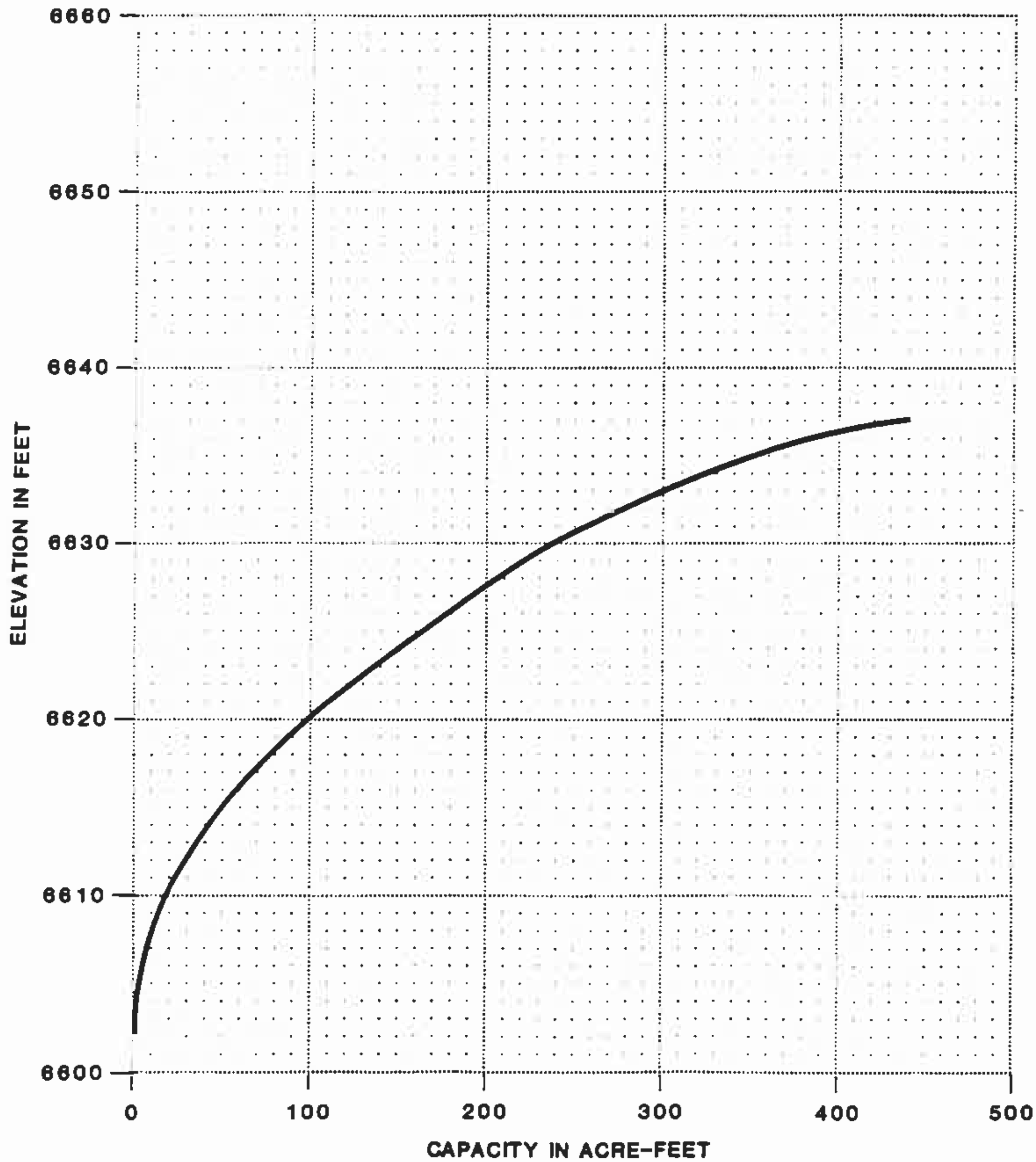
VOLUME-ELEVATION CURVE
J28-D

BY **Dames & Moore** Figure 4



VOLUME-ELEVATION CURVE
J28-G

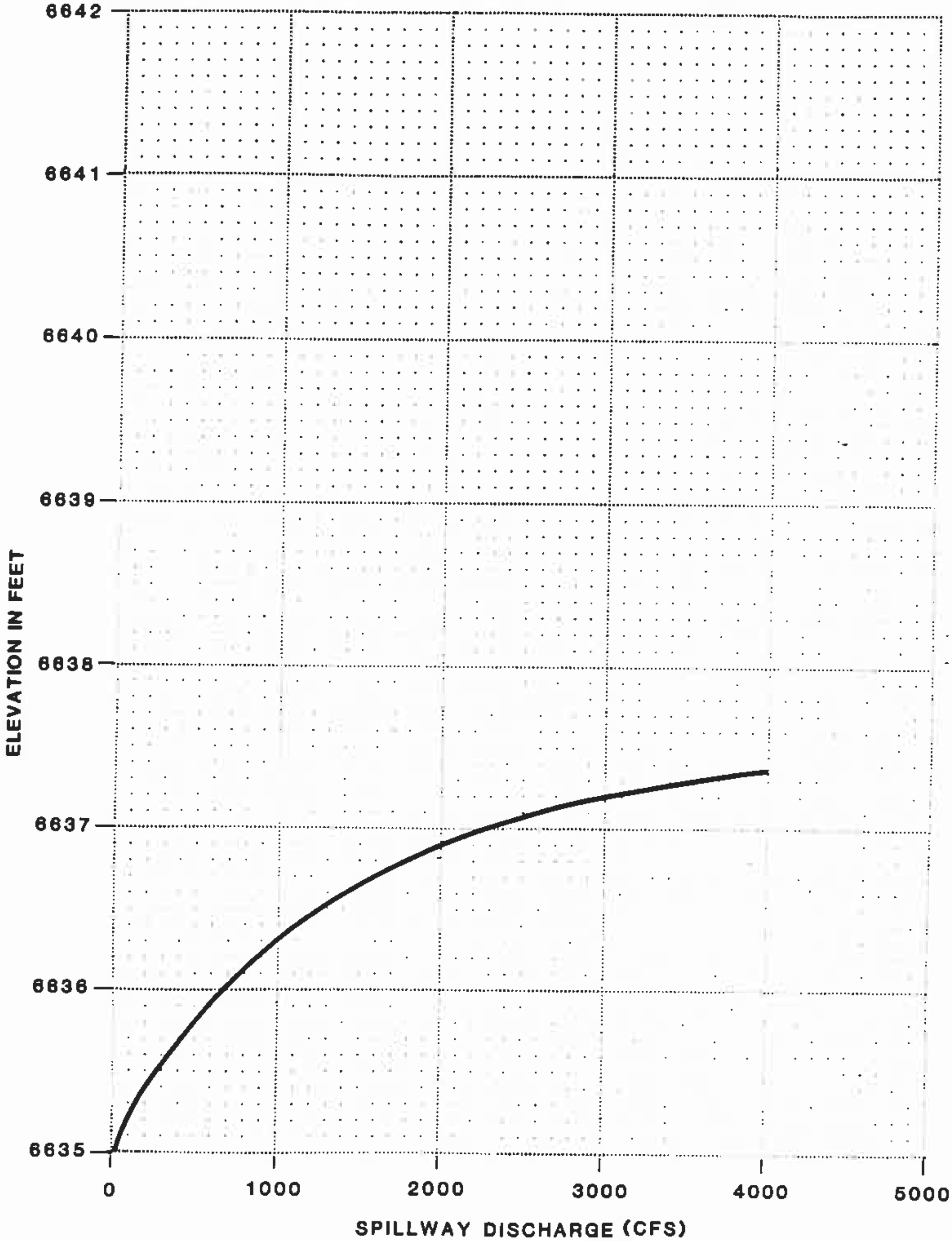
BY Dames & Moore Figure 5



VOLUME-ELEVATION
CURVE
J16-A
RESERVOIR

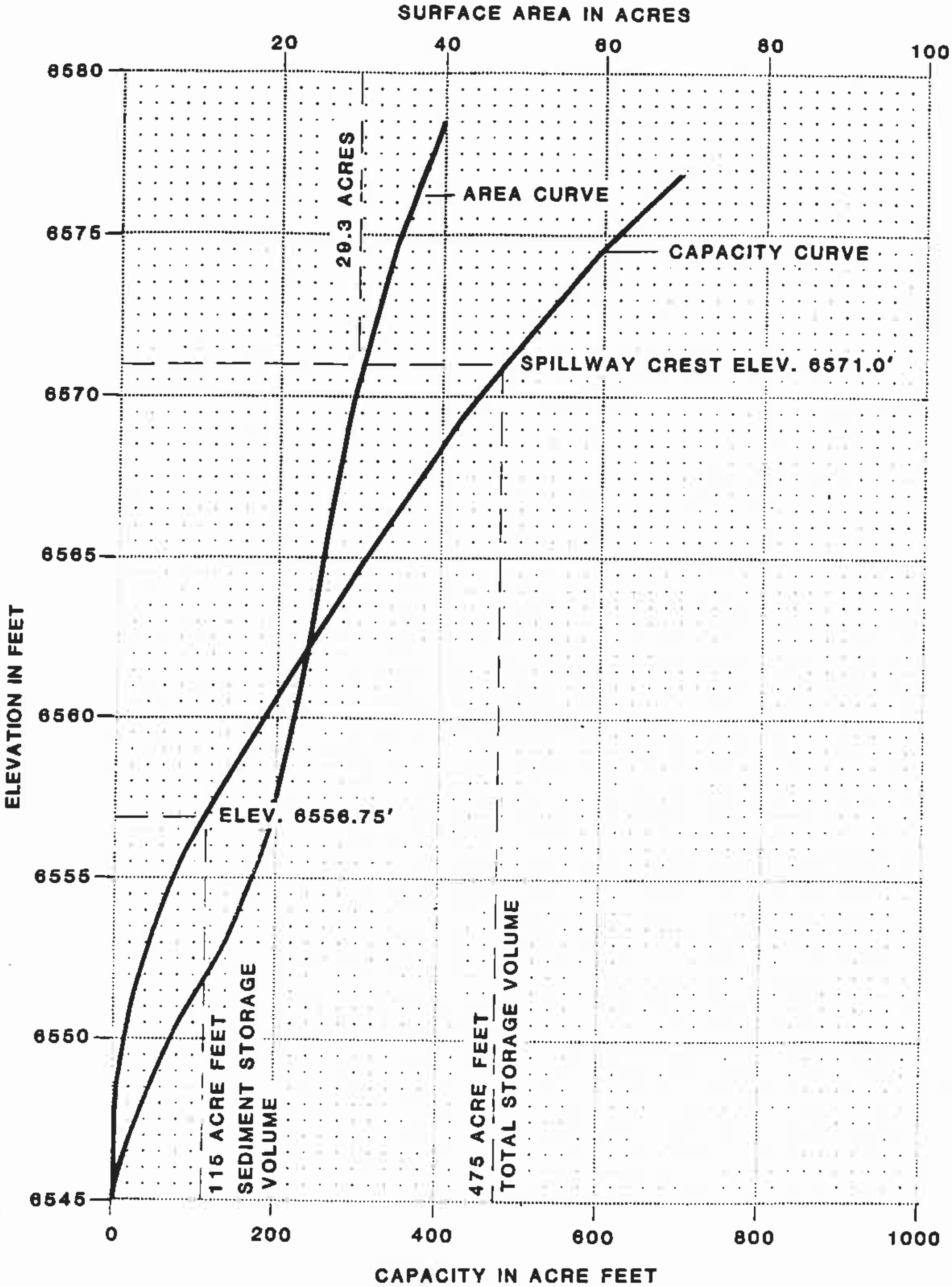
BY Dames & Moore

Figure 6



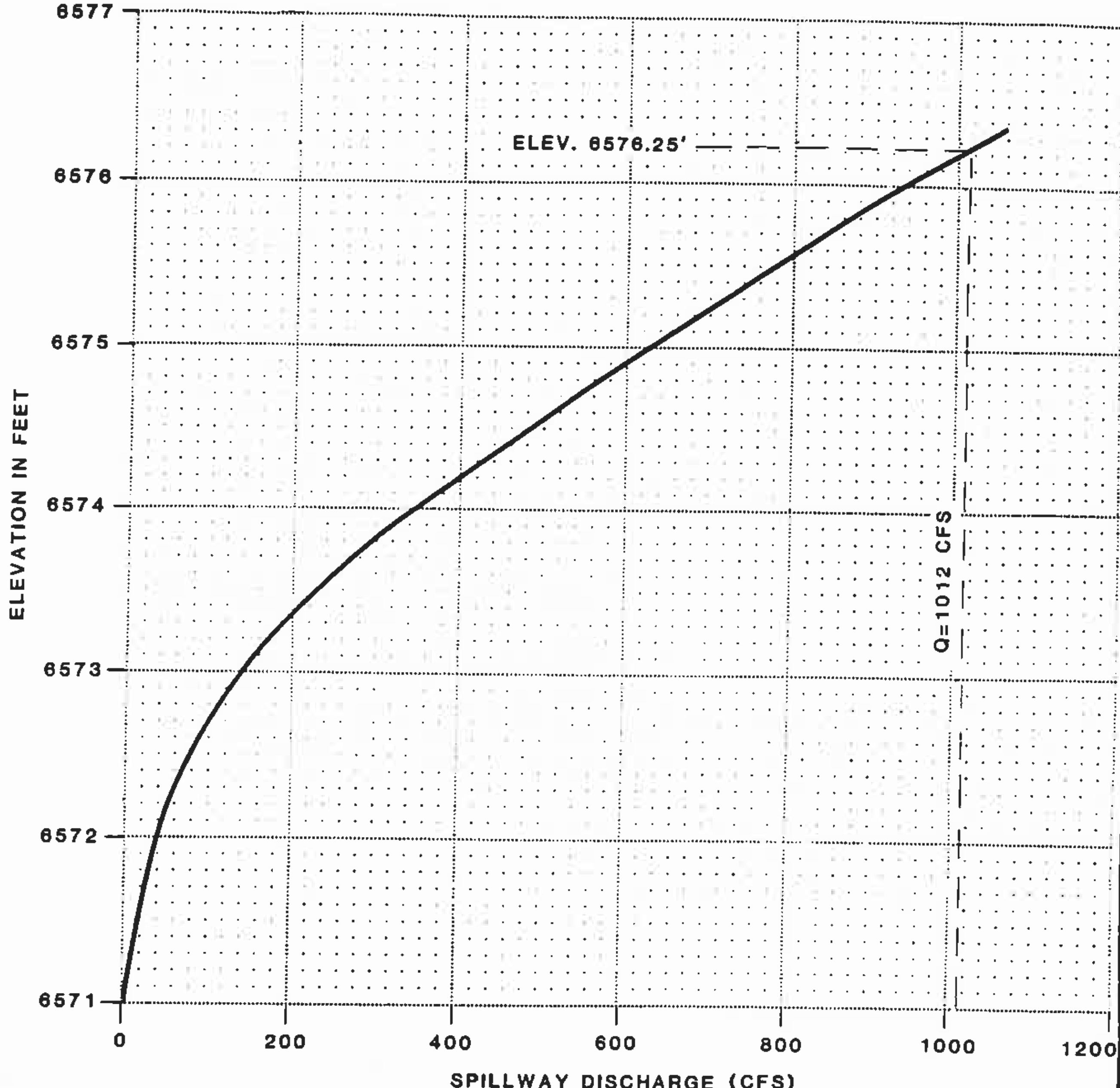
SPILLWAY RATING CURVE
J16-A

BY **Dames & Moore** Figure 7



VOLUME-ELEVATION CURVE REED VALLEY RESERVOIR

BY **Dames & Moore** Figure 8



SPILLWAY
RATING CURVE
REED VALLEY
DAM

BY Dames & Moore Figure 9

Table 3-5

HYDRAULIC CHARACTERISTICS OF CHANNEL REACHES

Reach No.	Description	Mannings "n" Left Overbank	Mannings "n" Channel	Mannings "n" Right Overbank	Length (ft)	Slope (ft/ft)	Maximum Ground El. (ft)
A - Channel entering J16-A Reservoir							
1	Between Sedimentation Structures J28-B and J28-C	0.05	0.04	0.05	1350	0.051	6840.0
2	Between Sedimentation Structures J28-C and J28-D	0.05	0.04	0.05	1850	0.013	6810.0
3	Sedimentation Structure J28-D to Sta. 5+00 J16 Diversion Channel	0.05	0.04	0.05	1950	0.023	6780.0
4	Sta. 5+00 to 21+60 J16 Diversion Channel	0.05	0.04	0.05	1660	0.0196	6714.0
5	Sta. 21+60 to 38+50 J16 Diversion Channel	0.05	0.04	0.05	1690	0.01	6680.0
6	Sta. 38+50 to 57+50 J16 Diversion Channel	0.05	0.04	0.05	1900	0.021	6640.0
B - Channel entering Reed Valley Reservoir							
1	Between Sedimentation Structure J28-G and Sta. 187+30 on Reed Valley Diversion Channel	0.05	0.04	0.05	1830	0.042	6790.0
2	Sta. 187+30 to 162+50 on Reed Valley Diversion Channel	0.05	0.04	0.05	2480	0.017	6716.0
3	Sta. 162+50 to 99+00 on Reed Valley Diversion Channel	0.05	0.04	0.05	6350	0.0147	6670.0

3.3 DESCRIPTION OF ANALYSES

Using the aforementioned information, dam-break floods for Sedimentation Structures J28-B, J28-C, and J28-D have been computed and the resulting hydrographs have been combined and routed through the channel up to Dam J16-A and thereafter through J16-A reservoir using the HEC-1 computer program (USACE, 1981). Copies of the computer outputs for Scenarios 1 and 2 defined in Table 2-1 are included in Appendices A and B, respectively.

Similarly, the dam-break floods for Scenarios 1 and 2 for Sedimentation Structure J28-G have been computed and the resulting hydrograph has been routed through the channel to Reed Valley Dam and thereafter through the Reed Valley reservoir using the HEC-1 computer program (USACE, 1981). Copies of the computer outputs for this case for Scenarios 1 and 2 are included in Appendices C and D, respectively.

Results of the above-mentioned analyses, along with those obtained by the approximate methods described in Section 3-1, are presented in Section 4.0.

4.0 RESULTS AND CONCLUSIONS

4.1 RESULTS

Table 4-1 show the peak flows at different locations of the downstream channel, and the peak outflows and stages for the J16-A Reservoir given by the HEC-1 computer program simulating Scenarios 1 and 2 of simultaneous breaches in Sedimentation Structures J28-B, J28-C, and J28-D. The peak flows at different locations of the Reed Valley Diversion Channel and its tributary (the natural channel downstream of Sedimentation Structure J28-G) and the peak outflows and stages for the Reed Valley Reservoir due to the two postulated dam-break scenarios, are also shown in Table 4-1.

Table 4-1

ESTIMATED PEAK FLOWS AND RESERVOIR STAGES

Reach	Peak Outflows (cfs)	
	Scenario 1	Scenario 2
A - J16-A Watershed		
J28-B	990	2,142
Reach 1	968	1,760
J28-C	989	1,969
Reach 2*	1,156	2,349
J28-D	1,083	1,960
Reach 3**	1,673	3,200
Reach 4	1,690	2,869
Reach 5	1,575	2,946
Reach 6	1,614	2,693
J16-A Dam	771	974

(Scenario 1) Peak Stage at J16-A Dam = 6636.06 ft
Freeboard = 3.94 ft
(Scenario 2) Peak Stage in J16-A Dam = 6636.19 ft
Freeboard = 3.81 ft

Reach	Scenario 1	Scenario 2
B - Reed Valley Watershed		
J28-G	1,343	2,839
Reach 1	1,260	1,952
Reach 2	1,196	1,671
Reach 3	736	856
Reed Valley Dam	502	529

(Scenario 1) Peak Stage at Reed Valley Dam = 6571.32 ft
Freeboard = 7.68 ft
(Scenario 2) Peak Stage at Reed Valley Dam = 6571.34 ft
Freeboard = 7.66 ft

*Combined flows from breaches in Sedimentation Structures J28-B and J28-C.
**Combined flows from breaches in Sedimentation Structures J28-B, J28-C, and J28-D.

A review of the estimated peak stages and freeboards for the J16-A and Reed Valley Dams shown in Table 4-1 indicates that these dams can safely pass the dam-break flood waves resulting from accidental breaches in the sedimentation structures located in their respective watersheds.

The approximate methods described in Section 3.1 were also used to estimate the peak outflows from postulated breaches in the sedimentation structures in each watershed. For the sake of comparison, the results of these computations for both scenarios are summarized in Table 4-2.

Table 4-2

ESTIMATED PEAK FLOWS AT BREACH LOCATIONS
(cfs)

Method of Analysis	Scenario 1				Scenario 2			
	J28-B	J28-C	J28-D	J28-G	J28-B	J28-C	J28-D	J28-G
HEC-1	990	989	1,083	1,343	2,142	1,969	1,960	2,839
USACE (1977)	3,478	947	1,742	3,477	7,634	2,103	3,775	8,075
State of California (1977)	1,046	217	380	1,228	1,135	253	429	1,430
Simplified Dam-Break Model	1,173	692	950	1,490	2,518	1,792	2,137	3,571

The results given by different methods vary widely and those given by the HEC-1 computer program lie between the maximum and minimum estimated values. As stated previously, the USACE (1977) method assumes instantaneous failure and the State of California (1977) method is purely empirical. The results of the HEC-1 and Simplified Dam-Break model are quite close. Both these methods take the gradual development of the breach into account and are based on generally accepted equations of flow through breach openings. Therefore, the results of the HEC-1 computer program used in this study are considered reasonable.

4.2 CONCLUSION

The MSHA Dams J16-A and Reed Valley have adequate storage and spillway capacities to safely discharge the dam-break flood waves resulting from accidental breaches in the sedimentation structures in their respective watersheds.

It should be noted that the mechanisms hypothesized to induce breaches in the sedimentation structures are extremely conservative and highly unlikely. These conservation assumptions include:

1) Continued blockage of the spillways causing water levels to fill to the embankment crests. This condition could only occur if the sedimentation structures are left unattended for extended periods of time.

2) That the MSHA Dams J16-A and Reed Valley are full to their respective spillway crests when the dam-break flood wave arrives.

3) That the sedimentation structures in the J16-A watershed, J28-B, J28-C and J28-D, will fail simultaneously. This event would have an extremely low probability of occurrence.

In view of these assumptions, the results of the analyses presented in this report are considered to be highly conservative.

5.0 REFERENCES

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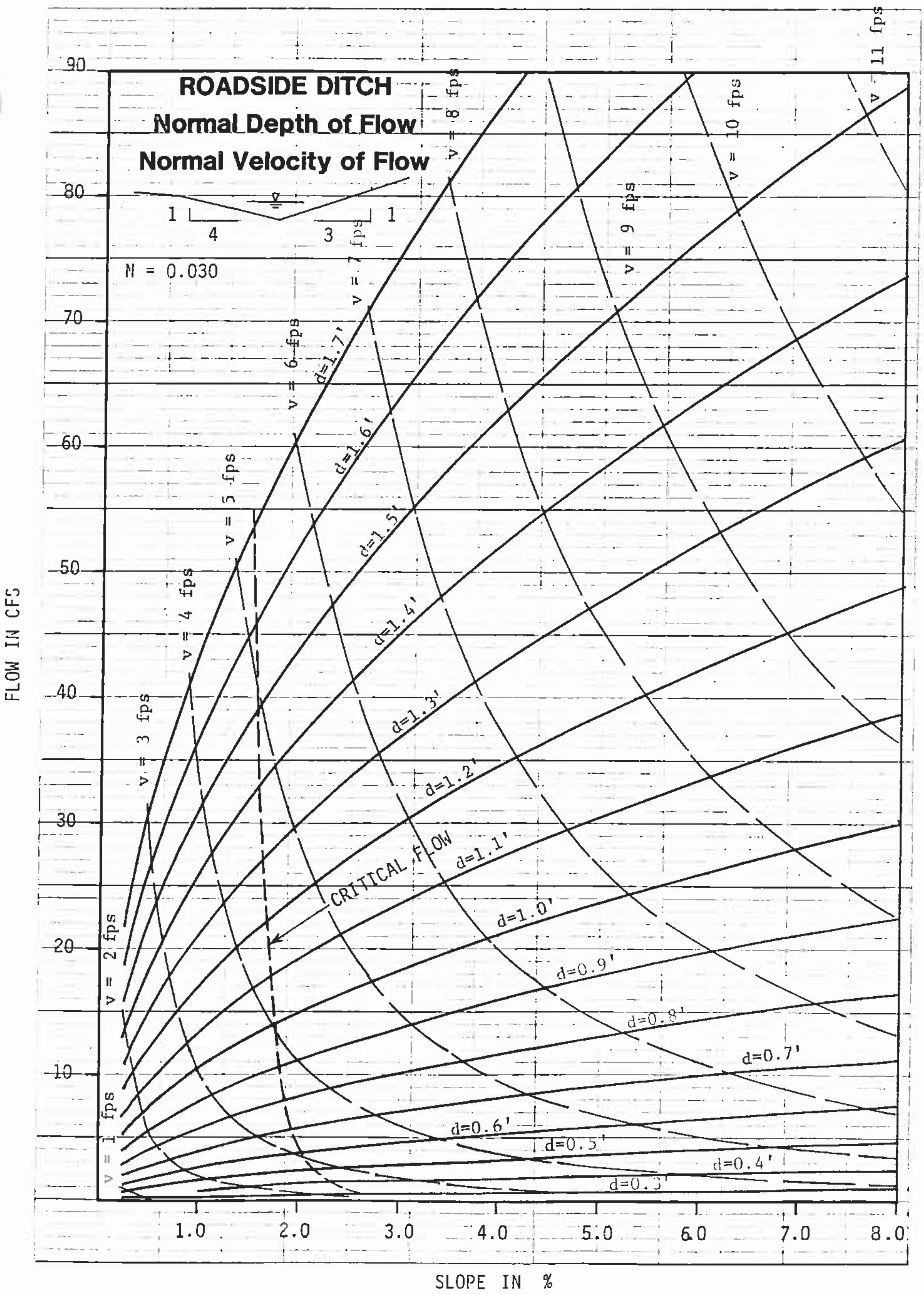
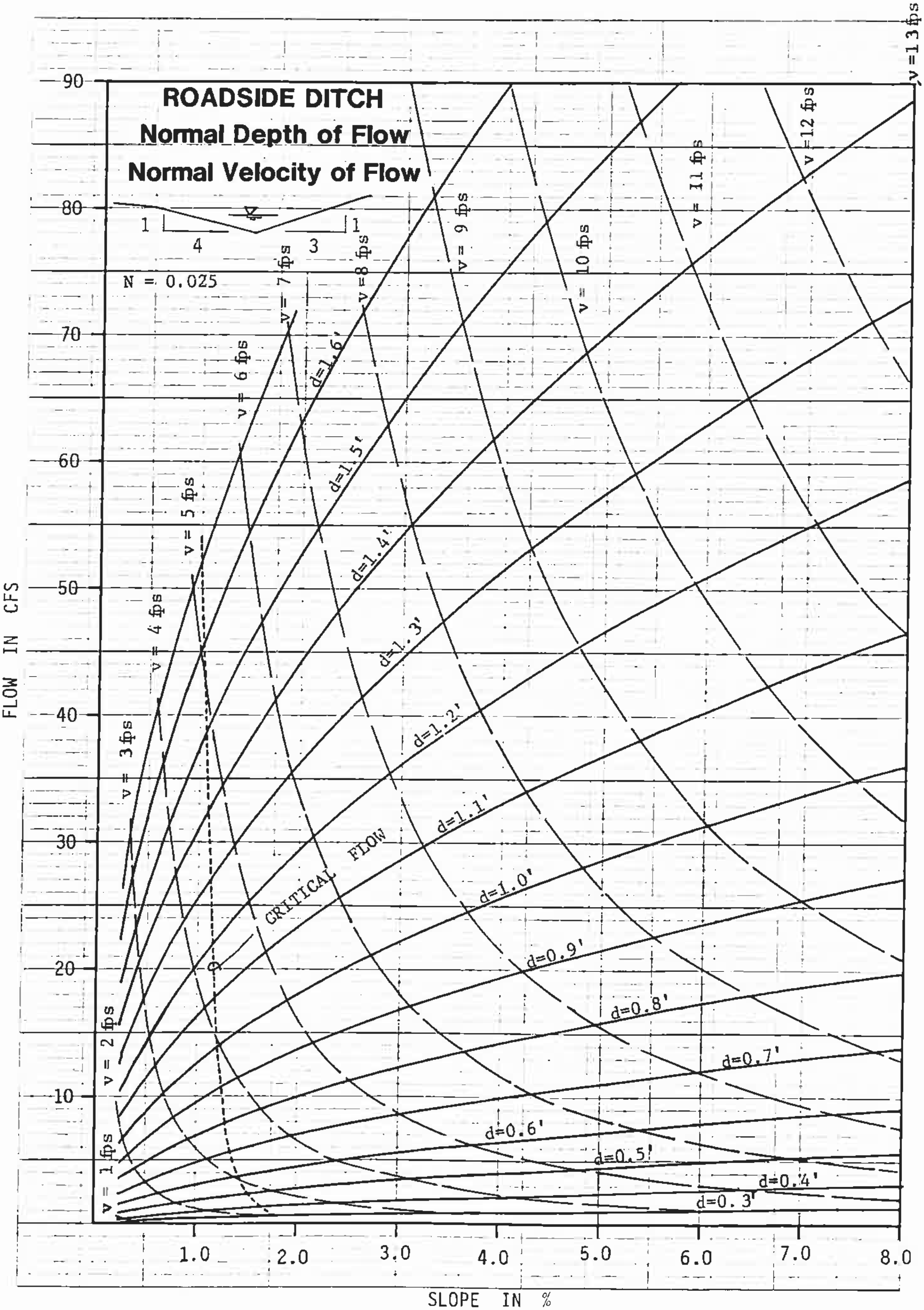
ATTACHMENT M

Roadside Ditches Capacity Charts



ROADSIDE DITCH
Normal Depth of Flow
Normal Velocity of Flow
1
4
3
1
N = 0.030
v = 1 fps
v = 2 fps
v = 3 fps
v = 4 fps
v = 5 fps
v = 6 fps
v = 7 fps
v = 8 fps
v = 9 fps
v = 10 fps
v = 11 fps
d=1.7'
d=1.6'
d=1.5'
d=1.4'
d=1.3'
d=1.2'
d=1.1'
d=1.0'
d=0.9'
d=0.8'
d=0.7'
d=0.6'
d=0.5'
d=0.4'
d=0.3'
CRITICAL FLOW
FLOW IN CFS
90
80
70
60
50
40
30
20
10
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
SLOPE IN %


ROADSIDE DITCH
Normal Depth of Flow
Normal Velocity of Flow
N = 0.025
1
4
3
1
v = 1 fps
v = 2 fps
v = 3 fps
v = 4 fps
v = 5 fps
v = 6 fps
v = 7 fps
v = 8 fps
v = 9 fps
v = 10 fps
v = 11 fps
v = 12 fps
v = 13 fps
d=1.6'
d=1.5'
d=1.4'
d=1.3'
d=1.2'
d=1.1'
d=1.0'
d=0.9'
d=0.8'
d=0.7'
d=0.6'
d=0.5'
d=0.4'
d=0.3'
CRITICAL FLOW
FLOW IN CFS
SLOPE IN %
10
20
30
40
50
60
70
80
90
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0

ATTACHMENT N

Geotechnical Inspection Report -

Haul Roads and Conveyor Beltline

GEOTECHNICAL INSPECTION REPORT

Haul Roads and Conveyor Beltlines

Kayenta and Black Mesa Coal Mines

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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1.0 INTRODUCTION

This report presents the results of geotechnical inspections completed for the two main haul roads and the conveyor beltline at Peabody Coal Company's Kayenta and Black Mesa Coal Mines in Navajo County, Arizona. The inspections were conducted to determine compliance with the Office of Surface Mining (OSM) Regulations 30 CFR, Parts 780.37, 816.150, and 816.151.

For purposes of the inspections, the haul roads have been designated the Black Mesa Haul Road and the Kayenta Haul Road. The Black Mesa Haul Road provides the main coal haulage access to the coal resource areas and facilities along the western and southern parts of the coal leases. The Black Mesa Haul Road, together with branches and access to ramps of active open pits, is approximately 12.22 miles (64,500 feet) in length. The Kayenta Haul Road provides coal haulage access to the coal resource areas and facilities along the northern and eastern parts of the coal leases. The total length of the Kayenta Haul Road, including branches and access to ramps, is approximately 18.02 miles (95,000 feet).

The conveyor beltline consists of nine segments comprising a total of about 15.72 miles (83,000 feet) and transports coal from the Kayenta mine facilities near J-28 to the silos at the rail loading site. The beltline was constructed in three phases: the pre-law phase from the silos to the N7/8 area was constructed in the mid 1970s; Phase I from the N7/8 to N14 area was built in 1982; and Phase II from the N14 to J28 area was built in 1983.

The locations of the haul roads in relation to existing facilities are shown on Plate 1A, Site Plan, Haul Roads. The location of the conveyor beltline is shown on Plate 1B, Site Plan, Conveyor Beltline.

2.0 PURPOSE AND SCOPE

The purpose of the inspections was to observe the existing conditions of the cuts and fills along the haul road and conveyor beltline alignments and to evaluate the stability of the haul road and conveyor beltline against the performance standards set forth in 30 CFR, Parts 780.37, 816.50 and 816.51. More specifically, the performance standards require that all embankment slopes have, at a minimum, a static factor of safety of 1.3.

To achieve this purpose, the following scope of work was accomplished:

- A review of pertinent records in Peabody Coal Company's site files, including topography, design drawings, inspection reports and construction records.
- A detailed reconnaissance of each alignment by a Dames & Moore senior geotechnical engineer during which lengths, widths, heights and slopes of all embankments were measured and signs of distress were recorded.
- A limited drilling program of selected road embankment fills and subsequent laboratory testing to evaluate the general characteristics of the materials used to construct the fills.
- Engineering analyses to evaluate stability of slopes.
- Preparation of a remedial compliance plan for slopes that do not meet the minimum performance standards for slope stability.

3.0 SITE DESCRIPTION

3.1 GENERAL SURFACE CONDITIONS

The mine site is located on Black Mesa, a moderately dissected highland within the Colorado Plateau Physiographic Province. The surface generally slopes gently to the southwest; drainage is also to the southwest by Moenkopi Wash and its tributaries. Overall relief within the mine site area ranges from about elevation 8100 feet along the rim of the mesa to about elevation 6150 feet where Moenkopi Wash exits the leasehold. Local relief between upland areas and the bottoms of adjacent washes is generally less than 250 to 300 feet.

3.2 GENERAL SUBSURFACE CONDITIONS

Throughout most of the site, the bedrock units exposed in cuts and as outcrops belong to the Wepo Formation which is part of the Upper Cretaceous Mesa Verde Group. The Wepo Formation consists of a series of thickly interbedded siltstones, mudstones, sandstones and coal. The siltstones and mudstones weather to low- to medium-plastic clayey soils, forming gentle yet extensively eroded slopes. The sandstones vary in competence, forming cliffs in areas where the sandstone is firmly cemented and weathering to slopes where it is weakly cemented.

Overburden soils mantling the bedrock consist of colluvium and materials from residual weathering on slopes and on the uplands and recent alluvium filling the washes. The colluvial and residual weathered materials vary from clay to sandy gravel depending on the parent material. The alluvial soils are predominantly silty and clayey sands with interbeds of platey gravel.

4.0 FIELD INSPECTION OF HAUL ROAD AND CONVEYOR BELTLINE ALIGNMENTS

4.1 SUMMARY OF INSPECTION RESULTS

In general, the 30.24 miles of haul roads and 15.72 miles of conveyor beltline are in good shape with only three or four major items that require remedial actions. These items fall into the category of small slope failures or slumps, possible settlement of conveyor beltline trestle footings and one or two cases of severe erosion which may lead to potential instability of embankment slopes. The remainder of the observations are in the category of routine and/or periodic maintenance tasks such as drainage ditch erosion, raveling and/or minor sloughing of slopes, erosion of slopes around conveyor footings and poorly developed drainage ditches.

General and specific inspection items are detailed in the following section and on Plates 2A through 2D; recommended remedial actions are discussed in the remedial compliance plan section of this report.

4.2 INSPECTION PROCEDURES

Field inspection of the haul roads and conveyor beltline was accomplished between August 29 and September 11, 1985 by a senior geotechnical engineer from Dames & Moore. Inspection procedures consisted of the following steps:

- a review of pertinent records and maps,
- a visual inspection of the haul road and conveyor beltline alignments,

- measurements of relevant dimensions and slope angles,
- notation of observed evidence of embankment distress including sloughing, tension cracks, erosion, and other signs of instability, and
- observations of drainage systems.

In general, 1 inch equals 400 feet scale maps of the transportation alignments were used to orient the inspection, and all visual observations were noted on these maps. Measurements of embankment slopes, crest widths and heights were made with a hand level, cloth tape and a calibrated rod. Table 4-1 presents the definitions of terms used during the inspection.

Table 4-1

DEFINITIONS OF INSPECTION TERMS

A. EROSION

Rill - less than 12 inches wide or 12 inches deep

Gully - greater than 12 inches wide or 12 inches deep

Minor erosion - rills on less than 25 percent of the surface; no gullies

Moderate erosion - rills on more than 25 percent but less than 50 percent of the surface; gullies on less than 5 percent of the surface

Severe erosion - rills on more than 50 percent of the surface; gullies on more than 5 percent of the surface

B. ROAD CONDITIONS

Good - fresh graveled/recently graded; ruts less than 1/4 inch deep and covering less than 10 percent of the traveled surface; no rills or gullies

Lightly rutted - ruts 1/4 to 1/2 inch deep over less than 25 percent of the traveled surface

Moderately rutted - ruts 1/2 to 1 inch deep over more than 25 percent of the traveled surface

Severely rutted - ruts greater than 1 inch deep

C. DEGREE OF DISTRESS

N - none to insignificant

P - potential or developing distress

Y - existing distress (slumps, undercutting, major settlement, etc.)

M - integrity of structure not threatened, but maintenance recommended

O - beyond scope of study

4.3 DESCRIPTION AND INSPECTION RESULTS OF TYPICAL ROUTE SECTIONS

4.3.1 General Dimensions and Typical Sections

The traveled lanes of the haul roads vary from 36 to 63 feet in width. Where it is planned to walk a dragline between mine areas, road widths increase up to 130 feet, usually by adding a second, untraveled lane to the right-of-way. Roadside drainage is provided by ditches ranging in width from 8 to 20 feet and in depth from less than 6 inches to 4 feet. Major embankment fills are commonly provided with safety berms outside the drainage ditches.

Conveyor beltlines are built on berms ranging from about 14 feet in width where no service road occupies the berm to about 42 feet in width where a service road has been built on either side of the beltline.

Construction of the haul roads and the conveyor beltlines was completed using four distinct typical sections:

1) At-grade construction
2) Cut
3) Cut-and-fill, Type A - longitudinal
4) Cut-and-fill, Type B - transverse or sidehill

These four section types are described in the following sections. Other facilities related to the alignments, including major embankments, trestles, underpasses and drainage, are also described.

4.3.2 At-Grade Construction

At-grade construction comprises those segments of the haul roads and conveyor beltlines where cuts or fills that were constructed to achieve subbase grade are generally less than 3 feet in height. Foundation preparation consists of stripping prior to placement of 1 to 3 feet of compacted subbase for the roads or footings for the conveyor beltline supports.

A summary of our inspection of all the at-grade construction sections along the haul road and beltline alignments is presented on Plate 2A along with a typical cross section to indicate the features of this section. Stationing of the roads and beltlines where this form of construction applies is also presented. In general, it is our opinion that the conditions of the at-grade construction sections of the haul roads and beltline are good; however, maintenance of the drainage ditches is required at a few locations in order to better divert water from the roadbed. Severe erosion, which can be addressed through periodic maintenance, was noted at Station 126+40 and the perimeter slope of the West Bypass.

4.3.3 Cut Slopes

Construction of segments of the haul roads and beltline that involve excavation falls into two categories: rock slopes and soil slopes. Further, cuts are subdivided into excavation to level crests of hills to form platforms and excavation into the slope to reduce the gradient of the alignment. Segments of the alignments involving cut slopes as the predominant construction feature are identified on Plate 2B along with descriptions of salient features of the alignment segments involving cut slopes and a summary of our field inspection.

Slopes excavated in rock range from less than 10 feet in height to in excess of 65 feet. The average inclination of slopes cut in rock ranges from 4:1 (14°) to 1:5 (80°), with localized vertical excavation. The steepness of rock cuts appears to be a function not only of rock competence, but also of available space and inclination of adjacent slopes. As shown on the typical cross section presented on Plate 2B, a gently sloping base is commonly constructed at the toe of excavated slopes between the cut slope and the drainage ditch.

Cut slopes in soil generally have been excavated at an inclination of about 3:1. The cut slopes range up to 40 feet in height, although a few slopes continue to rise above the lower cut at a flatter inclination. As part of site reclamation activities, cut slopes in both rock and soil that are flatter than 2:1 have been revegetated.

No instability or distress was revealed in cut slopes in either rock or soil during the field inspection. Some raveling of slopes along the conveyor beltline between Stations 529+40 and 541+40 and minor to moderate erosion was noted, which can be addressed through periodic maintenance.

4.3.4 Cut-and-Fill

Cut-and-fill construction has been used to build about 55 percent of the total lengths of the haul roads and conveyor beltline. This method of construction involves excavation of high ground or steep slopes and use of the excavated material as fill to raise alignment grade in adjacent depressions. The cut-and-fill construction was divided into two categories for purposes of this inspection: (1) Type A - longitudinal and (2) Type B - transverse.

4.3.4.1 Type A - Longitudinal

The longitudinal cut-and-fill sections (Type A) are completed parallel to the axis of the alignment where it is necessary to smooth out the natural hummocks and swales in the terrain. Material from excavation is pushed into depressions to raise the grade as shown on Plate 2C. This construction method usually results in cut slopes on both sides of the alignment and embankment fills across topographic lows; natural drainage is commonly disrupted by the fills, and culverts are required to provide drainage.

Excavated slopes associated with the longitudinal cut-and-fill sections range from as steep as vertical for rock slopes to as flat as 3:1 for cuts in soils. Embankment fills range up to 45 feet in height. The fills have been constructed by spreading the excavated materials in compacted lifts. In general, the side slopes of the embankment fills in the cut-and-fill sections are no steeper than 3:1. However, some embankment fills exist that have exterior slopes as steep as 1.35:1. Embankment fills with such steep side slopes were generally constructed prior to 1977 or were otherwise approved by OSM.

The results of our field inspection of all the longitudinal (Type A) cut-and-fill sections along the haul road and beltline alignments are presented on Plate 2C. No areas of major instability of Type A cut-and-fill sections were observed during the field inspection; however, small slumps have occurred along the conveyor beltline at Stations 24+60 and 497+00 which should be repaired as recommended in later sections of this report. Minor to moderate erosion was evident on both cut-and-fill slopes, and drainage ditches were discontinuous in some places. However, these problems are not considered to be of major consequence and can be addressed during normal maintenance.

4.3.4.2 Type B - Transverse

The transverse (Type B) cut-and-fill section involves excavation into a sidehill with the excavated materials being pushed out over the slope forming an extension of the excavated bench. The typical cross section, shown on Plate 2B, consists of the level, or slightly superelevated, grade of the alignment flanked by a cut slope on the inboard side and a fill slope on the outboard side.

The interior slopes (excavations) of the transverse cut-and-fill sections are as steep as vertical for competent rock slopes while the exterior slopes of the fills are 3:1 or flatter. Roadside drainage is provided by a ditch constructed at the toe of the excavated slope. Type B cut-and-fill sections result in less disruption of natural drainage than Type A because the fill is built on a side slope rather than across a drainage course.

The results of our inspection of the transverse (Type B) cut-and-fill sections are summarized on Plate 2D. No significant distress or instability of Type B cut-and-fill was noted during the field inspection. Some minor erosion of both cut slopes and fill slopes was evident and the drainage ditches needed to be cleared in a few places; these problems can be corrected during normal periodic maintenance.

4.3.5 Embankments

Haul road crossings of major washes are accomplished by means of major earthfill embankments. Five such embankments exist along the haul road alignments: (1) Black Mesa Haul Road Crossing of Moenkopi Wash, (2) Kayenta Haul Road Crossing of Reed Valley, (3) Kayenta Haul Road Crossing of Moenkopi Wash, (4) Kayenta Haul Road Crossing of Coal Mine Wash, and (5) Kayenta Haul Road Crossing of Yellow Water Canyon. The typical cross-section of each embankment is presented on Plates 3A through 3E, respectively. From one to five CMP culverts are installed at the base of the embankments to provide positive drainage at each crossing. The diameter of the culverts ranges from 54 to 108 inches.

The earthen embankments have been constructed with random fill to heights ranging from 30 to 50 feet; crest widths vary from 107 to 190 feet.

The typical cross section includes safety berms at the edges of the crest, ditches for drainage, and double lane (or provision for double lane) roadway. Side slopes of the embankments range from as steep as 1.3:1 to as flat as 4:1.

No significant evidence of major instability of any of the embankments was noted during our field inspection. However, some shallow surface sloughing and relatively severe erosion existed on the steep slopes of the Kayenta Haul Road Crossings at Coal Mine Wash and Yellow Water Canyon where gullies up to 8 feet deep and 3 feet wide are cut into the fill and tension cracks are evident in the fill. The Black Mesa Haul Road Crossing at Moenkopi Wash showed some shallow surface sloughing, however, the 1.3:1 embankments were the steepest observed slopes. Therefore, these three embankments were selected for a more detailed subsurface investigation and stability analyses which are described in subsequent sections of this report. Results of the stability analyses indicate that the factor of safety against deep-seated failure under static loading conditions for slopes flatter than 1.3:1 exceeds 1.3, which is the minimum factor of safety required by OSM.

4.3.6 Trestles

Overhead crossings and crossings of washes along the conveyor beltline are accomplished with trestle-supported structures. Most commonly, trestles consist of bipod steel pipes or wide-flange beams resting on 2- to 4-foot concrete pedestals. Occasionally, the trestle support consists of a single 12- or 18-inch-diameter steel pipe or, where very high sections occur, four legs consisting of wide-flange beams with cross-bracing. Support spacing is about 60 feet center-to-center. Possible settlement or movement of trestle footings has occurred at Stations 96+20 and 738+20; these trestle supports should be monitored at intervals to verify and document the movements.

4.3.7 Underpasses

Underpasses are associated with roads crossing above the conveyor beltline. The underpasses typically consist of 10-foot-diameter CMP culverts, which provide sufficient room for the beltline, and an access catwalk for inspection and maintenance. Only one underpass is larger; it consists of a 12- by 20-foot elliptical culvert section. Soil cover above the CMP culverts ranges from 18 inches to 4 feet.

4.3.8 Ditches and Culverts

Surface drainage control for the haul roads and conveyor beltlines is provided by ditches and culverts. Hydrologic and hydraulic analyses have been performed by Peabody Coal Company to design the ditches and culverts. These analyses are maintained in Peabody Coal Company's files.

Standard design procedures were reportedly followed to select CMP culvert sections appropriate to specific site requirements. Culverts ranging in diameter from 18 to 108 inches have been installed along the transportation alignments.

The design cross section of a roadside ditch consists of a "v"-notch with a 3:1 limb extending down from the roadbed and a 2:1 to 4:1 limb rising to form the outboard side of the ditch. The design cross section allows for about 1 foot of freeboard during the design 10-year discharge.

Our inspection showed that drainage ditches for the haul roads are generally in good shape with only minor to moderate erosion occurring at some stations. Exact locations where these drainage/erosion problems exist are listed on Plates 2A through 2D. Two factors contribute to the erosion problem in the ditches: (1) on inclined grades there are no provisions for reducing the velocity of flowing water, and (2) outfalls to sedimentation ponds commonly consist of open, unlined channels with down cut or fill slopes. Both factors contribute to severe erosion and gully development. Measures to reduce ditch flow erosion, including straw bales, have been tried with mixed results after erosion has initiated. A further problem involves continuity of ditches at road intersections. At several intersections, ditches end blindly and discharge onto the road.

The drainage system for the conveyor beltline is poor or undeveloped in the pre-law section (silos to N7/8 area) of the beltline and somewhat discontinuous in the Phase I and II sections. Exact locations where these conditions were noted are listed on Plates 2A through 2E. Remedial actions are recommended in later sections of this report.

5.0 FIELD EXPLORATION AND LABORATORY TESTING

5.1 FIELD EXPLORATION

As mentioned previously, field explorations were conducted at three of the major haul road embankments in order to investigate the composition of the fill materials used in construction of the embankments. The three embankments were the Black Mesa Haul Road Crossing of Moenkopi Wash, the Kayenta Haul Road Crossing of Coal Mine Wash, and the Kayenta Haul Road Crossing of Yellow Canyon Wash. These three embankments are the highest of the five haul road crossings and have the steepest slopes. Based on the assumption that quality of construction and material properties were similar in all of the inspected haul road embankments, it was assumed that these three embankments represented the most critical stability conditions.

One boring was drilled at each of these haul road crossings. The drilling was performed with a Mobile B-61 drilling rig supplied and operated by the Jim Winnek Drilling Company. The three borings were completed using hollow stem augers to depths ranging from 41.5 to 58 feet. The locations of the borings are shown on Plate 1A. Representative samples of the various soils encountered in the borings were recovered at 5- to 10-foot vertical intervals by driving a ring sampler through the hollow stem of the auger. The number of blows required to advance the sampler 1 foot using a 140-pound hammer falling 30 inches per blow was recorded for each sample recovered. A more detailed description of the sampling method has previously been provided in Section 3.5 of the General Report. These blow counts provide an indication of the relative density of the materials that were sampled. The samples were returned to Dames & Moore's laboratory for further classification and testing.

The drilling program was completed under the direction of a Dames & Moore field engineer who maintained a continuous log of each boring. The Log of Borings is presented on Plates 4A to 4C and a Key to the Log of Borings is presented on Plate 5. The soils were classified according to the Unified Soil Classification System shown on Plate 6. Ground water was encountered in the borings at the depths shown on the Log of Borings.

5.2 LABORATORY TESTING

All samples recovered from the borings were inspected in the laboratory to confirm the field classification. In addition, laboratory testing was completed to determine moisture content, dry density and particle size distribution of selected soil samples.

5.2.1 Moisture Content and Dry Density Determinations

The moisture content and dry density of selected soil samples were determined as an aid in estimation of their engineering properties and in correlation with other samples. Moisture content was determined in accordance with ASTM D 2216 procedures. The results of the moisture content and dry density determinations are presented on the Log of Borings, Plates 4A through 4C.

5.2.2 Particle Size Distribution

The particle size distribution of a representative sample of the random fill was determined by passing a specimen of the soil through a nested set of standard sieves. The test was completed in accordance with ASTM D422 procedures. The test results are presented on Plate 7, Composite Gradation Curve of Embankment Fill.

6.0 STABILITY ANALYSES

Using data provided by the field inspection, field exploration, and laboratory testing, stability analyses were completed to determine the factor of safety of existing haul road embankments against deep-seated failure. The analyses were performed using the computer program STABL2. STABL2 uses the Modified Bishop Method of Slices in a limiting equilibrium analysis.

Stability analyses were performed on the inlet side of three haul road embankment sections. The sections chosen for analysis are representative of the steepest and highest embankment slopes encountered during the field inspection. Stability analyses were performed for the following embankment sections:

- o Black Mesa Haul Road, Moenkopi Wash Crossing (see Plate 3A)
- o Kayenta Haul Road, Coal Mine Wash Crossing (see Plate 3D)
- o Kayenta Haul Road, Yellow Water Canyon Crossing (see Plate 3E)

Stability analyses were also performed to evaluate surface loading caused by 180-ton mine haul trucks. The Black Mesa Haul Road at Moenkopi Wash Crossing is the steepest roadway embankment section analyzed and was therefore assumed to be a "worst case" analysis for point loading. One and two haul trucks were analyzed passing over the roadway embankment section; the two haul truck analysis had both trucks passing over the embankment simultaneously with a distance of 8 feet between the trucks.

The engineering properties of the embankment materials and alluvial soils that were selected for the purpose of the stability analyses were based on the results of the field investigation and. laboratory testing conducted for this assignment. The results of investigations and laboratory testing for other embankment design and construction projects that have been completed at the Black Mesa and Kayenta Coal Mines were also given consideration in the selection of engineering properties for use in the stability analyses.

One boring was drilled at each of the three haul road locations listed above. The borings and results of laboratory tests on samples from these borings (Borings RB-1, RB-2, and RB-3) suggest that the embankment materials are similar and are typically composed of sandstone and shale rock fragments in a fine silty sandy matrix. In order to estimate typical shear strength properties for the embankment materials, we assumed that the material composition is closer to that of a residual shalestone than a residual sandstone. Based on this assumption, we used the same effective stress strength parameters for the haul road embankment materials as were used for the stability analyses of sediment control structures composed predominantly of residual shalestone material.

The engineering properties of bedrock materials that underlie the embankments were assumed based on our experience and on information and data provided in the literature. A summary of the unit weight and shear strength properties used in the analyses is presented in Table 6-1.

Table 6-1

SUMMARY OF UNIT WEIGHTS AND EFFECTIVE STRESS
SHEAR STRENGTH PARAMETERS USED IN STABILITY ANALYSES

Material Type	Total Unit Weight (pcf)	Friction Angle Angle (degrees)	Cohesion (psf)
Embankment Materials	118	33	200
Sandstone Bedrock	118	25	20,000
Shalestone Bedrock	118	25	20,000

The stability of the haul road embankment sections was analysed under dry conditions. Our discussions with Peabody Coal Company operational personnel indicate that, during the life of these embankment crossings, water has ponded against the slopes on two occasions for only a few hours until the water drained through the culverts. Therefore, it appears extremely unlikely that water would be impounded for a sufficient period to cause deep saturation of the embankment materials. On these rare occasions, any damage to the embankment slopes would be limited to minor sloughing of surficial, saturated material below the waterline and we do not believe that the stability of the slopes would be affected significantly.

The results of the stability analyses are summarized in Table 6-2 and on Plates 8A and 8B. In each case, the "critical" failure surface which we have identified is circular and of sufficient depth to be classified as "significant" (greater than 5-foot depth). The factors of safety calculated for each of the surfaces exceed OSM regulation 30 CFR Part 186.150 (b,9) requirements of 1.3 for static loading conditions. These results are supported by the fact that no major slope instabilities were observed at the haul road crossings.

In determining the influence of one and two 180-ton mine haul trucks, the calculated factors of safety were greater than the "critical" factor of safety. This indicates that the presence of haul trucks does not affect the stability of the roadway embankment section. The results of the stability analyses with one and two haul trucks included as line loads are shown on Table 6-2 and on Plate 8B.

Table 6-2

SUMMARY OF STABL2 STABILITY ANALYSIS RESULTS
FOR DRY SLOPE AND STATIC CONDITIONS

Haul Road	Crossing	Embankment Height (ft)	Embankment Slope	Computed Factor of Safety
Black Mesa	Moenkopi Wash	45	1.3:1	1.43
Black Mesa	Moenkopi Wash	45	1.3:1(one truck)	1.57
Black Mesa	Moenkopi Wash	45	1.3:1(two trucks)	1.83
Kayenta	Coal Mine Wash	58	2.3:1	1.63
Kayenta	Yellow Water Canyon	53	1.7:1	1.69

In the event that the additional haul road embankments are constructed, it would be reasonable to use the results of these stability analyses as a guide when embankment slopes are designed. However, more detailed analyses should be performed if the material to be used for embankment construction is not similar to the predominantly silty combination of residual shalestones and sandstones encountered in the existing embankments.

7.0 REMEDIAL COMPLIANCE PLAN

7.1 GENERAL

In general, there were no signs of major instabilities along the haul roads and conveyor beltline. The control of surface runoff and erosion were the only maintenance deficiencies encountered during the inspection. Erosion of steep and unprotected embankment slopes is to be expected of the highly erodible soils of Black Mesa, and continuous maintenance is needed to prevent erosion from impacting adversely on the haul road and conveyor beltline facilities. For example, ditch discharges have resulted in the development of severe erosion and deep gullying in some locations. Unless the open channels are lined with rock, half-culverts, Fabriform or other suitable erosion protection, the discharge from roadside ditches will continue to cause gully erosion.

It is recommended that straw bales be installed in roadside ditches to control the velocity of flow below the threshold velocity for erosion. For the ditch gradients observed, it is anticipated that spacing of the straw bales should range from about 400 feet for 2 percent grades to less than 100 feet for 6 percent grades. For steeper gradients, it may be more practical to line the ditches with rock and to dissipate flow energy with drop boxes. If remedial measures such as suggested above are not implemented, the erosion can be corrected through regular maintenance, although this may require periodic regrading and reconstruction of the eroded areas to the design lines and grades.

The remedial actions recommended consist of repairing a few small slumps that have occurred in embankment fills. An inventory of areas where existing or potential distress has been noted is listed on Table 7-1. Specific recommendations for the remedial actions are given in the subsequent sections.

Table 7-1

DISTRESS - LOCATION AND REMEDIAL TREATMENT

Route	Location (Station)	Distress	Remedial Treatment	Schedule of Proposed Remedial Work (year after approval)
Black Mesa Haul Road	213+50-225+10 Moenkopi Wash	Potential instability	Erosion and drainage control	1
Kayenta Haul Road	544+20-551+60 Coal Mine Wash	Surface sloughing; severe erosion	Erosion and drainage control	completed-'
	Yellow Water Canyon	Potential instability	Erosion control; clear culverts	2
Conveyor Beltline	24+60	Slump at culvert outfall	Buttress with rock	completed-1985
	96+20	Possible settlement of tower footing	Monitor by survey; if movement detected, adjust beltline or underpin footing	No Movement detected-1985
	497+00	Slump in cut slope	Trim and buttress slope as detailed on Plate 13	completed-1985
	529+40-541+40	Raveling of slope; debris slides	Remove debris; gunite and/or anchored wire mesh on slope	completed-1986, ongoing - Routine Maintenance

Revised 12/01/86

Table 7-1 (Con't)

DISTRESS - LOCATION AND REMEDIAL TREATMENT

Route	Location (Station)	Distress	Remedial Treatment	Schedule of Proposed Remedial Work (year after approval)
	618+50-623+00	Debris slides	Remove debris; gunite and/or anchored wire mesh on slope	completed-1986 ongoing - Routine Maintenance
	738+20	Possible movement of tower footing	Monitor by survey; if movement detected, replace tower	No movement detected-1985

7.2 BLACK MESA HAUL ROAD

The inclination of the haul road embankment fill slopes which cross Moenkopi Wash range from 1.3:1 to 1.5:1 (horizontal to vertical). No incipient slope failures were noted during our field inspection and results of the stability analysis conducted during this assignment indicate that embankment slopes of 1.3:1 (horizontal to vertical) have a factor of safety under static loading conditions in excess of 1.3. Since 1.3 is the minimum factor of safety required by OSM's performance standards for haul roads, the existing embankment slopes are stable; however, severe erosion, if not controlled, could lead to steeper slopes which would be unstable.

Severe erosion has occurred at Stations 126+40, 496+20, and the perimeter slope of the West Bypass at the Black Mesa Mine. At each of these locations, it is recommended that the parts of the slope affected by erosion be trimmed, reconstructed to grade, and protected with rockfill. The runoff or flow contributing to the erosion should be controlled with straw bales, silt fences or other suitable means and collected into drains consisting of gravel-filled trenches (French drains), Fabriform blankets, half-culverts or other suitable alternative.

7.3 KAYENTA HAUL ROAD

No incipient slope failures were observed along the 18.02 miles of this alignment, nor along its branches. The cuts and embankments, with few exceptions, have slopes of 3:1 (horizontal to vertical) or flatter. Areas of existing distress and/or potential instability are noted on Table 7-1.

Surficial instability was observed at only one location, the Coal Mine Wash Crossing, where tension cracks and sloughing occurred in the crest at the northeast end of the embankment. Explorations indicated that the embankment consists of a dense to very dense random fill comprised of silty sand to boulder-size fragments of sandstone derived from excavation into the flanks of the wash. The observed instability was related to erosion and sloughing of soils placed close to the angle of repose at the exterior of the slope. The embankment crossing of Yellow Water Canyon along the haul road to the N7 and N8 area has been constructed with side slopes ranging from 1.4 to 1.75:1 (horizontal to vertical); however, no evidence of existing instability was observed.

While there has been no deep-seated instability at either of the embankment crossings, the slopes are very susceptible to erosion. It is not anticipated that a deep-seated failure would occur under normal operating conditions, and buttressing or flattening the slopes is not a requirement. However, the program of regular observation, maintenance and drainage control should be continued to control gully erosion, as discussed in the following section.

The major areas of erosion occur where ditch flow is discharged over embankment or cut slopes through open, unlined channels to the sedimentation structures. Severe cases of gully erosion occur at the Coal Mine Wash and Yellow Water Canyon Crossings, where concentrated runoff has cut steep-sided gullies up to 8 feet deep and 3 feet wide into the fill. At those locations, the sides of the gullies are sloughing and tension cracks are developing parallel to the gullies.

It is recommended that the gullies be trimmed and backfilled with random fill and rock, as shown on Plate 9, to prevent further degradation of the slopes. Filter fabric should be installed between the random fill and rock. As an alternative, the gullies could be backfilled with random fill and a half-culvert, Fabriform or other suitable alternative laid on the surface as a flume to discharge ditch flow to the sedimentation structures.

Erosion of cut slopes and embankments due to general runoff varies from insignificant to moderate. Good surface erosion control appears to have been achieved where the slopes have been mulched. The best results have been achieved where the mulch has been crimped.

At Stations 585+20, 622+60 and 638+60, the road embankment blocks small drainage areas. No outlets have been provided for the drainages, although with improved ditching, storm discharge could be directed into internal impoundment N2-RA. However, this would effectively double the watershed area contributing to N2-RA. This alternative should be reviewed, as well as the alternative to provide culverts under the haul road at these locations.

7.4 CONVEYOR BELTLINE

Along the 15.7 miles of the conveyor beltline alignment only six occurrences of instability were noted. These are summarized in Table 7-1 and discussed below.

A slump is developing adjacent to the culvert outfall at Station 24+60 due to undercutting of the slope. The incipient slump is far enough away from the conveyor beltline that the slump would not affect conveyor operation. The main impact would be disruption of drainage and possible damage to the culvert. It is recommended that the toe of the slump block be buttressed with rockfill and that the channel around the culvert outlet be protected with riprap.

A second slump is developing at Station 497+00 where the conveyor beltline crosses over a road. A tension crack about 25 feet in diameter has developed in the cut slope on the right side of the road near the trestle footing. Horizontal and vertical movement along the tension crack is on the order of 4 inches. Further slippage of this block would potentially undermine the pier support of the conveyor trestle at this location. To stabilize this slope, it is recommended that the slope be trimmed and buttressed with rockfill as shown on Plate 10. Remedial actions have been taken by Peabody Coal Company during preparation of this report.

Extensive cuts into rock slopes have been excavated for the conveyor beltline, especially in the off-lease sections of the beltline where right-of-way limitations are 100 feet. Slope angles vary from 60 degrees to vertical, and excavated slope heights in the immediate vicinity of the beltline reach up to 60 feet. Where shale and mudstone layers are exposed, rapid weathering has resulted in accumulations of cones of debris at the toe of the cut slopes and some local raveling. Debris falls have obstructed the right service road between Stations 529+40 and 541+40. Cleaning of this service road is considered part of the routine maintenance program.

Elsewhere, between Stations 618+50 and 623+00, the debris slope is restrained from encroaching on the beltline by a retaining wall composed of wire mesh supported between wide-flange steel beams. Debris has accumulated to about one-third the height of the retention structure.

To prevent block and debris raveling from weathered cut slopes in rock, it is recommended that the cut slopes be stabilized by application of gunite, by wire mesh spread on the surface of the slope and held in place by rock anchors, wire mesh retaining walls, or by a combination of these methods. If the gunite alternative is chosen, provision must be made for weep holes to prevent buildup of water pressure behind the gunite layer.

The inspection identified locations where movement of trestle support footings was suspected, but could not be verified with the available information. At Station 96+20, settlement of the footing is suspected based on a barely detectable vertical misalignment of the beltline determined by visual inspection. At Station 738+20, apparent twisting of the cross-braced tower indicates a possible movement of an exfoliation block at the rim of the mesa. Before remedial measures can be developed, the amount and rate of movement, if any, at each of these sites should be determined. It is recommended that survey bench marks be established on the concrete footings and beltline frame at these locations. These markers should be surveyed at regular intervals.

East of the N8 Preparation Plant, the conveyor beltline extension to the J28 area has experienced only minor erosion. The steepest grade is about 6 percent, and erosion is limited to minor rills and channels on the service road. Footings for beltline support are individual 12-inch-diameter concrete pedestals extending through the gravel pad into natural ground to a depth of 6 feet.

West of the N8 Preparation Plant to the loadout silos in Long House Valley, erosion of both the service road and beltline foundation varies from minor to severe. Grades along the original beltline alignment reach up to 20 percent in places, and gravel fill or ballast is minimal. Overburden soils obtained adjacent to the beltline have been used extensively for grading the alignment. These soils are susceptible to erosion. Beltline support footings are concrete ties spanning the width of the beltline. Erosion along the beltline has undermined and exposed the base of the concrete ties at several locations. In 1986, Peabody Coal Company plans to replace the concrete ties with 12-inch-diameter by 6-foot-deep concrete pedestals.

Progressive erosion of fill embankments also threatens to undermine portions of the alignment. It is recommended that, to reduce erosion, the section of the beltline alignment between Stations 549+50 and 634+20 and from Stations 745+50 to 827+50 be trimmed and reballasted with 12 inches of gravel to cover the top of the ties with at least 6 inches of ballast. Severely eroded side slopes of embankment fills should also be regraded and protected with rockfill.

One of the main contributing factors of the severe erosion of the pre-law portion of the conveyor beltline is the poorly developed runoff control. Drainage ditches are minimal along the toes of excavated slopes, and runoff flows over the entire width of the right-of-way. The runoff concentrates along depressions in the alignment, aggravating the erosion. Therefore, it is recommended that, in addition to the reballasting of the beltline surface, drainage ditches be excavated and maintained along the edge of the service road. The discharge from the ditches should be carried down embankment slopes either in rock-lined channels, half culverts, Fabriform blankets or other suitable alternatives.

7.5 TRANSFER STATIONS

The conveyor beltline is composed of 10 segments varying in length from 5,000 to 14,000 feet. At the articulation between each segment is a transfer station containing the machinery and beltdrive for the next segment of beltline. The transfer stations are listed on Table 7-2.

Table 7-2

INVENTORY OF CONVEYOR BELTLINE TRESTLES

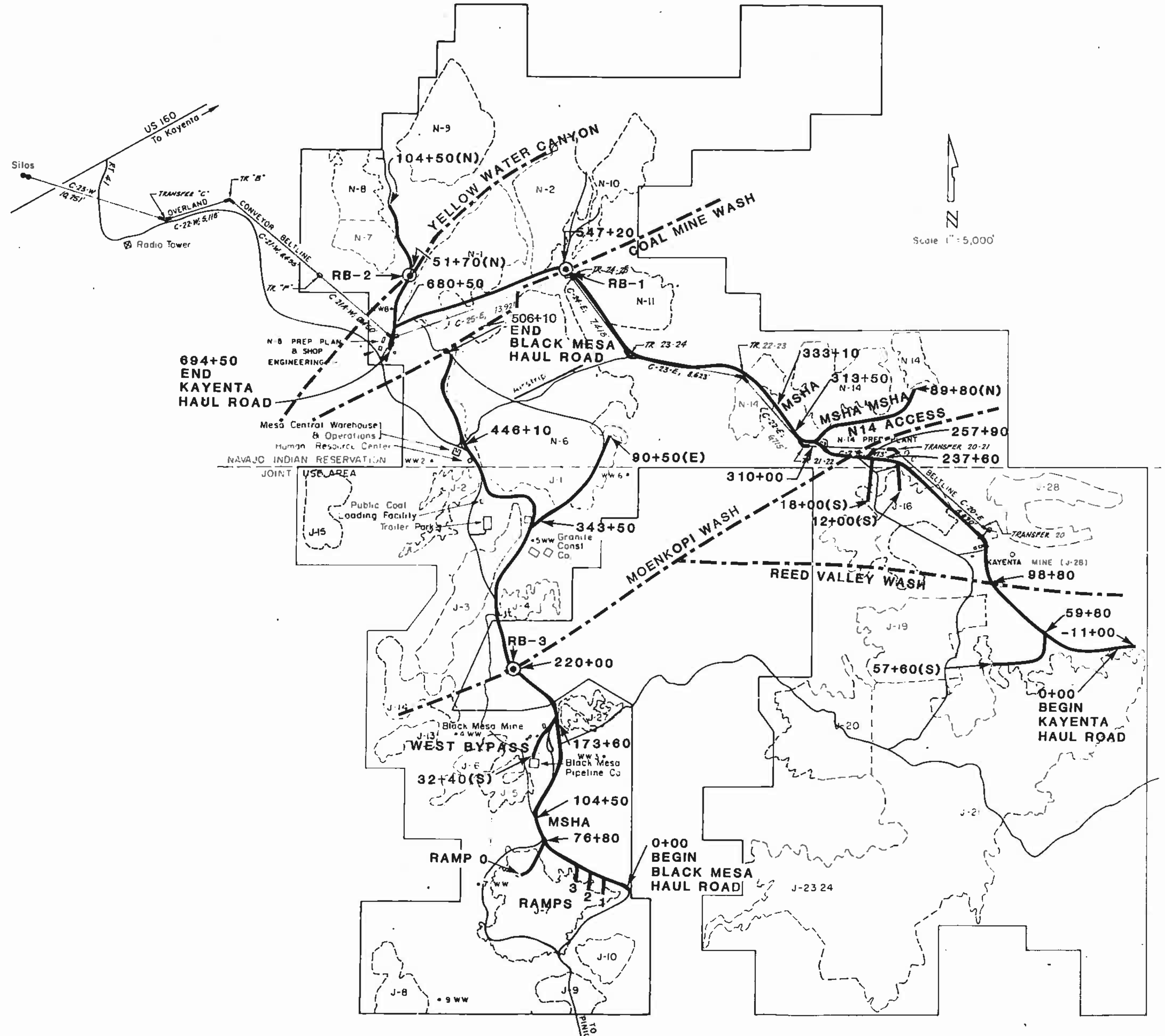
Interval (Station to Station)	No. of Towers	Condition of Footings	Distress
94+80- 99+90	5	Good	None; possible settlement of #2 tower
432+70-435+50	3	Good	None
495+20-500+40	6	Good	Slump 3' from #1
513+30-525+40	17	Good	None
544+10-547+10	1	Fair to Good	Partial undercutting of abutment
730+60-745+50	7	Fair to Good	Possible movement #2 footing
779+40-783+10	1	Good	Localized gully, slough east abutment
809+90-819+50	42	Good	None
827+50-838+10	7	Good	None

Note: For location of Stations, see Plate 1B.

The foundation for each transfer station has been developed by cut-and-fill, with a base fill of granular material. The foundation distress is the same at each transfer station. Uncontrolled runoff of washdown water from cleaning equipment and vehicles softens the base and subbase materials, resulting in potholes, and causes erosion and gully formation in the driveway and yard areas.

The most serious development of this type of distress is at the transfer station at Station 549+50. The facilities at this location consist of feeder conveyors as well as the main beltline, and have been constructed on three levels with two intervening cut slopes. Runoff of washdown water from the upper levels has undercut the concrete abutment of one of the feeder lines, and retaining walls have been built to stabilize the cut slopes.

It is recommended that at each transfer station the drainage be upgraded to collect washdown water and to discharge directly to a sedimentation structure. The drainage should include an asphaltic apron around the concrete slabs of the transfer structure. The apron should be sloped toward one or more catch basins, which should be connected to a buried drain pipe leading to the sedimentation structure. The outfall of the drain pipe should be within 5 feet of the ultimate high water level of the pond to prevent unnecessary erosion of the slope. Finally, the rutted surface of the yard area and driveway should be regraded and resurfaced with gravel.

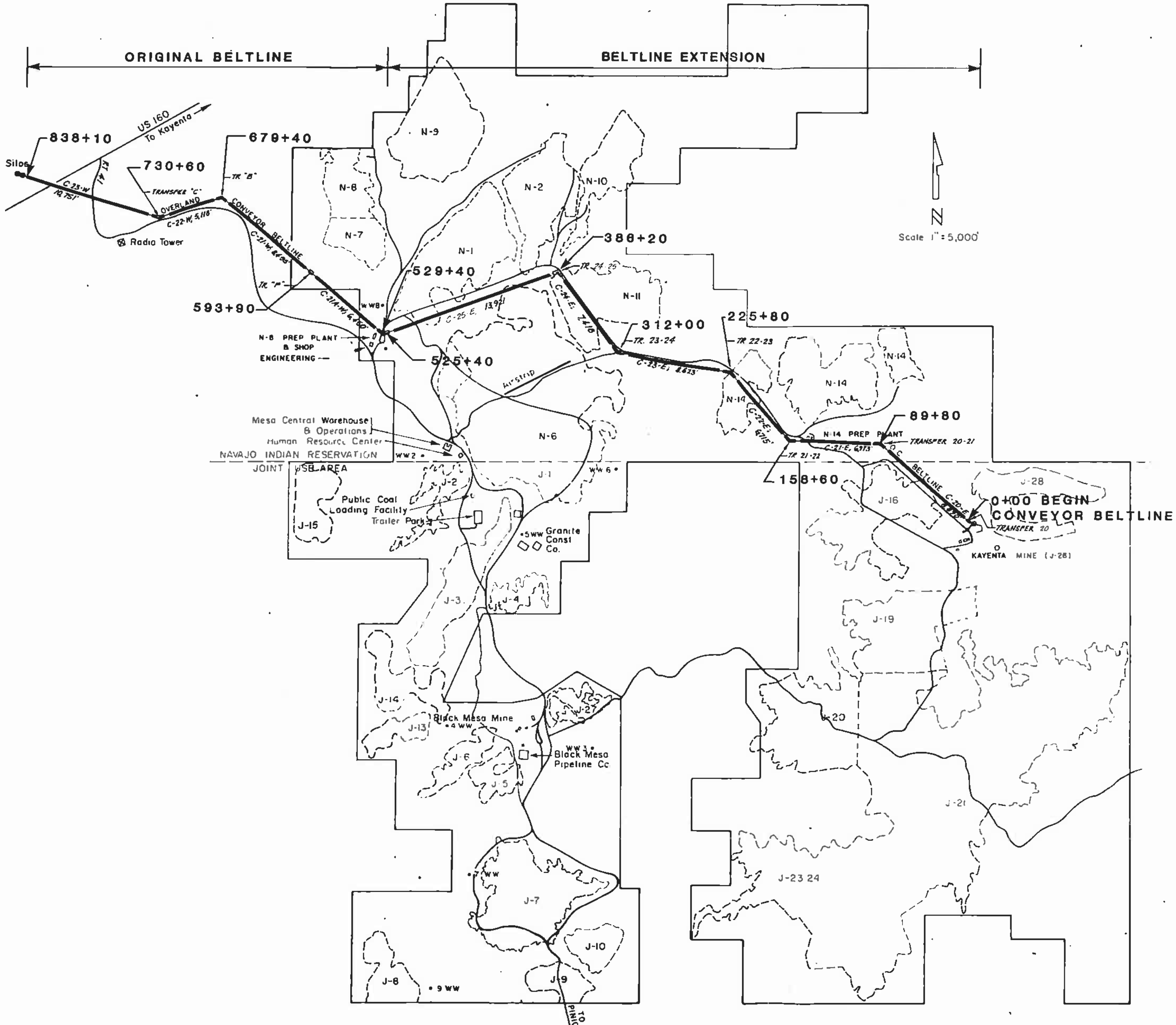


LEGEND

⊙ BORING LOCATION

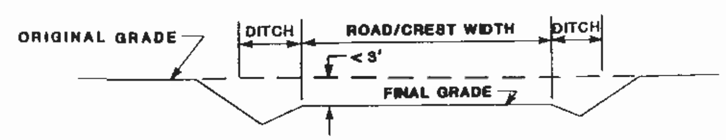
SITE PLAN
HAUL ROADS

BY **Dames & Moore** Plate 1A

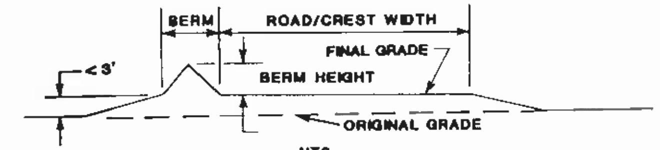


SITE PLAN
CONVEYOR BELTLINE

BY Dames & Moore Plate 1B



NTS
TYPICAL AT-GRADE CUT



NTS
TYPICAL AT-GRADE FILL

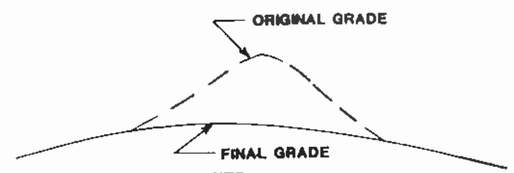
Route	Interval	Road/Crest Width (ft)	Ditch Width Left (ft)	Ditch Width Right (ft)	Berm Height Left (ft)	Berm Height Right (ft)	Conditions: Road/Crest	Conditions: Ditch/Drainage	Degree of Distress
Black Mesa Haul Road	0+00- 21+60	37	N.A.	N.A.	N.A.	N.A.	Lightly rutted	N.A.	N
	21+60- 46+40	45	12	6.5	N.A.	N.A.	Good to lightly rutted	Good to minor erosion	N
	104+50-153+30	63 - 71	12.5	7.5	N.A.	2 - 3	Good to lightly rutted	Minor to severe erosion	P
	153+30-173+60	57 - 63	14	12	N.A.	3	Lightly rutted	Minor to moderate erosion	N
	280+50-343+50	58 - 61	16 - 19	17	N.A.	N.A.	Good to lightly rutted	Good to minor erosion	N
Ramp 1	21+60- 12+00(s)	43	8	5	N.A.	N.A.	Good	Good to minor erosion	N
Ramp 2	37+40- 12+00(s)	63	19	19	N.A.	N.A.	Good	Good; but discharges on haul road	N,M-ditch outlet
Ramp 3	46+40- 12+00(s)	45	1	5	N.A.	N.A.	Good	Good to moderate erosion	N
Ramp 0	76+80- 20+50(s)	51	9	12	N.A.	N.A.	Good	Minor to moderate erosion	N
West Bypass	173+60- 10+20(s)	57	10	10	N.A.	4.5	Good to lightly rutted	Good to minor erosion	N
West Bypass	10+20(s)-19+90(s)	50	N.A.	N.A.	N.A.	N.A.	Lightly to moderately rutted	None: contributes to road distress	P-severe road erosion
Kayenta Haul Road	219+60-257+90	63	14	12	N.A.	N.A.	Good to lightly rutted	Good to moderate erosion	N
Ramp 19	237+60- 12+00(s)	66	12	17	N.A.	N.A.	Good to lightly rutted	Good to minor erosion	N
Ramp 20	257+90- 18+00(s)	71	10	9	0 - 2.5	0 - 3	Lightly rutted	Minor to moderate erosion	N
Ramp Access	310+00- 67+00(n)	86	20	9	N.A.	3.5- 5	Good to lightly rutted	Good	N
Access N7	58+40(n)-87+70(n)	57 - 70	0 - 12	11 - 15	N.A.	6	Good to lightly rutted	Minor to moderate erosion	N
Conveyor Beltline	186+70-210+60	35	N.A.	N.A.	N.A.	N.A.	Good	N.A.	N
	312+00-318+60	22	N.A.	N.A.	N.A.	N.A.	Good	N.A.	N
	435+50-448+10	35	N.A.	N.A.	N.A.	N.A.	Good	N.A.	N
	476+10-495+20	33	11	17	N.A.	N.A.	Good	N.A.	N
	634+20-669+00	28	N.A.	N.A.	N.A.	N.A.	Moderate erosion of support ties	Poor drainage control	M-tie bedding
	679+40-730+60	33 - 43	N.A.	N.A.	N.A.	N.A.	Good; support ties on rock	Poor drainage control	N
	750+60-779+40	28	20	N.A.	N.A.	N.A.	Good to minor erosion: erodable soils	Minor erosion	N,M-regrading
	801+60-809+90	28	N.A.	N.A.	N.A.	N.A.	Minor erosion of bedding	N.A.	M-regrading
	819+50-827+50	11	N.A.	N.A.	N.A.	N.A.	Good: gravel on erodable soils	N.A.	N

LEGEND
Degree of Distress
N = none
P = potential
Y = existing
M = maintenance required

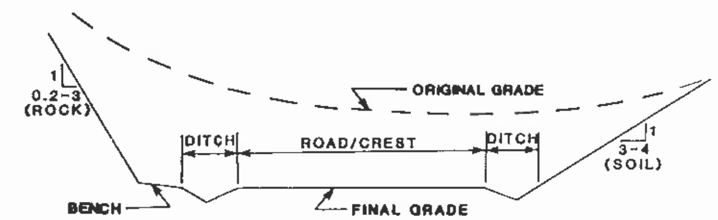
Notes: 1) For location of intervals, see Plates 1A and 1B
2) For description of erosion and road/crest conditions, see Table 4-1

INSPECTION SUMMARY AT-GRADE CONSTRUCTION SECTIONS

BY Dames & Moore Plate 2A



NTS
TYPICAL GRADING CUT



NTS
TYPICAL AT-GRADE CUT

Route	Interval	Road/Crest Width (ft)	Ditch Width Left (ft)	Ditch Width Right (ft)	Berm Height Left (ft)	Berm Height Right (ft)	Slope Left Height (ft)	Slope Left Slope	Slope Left Mat.	Slope Right Height (ft)	Slope Right Slope	Slope Right Mat.	Conditions Road	Conditions Drainage	Conditions Slopes	Degree of Distress
Kayenta Haul Road	38+80- 88+80	97	12	11	N.A.	N.A.	30	4:1	S/R	20	4:1	S/R	Good	Good	Good	N
	652+20-680+50	56	9	10	N.A.	N.A.	20	4:1	M	40	3:1	M	Good to lightly rutted	Good	Good to minor erosion	N
N8 Access	680+50- 45+80(n)	60	8	12	N.A.	N.A.	25	to vert	R	25	3-4:1	R	Lightly rutted	Good to minor erosion	Good to minor raveling	N
Conveyor Beltline	147+00-154+50	30	N.A.	N.A.	N.A.	N.A.	35	3:1	S/R	30	2-3:1	S/R	Good	N.A.	Minor to moderate erosion	N
	262+60-269+90	22	N.A.	N.A.	N.A.	N.A.	45	3:1	S/R	----	Grade	----	Good	N.A.	Minor erosion	N
	286+20-303+10	22	11 - 14	N.A.	N.A.	N.A.	20	3:1	S/R	----	Grade	----	Good	Minor erosion	Minor erosion	N
	366+10-380+10	27	8 - 10	N.A.	N.A.	N.A.	65	3:1	S/R	----	Grade	----	Good	Minor erosion	Minor erosion	N
	529+40-541+40	25 - 32	N.A.	N.A.	N.A.	N.A.	15	0.2-0.6:1	R	60	0.2-3:1	R	Fair; erosion, tilting	Poorly developed	Raveling and debris slide	P to Y

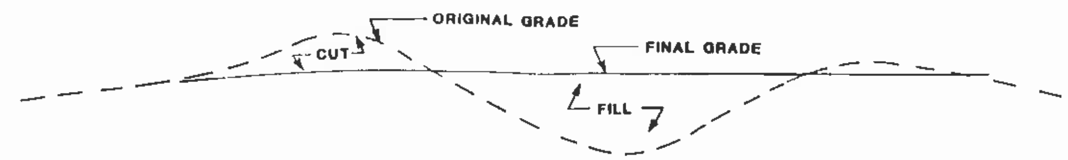
LEGEND
Mat. = material
S = soil
R = bedrock
S/R = soil overlying bedrock
M = mine waste (reclaimed area)

LEGEND
Degree of Distress
N = none
P = potential
Y = existing
M = maintenance required

Notes: 1) For location of intervals, see Plates 1A and 1B
2) For description of erosion and road/crest conditions, see Table 4-1

INSPECTION SUMMARY
CUT SLOPE
CONSTRUCTION SECTIONS

BY **Dames & Moore** Plate 2B



NTS
TYPICAL PROFILE
CUT AND FILL TYPE A

Route	Interval	Road/Crest Width (ft)	Fill Slopes Left Height (ft)	Fill Slopes Left Slope	Fill Slopes Right Height (ft)	Fill Slopes Right Slope	Cut Slopes Left Height (ft)	Cut Slopes Left Slope	Cut Slopes Left Mat.	Cut Slopes Right Height (ft)	Cut Slopes Right Slope	Cut Slopes Right Mat.	Ditch Width Left (ft)	Ditch Width Right (ft)	Berm Height Left (ft)	Berm Height Right (ft)	Conditions Road/Crest	Conditions Drainage	Conditions Slope	Degree of Distress
Black Mesa Haul Road	225+10-263+40	54 - 60	N.A.		35	1.35:1	25	0.8:1	R	20	3:1	R	11	18	N.A.	5	Good; gravel	Good to minor erosion	Good to minor erosion	N
	343+50-409+10	54 - 60	8	1.4:1	12	3:1	12	2:1	M	10	3:1	M	11-17	11-17	6.5	2.5-5	Good	Moderate to severe erosion	Good to minor erosion	N
	446+10-464+10	53 - 56	15	1.5:1	N.A.		N.A.			50	3-4:1	M	10	12	3-5	N.A. 3.5	Good; gravel	Good to minor erosion	Minor to moderate erosion	N
Ramp to N6	343+50-62+00(e)	55 - 57	12	1.4:1	12	1.35:1	Grade			Grade			12-17	5-17	N.A.	5	Lightly rutted	Good to minor erosion	Good	N
Kayenta Haul Road	20+40- 38+40	92	35	4:1	35	4:1	40	4:1	R	N.A.			10	18	N.A.	N.A.	Good	Good to minor erosion	Minor erosion; no berms	N,O
	386+30-544+20	101 - 111	45	2-3:1	45	1.5-3:1	50	3:1	R	40	3:1	R	15	14	N.A.	N.A.	Good to lightly rutted	Good to moderate erosion	Minor erosion	N,M
	626+20-652+20	44	45	4:1	N.A.		Grade			Grade			6	8	N.A.	N.A.	Good to lightly rutted	Good to minor erosion	Good	N
Conveyor Beltline	0+00- 30+10	33	20	3-4:1	20	3-4:1	Grade			Grade			D	D	N.A.	N.A.	Good	Discontinuous; minor erosion	Cracks	P
	71+20- 88+90	33	45	3:1	N.A.		N.A.			45	3:1	R	N.A.	D	N.A.	N.A.	Good	Discontinuous; minor erosion	Minor erosion	N,M
	88+90- 96+90	33	60	3:1	50	2.5:1	N.A.			25	3-4:1	R	N.A.	D	N.A.	N.A.	Good; trestle settlement	Discontinuous; minor erosion	Minor erosion	N to P
	98+70-113+90	41	40	3:1	25	3:1	N.A.			N.A.			N.A.	N.A.	N.A.	N.A.	Good	N.A.	Minor erosion	N,M
	113+90-133+30	44	32	3:1	20	3:1	30	3:1	R	28	3:1	R	D	D	N.A.	N.A.	Good	Discontinuous; minor erosion	Minor erosion	N,M
	172+40-186+70	35	30	3:1	15	3:1	50	3:1	R	0	0	R	D	D	N.A.	N.A.	Good	Discontinuous; minor erosion	Minor to moderate erosion	N,M
	210+60-225+80	35	15	3:1	25	3:1	5	3:1	S	15	3:1	R	D	D	N.A.	N.A.	Good	Discontinuous; minor erosion	Minor erosion	N
	329+80-366+10	27	40	3:1	N.A.		15	2-3:1	R	0	0	R	D	D	N.A.	N.A.	Good	Discontinuous; minor erosion	Minor to moderate erosion	N
	448+10-476+10	34	35	3:1	20	3:1	15	3:1	R	30	3:1	R	D	D	N.A.	N.A.	Good	Discontinuous; minor erosion	Minor erosion	N,M
	500+40-513+30	32	15	3:1	15	3:1	N.A.			23	3:1	M	N.A.	D	N.A.	N.A.	Good	Discontinuous; minor erosion	Minor erosion	N,M
	549+50-593+90	38 - 40	28	1.4-1.5:1	30	1.5:1	25	to vert	R	15	0.6:1	R	N.A.	N.A.	N.A.	N.A.	Fair; erosion of ftgs.	Poor; undeveloped	Minor to moderate erosion; raveling	N to P
	593+90-634+20	28	45	1.4:1	30	1.4-1.5:1	60	to vert	R	50	to vert	R	N.A.	N.A.	N.A.	N.A.	Fair; erosion of ftgs.	Poor; undeveloped	Minor to moderate erosion; raveling	Y
	783+10-801+60	28	10	1.5:1	15	1.5:1	30	0.6:1	R	20	0.6:1	R	D	D	N.A.	N.A.	Good to fair	Poor; undeveloped	Minor erosion	N,M

LEGEND
Mat. = material
S = soil
R = bedrock
S/R = soil overlying bedrock
M = mine waste (reclaimed area)

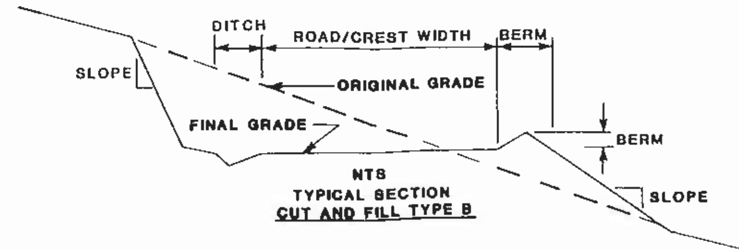
D = discontinuous

LEGEND
Degree of Distress
N = none
P = potential
Y = existing
M = maintenance required

Notes: 1) For location of intervals, see Plates 1A and 1B
2) For description of erosion and road/crest conditions, see Table 4-1

INSPECTION SUMMARY
TYPE A CUT-AND-FILL
CONSTRUCTION SECTIONS

BY Dames & Moore Plate 2C



Route	Interval	Road/Crest Width (ft)	Fill Slopes Left Height (ft)	Fill Slopes Left Slope	Fill Slopes Right Height (ft)	Fill Slopes Right Slope	Cut Slopes Left Height (ft)	Cut Slopes Left Slope	Cut Slopes Left Mat.	Cut Slopes Right Height (ft)	Cut Slopes Right Slope	Cut Slopes Right Mat.	Ditch Width Left (ft)	Ditch Width Right (ft)	Berm Height Left (ft)	Berm Height Right (ft)	Conditions Road/Crest	Conditions Drainage	Conditions Slope	Degree of Distress
Black Mesa Haul Road	46+40- 76+80	61	10	5:1	10	4:1	---	Grade	---	---	Grade	---	3-6	N.A.	N.A.	N.A.	Good to lightly rutted	Good to minor erosion	Good	N
	173+60-213+50	59	N.A.		18	1.5:1	---	Grade	---	---	Grade	---	19	12	N.A.	5	Good	Good to moderate erosion	Good	N
	263+40-280+50	61	N.A.		15	1.4:1	---	Grade	---	---	Grade	---	14	17	N.A.	5	Good	Good to minor erosion	Good	N
	409+10-446+10	41 - 47	35	1.4-3:1	N.A.		30	2:1	M	70	1.4:1	M	9	8-10	4-14	N.A.	Good	Good to severe erosion	Raveling, erosion	N to P
	464+10-506+10	48	45	1.4:1	N.A.		---	N.A.	---	50	4:1	M	N.A.	30	8	1.5	Good to lightly rutted	Minor to moderate erosion	Minor erosion	N to P
Access to N6	62+00(e)-90+50(e)	60	N.A.		40	1.35-4:1	25	5:1	M	---	N.A.	---	11	7.5	N.A.	7.5	Lightly rutted	Minor to moderate erosion	Minor erosion	N
West Bypass	19+90(s)-32+40(s)	50 - 100	N.A.		25	1.5-3:1	---	Grade	---	---	Grade	---	N.A.	N.A.	N.A.	N.A.	Good to lightly rutted	None	Severe erosion	P
Kayenta Haul Road	-11+00- 20+40	98 - 103	35	4:1	35	4:1	45	4:1	R	---	N.A.	---	10	23	N.A.	N.A.	Good	Good to minor erosion	Good	N
	111+40-140+30	107	40	4:1	45	4:1	---	N.A.	---	40	4:1	S/R	12	N.A.	3	N.A.	Good	Good	Minor erosion	N
	140+30-161+30	N.A.	N.A.		20	3:1	---	N.A.	---	30	3-4:1	R	N.A.	N.A.	N.A.	N.A.	Good	N.A.	Minor erosion	N
	161+30-219+60	141	35	4:1	35		---	Grade	---	---	Grade	---	12	10	3	N.A.	Lightly rutted	Good to minor erosion	Minor erosion	N
	271+90-298+20	124 - 134	15	3-4:1	10		40	4:1	R	25	4:1	R	11	14	3-5	N.A.	Good to lightly rutted	Good to moderate erosion	Minor erosion	N
	310+00-313+50	58	25	2:1	N.A.		---	Grade	---	---	Grade	---	14	11	N.A.	4	Good to lightly rutted	Good to minor erosion	Minor erosion	N
	333+10-386+30	126	30	3:1	50		50	3-4:1	R	---	N.A.	---	10	12	N.A.	N.A.	Good to lightly rutted	Good to minor erosion	Minor erosion	N
	551+60-569+20	75 - 85	15	4:1	N.A.		---	N.A.	---	70	4:1	M	10	N.A.	N.A.	N.A.	Good to lightly rutted	Good to minor erosion	Minor erosion	N
	569+20-613+60	44	20	4:1	N.A.		---	Grade	---	---	Grade	---	11	10	N.A.	N.A.	Good to lightly rutted	Good to minor erosion	Good	N
	613+60-626+20	36 - 44	42	4:1	N.A.		---	Grade	---	---	Grade	---	N.A.	9	N.A.	N.A.	Good to lightly rutted	Good to minor erosion	Good	N
	680+50-694+50	N.A.	40	1.3-1.5:1	N.A.		---	Grade	---	---	Grade	---	10-20	15	7	N.A.	Good to lightly rutted	Good to moderate erosion	Minor to moderate erosion	N to P
Access to N14	75+20(n)-89+80(n)	98	20	3:1	N.A.		---	N.A.	---	40	3:1	R	11	20	3	N.A.	Good to lightly rutted	Good to minor erosion	Minor to moderate erosion	N
Ramp to N8	87+70(n)-104+50(n)	78	N.A.		30	3:1	15	2:1	M	---	N.A.	---	12	13	N.A.	3-3.5	Lightly rutted	Good to minor erosion	Minor erosion	N
Conveyor Beltline	30+10- 71+20	33	14	4:1	N.A.		---	N.A.	---	235	3:1	R	N.A.	D	N.A.	N.A.	Good	Discontinuous	Minor erosion	N,M
	154+50-160+80	110	60	3:1	N.A.		---	N.A.	---	30	3:1	S	N.A.	D	N.A.	N.A.	Good	Discontinuous	Minor erosion	N
	160+80-172+40	35	15	1.5:1	N.A.		---	N.A.	---	---	Grade	---	N.A.	N.A.	N.A.	N.A.	Good	N.A.	Good	N,M
	225+80-262+60	42	30	3:1	25	3:1	20	3:1	S/R	50	3:1	S/R	D	D	N.A.	N.A.	Good	Discontinuous	Minor erosion	N,M
	318+60-329+80	27 - 48	30	3:1	N.A.		---	N.A.	---	---	Grade	---	N.A.	N.A.	N.A.	N.A.	Good	N.A.	Minor to moderate erosion	N

LEGEND
Mat. = material
S = soil
R = bedrock
S/R = soil overlying bedrock
M = mine waste (reclaimed area)

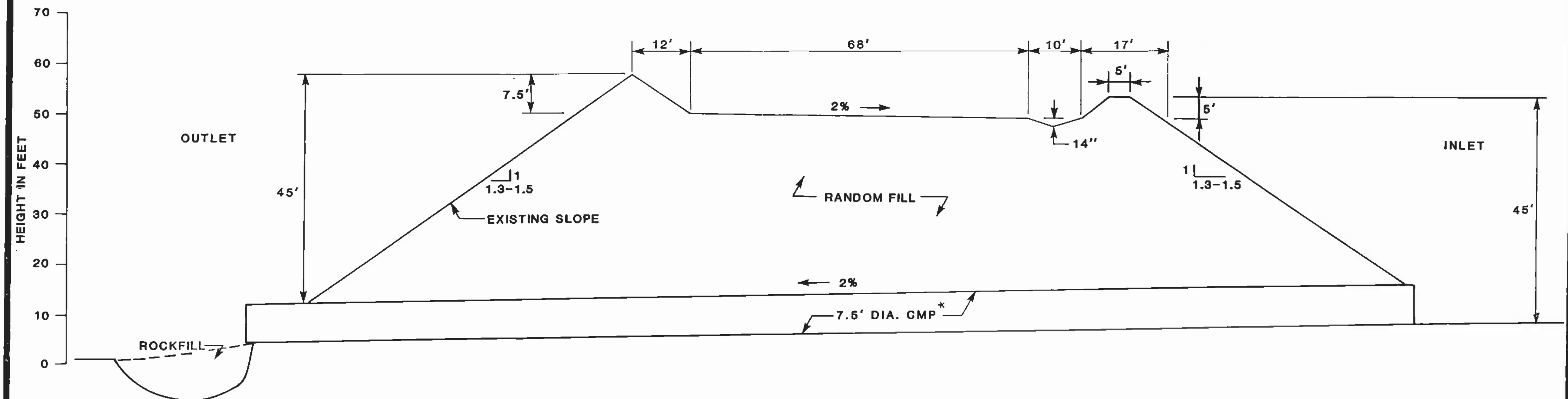
D = discontinuous

LEGEND
Degree of Distress
N = none
P = potential
Y = existing
M = maintenance required

Notes: 1) For location of intervals, see Plates 1A and 1B
2) For description of erosion and road/crest conditions, see Table 4-1

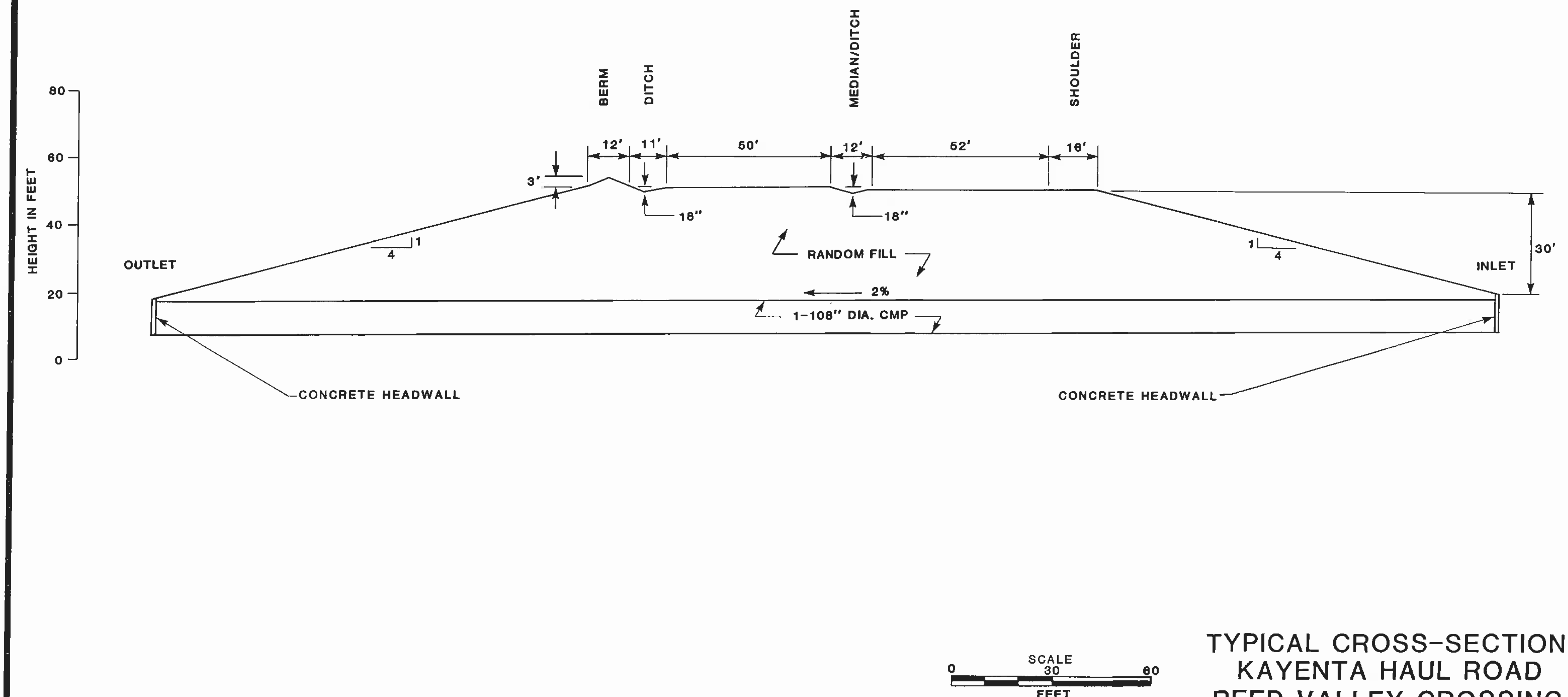
INSPECTION SUMMARY TYPE B CUT-AND-FILL CONSTRUCTION SECTIONS

BY Dames & Moore Plate 2D



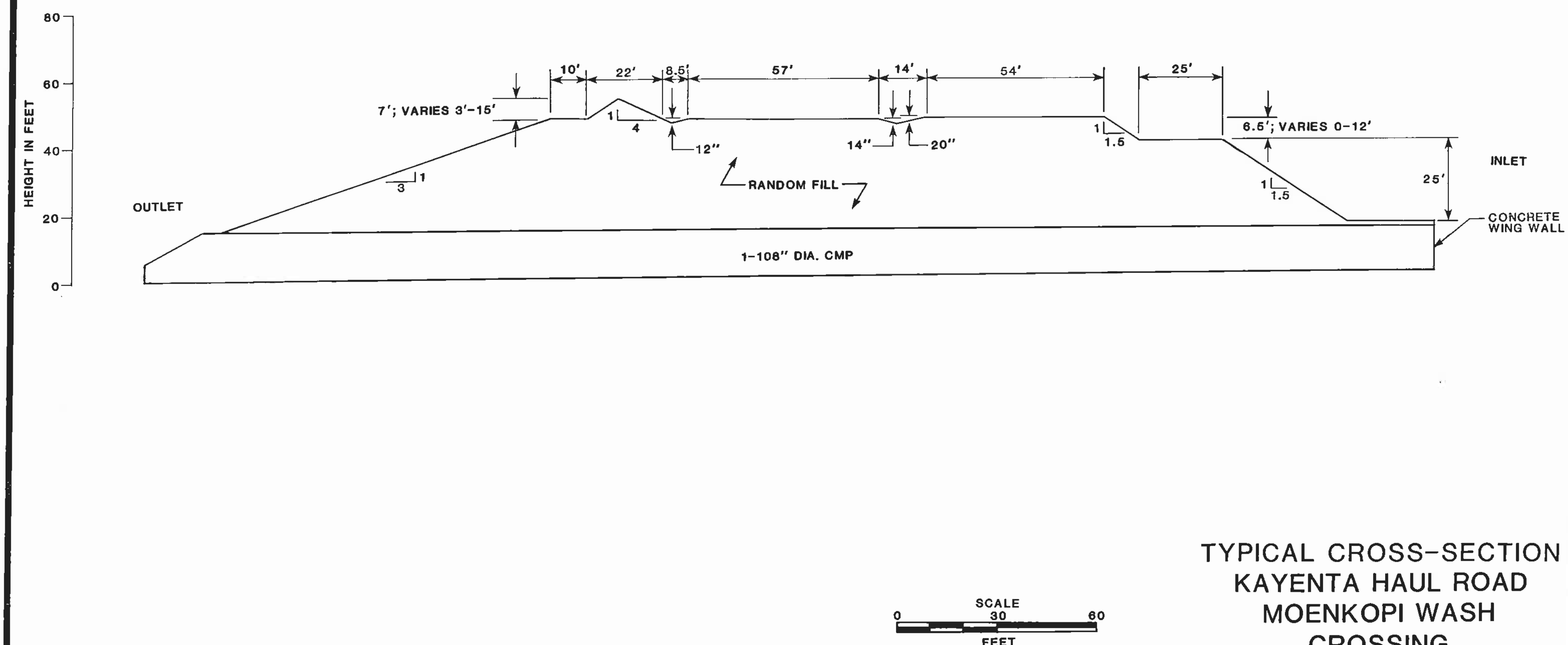
TYPICAL CROSS-SECTION BLACK MESA HAUL ROAD MOENKOPI WASH CROSSING

BY Dames & Moore Plate 3A



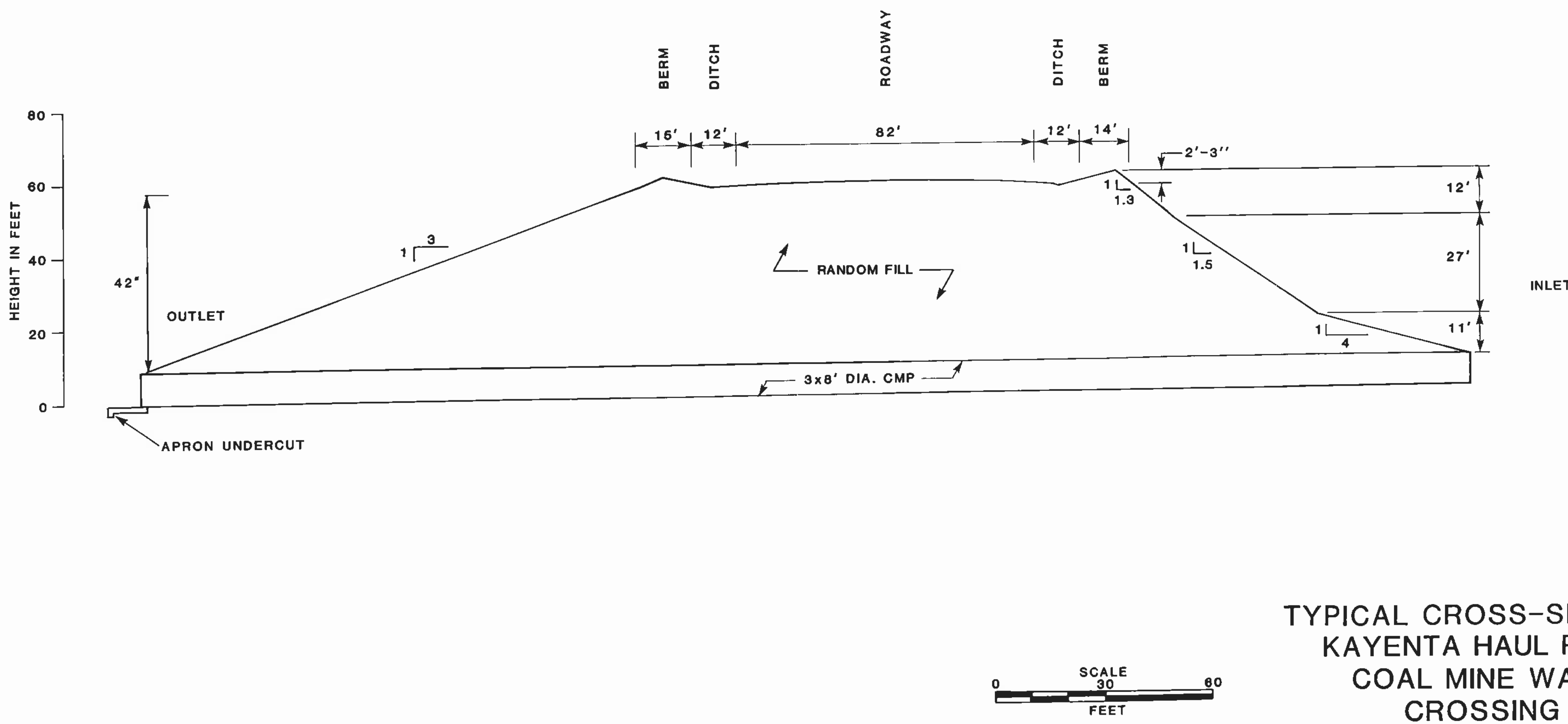
TYPICAL CROSS-SECTION
KAYENTA HAUL ROAD
REED VALLEY CROSSING

BY **Dames & Moore** Plate 3B



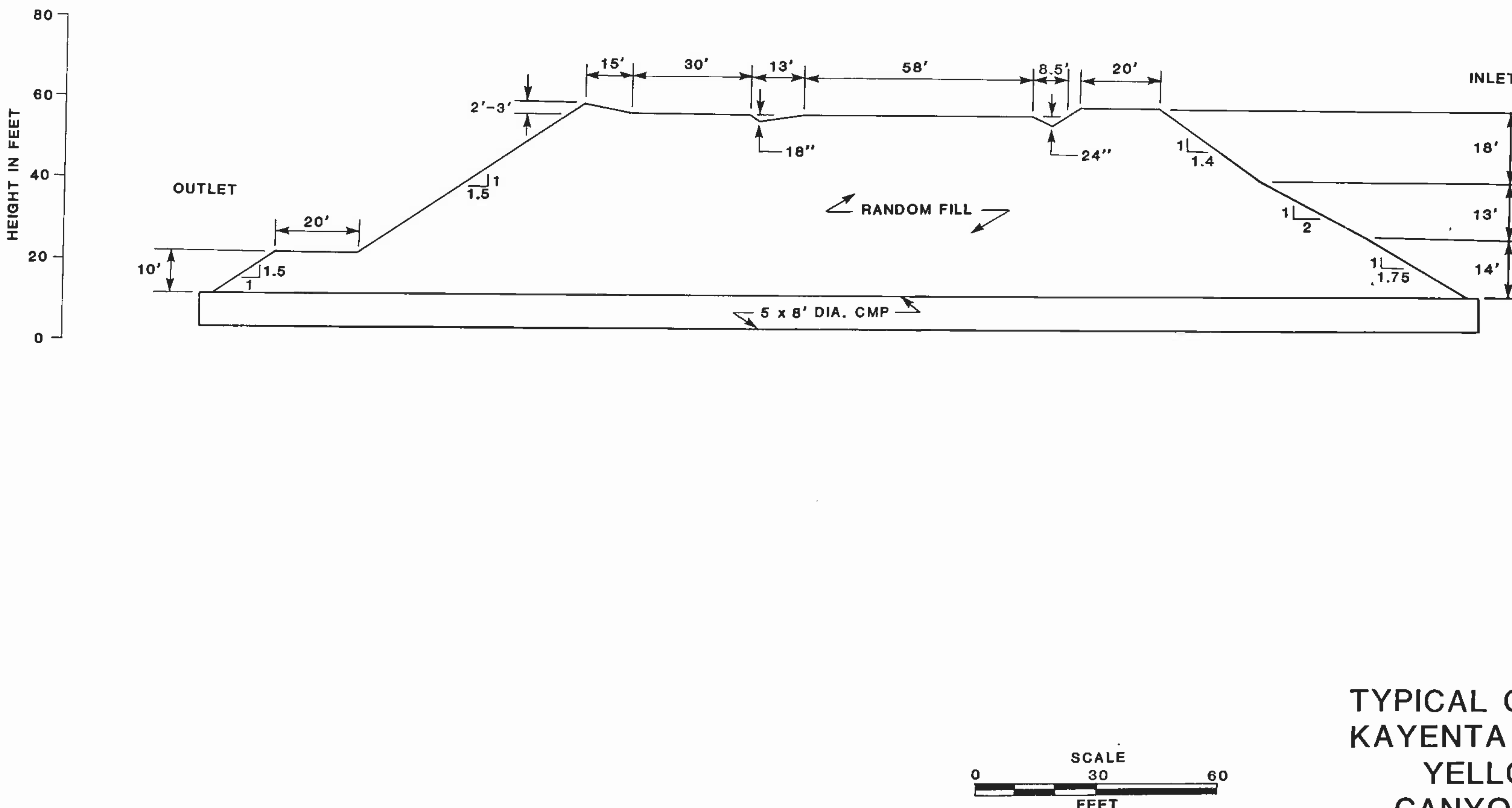
TYPICAL CROSS-SECTION KAYENTA HAUL ROAD MOENKOPI WASH CROSSING

BY Dames & Moore   Plate 3C



TYPICAL CROSS-SECTION
KAYENTA HAUL ROAD
COAL MINE WASH
CROSSING

BY **Dames & Moore** Plate 3D



TYPICAL CROSS-SECTION KAYENTA HAUL ROAD (N8) YELLOW WATER CANYON CROSSING

BY **Dames & Moore** Plate 3E

BORING RB-1

SURFACE ELEVATION: 6604.6 FEET
PCC COORDINATES
S 2234
E 31530

LABORATORY TEST DATA

Depth (ft)	Tests Reported Elsewhere	Atterberg Limits: Liquid Limit (%)	Atterberg Limits: Plasticity Index (%)	Strength Test Data: Type of Test	Strength Test Data: Normal or Confining Pressure (PSF)	Strength Test Data: Shear Strength (PSF)	Strength Test Data: Deviator Stress (PSF)	Moisture Content (%)	Dry Density (PCF)	Blows/Ft.	Symbols	Description
0											GM-GC	MULTIPLE SHADES OF BROWN FILL CONSISTING OF SHALE AND SANDSTONE FRAGMENTS IN A MATRIX OF SANDSTONE SILT (DENSE)
	MA*							9.8	113.3	92		
5								12.2	100.7	100/5"		VERY DENSE
	MA*									101		VERY DENSE
10												
	MA*											
15												
	MA*											
20	MA*							10.6	78.9	100/6"		VERY DENSE
25												
	MA*											
30												FILL (0 to approx. 32 ft)
								9.3	104.7	60	SM	BROWN SILTY FINE SAND WITH FRAGMENTS OF SANDSTONE (MEDIUM DENSE)
35												
40												
								7.3	100.5	36	SP	BROWN FINE SAND (MEDIUM DENSE)
45												
50											GP	GRAVEL IN BROWN FINE TO COARSE SAND MATRIX (VERY DENSE)
										100/5"		
55												
										100/5"	SHALE	GRAY SHALE (VERY DENSE)
60												
65												
70												
75												
80												

BORING TERMINATED AT 57.5 FEET ON 9/17/85.
GROUNDWATER ENCOUNTERED AT 48.0 FEET ON 9/17/85.

* MA RUN ON A COMPOSITE SAMPLE

LOG OF BORING

BY **Dames & Moore**

Plate 4A

BORING RB-2

SURFACE ELEVATION: 6606.3 FEET
PCC COORDINATES
S 1656
E 19732

LABORATORY TEST DATA

Depth (ft)	Tests Reported Elsewhere	Atterberg Limits: Liquid Limit (%)	Atterberg Limits: Plasticity Index (%)	Strength Test Data: Type of Test	Strength Test Data: Normal or Confining Pressure (PSF)	Strength Test Data: Shear Strength (PSF)	Strength Test Data: Deviator Stress (PSF)	Moisture Content (%)	Dry Density (PCF)	Blows/Ft.
30								6.7	108.8	69
40								10.4	111.5	87
50								7.0	88.9	48
58										100/5"

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80

BLOWS/FT. | SAMPLES | SYMBOLS | DESCRIPTION

Symbol	Description
SM	MULTIPLE SHADES OF BROWN FILL CONSISTING OF SHALE AND SANDSTONE FRAGMENTS IN A MATRIX OF SAND AND SILT
	MOTTLED BROWN, TAN RESIDUAL SANDSTONE (DENSE)
	MULTI-COLORED RESIDUAL SHALE (DENSE)
ML	BROWN FINE SANDY SILT (MEDIUM DENSE)
SHALE	BROWN SHALE (VERY DENSE)

FILL

BORING TERMINATED AT 58.5 FEET ON 9/17/85.
NO GROUNDWATER ENCOUNTERED.

LOG OF BORING

BY **Dames & Moore** Plate 4B

BORING RB-3

SURFACE ELEVATION: 6314.5 FEET
PCC COORDINATES
S 32249
E 28146

Depth (ft)	Tests Reported Elsewhere	Atterberg Limits: Liquid Limit (%)	Atterberg Limits: Plasticity Index (%)	Strength Test Data: Type of Test	Strength Test Data: Normal or Confining Pressure (PSF)	Strength Test Data: Shear Strength (PSF)	Strength Test Data: Deviator Stress (PSF)	Moisture Content (%)	Dry Density (PCF)	Blows/Ft.	Symbols	Description
0											SM	MULTIPLE SHADES OF BROWN FILL CONSISTING OF SHALE AND SANDSTONE FRAGMENTS IN A MATRIX OF SAND AND SILT (FILL)
5												
10												
15												
20								6.5	111.5	44		MEDIUM DENSE
25												
30								10.2	117.6	39		MEDIUM DENSE
35												
40												BOULDER (?) OR BEDROCK (?)
45												
50												
55												
60												
65												
70												
75												
80												

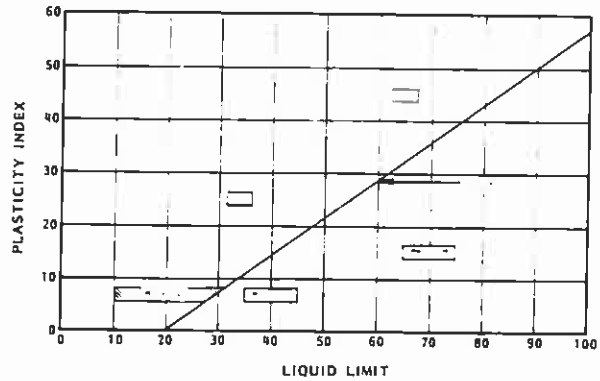
BORING TERMINATED AT 41.5 FEET ON 9/21/85.
NO GROUNDWATER ENCOUNTERED.

LOG OF BORING

BY **Dames & Moore** Plate 4C

SYMBOL	TYPE OF TEST
M	MOISTURE
QD	QUICK MD TEST BASED ON ASSUMED SPECIFIC GRAVITY
MD	MOISTURE-DENSITY
CD	CHUNK DENSITY ON BULK SAMPLE
RD	RELATIVE DENSITY
COMP	COMPACTION CURVE
CI	CALIFORNIA IMPACT
CC	COMPACTED CORE
G	SPECIFIC GRAVITY
pH	HYDROGEN ION CONCENTRATION
MA	MECHANICAL ANALYSIS *
SA	SIEVE ANALYSIS (-200 ONLY)
HA	HYDROMETER ANALYSIS (-200 ONLY)
AL	ATTERBERG LIMITS (LL & PL)
SL	SHRINKAGE LIMIT
FS	FREE SWELL
SS	SHRINK-SWELL
EXP	EXPANSION
C (COL)	CONSOLIDATION (COLLAPSE)
VC	VIBRATING CONSOLIDATION
P	PERMEABILITY
FP	FIELD PERMEABILITY
UC	UNCONFINED COMPRESSION
TXUU	TRIAXIAL COMPRESSION TEST 1. UNCONSOLIDATED-UNDRAINED
TXCU	2. CONSOLIDATED-UNDRAINED
TXCUM	3. CU/MULTIPHASE**
TXCUPP	4. CU/WITH PORE PRESSURE MEASUREMENTS
TXCD	5. CONSOLIDATED-DRAINED
DS/UU	DIRECT SHEAR TEST 1. UNCONSOLIDATED-UNDRAINED
DS/CU	2. CONSOLIDATED-UNDRAINED
DS/CD	3. CONSOLIDATED-DRAINED
DS/CD/M:	4. CD/MULTIPHASE**
LV	TORVANE SHEAR (LAB VANE SHEAR)

* INCLUDES COMPLETE ANALYSIS, SIEVING AND HYDROMETER
** SERIES OF TESTS RUN ON SAMPLE



PLASTICITY CHART

- INDICATES DEPTH OF AUGER CUTTINGS SAMPLE
- INDICATES DEPTH OF UNDISTURBED SAMPLE
- INDICATES DEPTH OF DISTURBED SAMPLE
- INDICATES DEPTH OF SAMPLING ATTEMPT WITH NO RECOVERY
- INDICATES DEPTH OF STANDARD PENETRATION TEST
- INDICATES DEPTH OF STANDARD PENETRATION TEST WITH NO RECOVERY

70% 51 INDICATES DEPTH AND LENGTH OF CORE RUN

RQD (ROCK QUALITY DETERMINATION) PERCENT OF THE TOTAL CORE RUN HAVING AN UNFRACTURED LENGTH OF 4" OR MORE

PERCENT OF CORE RUN RECOVERED

- INDICATES DEPTH OF FIELD VANE SHEAR TEST

NOTE
UNLESS OTHERWISE NOTED SAMPLING RESISTANCE IS MEASURED IN BLOWS PER FOOT REQUIRED TO DRIVE SAMPLER 12-INCHES AFTER SAMPLER HAS BEEN SEATED 6-INCHES. A 140-POUND HAMMER, FREE FALLING A DISTANCE OF 30 INCHES IS USED TO DRIVE THE SAMPLER.

KEY TO SAMPLES

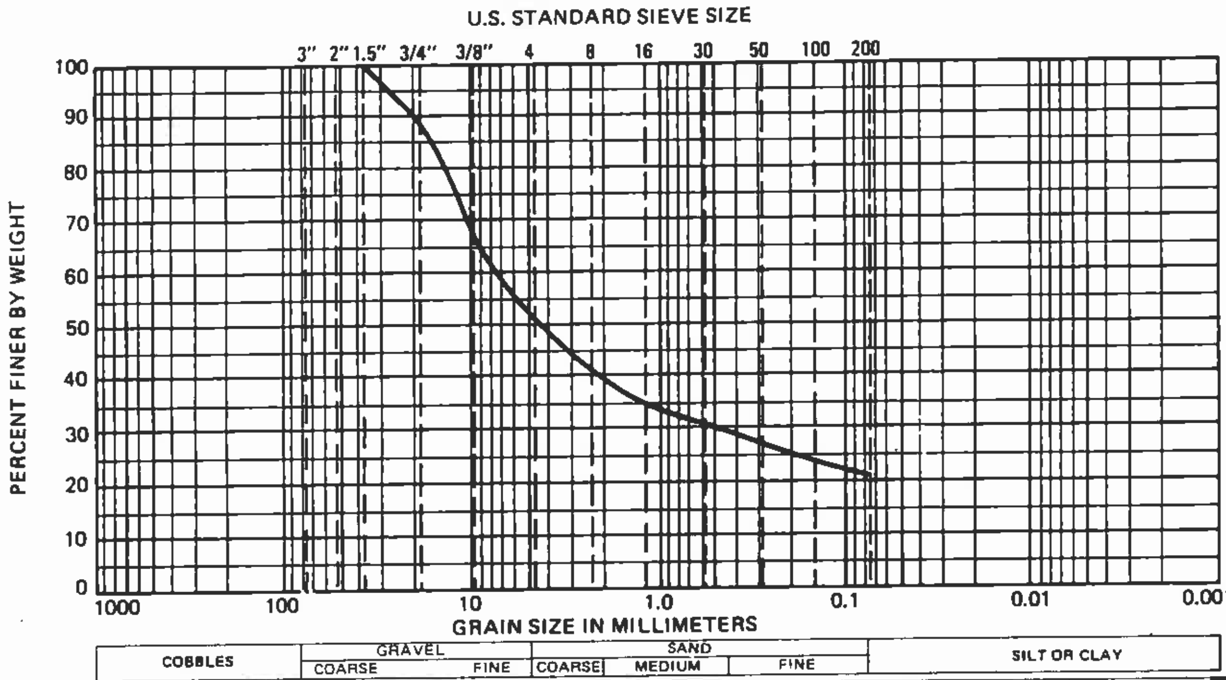
KEY TO LOG OF BORINGS

MAJOR DIVISIONS			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

UNIFIED SOIL CLASSIFICATION SYSTEM

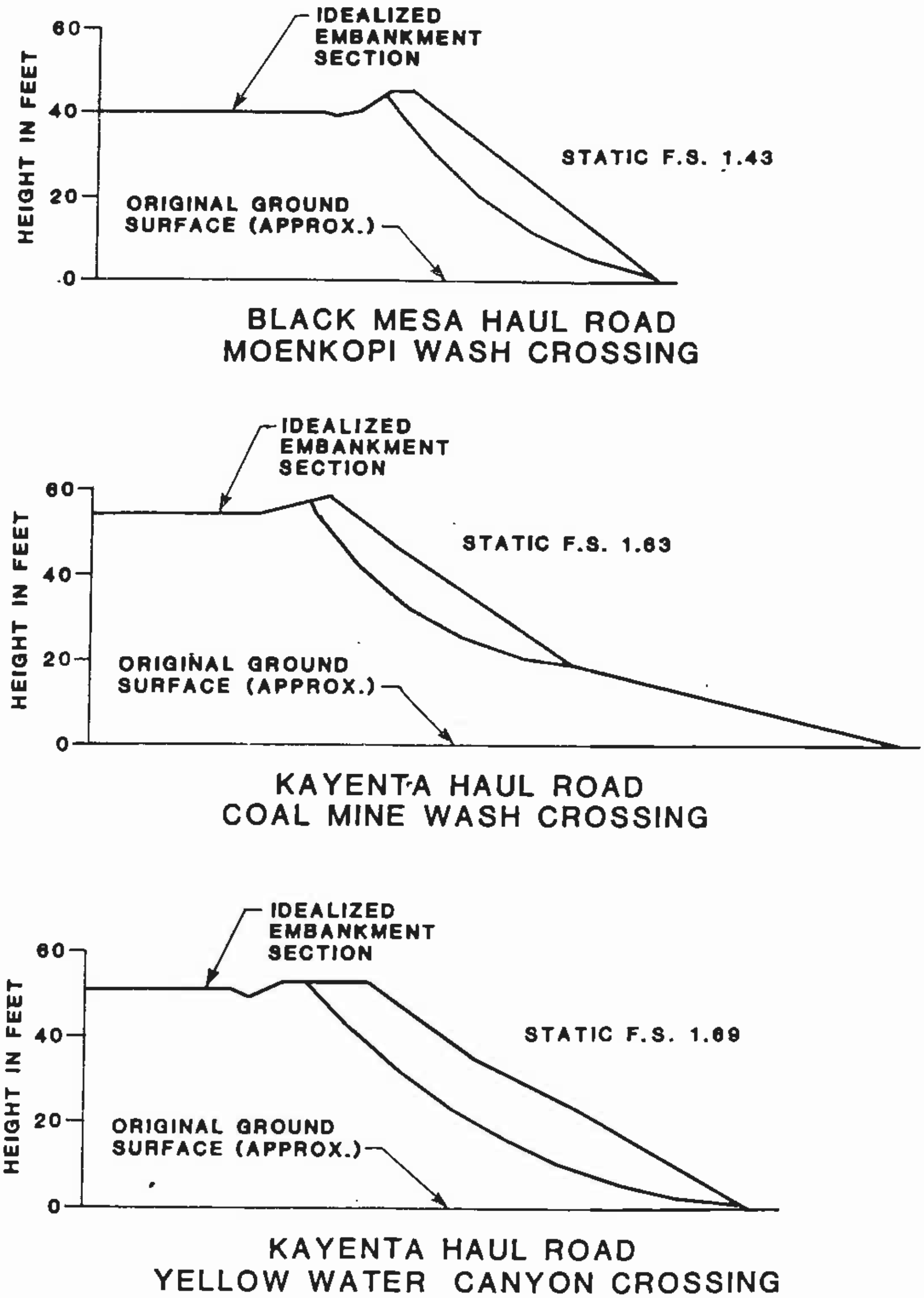
BY **Dames & Moore** Plate 6



RB-1	DEPTH	CLASSIFICATION		NAT. W C	LL	PL	PI	
SAMPLE 1-8	COMPOSITE	GM-GC	BROWN FILL CONSISTING OF SHALE & SANDSTONE FRAGMENTS IN A MATRIX OF SAND AND SILT	7.7	-	-	-	

COMPOSITE GRADATION CURVE OF EMBANKMENT FILL

BY **Dames & Moore** Plate 7

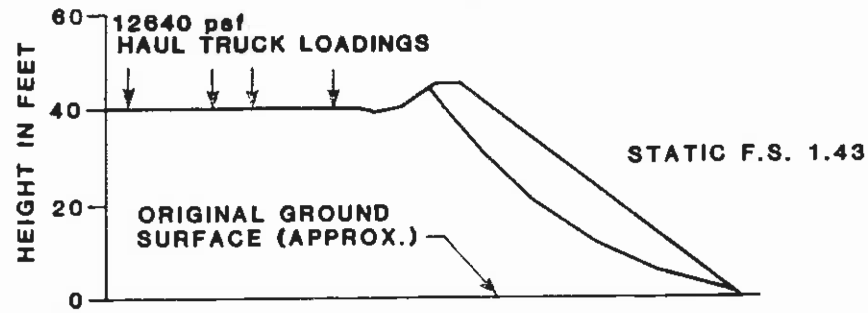


SCALE: 1'' = 40'

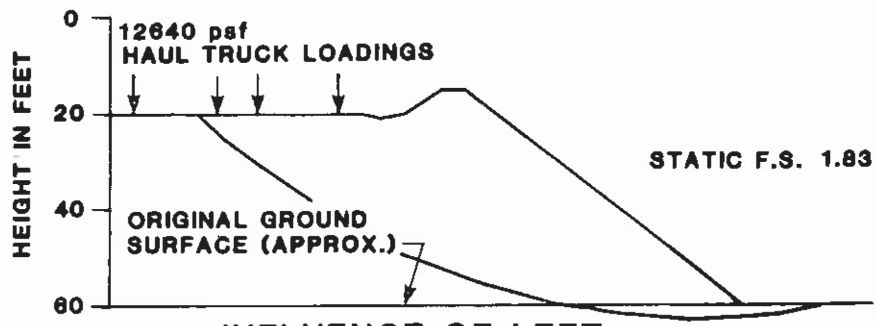
STABILITY ANALYSIS CRITICAL FAILURE SURFACES HAUL ROAD EMBANKMENTS

BY Dames & Moore — Plate 8A

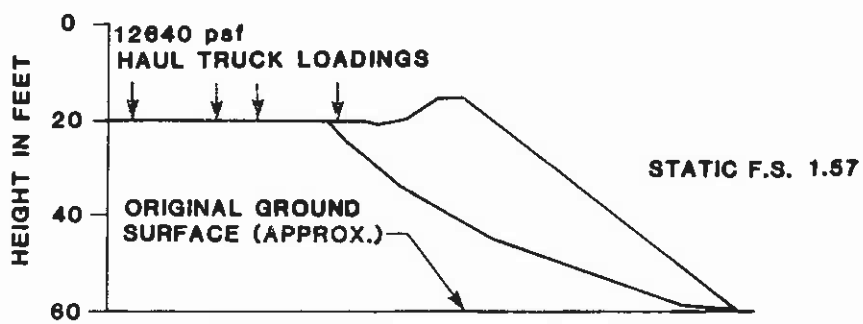
BLACK MESA HAUL ROAD
MOENKOPI WASH CROSSING



CRITICAL FAILURE SURFACE



INFLUENCE OF LEFT
MOST WHEEL LOADS

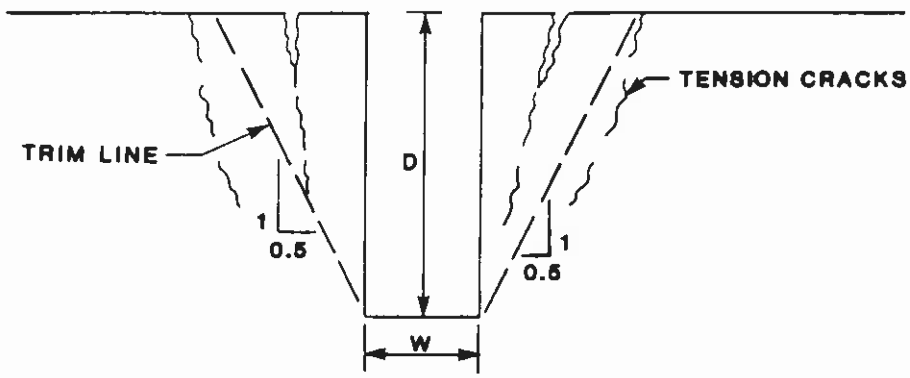


INFLUENCE OF RIGHT
MOST WHEEL LOADS

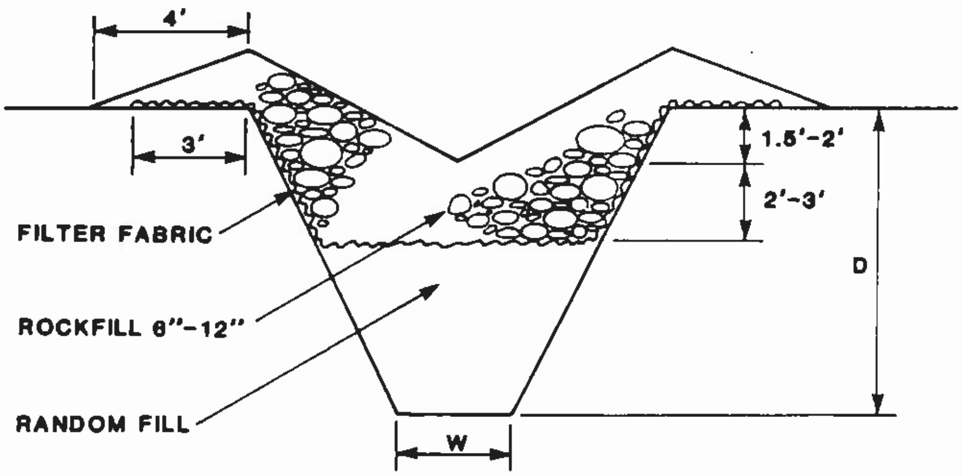
SCALE 1" = 40'

STABILITY ANALYSIS
CRITICAL
FAILURE SURFACES
HAUL ROAD EMBANKMENTS

BY **Dames & Moore** Plate 8B



DETAIL OF GULLY TRIMMING



DETAIL OF REMEDIAL ROCK-LINING
FOR GULLIES

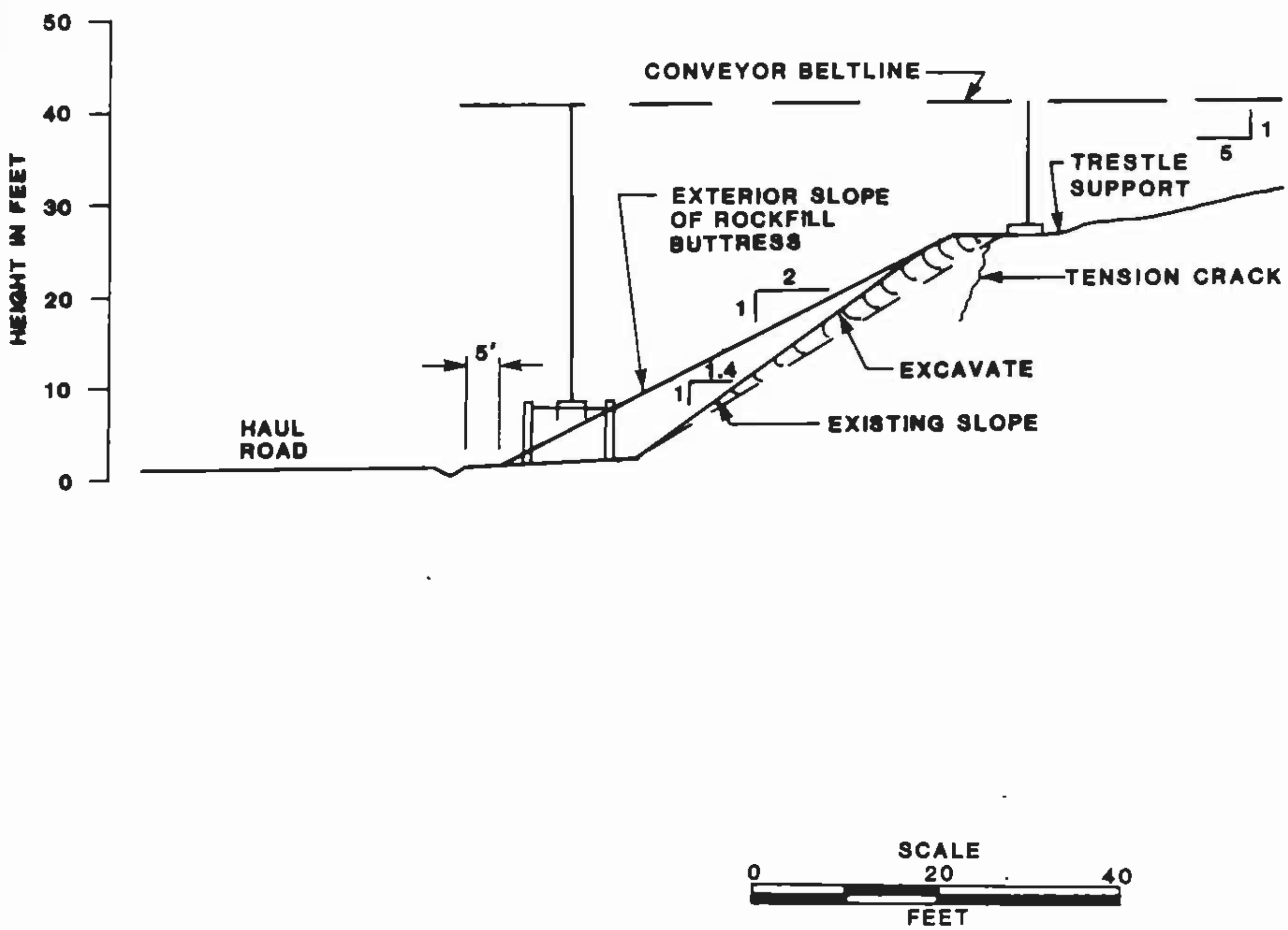
W = EXISTING BASE WIDTH OF GULLY

D = EXISTING DEPTH OF GULLY TRIM

SCALE
0 5 10
FEET

REMEDIAL TREATMENT FOR GULLIES

BY Dames & Moore Plate 9



RECOMMENDED REMEDIAL SLOPE STABILIZATION

CONVEYOR BELTLINE

STATION 497+00

BY **Dames & Moore** Plate 10

ATTACHMENT N-1

Condition #15 Response of 12-28-90

CONDITION #15 RESPONSE

Comment:

15. Within 180 days of permit issuance, PCC shall demonstrate to OSM in writing that all roads proposed as part of the postmining land use plan would facilitate access to residential areas and grazing lands. As part of this demonstration, PCC shall submit to OSM supporting documentation incorporating comments from BIA and the Navajo Tribe on the proposed road locations and design.

Response:

The location and design of roads for the Black Mesa Complex is discussed in Chapter 6, "Transportation Facilities", Volume 1 of the PAP. In Volume 11, Chapter 24, Bonding, approximately 13.5 miles of roads in the AZ-0001C permit area and 7.6 miles of roads in the AZ-0001 permit area are proposed as permanent primary roads. These roads will become part of the postmining land use plan to provide a permanent transportation network on Black Mesa to facilitate the access to residential and grazing areas scattered throughout the Black Mesa lease area. Drawing No. 85445, "Permanent Roads Map", was prepared to show the location of these proposed roads, the location of residential homesites, and the location of grazing boundaries within the Black Mesa lease area. Note some of these homesites and grazing boundaries are still being reviewed by local, Tribal, and BIA officials; therefore, they may be revised in the future. Included with Drawing No. 85445 are two indexes to the map. The first is the "Homesites Index" and the second is the Grazing Rights Index. These indexes contain the names of the people associated with the homesite and grazing identification numbers on the map.

After the review of Drawing No. 85445 and the two indexes, it becomes very apparent the proposed roads are the major all-weather access points across the major drainages on Black Mesa (i.e., Coal Mine Wash, Moenkopi Wash [both Black Mesa side and J-16 area], Red Peak Valley Wash, etc.). Total reclamation of these proposed roads will hinder access for residences and grazing right owners on the south and east portion of the permit area, as well as school buses, emergency vehicles, and the general public who need to traverse this area.

Finally, OSMRE has requested as part of this condition, Peabody contact BIA and Navajo Tribal officials and solicit comments on the proposed road locations and designs. In addition, OSMRE officials said BIA would be the lead agency to solicit and coordinate the submittal of comments to Peabody. Based on the above, Peabody representatives have had numerous telephone and written communications with the BIA representative during the 180 days, including an informational meeting in Window Rock, Arizona at BIA's office on August 22, 1990. This meeting included representatives from all interested BIA agencies, as well as Navajo Tribal, and Peabody Coal Company representatives. In this meeting, the requirements of this condition was discussed, the representatives were given a copy of Drawing 89800, "Bonding Map", which shows the locations of the proposed permanent roads, a copy of the road design specifications found in Chapter 6 of the AZ-0001C permit, and a map showing the homesite locations on Black Mesa.

Based on a telephone conversation with the BIA representative on December 26, 1990, he has surveyed the BIA and Tribal representatives and has received no objections to the proposed roads. In addition, he did not believe the BIA and Tribal representatives will have any comments by the end of the 180-day period.

In conclusion, based on the enclosed information, map, and design specifications for primary roads in Chapter 6 of the AZ-0001C permit, Peabody respectfully concludes the response to this condition.

PERMANENT ROADS MAP

(Drawing No. 85445)

Homesites Index

1. Bilta and Alice Begay, Phillip Begay, Wayne and Martha Lufkins, Leo Begay
2. John and Helen Kescoli, Maxine Kescoli, Jimmy and Teresa Little
3. Kee and Julia Russell, Jerry Russell, Bilta Begay
4. Alice Yazzie, Norman Yazzie, George and Mae Pulinosis, George Williams, Jack Williams, Tom and Julia Sherlock, Katherine Draper
5. Maxine Kescoli, Mary Gilmore
6. Cindy Lake, Ated Lake, Dzanh Lake
7. Esther Lake, Ated Lake
8. Tom Lake, Anita Lake
9. Bah Begay, Raymond Begay, Leonard and Molly Honnie, Oscar and Zonnie Whitehair
10. Kathie Charley
11. Steven and Katherine Manymules
12. Preston and Sadie Kelly
13. Priscilla Yazzie
14. Roy and Alice Tso
15. Billy and Sally Chief
16. Simon and Thelma Crank, Robert Crank, Thomas Crank, Mabel and Bennie Jim
17. Paul and Thelma Johnson, Spences Johnson
18. Keith and Pauletta Russell

19. Alice Crank, Teresa and Jim Little, Johnson Crank

20. Rose Yazzie, Rube Begishie, Sally Chief

21. Eli and Lilly Crank, Bessie Parrish, Harrison Crank

22. James Cody

23. Billy Austin, Billy Austin, Jr.

24. Leo and Rena Peaches

25. James Yazzie

26. Alice Yazzie

27. James Cody, Roger Cody, Myrata Cody

28. Earlene Albert

29. Calvin Etsitty

30. George and Lena Begay, Phillip Etsitty

31. Bessie Luna

32. Alta R. Albert

33. Annie Herrera

34. Betty Crank, Keevin and Irene Becenti, Stanley and Fannie Tallman, Albert Crank, Lilly Johnson, Cornelius Farley, Steven and Irene Etsitty, Ben Crank, Annie Herrera, Raymond James, Edward Yazzie, Robert Little, Bessie Luna, Don Benally, Evelyn Seaton

35. Irene Freeman

36. Betty Crank

37. Jack Chief

38. Nephi Chief, Lilly Chief, Paul Chief

39. Gary and Elsie Vandever

40. Rose Farley, Bessie Begay, Mable Thomas

41. Leslie Etsitty, Calvin Etsitty

42. Laura Edcitty

43. Fred Smith, Bobby and Annie Smith

44. Nelson Blackhat

45. Bessie Smith, Ambrose Smith

46. Merlin Begay, Daniel Benally

47. Cindy Lake

48. Dzanh Lake

49. Frank Lake

50. Daniel and Mabel Benally

51. Ated Lake, Chester Lake

52. Earl and Anita Kescoli

53. Mary Lake, Clarence Lake, Milton Lake, Duane Lake, Lorraine Vandever, Manymules daughter

54. Mary Boyd

55. Johnson Little, Amy Little

56. Sam and Ella Little, Ben and Ida Little

57. Mary Boyd

58. Cindy Lake

59. Henry Schmitt

60. Eddie Bigman

61. Eugene Leonard

62. Charlie and Sarah Keith

63. John Bahe

64. Anna Herrera

65. James Yazzie

66. Bessie Luna

67. Gary and Elsie Vandever

68. Bessie Begay

69. Bessie Begay

70. Woody Anderson
71. Ated Lake
72. Molita Lake
73. Lenora Begay
74. Leonard and Molly Honnie
75. Stanley Tsosie

PERMANENT ROADS MAP
(Drawing No. 85445)

Grazing Rights Index

Grazing Area #	Grazing Right Owners	Grazing Area #	Grazing Right Owners
3-B	Betty Crank	9	Silas Yazzie
3-C	Bessie Luna	9	Lucille Benally
3-C	Alta Rose Albert	9	Mary Lake
3-C	Annie Herrera	10	(Unavailable)
4-A	Lilly Chief	13	Rose Farley
4-C	Lilly Chief	13	Benny Etsitty
5	Rose Farley	13	John Bahe
5	Benny Etsitty	13	Carmelita Clark
5	John Bahe	13	Mabel Thomas
5	Carmelita Clark	13	Inez Cody
5	Mabel Thomas	13	Elsie Vandever
5	Inez Cody	13	Edward Begay, Sr.
5	Elsie Vandever	13	Calvin Etsitty
5	Edward Begay, Sr.	14	Eli Crank
5	Calvin Etsitty	15	Rose Yazzie
6	Rose Farley	15	Kee Crank
6	Benny Etsitty	15	Sally Chief
6	John Bahe	15	Thelma Johnson
6	Carmelita Clark	15	Helen Kescoli
6	Mabel Thomas	15	Ruby Begishe
6	Inez Cody	15	Johnson Crank
6	Elsie Vandever	16	Rose Farley
6	Edward Begay, Sr.	16	Benny Etsitty
6	Calvin Etsitty	16	John Bahe
7-B	Anita Lake Yazzie	16	Carmelita Clark
7-B	Joe Lake	16	Mabel Thomas
7-B	Lilly Chief	16	Inez Cody
7-B	Daniel Benally	16	Elsie Vandever
7-C	Anita Lake Yazzie	16	Edward Begay, Sr.
7-C	Joe Lake	16	Calvin Etsitty
7-C	Daniel Benally	17	Betty Crank
7-D	Anita Lake Yazzie	18	Bessie Luna
7-D	Joe Lake	18	Annie Herrera
7-E	Anita Lake Yazzie	18	Alta Rose Albert
7-E	Joe Lake	19	Ned Yazzie
7-E	Daniel Benally	20	John Billy Tsosie
8-A	Anita Lake Yazzie	20	Walter Begay, Sr.
8-A	Joe Lake	21	Alice Yazzie
8-A	George Pulinos	22	Rose Farley
8-A	Mary Lake	22	Benny Etsitty
8-B	George Pulinos	22	John Bahe
8-B	Mary Lake	22	Carmelita Clark
9	Roy Huskey	22	Mabel Thomas
9	Jacqueline Boyd	22	Inez Cody
9	Elouise Interpreter	22	Elsie Vandever
9	Eugene Leonard	22	Edward Begay, Sr.

PERMANENT ROADS MAP
(Drawing No. 85445)

Grazing Rights Index
(Continued)

Grazing Area #	Grazing Right Owners
22	Calvin Etsitty
23	Billy Austin
24	James Cody
25	Inez Cody
26	Alta Rose Albert
26	Bessie Luna
26	Annie Herrera
27	Rose Yazzie
27	Kee Crank
27	Sally Chief
27	Thelma Johnson
27	Helen Kescoli
27	Ruby Begishe
27	Johnson Crank
28	Rose Farley
28	Benny Etsitty
28	John Bahe
28	Carmelita Clark
28	Mabel Thomas
28	Inez Cody
28	Elsie Vandever
28	Edward Begay, Sr.
28	Calvin Etsitty
28	Betty Crank
29	Bessie Luna
29	Annie Herrera
29	Alta Rose Albert
29	Alice Yazzie
30	Marilyn Yazzie
30	Woodie Anderson
30	Alice Tso
30	Katherine Manymules
30	Ella M. Yazzie
30	Lena Tso
30	Sarah Kee
31	Simon Crank
32	Julia Jane Russell
33	Leonard Honnie, Jr.

ATTACHMENT O

Typical SEDIMENT II Inputs for

Drainage Control Structures

Typical SEDIMOT II Input (Culverts and Ditches)

Card Code	Parameters	Inputs
1	Watershed Identification	= ________
2	Storm Type	= (SCS Type II)
	No. of Depth Time Values	= 2
3	Rainfall Depth (inch)	= 1.61 (10yr.-6hr. Storm)
	Storm Duration (hr)	= 6.00
	Storm Time Increment	= 0.1
	Max. 30 Min. Intensity	= 1.0
4	Number of Junctions	= 1
	Sedimentology and/or Hydrology	= 1 (Hydrology Only)
5	Number of Branches per Junction	= 1
10	Number of Structures per Branch	= 1
11	Travel Time Between Structures (hr)	= 0.0
	Muskingum's k Between Structures (hr)	= 0.0
	Muskingum's X Between Structures (hr)	= 0.0
12	Number of Subwatersheds per Structures	= 1
	Type of Sediment Control Structure	= 1 (Null Structure)
	Print Control Variable for Total Drainage	= 2 (Hydrograph)
	Print Control Variable for Drainage Between Structures	= 2 (Hydrograph)
	Print Option for Subwatershed Inputs	
13	Subwatershed Area (Acres)	= ____
	Curve Number	= ____
	Time of Concentration	$= \left(\frac{11.9(L)^3}{H}\right)^{0.385}$
	Travel Time (to Structure)	= 0.0
	Muskingum's k (to Structure)	= 0.0

Typical SEDIMOT II Input (Culverts and Ditches) (Cont.)

Card Code	Parameters	Inputs
	Muskingum's X (to Structure)	= 0.0
	Hydrology Print Option	= 1.0 (Input Tables)
	Hydraulic Surface Condition	= ______
	Number of Flow Segements	= 0.0

Note: If the disturbance in the watershed exceeds 50%, use 1.0 (disturbed) for "Hydraulic Surface Condition", otherwise use 2.0 (agricultural).

ATTACHMENT P

Dodson and Associates Hydraulic Programs

-TRAP

-PIPE

1 INTRODUCTION

1.1 PURPOSE OF THE PROGRAM

A trapezoidal channel has flat bottom and sloping sides, as illustrated on Exhibit 1, in Appendix A of this manual. Trapezoidal shapes are often used for man-made channels, because they are relatively easy to construct and maintain, and provide good flow capacity. This program quickly computes the Normal Depth, Critical Depth, and Rating Curve for flow in a trapezoidal channel. One section of this manual is devoted to each of these procedures.

Using this computer program, you can quickly and easily analyze the hydraulic characteristics of almost any trapezoidal channel, including those with a different side slope on each bank. It's important to realize that triangular and rectangular channels can be easily analyzed by this program, because they are both special kinds of trapezoidal channels. A triangular channel is a trapezoidal channel with a channel bottom width of zero. A rectangular channel is a trapezoidal channel with side slopes of zero (vertical sides).

1.2 INFORMATION TO HELP YOU GET STARTED

1.2.1 Files on the Program Disk

Your program disk contains at least two files:

TRAP.COM is the file containing the trapezoidal channel analysis program and all of the on-line help screens.

TRAP87.COM is a special version of the program designed for use only on computers with the 8087 or 80287 math co-processors. Except for its faster operation, TRAP87.COM is identical to TRAP.COM.

In addition to these files, your disk may also contain several demonstration programs of other software products available from Dodson & Associates, Inc. You may select any of these demonstration programs by simply typing the file name and pressing the return key.

1.2.2 Getting Started Quickly

To start the program, do the following:

1) Start up your computer using the hard disk or a floppy disk with the DOS system files on it.

2) Insert the program disk, and close the disk drive door.

3) Type TRAP or TRAP87 and press the return key to start the trapezoidal channel analysis program.

4) In a few seconds the program will be loaded and you will be able to proceed through this manual and practice the use of each procedure.

2 NORMAL DEPTH PROCEDURE

2.1 PURPOSE OF NORMAL DEPTH PROCEDURE

Normal Depth is the depth at which uniform flow will occur in an open channel. In other words, if you had a uniform channel of infinite length, carrying a constant flow rate, then flow in the channel would be at a constant depth at all points along the channel, and this depth would be the normal depth.

It is often useful to determine Normal Depth, because it may represent a good approximation of the actual depth of flow within a channel segment. It is common practice, for example, to use Normal Depth computations to prepare a preliminary design for channel improvements, and then to check or refine the design by computing the water surface profile in the channel using the Standard Step or Direct Step Methods, or computer programs based on these methods.

2.2 REQUIRED INPUT DATA FOR NORMAL DEPTH PROCEDURE

2.2.1 Flow Rate

The user must supply the flow rate which the channel is to convey, in cubic feet per second (cfs). Sometimes, the flow rate may vary through the length of a channel segment, because of local inflow to the channel. In such cases, you must decide whether to base your analysis on the maximum flow rate or the average flow rate in the channel segment. Local drainage regulations or practice may provide guidance in this regard. When in doubt, it is recommended that the analysis be performed with each flow rate and the results compared.

2.2.2 Channel Bottom Slope

The channel bottom slope is the average drop in elevation per foot of length along the channel. For example, if the channel bottom drops 1 foot in a lenth of 1000 feet, then the channel bottom slope is 0.001 feet per foot. Channel bottom slopes are sometimes expressed in percent. A slope of 0.001 feet per foot is the same as a 0.1% slope.

The slopes of the water surface and the energy grade line are assumed to be the same as the channel bottom slope for normal flow conditions. Therefore, it is important to provide the best possible estimate of the channel bottom slope.

2.2.3 Manning's Roughness Coefficient

This program uses Manning's Equation to analyze open-channel flow. The roughness of the channel is represented by Manning's Roughness Coefficient, commonly called the "n-value". Suggested values for Manning's n-value are listed in Appendix B of this manual, and in many hydraulics reference books. Roughness coefficients should be adjusted according to experience in your geographic area.

2.2.4 Channel Side Slopes

The slope of each channel bank is illustrated on Exhibit 1. The program expects the side slopes to be represented as the "Z-Ratio", which is the ratio of horizontal distance to vertical rise in the channel bank. For example, a channel bank which rises 1 foot for each three feet of horizontal distance would have a side slope of 3:1, and a Z-Ratio of 3. Z-Ratios of 3 or 4 are common for earthen channels. Concrete-lined channels may have steeper banks, with Z-Ratios of 1.5 or 2.

This program has the capability of analyzing channels with a different side slope for each channel bank. For example, flow in a street gutter can be analyzed using this program. The vertical curb would cause the side slope to be 0 on one side. On the other side, a 6-inch difference between the pavement crown elevation and the gutter elevation, divided by a 12-foot lane width, would yield a side slope of 24.

2.2.5 Channel Bottom Width

Exhibit 1, in Appendix A, illustrates the bottom width of the channel section.

2.3 DESCRIPTION OF RESULTS OF NORMAL DEPTH PROCEDURE

2.3.1 Normal Depth

This program computes Normal Depth using an iterative approach to arrive at a value which satisfies Manning's Equation:

$$Q = \frac{1.486}{n} A R^{(2/3)} S^{(1/2)}$$

in which:

- Q = Flow Rate in the channel (cfs)
- n = Manning's Roughness Coefficient
- A = Area of Flow (square feet)
- R = Hydraulic Radius (feet) = (Flow Area)/(Wetted Perimeter)
- S = Slope of Energy Grade Line (feet per foot)

The equation is re-arranged in terms of the depth of flow. An initial flow depth estimate of 1 foot is substituted into the equation, and a new approximation is computed for the flow depth. The new value is compared with the previous approximation, and if the difference is less than 0.001 feet, the depth is assumed to be the Normal Depth. If not, a new approximation for Normal Depth is computed as the geometric mean of the previous two approximations. This method gives very quick, precise, and reliable values for the Normal Depth of flow in a trapezoidal channel.

2.3.2 Flow Velocity

After the program computes the Normal Depth, the flow velocity in the channel is computed as simply the flow rate divided by the cross-sectional area of the flow. The velocity is assumed to be constant throughout the cross-section.

The flow velocity is an important consideration in many channel design situations. The allowable flow velocity may be limited by local drainage criteria.

2.3.3 Froude Number

The Froude Number is the ratio of the inertial forces to the gravitational forces in a flowing fluid. It is computed using this formula:

$$\text{Froude Number} = \frac{V}{(gA/T)^{(1/2)}}$$

in which:

- V = Flow Velocity (fps)
- g = Acceleration due to gravity = 32.2 feet/sec/sec
- A = Cross-sectional Area of Flow (square feet)
- T = Top width of Flow (feet)

If the Froude Number is greater than one (1.00), then flow in the channel is "super-critical". A Froude Number less than one is more common, indicating "sub-critical" flow. Section 3 of this manual contains more information on critical flow and critical depth.

2.3.4 Velocity Head

Water flowing in an open channel contains two major types of energy: potential energy and kinetic energy. Potential energy is expressed as the elevation of the water surface. Kinetic energy is expressed as the "velocity head". The term "head" can also be stated as "energy level".

The velocity head is computed using the following formula:

$$\text{Velocity Head} = \frac{V^2}{2g}$$

in which

- V = Flow Velocity in the channel (fps)
- g = Acceleration due to gravity = 32.2 feet/sec/sec

2.3.5 Energy Head

The "Energy Head" of the flow is the total energy of the flow, including both potential energy and kinetic energy. In other words, the energy head is simply the sum of the water surface elevation and the velocity head.

2.3.6 Cross-Sectional Area of Flow

The cross-sectional area of flow is computed in order to provide a quick check on the other computed quantities, and also to aid in computing excavation requirements for a channel. The flow area is computed using the following formula:

$$\text{Flow Area} = (B+T)(D/2)$$

in which:

B = Channel Bottom Width (feet)
T = Top Width of Flow (feet)
D = Depth of Flow (feet)

2.3.7 Top Width of Flow

The top width of flow is illustrated on Exhibit 1, in Appendix A. It is computed in order to make it easier to quickly estimate the required right-of-way width for a channel. The top width of the channel will probably be greater than the top width of the flow, because most channels are required to have some freeboard.

2.4 EXAMPLE OF NORMAL DEPTH PROCEDURE

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

Flow Rate (cubic feet per second)	200
Channel Bottom Slope (feet per foot)	.0005
Manning's Roughness Coefficient (n-value)	.040
Channel Side Slope - Left Side (horizontal/vertical)	3
Channel Side Slope - Right Side (horizontal/vertical)	3
Channel Bottom Width (feet)	6

*** RESULTS ***

NORMAL DEPTH (FEET)	5.33
Flow Velocity (feet per second)	1.71
Froude Number	.171
Velocity Head (feet)	.05
Energy Head (feet)	5.37
Cross-Sectional Area of Flow (square feet)	117.05
Top Width of Flow (feet)	37.95

Press Return to repeat this operation, or Esc to return to Main Menu

---

3 CRITICAL DEPTH PROCEDURE

3.1 PURPOSE OF CRITICAL DEPTH PROCEDURE

Critical Depth occurs when the flow in a channel has minimum specific energy. Specific Energy refers to the sum of the depth of flow and the velocity head. It can be shown mathematically that the velocity head is equal to one-half the depth of flow at Critical Depth. Critical Depth depends only on the channel shape, roughness, and flow rate.

It is sometimes useful to compute Critical Depth in order to analyze the type of flow profile which will occur in a particular channel.

3.2 REQUIRED INPUT DATA FOR CRITICAL DEPTH PROCEDURE

In order to compute the Critical Depth of flow in a channel, the program requires that you supply the following items of input data:

1) The Flow Rate in the channel.

2) The Manning's Roughness Coefficient for the channel.

3) The Channel Side Slopes (which may differ for each side, and may be zero).

4) The Channel Bottom Width (which may be zero).

Each of these items is described in connection with the Normal Depth procedure in Section 2.2 of this manual.

3.3 DESCRIPTION OF RESULTS OF CRITICAL DEPTH PROCEDURE

3.3.1 Critical Depth

This program computes the critical depth by an iterative procedure, which arrives at a value which satisfies the following equation:

$$\frac{Q^2}{g} = \frac{A^3}{T}$$

in which

Q = Flow Rate in the channel, in cfs
g = Acceleration due to gravity (32.2 ft/sec/sec)
A = Cross-sectional area of flow (square feet)
T = top width of flow (feet)

The Newton-Raphson method of locating roots of a polynomial equation is used to solve the equation for the Critical Depth. This method gives a quick and efficient solution which is accurate to within 0.001 foot.

3.3.2 Critical Slope

Critical Slope is the channel slope at which Normal Depth equals Critical Depth. Critical Slope is computed by inserting the Critical Depth in Manning's Equation, which is re-arranged as follows:

$$S^{(1/2)} = \frac{Qn}{1.486AR^{(2/3)}}$$

in which:

S = Slope of Energy Grade Line (feet per foot)
Q = Flow Rate in the channel (cfs)
n = Manning's Roughness Coefficient
A = Area of Flow (square feet)
R = Hydraulic Radius (feet) = (Flow Area)/(Wetted Perimeter)

3.3.3 Flow Velocity

The flow velocity is computed as the flow rate divided by the cross-sectional area of flow.

3.3.4 Froude Number

The Froude Number is the ratio of the inertial forces to the gravitational forces in a flowing fluid. It is computed using this formula:

$$\text{Froude Number} = \frac{V}{(gA/T)^{(1/2)}}$$

in which:

V = Flow Velocity (fps)
g = Acceleration due to gravity = 32.2 feet/sec/sec
A = Cross-sectional Area of Flow (square feet)
T = Top Width of Flow (feet)

At Critical Depth, the Froude Number equals 1. Therefore, the computed Froude Number provides a quick check on the accuracy of the computed critical depth. The Froude Number should always be very close to 1.000 for the Critical Depth procedure.

3.3.5 Other Results

The Velocity Head, Energy Head, Cross-section Area of Flow, and Top Width of Flow are computed for the Critical Depth as described for the Normal Depth procedure, in Section 2.3 of this manual.

3.4 EXAMPLE OF CRITICAL DEPTH PROCEDURE

TRAPEZOIDAL CHANNEL ANALYSIS
CRITICAL DEPTH COMPUTATION

Flow Rate (cubic feet per second)	200
Manning's Roughness Coefficient (n-value)	.040
Channel Side Slope - Left Side (horizontal/vertical)	3
Channel Side Slope - Right Side (horizontal/vertical)	3
Channel Bottom Width (feet)	6

*** RESULTS ***

CRITICAL DEPTH (FEET)	2.26
Critical Slope (feet per foot)	.0215
Flow Velocity (feet per second)	6.90
Froude Number	1.000
Velocity Head (feet)	.74
Energy Head (feet)	3.00
Cross-Sectional Area of Flow (square feet)	28.98
Top Width of Flow (feet)	19.59

Press Return to repeat this operation, or Esc to return to Main Menu

---

4 RATING CURVE PROCEDURE

4.1 PURPOSE OF RATING CURVE PROCEDURE

A Rating Curve is simply a table or curve which relates the flow rates to flow depths in a channel. As you insert flow depths, the Rating Curve procedure quickly computes the flow rate in the channel, and other information about flow at the specified depth. You may specify as many depths as you like.

Rating Curves are useful in estimating the capacity of a channel over a wide range of flood events or storm frequencies, or in quickly relating a known flood stage to a certain peak flow rate.

4.2 REQUIRED INPUT DATA FOR RATING CURVE PROCEDURE

4.2.1 Description of Channel

In order to compute a Rating Curve for the channel, the program requires that you supply the following items of input data:

1) The Channel Bottom Slope.

2) The Manning's Rougnness Coefficient for the channel.

3) The Channel Side Slopes (which may differ for each side, and may be zero).

4) The Channel Bottom Width (which may be zero).

Each of these items is described in connection with the Normal Depth procedure in Section 2.2 of this manual.

4.2.2 Flow Depths

Once you have defined the shape and roughness of the channel, the program begins to prompt you for flow depths. As you enter each flow depth and press the Return key, the program quickly computes the flow rate and other information about flow at the specified depth. Any reasonable flow depth may be entered. For best results, however, you may wish to enter a series of flow depths at selected intervals. For example, from 1 foot to 10 feet, at one foot intervals.

4.3 DESCRIPTION OF RESULTS OF RATING CURVE PROCEDURE

4.3.1 Flow Rate

For each Flow Depth which you specify, the program computes the flow rate using Manning's Equation:

$$Q = \frac{1.486}{n} AR^{(2/3)} S^{(1/2)}$$

in which:

Q = Flow Rate in the channel (cfs)
n = Manning's Roughness Coefficient
A = Area of Flow (square feet)
R = Hydraulic Radius (feet) = (Flow Area)/(Wetted Perimeter)
S = Slope of Energy Grade Line (feet per foot)

The Flow Area and Hydraulic Radius are computed from the given Flow Depth.

4.3.2 Other Results

The other results of the Rating Curve procedure, including the Flow Velocity, the Froude Number, the Velocity Head, the Energy Head, the Flow Area, and the Top Width, are all computed by the methods described in Section 2.3, which deals with the Normal Depth procedure.

4.4 EXAMPLE OF RATING CURVE PROCEDURE

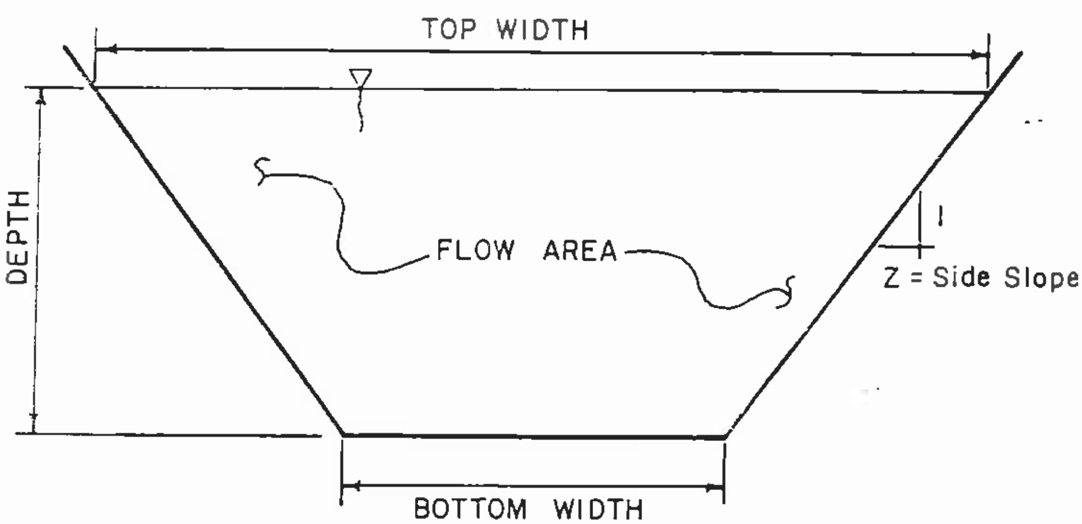
TRAPEZOIDAL CHANNEL ANALYSIS
RATING CURVE COMPUTATION

Channel Bottom Slope (feet per foot)	.0005
Manning's Rougnness Coefficient (n-value)	.040
Channel Side Slope - Left Side (horizontal/vertical)	3
Channel Side Slope - Right Side (horizontal/vertical)	3
Channel Bottom Width (feet)	6

*** RESULTS ***

Depth (ft)	Flow Rate (cfs)	Velocity (fps)	Froude Number	Velocity Head(ft)	Energy Head(ft)	Flow Area (sq ft)	Top Width (ft)
1.00	6.06	.67	.137	.01	1.01	9.00	12.00
2.00	23.59	.98	.150	.01	2.01	24.00	18.00
3.00	55.35	1.23	.158	.02	3.02	45.00	24.00
4.00	104.23	1.45	.165	.03	4.03	72.00	30.00
5.00	172.90	1.65	.170	.04	5.04	105.00	36.00
6.00	263.89	1.83	.174	.05	6.05	144.00	42.00
7.00	379.60	2.01	.178	.06	7.06	189.00	48.00
8.00	522.32	2.18	.182	.07	8.07	240.00	54.00
9.00	694.24	2.34	.185	.08	9.08	297.00	60.00
10.00	897.47	2.49	.188	.10	10.10	360.00	66.00
11.00	1134.07	2.64	.191	.11	11.11	429.00	72.00
12.00	1406.02	2.79	.193	.12	12.12	504.00	78.00
13.00	1715.25	2.93	.196	.13	13.13	585.00	84.00

Enter Depth of Flow, or Press the Esc Key to End



TRAPEZOIDAL CHANNEL

DODSON & ASSOCIATES, INC.

JOB NO.	DATE	EXHIBIT
		1

Applied Hydraulics in Engineering

Henry M. Morris and James M. Wiggert, 1972, the Ronald Press Company, New York. This book is a general text on hydraulics. Chapters 4, 5, and 6 are especially related to open-channel flow.

Civil Engineering Hydraulics

R. E. Featherstone and C. Nalluri, 1982, Granada Publishing Limited, London. This book is fairly theoretical, but with many examples. Chapter 8 applies to open-channel flow.

Design Charts for Open-Channel Flow

1980, U. S. Department of Transportation, Federal Highway Administration, Washington, D.C. This is an excellent reference, containing many charts for computing normal depth and critical depth of flow in open channels. The charts can be cross-checked with the results of this computer program.

Handbook of Hydraulics

Ernest F. Brater and Horace Williams King, 1976, McGraw-Hill, Inc. New York. This book is not a good place to start learning about hydraulics, but we keep coming back to it for information not easily available elsewhere.

Modern Sewer Design

1980, American Iron and Steel Institute, Washington, D.C. This book is an excellent reference on practical hydraulics.

Open Channel Hydraulics

Ven Te Chow, 1959, McGraw-Hill, Inc. New York. This is the classic text on hydraulics.

Water Resources Engineering

Ray K. Linsley and Joseph B. Franzini, 1979, McGraw-Hill, Inc., New York. This is an excellent general text. Chapter 10 relates to open channels.

1 INTRODUCTION

1.1 PURPOSE OF THE PROGRAM

A pipe culvert is a relatively short segment of a round pipe which connects two channels or bodies of water, as illustrated on Exhibit 1, in Appendix A of this manual. This program can analyze Pressure Flow in a culvert, or can determine the size of [illegible] in a culvert by Control Design. One section of this manual is devoted to each of these procedures.

1.2 INFORMATION TO HELP YOU GET STARTED

1.2.1 Files on the Program Disk

Your program disk contains at least two files:

PIPE.COM is the file containing the pipe culvert analysis program and all of the on-line help screens.

PIPE87.COM is a special version of the program designed for use only on computers with the 8087 or 80287 math co-processors. Except for its faster operation, PIPE87.COM is identical to PIPE.COM.

In addition to these files, your disk may also contain several demonstration programs of other software products available from Dodson & Associates, Inc. You may select any of these demonstration programs by simply typing the file name and pressing the return key.

1.2.2 Getting Started Quickly

To start the program, do the following:

1) Start up your computer using the hard disk or a floppy disk with the DOS system files on it.

2) Insert the program disk, and close the disk drive door.

3) Type CIRC or CIRC87 and press the Return key to start the circular channel analysis program.

4) In a few seconds the program will be loaded and you will be able to proceed through this manual and practice the use of each procedure.

2 CONTROL DESIGN PROCEDURE

2.1 PURPOSE OF CONTROL DESIGN PROCEDURE

The analysis of flow in culverts is complicated. It is common to use the concepts of "Inlet Control" and "Outlet Control" to simplify the analysis. Inlet Control flow occurs when the flow capacity of the culvert entrance is less than the flow capacity of the culvert barrel. Outlet Control flow occurs in other cases.

For Inlet Control, the headwater required to produce a certain flow rate is computed by assuming that the culvert inlet acts as an orifice. Therefore, the Inlet Control headwater depends only on the geometry of the culvert opening. The headwater of a culvert is the difference between the upstream culvert flow-line elevation and the elevation of the water surface in the channel immediately upstream of the culvert. The headwater is illustrated on Exhibit 1.

For Outlet Control, the required headwater is computed by taking the depth of flow at the culvert outlet plus all head losses, minus the change in flow-line elevation of the culvert from the upstream to downstream end. The program considers the entrance losses, the friction loss in the culvert barrel, and the loss of velocity head at the outlet (which is reduced if there is flow velocity in the channel downstream of the culvert).

This procedure computes the headwater required for Inlet Control conditions and for Outlet Control conditions. The type of flow is determined by the greater headwater.

Exhibit 2, in Appendix A of this manual, contains a flow chart for the Control Design Procedure of this program. You may find it convenient to refer to this flow chart as you read this section of the manual and use the program.

2.2 REQUIRED INPUT DATA FOR CONTROL DESIGN PROCEDURE

2.2.1 Flow Rate

The required flow rate, in cfs, may be any reasonable positive value.

2.2.2 Culvert Diameter

The inside diameter of the culvert opening is important not only in determining the total flow area of the culvert, but also in determining whether the headwater and tailwater elevations are adequate to submerge the inlet or outlet of the culvert. Exhibit 1 of this manual illustrates the culvert diameter.

2.2.3 Tailwater Elevation

The Tailwater of a culvert is the difference between the downstream culvert flow-line elevation and the elevation of the water surface in the channel immediately downstream of the culvert. The tailwater is illustrated on Exhibit

1.

It is important to remember that the headwater and tailwater depths are each measured from the culvert flow-line elevation on different ends of the culvert. Therefore, just because the headwater and the tailwater are equal for a particular culvert, it is not necessarily true that the water surface elevations on the upstream and downstream side of the culvert are equal.

2.2.4 Mannings Roughness Coefficient

This program uses Manning's Equation to compute friction losses in the culvert barrel. The roughness of the culvert is represented by Manning's Roughness Coefficient, commonly called the "n-value". Suggested values for Manning's n-value are listed in Appendix B of this manual, and in many hydraulics reference books. Roughness coefficients should be adjusted according to experience in your geographic area, and according to your judgment of the culvert condition.

Some engineers have a tendency to be "conservative" in estimating n-values. However, values which are conservative in one respect may be non-conservative in another. It is not generally acceptable as a designer to simply add a certain percentage to all coefficients in order to produce a conservative design. For example, a culvert which has more flow capacity than the design computations indicate may have excessive flow velocities which cause downstream erosion.

2.2.5 Entrance Loss Coefficient

The Entrance Loss Coefficient is used to determine the amount of head loss which occurs at the entrance to the culvert. A higher value for the coefficient gives a higher head loss.

Appropriate values for the entrance loss coefficient range from 0.2 to about 0.8 for pipe culverts. For a sharp-edged culvert entrance with no rounding, 0.5 is recommended. For a well-rounded entrance, 0.2 is appropriate. An example of a fairly well-rounded entrance is the socket end of a concrete pipe section.

Appendix C of this manual contains a further discussion of the entrance loss coefficient, and presents a list of values for different types of culvert entrances.

2.2.6 Orifice Flow Coefficient

The Orifice Flow Coefficient is used in the program to determine the flow capacity of the culvert inlet as an orifice. A higher value for the coefficient gives a higher flow capacity. Appropriate values range from 0.55 to about 0.90. A value of 0.62 is appropriate for many common situations.

2.2.7 Culvert Length

The culvert length should be measured in feet, along the center-line of the culvert.

2.2.8 Culvert Slope

The flow-line of a culvert is the lowest point on the inside of the culvert opening. Most culverts are installed with some "positive slope". That is, the flow-line of the culvert is slightly lower on the downstream end than the upstream end, so that some flow velocity can be maintained in the culvert even under low flow conditions. A sufficient slope to maintain a minimum flow velocity of 3 feet per second is often required.

The culvert flow-line slope is the average drop in elevation per foot of length along the culvert. For example, if the culvert flow-line drops 1 foot in a lenth of 100 feet, then the culvert flow-line slope is 0.01 feet per foot. Culvert flow-line slopes are sometimes expressed in percent. A slope of 0.01 feet per foot is the same as a 1% slope.

This program assumes that the size, shape, roughness, and slope of the culvert is constant throughout the length of the culvert. The slope of the culvert is used by the program to compute the drop in flow-line between the upstream and downstream ends of the culvert. It is also used to compute the normal depth of flow in the culvert under inlet control conditions.

2.2.9 Downstream Flow Velocity

In analyzing flow through culverts, it is common to assume that the kinetic energy of the water flowing through the culvert is lost when the water exits the culvert and enters a "still pool" of water on the downstream side of the culvert. The exit loss would then equal the velocity head of the flow in the culvert.

Often, however, the culvert is located in a channel in which the flow continues downstream of the culvert without being detained downstream of the culvert. In such cases, the velocity head in the culvert may not be completely lost. For this reason, this program allows you to enter a value for the downstream channel velocity. The program then considers the downstream flow velocity in computing the exit loss of the culvert, as described in Section 2.3.3.4 of this manual.

2.3 DESCRIPTION OF RESULTS OF CONTROL DESIGN PROCEDURE

2.3.1 Inlet Control Headwater

As mentioned previously, this procedure computes the required headwater for both inlet control and outlet control conditions. The results of both computations are displayed. However, the higher computed headwater is listed first and highlighted, so that it is convenient to quickly tell whether the culvert will operate under inlet control or outlet control.

For inlet control conditions, the capacity of the culvert is limited by the capacity of the culvert opening, rather than by conditions farther downstream. For inlet control flow, the culvert inlet acts as an orifice. Therefore, the inlet control headwater can be determined by the orifice flow equation:

$$H = R/2 + [1/C^2][Q^2/(2gA^2)]$$

in which:

- H = Headwater (feet), measured above the culvert flow-line
- R = Rise of culvert (height of culvert opening) (feet)
- C = Orifice Flow Coefficient
- Q = Flow Rate (cfs)
- g = Acceleration due to gravity (feet/second/second)

2.3.2 Outlet Control Headwater

For outlet control flow, the required headwater must be computed considering several conditions within the culvert and downstream. The headwater required for outlet control conditions is computed as follows:

$$HeadWater = D + H - LS$$

in which:

- D = The flow depth at the culvert outlet (feet) (see Section 2.3.8.1)
- H = The head loss in the culvert (feet) (see Section 2.3.3)
- L = The length of the culvert (feet)
- S = The slope of the culvert flow-line (feet/foot)

2.3.3 Head Loss Through Culvert

2.3.3.1 Head Loss Formula

The total Head Loss, or energy loss, through the culvert is measured in feet. The head loss is computed using the following formula:

$$HeadLoss = Friction\ Loss + Entrance\ Loss + Exit\ Loss$$

As described in Section 2.3.8.1 of this manual, the head at the culvert outlet may be greater than the tailwater under certain conditions. Under these conditions, the total head loss through the culvert will include an additional exit loss equal to the difference between the culvert outlet head and the tailwater.

The following sections of this manual describe the methods used by the program to compute each of these losses.

2.3.3.2 Method of Computing Friction Losses

The friction loss in the culvert is computed using Manning's formula, which is expressed as follows:

$$F = L\left[Qn/1.486AR^{(2/3)} \right]^2$$

in which:

- F = Friction Loss (feet)
- L = Culvert Length (feet)
- Q = Flow Rate in the culvert (cfs)
- n = Manning's Roughness Coefficient
- A = Area of Flow (square feet)
- R = Hydraulic Radius (feet) = (Flow Area)/(Wetted Perimeter)

2.3.3.3 Method of Computing Entrance Losses

The entrance loss is computed as described in Section 2.2.5 and Appendix C of this manual.

2.3.3.4 Methods of Computing Exit Losses

2.3.3.4.1 Pressure Flow Conditions

For pressure flow, the exit loss is computed by the following formula, which is taken from page 111 of "Modern Sewer Design" (see Appendix D, References):

$$L = (V-C)^2/(2g)$$

in which:

- L = Exit Loss (feet)
- V = Flow Velocity in culvert (fps)
- C = Flow Velocity in channel downstream (fps)
- g = Acceleration due to gravity (feet/second/second)

If the downstream channel flow velocity is greater than the flow velocity in the culvert, the exit loss is assumed to be zero.

2.3.3.4.2 Open-Channel Flow Conditions

For open-channel flow, the exit loss is computed by the following formula, which is taken from page 110 of "Modern Sewer Design" (see Appendix D, References):

$$L = 0.2\{[V^2/(2g)] - [C^2/(2g)]\}$$

in which:

- L = Exit Loss (feet)
- V = Flow Velocity in culvert (fps)
- C = Flow Velocity in channel downstream (fps)
- g = Acceleration due to gravity (feet/second/second)

0.2 = the expansion loss coefficient

If the downstream channel flow velocity is greater than the flow velocity in the culvert, then this formula provides a negative value for the exit loss. In such a case, the exit loss is assumed to be zero.

2.3.4 Flow Velocity in Culvert

The flow velocity in the culvert is computed as simply the flow rate divided by the cross-sectional area of the flow. The depth of flow in the culvert depends on the conditions of flow. If the tailwater exceeds the culvert height, or the critical depth of flow in the culvert exceeds the culvert height, then the culvert will flow full, and the cross-sectional area of flow is equal to the cross-sectional area of the culvert opening.

For other conditions, however, the flow depth may be equal to the tailwater elevation, the normal depth of flow in the culvert, or a value between the critical depth of flow and the height of the culvert. The Program Flow Chart contained in Exhibit 2 of this manual illustrates the determination of the flow depth in the culvert.

The allowable flow velocity of a culvert may be restricted to a certain value, such as 10 feet per second. In some cases, high flow velocities at the downstream end of a culvert may create the need for erosion protection.

2.3.5 Froude Number in Culvert

Froude Number is the ratio of the inertial forces to the gravitational forces in a flowing fluid. It is computed using this formula:

$$\text{Froude Number} = \frac{V}{(gA/T)^{(1/2)}}$$

in which:

V = Flow Velocity (fps)
g = Acceleration due to gravity = 32.2 feet/sec/sec
A = Cross-sectional Area of Flow (square feet)
T = Top Width of Flow (feet)

If the Froude Number is greater than one (1.00), then flow in the culvert is "super-critical". A Froude Number less than one indicates "sub-critical" flow. Critical flow is indicated by a Froude Number of 1.00.

2.3.6 Velocity Head in Culvert

The velocity head represents the level of kinetic energy within the culvert. The velocity head is used to estimate the culvert entrance and exit losses, and is computed using the following formula:

$$\text{Velocity Head} = V^2 / 2g$$

in which
V = Flow Velocity in the culvert (fps)
g = Acceleration due to gravity = 32.2 feet/second/second

2.3.7 Special Information for Inlet Control

2.3.7.1 Normal Depth of Flow In Culvert

For Inlet Control conditions, the depth of flow within the culvert is assumed to be Normal Depth. This assumption is only valid if the culvert pipe is sufficiently long to allow the flow depth to stabilize at Normal Depth. Some of the references listed in Appendix D indicate that the culvert length should be at least 6 times the culvert height before normal depth is attained.

This program uses a procedure based on Manning's equation to solve for normal depth:

$$Q = \frac{1.486}{n} AR^{(2/3)} S^{(1/2)}$$

in which:
Q = Flow Rate in the channel (cfs)
n = Manning's Roughness Coefficient
A = Area of Flow (square feet)
R = Hydraulic Radius (feet) = (Flow Area)/(Wetted Perimeter)
S = Slope of Energy Grade Line (feet per foot)

The first step in the procedure is to compute the maximum flow capacity of the culvert. This capacity occurs at a flow depth of 0.938 times the culvert diameter. If this capacity is less than the required flow rate (as entered by you), then the program assumes full flow conditions.

Assuming that the channel has sufficient capacity to convey the required flow rate, this program computes normal depth using an iterative approach. Manning's Equation is re-arranged in terms of the depth of flow. An initial flow depth estimate of one-half of the channel diameter is substituted into the equation, and a new approximation is computed for the flow depth.

The new value is compared with the previous approximation, and if the difference is less than 0.001 feet, the depth is assumed to be the Normal Depth. If not, a new approximation for Normal Depth is computed as the geometric mean of the previous two approximations.

This method gives very quick, precise, and reliable values for the Normal Depth of flow in a circular channel, except in cases in which the normal depth is above about 88% of the channel diameter. In such cases, the program may complete the maximum 30 iterations without reaching the required accuracy.

2.3.8 Special Information for Outlet Control

2.3.8.1 Head at Culvert Outlet

The head at the culvert outlet is one of the most important determinants of the type of flow in a culvert. The program flow chart contained on Exhibit 2 illustrates the assumptions made by the program in determining the culvert outlet head.

If the tailwater is equal to or greater than the culvert height, then the culvert flows full, and the outlet head is equal to the tailwater. If the tailwater is less than the culvert height, however, the program computes the critical depth of flow in the culvert (as described in the following section). The program then assumes that the outlet head is halfway between the critical depth and the height of the culvert, unless the tailwater is higher than this value, in which case the outlet head is equal to the tailwater. It is evident, then, that the outlet head is equal to the tailwater except in low tailwater conditions.

2.3.8.2 Critical Depth of Flow in Culvert

This program computes the critical depth by an iterative procedure, which arrives at a value which solves the following equation:

$$(Q/g)^{2} = (A/T)$$

in which
- Q = Flow Rate in the channel, in cfs
- g = Acceleration due to gravity (32.2 ft/sec/sec)
- A = Cross-sectional area of flow (square feet)
- T = top width of flow (feet)

The program first estimates the critical depth in a square channel having an area equal to the circular channel. This depth is as follows:

$$F = Q^{2}/(g\ r^{2}) + r(1+\ \ /2)$$

in which:
- F = Estimate of Critical Depth (feet)
- Q = Flow Rate (cfs)
- g = Acceleration due to gravity (32.2 feet/sec/sec)
- = 3.1415926+
- r = Radius of Channel (feet)

This estimate is then inserted into the first equation. If the two sides of the equation do not agree to within 0.001 feet, a new estimate of the critical depth is computed by the following equation:

$$d = F[(Q^{2}/g)/(a^{3}/T)]^{\{(2/9)[|(d-r)/r|+1]\}}$$

in which:

- d = new estimate of critical depth (feet)
- c = old estimate of critical depth (feet)
- Q = flow rate (cfs)
- g = acceleration due to gravity (32.2 feet/sec/sec)
- a = cross-sectional area of flow (square feet)
- T = top width of flow (feet)
- r = radius of channel (feet)

The critical depth procedure automatically terminates after 30 iterations, even if the desired accuracy cannot be attained. This usually results from a situation in which the critical depth exceeds about 88% of the channel diameter.

2.4 EXAMPLES OF CONTROL DESIGN PROCEDURE

2.4.1 Example of Inlet Control

```
--------------------------------------------------------------------------
                  PIPE CULVERT ANALYSIS
      DETERMINATION OF CONTROL AND HEADWATER ELEVATION
Flow Rate (cubic feet per second)                              200
Culvert Diameter (feet)                                        4
Tailwater Elevation above Culvert Flow-Line (feet)             3
Manning's Roughness Coefficient (n-value)                      .013
Entrance Loss Coefficient of Culvert Opening                   .5
Orifice Flow Coefficient of Culvert Opening                    .62
Culvert Length (feet)                                          100
Culvert Slope (feet per foot)                                  .020
Channel Flow Velocity Downstream (feet per second)             3
                       *** RESULTS ***

INLET CONTROL HEADWATER ABOVE CULVERT FLOW-LINE (FEET)            12.23
Outlet Control Headwater above Culvert Flow-Line (feet)            8.46
Head Loss Through Culvert (feet)                                  12.23
Flow Velocity (feet per second)                                   18.43
Froude Number                                                     1.755
Velocity Head (feet)                                               5.28
SPECIAL INFORMATION FOR INLET CONTROL CONDITIONS:
Normal Depth of Flow in Culvert (feet)                             3.22

Press Return to repeat this operation, or Esc to return to Main Menu
--------------------------------------------------------------------------
```

2.4.2 Example of Outlet Control with High Tailwater

PIPE CULVERT ANALYSIS
DETERMINATION OF CONTROL AND HEADWATER ELEVATION

Flow Rate (cubic feet per second)	200
Culvert Diameter (feet)	4
Tailwater Elevation above Culvert Flow-Line (feet)	3
Manning's Roughness Coefficient (n-value)	.013
Entrance Loss Coefficient of Culvert Opening	.5
Orifice Flow Coefficient of Culvert Opening	.62
Culvert Length (feet)	150
Culvert Slope (feet per foot)	.020
Channel Flow Velocity Downstream (feet per second)	3

*** RESULTS ***

OUTLET CONTROL HEADWATER ABOVE CULVERT FLOW-LINE (FEET)	12.45
Inlet Control Headwater above Culvert Flow-Line (feet)	12.23
Head Loss Through Culvert (feet)	[illegible]
Flow Velocity (feet per second)	15.92
Froude Number	1.402
Velocity Head (feet)	3.93
SPECIAL INFORMATION FOR OUTLET CONTROL CONDITIONS:	
Head at Culvert Outlet (feet)	[illegible]

Press Return to repeat this operation, or Esc to return to Main Menu

2.4.3 Example of Outlet Control with Low Tailwater

PIPE CULVERT ANALYSIS
DETERMINATION OF CONTROL AND HEADWATER ELEVATION

Flow Rate (cubic feet per second)	200
Culvert Diameter (feet)	4
Tailwater Elevation above Culvert Flow-Line (feet)	8
Manning's Roughness Coefficient (n-value)	.013
Entrance Loss Coefficient of Culvert Opening	.5
Orifice Flow Coefficient of Culvert Opening	.70
Culvert Length (feet)	150
Culvert Slope (feet per foot)	.010
Channel Flow Velocity Downstream (feet per second)	2

*** RESULTS ***

OUTLET CONTROL HEADWATER ABOVE CULVERT FLOW-LINE (FEET)	10.38
Inlet Control Headwater above Culvert Flow-Line (feet)	10.03
Head Loss Through Culvert (feet)	8.88
Flow Velocity (feet per second)	15.92
Froude Number	1.402
Velocity Head (feet)	3.93
SPECIAL INFORMATION FOR OUTLET CONTROL CONDITIONS:	
Head at Culvert Outlet (feet)	4.00
Critical Depth of Flow in Culvert (feet)	4.00

Press Return to repeat this operation, or Esc to return to Main Menu

3 PRESSURE FLOW PROCEDURE

3.1 PURPOSE OF PRESSURE FLOW PROCEDURE

Pressure flow occurs in a culvert when the culvert inlet and outlet (the upstream and downstream openings) are both submerged.

In pressure flow, the head loss through the culvert is caused by three main factors: the losses at the culvert entrance, the losses due to friction in the culvert barrel, and the loss of kinetic energy when the flow leaves the culvert.

In this procedure, the computer program allows you to quickly compute a pressure flow "rating curve" for a pipe culvert. A rating curve is simply a table or curve which relates the flow rates to energy losses. You must first describe the pipe culvert. Then, as you insert flow rates, the program quickly computes the head losses through the culvert, and other information about flow. You may specify as many flow rates as you like.

3.2 REQUIRED INPUT DATA FOR PRESSURE FLOW PROCEDURE

3.2.1 Culvert Diameter

The inside diameter of the culvert opening is important not only in determining the total flow area of the culvert, but also in determining whether the headwater and tailwater elevations are adequate to submerge the inlet or outlet of the culvert.

3.2.2 Mannings Roughness Coefficient

This program uses Manning's Equation to compute friction losses in the culvert barrel. The roughness of the channel is represented by Manning's Rougnness Coefficient, commonly called the "n-value". Suggested values for Manning's n-value are listed in Appendix B of this manual, and in many hydraulics reference books.

Please refer to Section 2.2.4 of this manual for comments about the appropriate choice of n-value and other coefficients.

3.2.3 Entrance Loss Coefficient

The Entrance Loss Coefficient is used to determine the amount of head loss which occurs at the entrance to the culvert. A higher value for the coefficient gives a higher head loss.

Appropriate values for the entrance loss coefficient range from 0.2 to about 0.8 for pipe culverts. For a sharp-edged culvert entrance with no rounding, 0.5 is recommended. For a well-rounded entrance, 0.2 is appropriate. An example of a fairly well-rounded entrance is the socket end of a concrete pipe section.

Appendix C of this manual contains a further discussion of the entrance loss coefficient, and presents a list of values for different types of culvert entrances.

3.2.4 Culvert Length

The culvert length should be measured in feet, along the center-line of the culvert.

3.2.5 Channel Flow Velocity Downstream

In analyzing flow through culverts, it is common to assume that the kinetic energy of the water flowing through the culvert is lost when the water exits the culvert and enters a "still pool" of water on the downstream side of the culvert. This "exit loss" would then equal the "velocity head" of the flow in the culvert.

Often, however, the culvert is located in a channel in which the flow continues downstream of the culvert without ever being detained in a "still pool". In such cases, the velocity head in the culvert may not be completely lost. For this reason, this program allows you to enter a value for the downstream channel velocity. The program then considers the downstream flow velocity in computing the exit loss of the culvert, by the method described in Section 2.3.3.4.1 of this manual.

3.2.6 Flow Rates

After you have inserted all of the input data values which describe the size and condition of the culvert, the program allows you to begin entering flow rates. As you enter each flow rate and press the return key, the program quickly computes the head loss and other details about the flow through the culvert.

You may enter as many flow rates as you like. They may be of any reasonable value (zero or positive). If you enter an excessively large flow rate, the program may not be able to compute and propertly display the corresponding head loss.

When you are ready to stop entering flow rates, you may press the Esc key.

3.3 DESCRIPTION OF RESULTS OF PRESSURE FLOW PROCEDURE

3.3.1 Head Loss

The Head Loss is measured in feet, and represents the total energy loss of flow through the culvert. The head loss is computed for each flow rate using the following formula:

HeadLoss = Friction Loss + Entrance Loss + Exit Loss

The friction loss in the culvert is computed using Manning's formula, as described in Section 2.3.3.2 of this manual.

The entrance loss is computed as described in Section 2.3.3.3 and Appendix C of this manual.

The Exit Loss for pressure flow conditions is computed by the formula given in Section 2.3.3.4.1 of this manual.

3.3.2 Velocity

The flow velocity in the culvert is computed as simply the flow rate divided by the cross-sectional area of the flow. Since the culvert flows full under pressure flow conditions, the flow area equals the cross-sectional area of the culvert opening.

3.3.3 Froude Number

Froude Number is the ratio of the inertial forces to the gravitational forces in a flowing fluid. It is computed as described in Section 2.3.5 of this manual.

3.3.4 Velocity Head

The velocity head represents the level of kinetic energy. The velocity head is used to estimate the culvert entrance and exit losses, and is computed using the formula stated in Section 2.3.6 of this manual.

3.4 EXAMPLE OF PRESSURE FLOW PROCEDURE

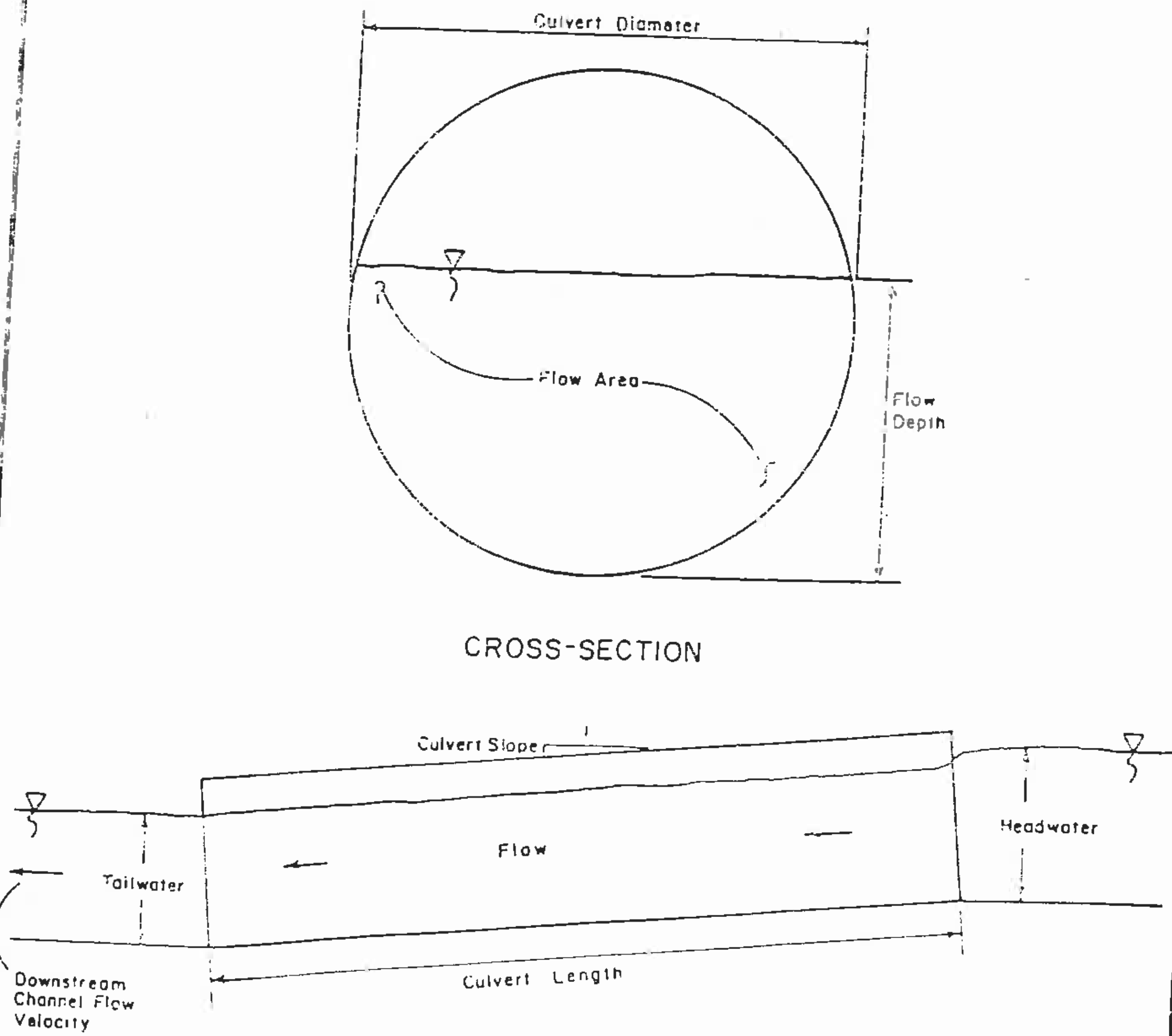
PIPE CULVERT ANALYSIS
PRESSURE FLOW ANALYSIS

Culvert Diameter (feet)	3.5
Manning's Roughness Coefficient (n-value)	.013
Entrance Loss Coefficient of Culvert Opening	.5
Culvert Length (feet)	150
Channel Flow Velocity Downstream (feet per second)	3

*** RESULTS ***

Flow Rate (cfs)	Head Loss (ft)	Velocity (fps)	Froude Number	Velocity Head (ft)
0.00	0.00	0.00	0.000	0.00
10.00	0.02	1.04	0.098	0.02
20.00	0.09	2.08	0.196	0.07
30.00	0.21	3.12	0.294	0.15
40.00	0.39	4.16	0.392	0.27
50.00	0.66	5.20	0.490	0.42
60.00	1.00	6.24	0.587	0.60
70.00	1.42	7.28	0.685	0.82
80.00	1.92	8.32	0.783	1.07
90.00	2.51	9.35	0.881	1.36
100.00	3.17	10.39	0.979	1.68
110.00	3.91	11.43	1.077	2.03
120.00	4.74	12.47	1.175	2.42

Enter Flow Rate, or Press the Esc Key to End



CROSS-SECTION

PROFILE

PIPE CULVERT	DODSON & ASSOCIATES, INC. HYDROLOGISTS AND CIVIL ENGINEERS		
	JOB NO.	DATE APRIL 85	EXHIBIT 1

PURPOSE OF THE ENTRANCE LOSS COEFFICIENT

The entrance loss coefficient is used to estimate the amount of energy lost as flow enters the culvert from upstream. Entrance losses are computed as a fraction of the "velocity head" or kinetic energy of flow in the culvert. The velocity head in the culvert is computed as:

$$\text{Velocity Head} = V^2/(2g)$$

in which:

- V = flow velocity in the culvert (fps)
- g = acceleration due to gravity (32.2 feet/second/second)

The velocity head is multiplied by the entrance loss coefficient to estimate the amount of energy loss at the culvert entrance. As shown in the following table, entrance losses can vary from about 0.1 to about 0.8 of the velocity head for pipe culverts.

The source of the information in the following table is "Street and Highway Drainage", Institute of Transportation and Traffic Engineering, University of California at Berkeley, 1969.

VALUES OF ENTRANCE LOSS COEFFICIENT

TYPE OF STRUCTURE AND DESIGN OF ENTRANCE	COEFFICIENT
Concrete Pipe Projecting from Fill (no headwall):	
Socket end of pipe	0.20
Square cut end of pipe	0.50
Concrete Pipe with Headwall or headwall and wingwalls:	
Socket end of pipe	0.10
Square cut end of pipe	0.50
Rounded entrance, with rounding radius = 1/12 of diameter	0.10
Corrugated Metal Pipe:	
Projecting from fill (no headwall)	0.80
With Headwall or headwall and wingwalls, square edge	0.50

Applied Hydraulics in Engineering

Henry M. Morris and James M. Wiggert, 1972, the Ronald Press Company, New York. This book is a general text on hydraulics. Chapters 4, 5, and 6 are especially related to open-channel flow.

Civil Engineering Hydraulics

R. E. Featherstone and C. Nalluri, 1982, Granada Publishing Limited, London. This book is fairly theoretical, but with many examples. Chapter 8 applies to open-channel flow.

Design Charts for Open-Channel Flow

1980, U. S. Department of Transportation, Federal Highway Administration, Washington, D.C. This is an excellent reference, containing many charts for computing normal depth and critical depth of flow in open channels. The charts can be cross-checked with the results of this computer program.

Handbook of Hydraulics

Ernest F. Brater and Horace Williams King, 1976, McGraw-Hill, Inc. New York. This book is not a good place to start learning about hydraulics, but we keep coming back to it for information not easily available elsewhere.

Modern Sewer Design

1980, American Iron and Steel Institute, Washington, D.C. This book is an excellent reference on practical hydraulics.

Open Channel Hydraulics

Ven Te Chow, 1959, McGraw-Hill, Inc. New York. This is the classic text on hydraulics.

Water Resources Engineering

Ray K. Linsley and Joseph B. Franzini, 1979, McGraw-Hill, Inc., New York. This is an excellent general text. Chapter 13 relates to open channels.

ATTACHMENT Q

Existing and Proposed Culvert Inventory

Revised 03/26/2010

EXISTING AND PROPOSED PIPE CULVERTS

BLACK MESA/KAYENTA MINES

OBS	CULVERT ID	TOTAL WATERSHED (ac)	CURVE NUMBER	FLOW RATE (cfs)	HEADWATER[2] 10YR -6HR. (ft)	DW/D RATIO	CULVERT DIAMETER (in)	PIPE LENGTH (ft)	PIPE SLOPE (%)	DOWNSTREAM[1] VELOCITY (fps)
1	E0001	25.0	77	1.68	2.00	0.50	48	96	4.2	1.43
2	E0002	25.0	77	1.68	1.01	0.51	24	96	4.2	3.42
3	E0007	6.0	85	5.31	1.12	0.56	24	51	2.6	3.93
4	E0008	3.7	91	4.69	1.09	0.55	24	75	3.8	4.98
5	E0009	288.6	77	49.07	4.28	1.43	36	55	0.0	6.94
6	E0011	32.0	83	24.60	3.03	0.51	(design) 72	230	5.0	9.68
7	E0012	16.2	83	12.45	4.00	0.50	96	176	6.0	5.90
8	E0013	3.3	83	2.54	1.51	0.50	36	110	8.0	4.47
9	E0014	129.8	83	64.83	2.74	0.34	96	250	5.8	8.67
10	E0015	80.6	83	43.32	4.03	0.50	96	200	4.9	8.44
11	E0016	67.0	83	17.78	3.52	0.44	96	100	1.0	5.60
12	E0017	67.0	83	17.78	3.52	0.44	96	100	1.0	5.60
13	E0018	7.4	84	6.11	1.31	0.52	30	91	12.3	7.35
14	E0019	1.2	83	0.92	4.00	0.50	96	98	3.2	2.84
15	E0020	2.8	85	2.48	1.03	0.52	24	67	4.9	4.11
16	E0021	3.0	84	2.48	1.26	0.50	30	112	4.0	3.49
17	E0022	9.9	81	6.54	1.32	0.53	30	120	4.14	5.17
18	E0023	8.3	81	5.48	1.30	0.52	30	120	4.1	6.14
19	E0024	18.9	82	7.32	1.31	0.52	30	120	1.9	5.12
20	E0025	12.9	81	8.52	1.31	0.44	36	130	2.1	5.46
21	E0026	27.2	82	19.41	1.80	0.60	36	110	2.3	6.77
22	E0027	6.5	82	2.56	1.03	0.52	24	210	3.6	3.93
23	E0028	4.1	81	2.71	1.03	0.52	24	50	4.5	3.34
24	E0029	26.9	83	20.68	1.85	0.62	36	135	2.6	6.84
25	E0030	84.3	80	32.57	3.08	1.03	36	150	2.0	3.24
26	E0031	12.0	73	1.76	2.50	0.50	60	125	2.0	2.64
27	E0032	12.0	73	1.76	2.50	0.50	60	125	2.0	2.64
28	E0033	15.9	85	10.19	1.58	0.63	30	380	3.5	6.53
29	E0034	46.7	84	39.55	3.50	1.17	36	460	4.7	5.81
30	E0035	watershed	combined	with	E0034					
31	E0036	45.4	76	19.05	1.79	0.60	36	370	3.0	2.48
32	E0037	66.0	73	10.55	1.48	0.49	36	420	3.7	2.12
33	E0038	14.6	83	5.61	2.01	0.50	54	322	3.2	4.13
34	E0039	136.3	83	73.26	3.11	0.69	54	420	4.0	3.48
35	E0040	6.0	83	4.61	1.09	0.55	24	220	6.7	5.64
36	E0041	36.8	83	28.29	2.15	0.72	36	480	6.7	2.74
37	E0042	11.8	81	5.24	1.52	0.51	36	220	4.5	4.61
38	E0043	5.3	82	3.78	1.06	0.53	24	260	5.3	3.45

EXISTING AND PROPOSED PIPE CULVERTS

BLACK MESA/KAYENTA MINES

OBS	CULVERT ID	TOTAL WATERSHED (ac)	CURVE NUMBER	FLOW RATE (cfs)	HEADWATER[2] 10YR -6HR. (ft)	DW/D RATIO	CULVERT DIAMETER (in)	PIPE LENGTH (ft)	PIPE SLOPE (%)	DOWNSTREAM[1] VELOCITY (fps)
39	E0044	9.5	83	7.30	1.54	0.51	36	220	3.6	4.68
40	E0045	70.2	83	53.97	3.53	0.88	48	640	1.5	9.07
41	E0046	23.7	83	11.40	1.61	0.54	36	120	10.2	4.82
42	E0047	5.7	82	1.26	0.77	0.39	24	80	4.3	4.22
43	E0048	5.7	85	1.26	0.70	0.39	24	80	4.3	4.22
44	E0049	2.0	86	1.89	1.01	0.51	24	58	0.5	4.11
45	E0050	15.2	90	18.30	2.08	0.69	36	314	1.5	5.30
46	E0051	5.7	89	6.48	1.17	0.59	24	260	1.9	5.34
47	E0052	23.2	73	6.81	1.54	0.51	36	180	3.4	6.08
48	E0053	16.9	73	4.96	1.10	0.55	24	140	1.6	3.70
49	E0054	10.1	80	3.08	1.04	0.52	24	50	4.4	8.00
50	E0055	10.1	80	3.08	1.04	0.52	24	100	2.5	8.00
51	E0057	37.4	73	10.97	1.49	0.75	36	150	5.0	4.11
52	E0058	68.4	73	20.06	1.83	0.61	36	100	5.4	6.35
53	E0059	89.6	73	13.43	2.05	0.51	48	130	3.1	6.58
54	E0060	7.1	73	2.08	1.02	0.51	24	70	6.4	3.35
55	E0061	60.8	75	13.33	2.05	0.51	48	150	4.9	5.08
56	E0062	5.3	73	1.55	1.01	0.51	24	164	6.0	3.78
57	E0063	17.3	73	2.54	0.77	0.39	24	71	2.3	4.72
58	E0064	17.3	73	2.54	0.77	0.39	24	71	2.3	4.72
59	E0065	38.3	73	11.23	4.00	0.50	96	240	2.5	3.74
60	E0066	89.2	75	17.96	2.30	0.51	54	330	2.5	9.17
61	E0067	32.1	91	40.82	2.85	0.95	36	112	3.0	6.16
62	E0069	14.3	91	18.21	1.77	0.59	36	106	4.0	7.09
63	E0070	14.6	89	16.88	2.76	1.38	24	93	3.0	3.45
64	E0071	7.7	91	9.74	1.39	0.70	24	80	8.9	7.40
65	E0072	16.7	89	18.77	2.11	0.70	36	120	4.7	5.16
66	E0074	6.8	91	8.69	1.31	0.66	24	94	1.0	4.78
67	E0076	22402.4	80	754.60	17.16	2.15	96	366	0.9	6.53
68	E0077	22402.4	80	754.60	17.16	2.15	96	366	0.9	6.53
69	E0078	22402.4	80	754.60	17.16	2.15	96	366	0.9	6.53
70	E0079	21363.0	80	1385.00	14.01	1.00	168	312	0.8	4.92
71	E0080	21636.0	80	1385.00	14.01	1.00	168	312	0.8	4.92
72	E0081	27165.0	80	315.90	7.87	0.98	96	324	0.6	11.48
73	E0082	27165.0	80	315.90	7.87	0.98	96	324	0.6	11.48
74	E0083	27165.0	80	315.90	7.87	0.98	96	324	0.6	11.48
75	E0084	27165.0	80	315.90	7.87	0.98	96	324	0.6	11.48
76	E0085	27165.0	80	315.90	7.87	0.98	96	324	0.6	11.48

EXISTING AND PROPOSED PIPE CULVERTS

BLACK MESA/KAYENTA MINES

OBS	CULVER ID	TOTAL WATERSHED (ac)	CURVE NUMBER	FLOW[1] RATE (cfs)	HEADWATER[2] 10YR-6HR (ft)	DW/D RATIO	CULVERT DIAMETER (in)	PIPE LENGTH (ft)	PIPE SLOPE (%)	DOWNSTREAM[1] VELOCITY (fps)
77	E0086	42323.7	81	752.00	30.00	4.62	78	262	2.0	6.30
78	E0087	42323.7	81	1039.00	30.00	4.00	90	262	2.0	6.03
79	E0088	6.4	91	8.14	1.55	0.52	36	250	3.8	5.34
80	E0089	20.9	76	5.23	1.52	0.51	36	460	1.0	2.95
81	E0090	79.9	75	14.85	2.06	0.52	48	300	2.5	3.85
82	E0091	1649.0	79	431.00	6.35	0.71	108	540	2.1	9.00
83	E0092	7.1	78	3.63	1.05	0.53	24	240	6.0	2.43
84	E0093	12.2	90	14.69	1.67	0.56	36	334	6.0	3.72
85	E0094	11.8	91	12.00	1.59	0.80	24	200	1.5	4.14
86	E0095	17.2	91	21.87	1.89	0.63	36	220	6.0	4.68
87	E0096	283.9	91	243.36	8.71	1.74	60	380	3.5	8.03
88	E0097	16.4	91	20.86	1.85	0.62	36	160	4.0	4.84
89	E0098	29.6	91	29.91	2.22	0.74	36	240	6.0	4.77
90	E0099	75.0	90	71.08	3.95	1.13	42	325	5.0	7.19
91	E0100	340.2	84	152.01	4.92	0.98	60	290	3.0	7.02
92	E0101	29.8	84	24.60	1.99	0.66	36	170	3.0	5.70
93	E0102	111.2	85	62.81	3.47	0.99	42	290	3.0	5.69
94	E0103	4.2	91	5.34	1.22	1.04	14	127	4.6	3.84
95	E0106	35.0	85	21.30	1.87	0.62	36	100	3.3	6.05
96	E0107	81.8	83	43.97	3.06	1.05	36	126	4.3	7.12
97	E0108	1.4	83	1.08	1.00	0.50	24	71	1.1	1.28
98	E0109	7.6	81	5.02	1.52	0.51	36	520	5.0	5.13
99	E0110	8.2	81	3.64	1.76	0.50	42	220	2.7	3.01
100	E0111	6.0	73	0.88	1.00	0.50	24	160	2.0	2.68
101	E0116	2.0	91	2.54	1.03	0.69	18	75	2.9	3.13
102	E0117	8.8	73	2.58	1.03	0.52	24	150	8.0	3.74
103	E0119	214.1	82	88.29	10.82	3.61	36	96	2.5	4.01
104	E0120	29.8	83	16.02	2.05	1.03	24	58	2.0	.08
105	E0122	43.3	87	31.20	2.98	0.99	36	320	4.7	4.52
106	E0125	89.6	81	6.34	2.58	1.29	24	60	3.0	3.64
107	E0127	29.7	79	10.14	1.42	0.71	24	160	2.0	1.10
108	E0128	33.1	82	23.62	1.95	0.97	24	160	2.0	1.19
109	E0143	41.0	83	16.09	2.64	1.32	24	160	2.0	3.79
110	E0144	59.6	82	18.38	2.38	1.19	24	140	2.0	4.00
111	E0146	46.7	84	38.56	2.70	0.90	36	160	2.0	9.20
112	P0147	5.3	83	4.06	1.03	0.52	24	140	2.0	2.71
113	P0148	350.6	83	127.68	6.17	1.54	48	160	3.0	5.54

EXISTING AND PROPOSED PIPE CULVERTS

BLACK MESA/KAYENTA MINES

OBS	CULVER ID	TOTAL WATERSHED (ac)	CURVE NUMBER	FLOW[1] RATE (cfs)	HEADWATER[2] 10YR-6HR (ft)	DW/D RATIO	CULVERT DIAMETER (in)	PIPE LENGTH (ft)	PIPE SLOPE (%)	DOWNSTREAM[1] VELOCITY (fps)
114	E0150	26.5	91	33.70	2.42	0.80	48	120	1.0	6.96
115	P0152	42323.7	81	1946.00	30.00	3.00	120	260	0.5	6.30
116	P0153	42323.7	81	1946.00	30.00	3.00	120	260	0.5	6.30
117	E0159	24.4	81	5.49	1.12	0.69	24	120	3.6	3.49
118	E0160	46.9	84	24.70	1.99	0.56	24	40	6.8	5.58
119	E0172	4.8	91	4.81	1.09	0.55	24	80	3.4	1.10
120	E0173	6.5	91	8.23	2.07	1.38	18	100	2.0	3.05
121	E0180	2.8	93	3.95	1.01	0.51	24	120	0.5	1.48
122	E0181	3.6	93	4.74	1.23	0.62	24	110	0.5	1.55
123	E0182	9.0	93	9.21	1.35	0.68	24	180	3.0	3.58
124	E0183	4.9	93	5.78	1.14	0.57	24	180	3.0	3.17
125	E0201	177.4	78	43.56	2.69	0.54	60	380	1.1	7.82
126	E0203	26.7	81	10.74	1.50	0.50	36	120	2.0	2.31
127	E0204	31.7	81	20.68	2.25	0.75	36	60	3.0	5.80
128	E0205	188.3	81	58.71	5.43	1.81	36	40	3.0	7.79
129	E0207	4.9	80	2.96	0.74	0.25	36	100	2.0	3.40
130	E0208	24.9	88	22.02	2.35	0.78	36	120	3.0	7.51
131	E0209	24.7	87	18.41	2.98	1.49	24	80	4.0	4.41
132	E0215	20.3	82	14.34	2.37	1.19	24	110	1.4	3.98
133	E0216	2.5	91	2.87	0.84	0.42	24	140	4.1	3.64
134	E0217	4.4	84	2.09	0.70	0.35	24	70	1.1	2.42
135	E0222	41.6	64	0.92	0.44	0.22	24	30	6.9	2.38
136	E0228	192.6	81	59.64	5.55	1.85	36	135	3.0	7.61
137	E0229	3.5	89	3.91	1.00	0.50	24	40	2.0	2.20
138	E0237	42.8	76	17.64	2.84	1.42	24	40	2.0	2.20
139	E0238	16.0	78	8.07	1.58	0.79	24	30	4.0	9.86
140	E0239	20.9	81	13.61	2.28	1.14	24	30	2.0	3.23
141	E0240	30.3	80	18.20	2.07	0.69	36	40	2.0	5.30
142	E0241	588.6	81	137.78	8.81	2.20	48	60	2.5	8.04

EXISTING AND PROPOSED PIPE CULVERTS

BLACK MESA/KAYENTA MINES

OBS	CULVER ID	TOTAL WATERSHED (ac)	CURVE NUMBER	FLOW[1] RATE (cfs)	HEADWATER[2] 10YR-6HR (ft)	DW/D RATIO	CULVERT DIAMETER (in)	PIPE LENGTH (ft)	PIPE SLOPE (%)	DOWNSTREAM[2] VELOCITY (fps)
143	E0244	2.0	89	2.21	0.72	0.36	24	100	2.0	6.04
144	E0246	8.1	89	9.11	DROP INLET	N/A	36	300	2.0	3.32
145	E0247	9.8	90	11.67	2.03	1.02	24	100	2.0	8.97
146	E0248	2.7	91	3.44	0.93	0.47	24	50	2.0	6.25
147	E0259	538.8	78	99.92	4.07	0.68	72	140	2.0	4.61
148	E0266	2340.5	78	795.60	5.67	0.63	108	280	3.0	6.93
149	E0270	404.2	81	29.82	2.89	0.96	36	160	2.0	5.54
150	E0271	404.2	81	29.82	2.89	0.96	36	160	2.0	5.54
151	E0272	404.2	81	29.82	2.89	0.96	36	160	2.0	5.54
152	E0273	16.2	81	10.54	1.89	0.95	24	42	2.0	4.93
153	E0274	564.4	81	20.15	4.72	2.51	24	160	2.0	6.58
154	P0275	564.4	81	80.60	4.72	1.26	48	160	2.0	6.58
155	E0280	344.5	80	121.98	5.30	1.06	60	80	1.0	8.08
156	E0292	0.6	91	0.77	0.41	0.20	24	60	3.0	3.20
157	E0293	1.4	91	1.77	0.63	0.31	24	80	5.0	4.90
158	E0294	25.1	77	7.96	1.26	0.42	36	80	2.0	5.26
159	E0300	112.0	89	104.27	4.73	0.95	60	20	3.0	10.01
160	E0301	5.0	81	3.21	0.89	0.45	24	20	2.0	2.14
161	E0302	5.0	81	2.58	0.79	0.40	24	20	2.0	2.07
162	E0304	19.6	81	8.99	1.70	0.85	24	100	2.0	2.28
163	E0305	0.3	81	0.19	0.25	0.25	12	55	2.0	0.46
164	E0306	1.5	91	1.68	0.89	0.89	12	60	1.0	5.93
165	E0309	27.1	91	7.86	1.54	0.77	24	40	10.3	9.77
166	E0310	6.4	92	8.46	1.63	0.82	24	50	7.6	8.92
167	E0311	4.9	91	6.12	1.09	0.36	36	100	2.0	4.87
168	E0312	4.8	91	6.01	1.08	0.36	36	100	1.8	4.66

EXISTING AND PROPOSED PIPE CULVERTS
BLACK MESA/KAYENTA MINES

OBS	CULVER ID	TOTAL WATERSHED (ac)	CURVE NUMBER	FLOW RATE (cfs)	HEADWATER[2] 10YR-6HR (ft)	HW/D RATIO	CULVERT DIAMETER (in)	PIPE LENGTH (ft)	PIPE SLOPE (%)	DOWNSTREAM[1] VELOCITY (fps)
169	E0314	12.5	91	14.02	2.33	1.17	24	60	3.0	7.21
170	E0315	6.1	91	6.91	1.16	0.39	36	40	2.0	5.05
171	E0319	160.9	86	47.0	5.0	1.7	36	160	2.5	6.1
172	E0322	160.9	86	47.0	5.0	1.7	36	160	2.5	6.1
173	E0325	56.4	81	28.0	5.0	2.5	24	100	2.5	4.98
174	E0328	5.5	86	5.3	5.0	2.5	24	160	2.5	1.88
175	E0329	14.2	86	13.5	5.0	2.5	24	160	2.5	2.92
176	E0330	28.8	86	21.8	5.0	2.5	24	160	2.5	2.82
177	E0331	218.0	86	68.6	6.0	2.0	36	160	2.5	3.79
178	E0332	0.51	91	0.65	.9	1.8	6	36	1.0	1.44
179	E0333	0.74	91	0.94	.8	.8	12	105	2.0	1.59
180	E0334	0.14	91	0.18	0.5	0.5	12	14	1.0	0.99
181	E0340	9.40	86	8.96	1.41	0.56	18	60	5.0	7.68
182	E0400	3.11	91	2.52	1.57	1.35	(design) 14	50	1.1	3.46
183	E0401	792	86	402.6	14.39	2.4	72	270	2.0	7.65
184	P0402	22410.6	80	754.60	17.16	1.90	108	430	0.9	6.53
185	P0403	22410.6	80	754.60	13.2	1.32	120	430	0.9	5.94
186	P0404	22410.6	80	754.60	17.16	1.90	108	430	0.9	6.53
187	P0405	34.9	81	12.5	2.0	0.8	30	250	2.0	2.60
188	P0406	286.5	84	112.3	4.5	0.75	72	440	2.0	5.63
189	P0407	14407.7	82	347.9	8.4	1.05	96	430	1.0	5.66
190	P0408	14407.7	82	347.9	8.4	1.05	96	430	1.0	5.66
191	P0409	14407.7	82	347.9	8.4	1.05	96	430	1.0	5.66
192	P0410	14407.7	82	347.9	8.4	1.05	96	430	1.0	5.66
193	P0411	15.8	91	17.2	3.0	1.5	24	215	1.5	3.8

Note: [1] When the Downstream Velocity is greater than 6.0 ft/sec, adequate downstream erosion-resistant channel lining will be installed where competent bedrock does not exist.

[2] Design Headwater Depth (DHW) = Headwater depth plus one foot for freeboard

Culvert ID#: EXXXX = Existing Culvert

PXXXX = Proposed Culvert

Revised 06/10/2005

PEABODY WESTERN

Peabody Western Coal Company

RECEIVED
MAY 22 2000
OFFICE OF SURFACE MINING
ALBUQUERQUE FIELD OFFICE

May 19, 2000

Mr. Jerry Gavette
Office of Surface Mining
Reclamation and Enforcement
1999 Broadway, Suite 3320
Denver, CO 80202-5733

Re: **Kayenta Mine / Permit AZ-0001D / Culvert Removal Minor Field Permit Revision**

Dear Mr. Gavette:

Pursuant to our telephone conversation on May 18,2000, PWCC received approval from Edzel Pugh, OSM Inspector, to remove three culverts (i.e. Culvert #E0303, #E0245 and #E0249) in the permit document and from their field location.

Enclosed are eleven copies of the minor field permit revision submittal, and the notarized verification statement. Please insert the minor field permit revision submittal in the AZ-0001D Permit, Volume 7, Chapter 6, at the end of Attachment Q. If you have any questions, please feel free to contact Gary Wendt or me.

Sincerely,

Jim Schlenvogt

James G. Schlenvogt, P.E.
Engineering and Reclamation Manager
Kayenta Mine

Enc.

C: B. Dunfee (PHCI)
R. Lehn (PWCC-BM)
E. Pugh (OSM – AFO) ✓
G. Wendt (PWCC-KM)

VERIFICATION

I verify under oath that the information contained in this application for a permit; revision; renewal; or transfer, sales or assignments of permit rights is true and correct to the best of my information and belief.

Signature of Responsible Official *Gary W. Wendt*

Title Supervisor, Environmental Program Date May 19, 2000

SUBSCRIBED AND SWORN TO BEFORE ME BY *Gary W. Wendt*

This *19th* Day of *May* 20*00*

NOTARY PUBLIC *Jean M. Schlenvogt*

MY COMMISSION EXPIRES ______

OFFICIAL SEAL
JEAN M. SCHLENVOGT
NOTARY PUBLIC - STATE OF ARIZONA
COCONINO COUNTY
My commission expires March 31, 2004.

Field Approval of a Permit Revision — U.S. Office of Surface Mining

Permit ID: AZ-0001D — Approval Date: 05/18/2000

Permittee: Peabody Western Coal Company - Kayenta Mine

Description of Permit Revision: Approval to remove Culverts: #E0303, #E0245, #E0249 around the J-28 Facilities Area.

Based on a field review of the proposed revision described above, I have made the findings listed on the back of this form and hereby approve this permit revision:

(✓) without conditions–this revision approval form is incorporated into the approved permit application for the permit identified above.

( ) with the following condition: The permittee shall submit to OSM within days after this permit revision approval, the required number of copies of the revised or added pages, maps, etc. needed to update the approved permit application with this approved revision, along with clear instructions for updating the permit application.

Edzel R. Pugh
Inspector

179
Inspector ID No.

Receipt by Permittee:

James Schlenvogt
Printed Name of Permittee's Representative

Mgr, Engineering & Reclation
Title of Permittee's Representative

James Schlenvogt
Signature of Permittee's Representative

May 18, 2000
Date of Service

Findings for Field Approval of a Permit Revision

1. Reclamation as required by the Surface Mining Control and Reclamation Act of 1977 (SMCRA) and the Indian Lands Program (30 CFR Chapter VII, Subchapter E) can be accomplished under the reclamation plan contained in the permit application, as revised by this permit revision.

2. The revision described herein is not significant and complies with all requirements of the Surface Mining Control and Reclamation Act and

   the Indian Lands Program at 30 CFR Chapter VII, Subchapter E.

3. No other requirements under 30 CFR 773.15(c) are applicable.

4. The proposed revision does not indicate that the applicant has added a new partner, officer, principal, principal shareholder, director, or person with a similar ownership or control function required to be listed in the application pursuant to 30 CFR 778.13(c).

5. This revision approval is for a minor revision to the permit where the environmental impacts of the permit approval have been adequately analyzed in:

   the 05/17/90 Environmental Assessment of the approval of the Kayenta Mine permit application (EIS).

   The actions proposed in the permit revision do not change the environmental impacts. The discussion of environmental impacts in the document identified above remain current and adequate for OSM to take action on this proposed permit revision because no additional environmental impacts would occur beyond those identified in the document identified above.

OSM Office Addresses and Contacts

Office of Surface Mining
505 Marquette Ave. NW
Suite 1200
Albuquerque, NM 87102

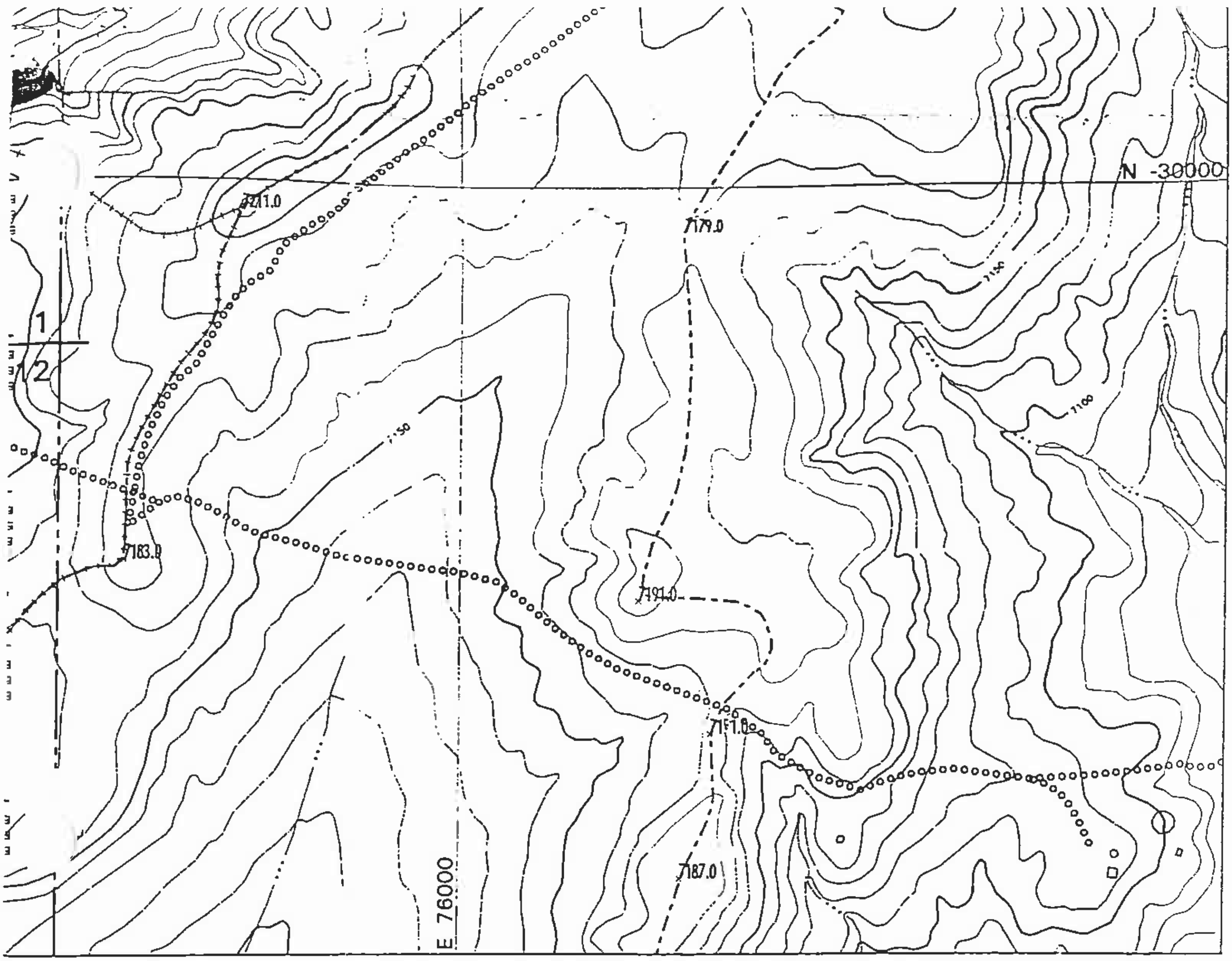
Edzel R Pugh
Field Coordinator

505-248-5088
Telephone

Office of Surface Mining
1999 Broadway
Suite 3320
Denver, CO 80209

Jerry Gavette
Permit Coordinator

303-844-1496
Telephone



J21-A1

REVISIONS		
CHK'D	DATE	DESCRIPTION
JGS	3/1/95	5YR Permit Ren
JGS	10-18-95	E Q SITES
JGS	6-26-96	CULVERT REV
JGS	12-2-96	5 YR. MINE PLAN REV.
JGS	10-15-97	OSM RESPONSE

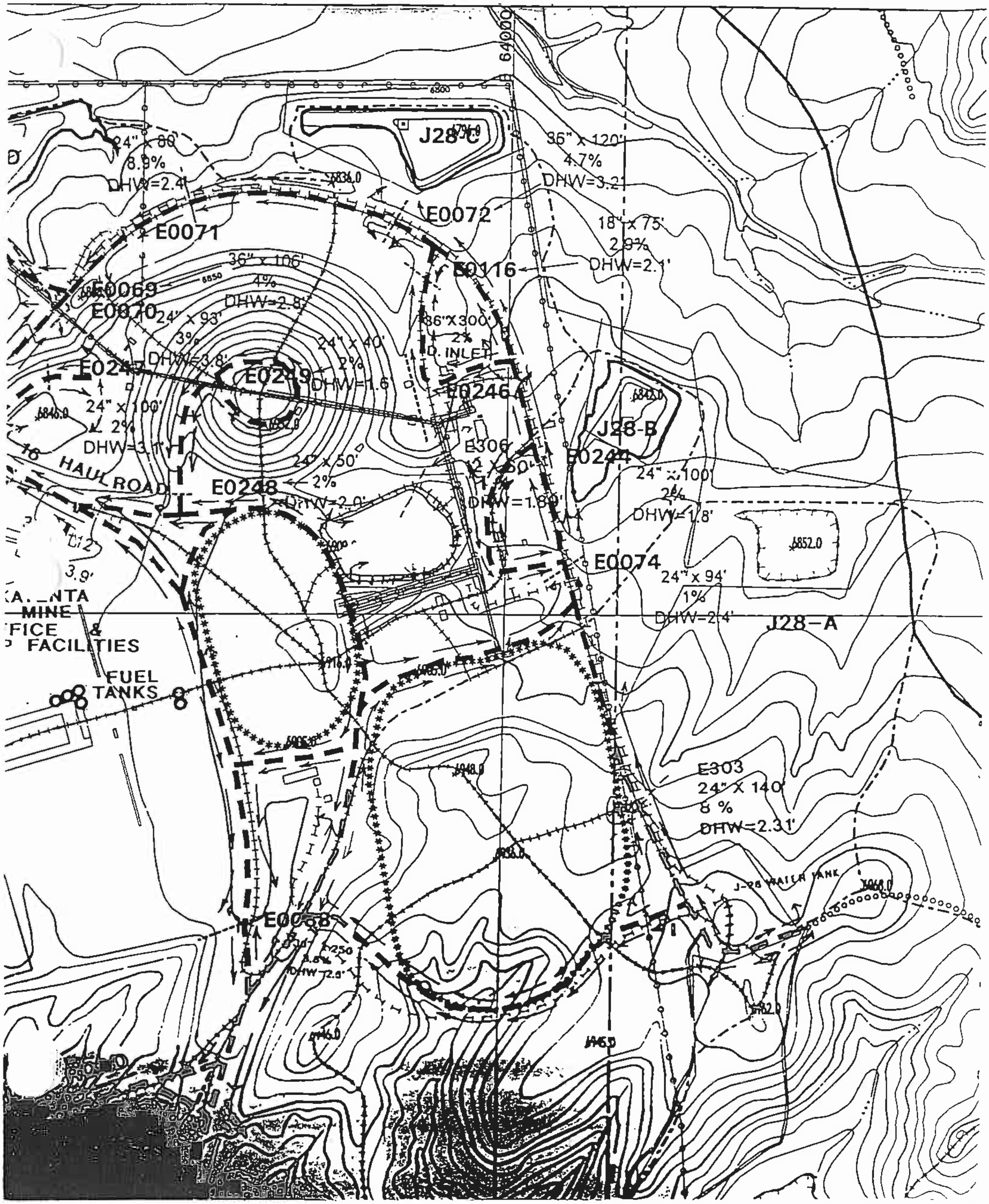
Drawing No. 85400

Drainage Area and Facilities Map
Sheet No. N-9

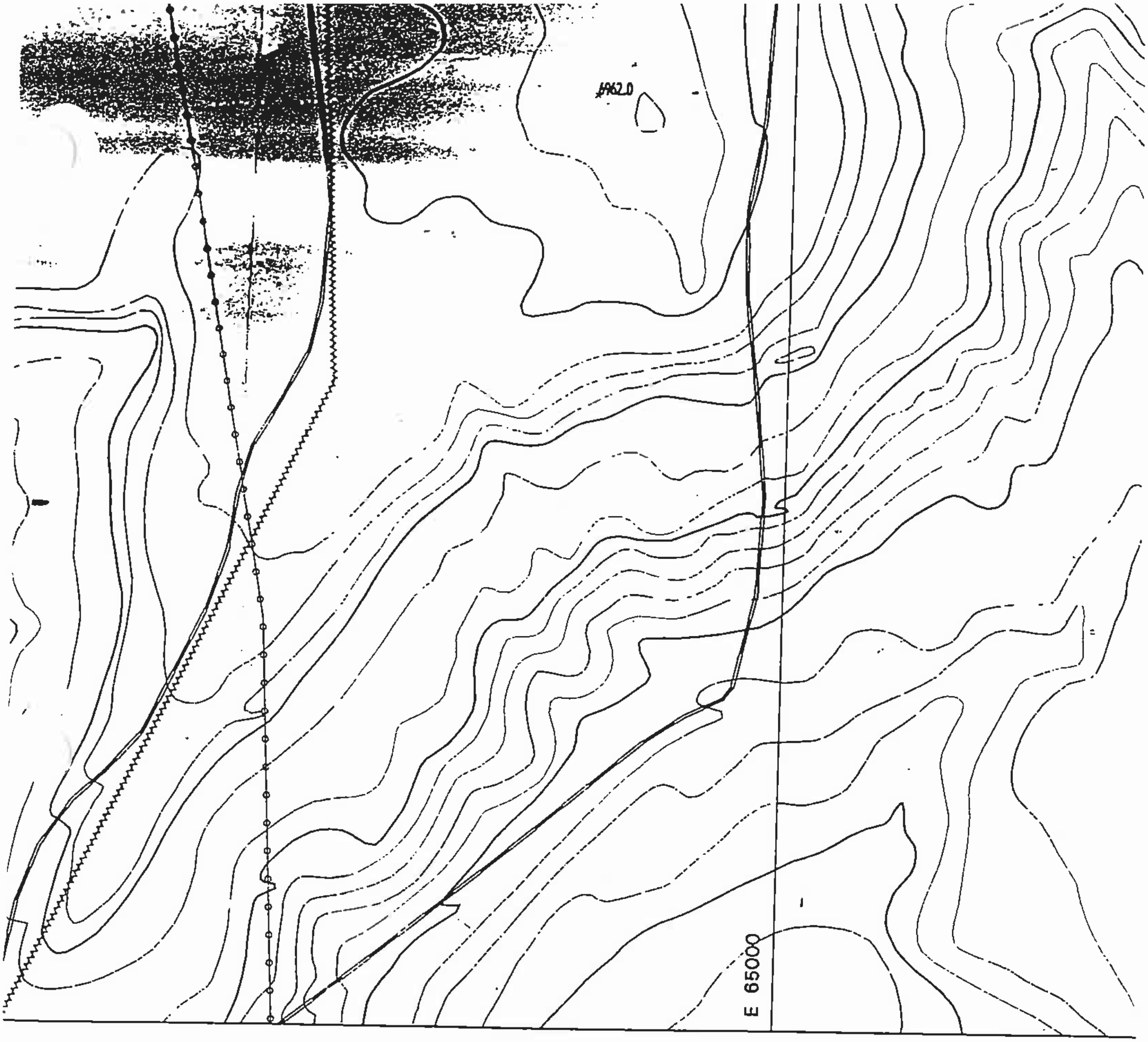
Black Mesa Complex

P.W.C.C. 1300 S. Yale Flagstaff, AZ 86001

DESIGNED BY:	P.W.C.C.	SCALE:	1 in. = 400 ft.
DRAWN BY:	P.W.C.C.	DRAWING DATE:	02/23/95
CHECKED BY:	J. Schlenvogt	PHOTO DATE:	11/19/84
CONTOUR INTERVAL: 10			



J28-C
24" x 80'
8.9%
DHW=2.4'
36" x 120'
4.7%
DHW=3.2'
E0072
E0071
18" x 75'
2.9%
DHW=2.1'
36" x 106'
4%
DHW=2.8'
E0116
E0069
E0070
24" x 93'
3%
DHW=3.8'
36"X300'
2%
D. INLET
24" X 40'
2%
DHW=1.6
E0247
E0249
E0246
24" x 100'
2%
DHW=3.1'
J28-B
E306
E0244
HAUL ROAD
24" x 50'
2%
DHW=2.0'
E0248
24" x 100'
2%
DHW=1.8'
DHW=1.80'
E0074
24" x 94'
1%
DHW=2.4'
J28-A
MINE
FACILITIES
FUEL
TANKS
E303
24" X 140'
8 %
DHW=2.31'
J-28 WATER TANK
E0068



(Sheet 6A)

REVISIONS

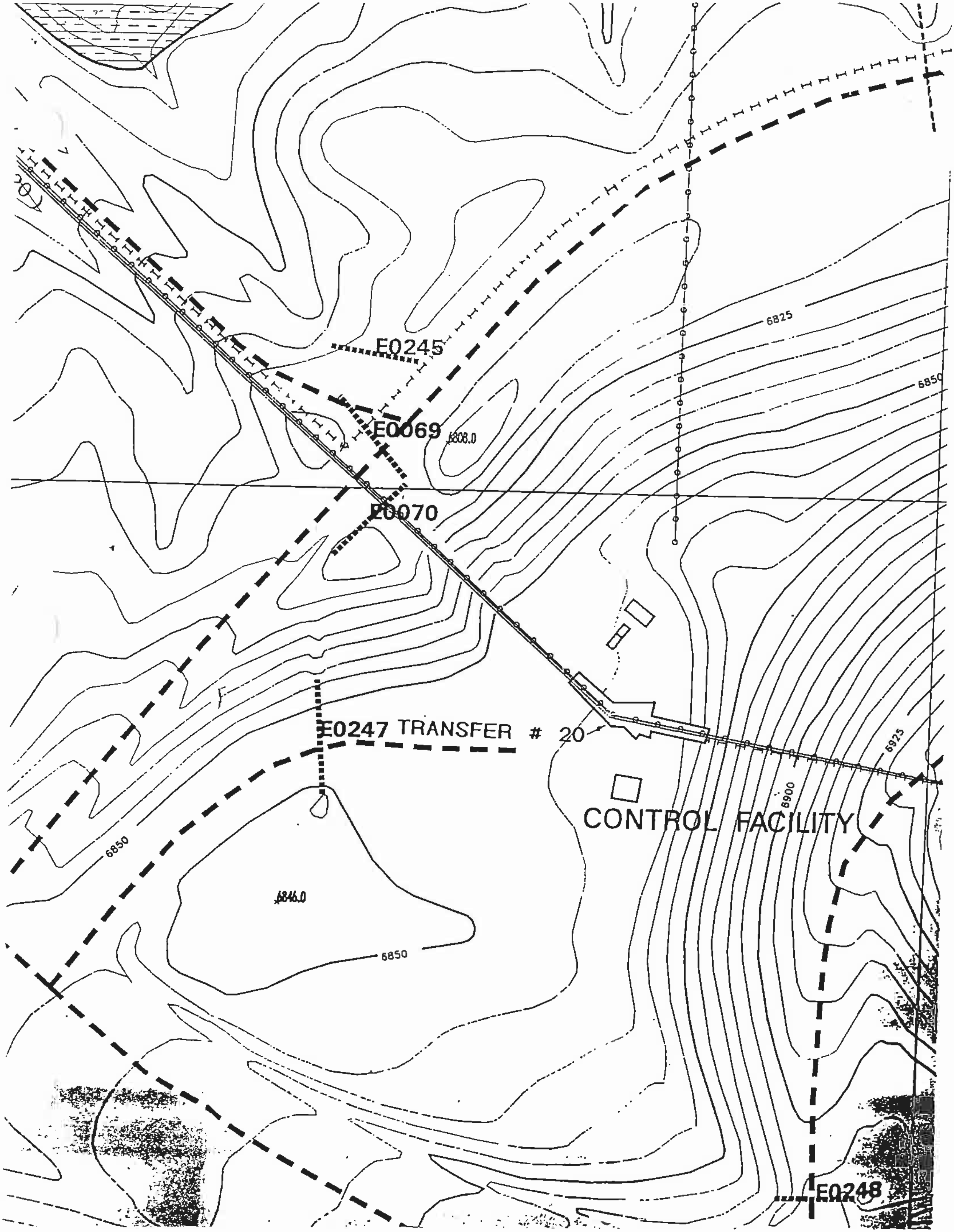
CHK'D	DATE	DESCRIPTION
J.G.S.	3 / 1 / 95	5 Yr. Permit rev.
JGS	6-26-96	CULVERT RIV.

Kayenta Mine Facilities Map
Drawing No. 85480

Black Mesa Complex

Peabody Western 1300 S. Yale Flagstaff, AZ 86001

DESIGNED BY:	J. Schlenvogt	SCALE:	1 in. = 100 ft.
DRAWN BY:	S. Walker	DRAWING DATE:	2/15/95
CHECKED BY:	J. Schlenvogt	PHOTO DATE:	7/1/92
CONTOUR INTERVAL: 20			



E0245
E0069
6808.0
E0070
6825
6850
E0247 TRANSFER # 20
CONTROL FACILITY
6900
6925
6850
6846.0
6850
E0248

EXISTING AND PRO[illegible]ED PIPE CULVERTS
BLACK MESA/KAYENTA MINES

OBS	CULVER ID	TOTAL WATERSHED (ac)	CURVE NUMBER	FLOW RATE (cfs)	HEADWATER[2] 10YR-6HR (ft)	HW/D RATIO	CULVERT DIAMETER (in)	PIPE LENGTH (ft)	PIPE SLOPE (%)	DOWNSTREAM[1] VELOCITY (fps)
169	E0314	12.5	91	14.02	2.33	1.17	24	60	3.0	7.21
170	E0315	6.1	91	6.91	1.16	0.39	36	40	2.0	5.05
171	E0319	160.9	86	47.0	5.0	1.7	36	160	2.5	6.1
172	E0322	160.9	86	47.0	5.0	1.7	36	160	2.5	6.1
173	E0328	5.5	86	5.3	5.0	2.5	24	160	2.5	1.88
174	E0329	14.2	86	13.5	5.0	2.5	24	160	2.5	2.92
175	E0330	28.8	86	21.8	5.0	2.5	24	160	2.5	2.82
176	E0331	218.0	86	68.6	6.0	2.0	36	160	2.5	3.79
177	E0332	0.51	91	0.65	.9	1.8	6	36	1.0	1.44
178	E0333	0.74	91	0.94	.8	.8	12	105	2.0	1.59
179	E0334	0.14	91	0.18	0.5	0.5	12	14	1.0	0.99
180	E0340	9.40	86	8.96	1.41	0.56	18	60	5.0	7.68
							(design)			
181	E0400	3.11	91	2.52	1.57	1.35	14	50	1.1	3.46
182	E0401	792	86	402.6	14.39	2.4	72	270	2.0	7.65
183	P0402	22410.6	80	754.60	17.16	1.90	108	430	0.9	6.53
184	P0403	22410.6	80	754.60	13.2	1.32	120	430	0.9	5.94
185	P0404	22410.6	80	754.60	17.16	1.90	108	430	0.9	6.53
186	P0405	34.9	81	12.5	2.0	0.8	30	250	2.0	2.60
187	P0406	286.5	84	112.3	4.5	0.75	72	440	2.0	5.63
188	P0407	14407.7	82	347.9	8.4	1.05	96	430	1.0	5.66
189	P0408	14407.7	82	347.9	8.4	1.05	96	430	1.0	5.66
190	P0409	14407.7	82	347.9	8.4	1.05	96	430	1.0	5.66
191	P0410	14407.7	82	347.9	8.4	1.05	96	430	1.0	5.66
192	P0411	15.8	91	17.2	3.0	1.5	24	215	1.5	3.8
193	P0412	326.7	86	120.65	12.0	3.4	42	270	3.5	9.6

Note: [1] When the Downstream Velocity is greater than 6.0 ft/sec, adequate downstream erosion-resistant channel lining will be installed where competent bedrock does not exist.

[2] Design Headwater Depth (DHW) = Headwater depth plus one foot for freeboard

Culvert ID#: EXXXX = Existing Culvert

PXXXX = Proposed Culvert

J19/J21 DRAGLINE REPAIR ENTRANCE ROAD CULVERT DESIGN

Gary Altsisi, P.E.

Peabody Western Coal Co.
P.O. Box 650
Kayenta, AZ 86033

Phone: 928-677-3201

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.600 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	326.700	326.700	120.65	14.31

Structure Detail:

Structure #1 (Null)

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	326.700	0.891	0.000	0.000	86.000	F	120.65	14.309
	Σ	**326.700**						**120.65**	**14.309**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	3.01	167.00	5,550.01	1.730	0.891
#1	**1**	**Time of Concentration:**					**0.891**

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
250.00	3.50	0.0240	12.00	0.50	0.90

Culvert Results:

Minimum pipe diameter: 1 - 42 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 120.65 cfs

Maximum Headwater = 12.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (36 in)	**Discharge (cfs) (42 in)**	Discharge (cfs) (45 in)
1.20	8.26	**9.64**	10.32
2.40	23.36	**27.25**	29.20
3.60	42.58	**50.06**	53.63
4.80	57.14	**72.27**	79.59
6.00	68.05	**89.27**	99.80
7.20	73.09	**103.53**	116.56
8.40	76.30	**110.47**	129.34
9.60	79.35	**115.05**	135.56
10.80	82.34	**119.46**	140.83
12.00	85.18	**123.71**	145.91
13.20	87.95	**127.83**	150.81
14.40	90.63	**131.82**	155.55
15.60	93.23	**135.67**	160.16
16.80	95.77	**139.42**	164.64
18.00	98.23	**143.09**	169.00

ATTACHMENT R

United States Department of the Interior

MINING ENFORCEMENT AND SAFETY ADMINISTRATION
COAL MINE HEALTH AND SAFETY
DISTRICT 9
POST OFFICE BOX 15037
DENVER, COLORADO 80215

March 25, 1977

In Reply Refer To:
EMS:D9-6029

Mr. Roger Dewey
Area Engineer
Peabody Coal Company
P.O. Box 23
Farmington, New Mexico 87401

Re: Kayenta Mine
I.D. No. 02-01195
Kayenta Mine Reservoir
I.D. No. 1211-AZ-9-0001

Dear Mr. Dewey:

The information submitted on August 25, 1976, for the subject site as required by Section 77.216-2(a), 30 CFR 77, has been reviewed and approved by this office.

Since a site visit was not made by our technical specialist, it is assumed that the information submitted is correct and accurate. Should a subsequent inspection of the site reveal a deficiency, additional information may then be required.

Sincerely yours,

John W. Barton
District Manager

American Revolution Bicentennial 1776-1976

GEOTECHNICAL INVESTIGATION REPORT

Dam No. 1 - Kayenta Mine

Navajo County, Arizona

SHB Job No. E76-29A

SERGENT, HAUSKINS & BECKWITH

CONSULTING SOIL AND FOUNDATION ENGINEERS
PHOENIX • ALBUQUERQUE • EL PASO • TUCSON

SERGENT, HAUSKINS & BECKWITH — CONSULTING SOIL AND FOUNDATION ENGINEERS

APPLIED SOIL MECHANICS • ENGINEERING GEOLOGY • MATERIALS ENGINEERING

R. DWAINE SERGENT P.E. · DALE V. BEDENKOP P.E. · JOHN J. MORAN P.E.
JOHN B. HAUSKINS P.E. · ROBERT D. BOOTH P.E. · DONALD G. METZGER GEOL.
GEORGE H. BECKWITH P.E. · BENNY E. McMILLAN P.E. · BUD WOODWARD

August 16, 1976

Peabody Coal Company
P. O. Box 23
117 East Ute Street
Farmington, New Mexico 87401

SHB Job No. E76-29A

Attention: Roger Dewey, P.E.

Re: Dam No. 1
Kayenta Mine
Navajo County, Arizona

Gentlemen,

Our Geotechnical Investigation Report on the referenced project is herewith submitted. Included in this report are the results of subsurface exploration and laboratory analysis, along with a discussion of our engineering analysis and our conclusions and recommendations.

Should any questions arise concerning this report, we would be pleased to discuss them with you.

Respectfully submitted,
Sergent, Hauskins & Beckwith Engineers

By ______________________
Robert W. Crossley, E.I.T.

Reviewed by ______________________
George H. Beckwith, P.E.

GEORGE HENRY BECKWITH
ARIZONA, U.S.A.
8-16-76

Copies: Addressee (4)
Peabody Coal Company
St. Louis, Missouri
Attn: Francis X. Kaiser, Jr., P.E. (1)

REPLY TO 3940 W CLARENDON PHOENIX ARIZONA 85019

PHOENIX (602) 272 6848 · ALBUQUERQUE (505) 345 8606 · EL PASO (915) 591 8188 · TUCSON (602) 884 9333

TABLE OF CONTENTS

REPORT

SHB Job No. E76-29A

1. INTRODUCTION

This report is submitted pursuant to a geotechnical investigation made by this firm of Kayenta Pond, a fresh water retention reservoir, MESA I.D. No. 1211-AZ-9-0001, located at the Peabody Coal Company Kayenta Mine on Black Mesa in Navajo County, Arizona. The general location of the site is shown on Figure 1*.

An objective of this investigation was to evaluate the physical properties of embankment materials and of the soil and rock beneath the embankment in order to analyze the safety of the dam. A second objective was to provide recommendations for any remedial measures which might be necessary to bring the impoundment in full compliance with current "Design Guidelines for Coal Refuse Piles and Water, Sediment or Slurry Impoundments and Impounding Structures" published by the United States Department of the Interior, Mining Enforcement and Safety Administration.

The scope of our investigation was limited to analysis of geotechnical factors affecting dam stability. It is understood that Peabody Coal Company is performing the necessary hydrological analysis.

*Figures and illustrations are presented in Appendix C.

2. PROJECT DESCRIPTION

Details of the project were provided to us by Roger Dewey, P.E., and Reynaldo Armijo, staff engineer, of Peabody Coal Company.

The water retention pond was constructed in 1972 to provide storage of fresh water to be used at Kayenta Mine for dust control, washing, and to be mixed with coal for transport in the coal-slurry pipeline to the Mohave Generating Station in Nevada. The pond, which is fed as needed from two wells through an 8-inch standpipe, has a bottom elevation of 6603 and a maximum crest elevation of about 6618 at its lowest point near the southwest corner of the embankment. Discharge into the pond is through a standpipe near the center. At the time of our investigation, the inside freeboard was about 5 feet.

The surface area of the pond is about 125,000 square feet (2.9 acres) with inside slopes ranging from 3:1 to 4.3:1 (horizontal to vertical). It is estimated that if it was filled to its crest elevation, the pond could contain at most 1,000,000 cubic feet (22.0 acre-feet).

It is understood that the embankment is lined throughout the inside slopes and bottom with a polyvinyl chloride plastic membrane. The commercial product used was water vinyl liner (PVC). Thickness is 0.015 inch on the bottom and 0.020 inch on the slopes. It was furnished by Water Saver Company, Inc. of Denver, Colorado. About 6 inches of soil cover is present over the liner.

The pond is protected on all sides by a chain link fence. There is a light growth of grass on the crest and side slopes.

3. INVESTIGATION

3.1 Subsurface Exploration

The subsurface exploration program, which was planned and executed by this firm in order to provide the necessary geotechnical information, consisted of a total of three exploratory borings. Borings numbered 7, 8 and 9 were drilled using 6 5/8" O.D., 3¼" I.D., hollow stem auger through the dam embankment into the rock which provides the foundation for the embankment. In borings 7 and 8, the drilling was continued until the auger or sampler refused on hard sedimentary rock. Boring 9 was discontinued in weathered sandstone after penetration of 10 feet. Standard penetration testing or open-end drive sampling was performed at intervals of 5 feet or less in these borings.

Results of the field investigation are presented in Appendix A which includes a site plan showing boring locations, logs of the test borings and a brief description of drilling and sampling equipment and procedures. The subsurface exploration was supervised by Robert W. Crossley, staff engineer of this firm, who located the borings, continuously examined and logged the drill cuttings and drive samples, and prepared the boring logs.

3.2 Laboratory Analysis

Grain-size analysis, Atterberg Limits, moisture-density and direct shear tests were performed on selected samples to aid in soil classification and evaluation of engineering properties. Results of these tests are presented in Appendix B along with a brief description of the testing procedures.

3.3 Site Inspection

The site was visited on April 14, 1976, by principal engineer, George H. Beckwith and Robert Crossley of this firm, along with Messrs. Roger Dewey, Francis Kaiser and Reynaldo Armijo of Peabody Coal Company. The purpose of this visit was to observe the present condition of the pond and to perform a brief reconnaissance of the adjacent topography and geology.

3.4 Survey of Borings

Topographic and planimetric survey data of the pond area were furnished to us by Peabody Coal Company of Kayenta, Arizona on plates dated April 3, 1976 and April 21, 1976, respectively.

4. GEOLOGY, EMBANKMENT & SEISMICITY

4.1 Aerial & Site Geology

Black Mesa, in the area of investigation, is composed of rocks of Jurassic and Cretaceous ages. The surface slopes gently to the southwest. The uppermost formation of Black Mesa is the Wepo Formation, which has been eroded into parallel ridges and narrow valleys. O'Sullivan et al (21)* describe the Wepo as alternating siltstone, mudstone, coal, and sandstone beds, and as 304 to 743 feet in thickness.

4.2 Geologic History & Structure

According to O'Sullivan et al (21), the Wepo Formation was deposited primarily in a continental environment in which siltstones, mudstones, coal and sandstone were laid down. Locally, some marine sandstones are interbedded in the formation.

Following deposition of the Wepo Formation and younger formations of Cretaceous age, the Navajo Country was affected by a structural period during late Cretaceous and early Tertiary time - the Laramide Orogeny. This resulted in an assortment of folds; such as basin downwarps, uplifts, monoclines, anticlines and synclines (1). One of the downwarps is the Black Mesa Basin. Black Mesa is a dissected highland in the structural center of this basin. In late Tertiary and Quaternary time, the Navajo Country was upwarped and locally faulted.

*Numbers in parentheses correspond to references listed at end of report.

Maps prepared by Cooley et al (1) show that the Wepo Formation of the northern part of Black Mesa has been warped by gentle monoclines and synclines and has not been broken by faults. The nearest faults are shown as 30 to 50 miles north-northwest from the area of investigation, and these trend from eastward to northeastward. Two east trending faults, about 4 to 5 miles long, are about 30 miles from the site. Several northeast trending faults as long as 12 miles occur about 40 miles from the site.

4.3 Embankment Soils

4.3.1 Description of Soils

The embankment was found to be comprised predominantly of clayey sand and clayey silt with lesser amounts of clean sand and gravel mixtures. There is, in the upper few feet of boring 7, a considerable amount of organic carbonaceous material present. Penetration test data indicates the embankment materials are generally moderately firm to firm or medium dense to dense. However, scattered looser zones were present.

Moisture contents were very low throughout, with the exception of the near surface soils in boring 7. Higher moisture contents in this zone apparently are the result of recent snowmelt. Careful inspection of the toe of the embankment revealed no evidence that there has been direct seepage from the pond through the embankment or foundation.

4.3.2 Piping Potential

Sherard et al (2) have published a rough empirical relationship of observed piping and soil types. Using this criteria, the embankment materials probably would fall into categories 4 to 5. The soil and rock foundation materials would have extremely high resistance to internal erosion. In this system, soils are ranked according to their resistance to piping; 1 being most resistant and 8 being least resistant.

4.4 Seismology

4.4.1 Seismic History of the Area

Research was made of the seismic history of the general area of the site. Principal source of information was "Earthquake History of the United States" by Coffman and Von Hake (3). It presents a table listing earthquakes in the Western Mountain Region with intensities equal to or greater than V on the Modified Mercalli Intensity Scale of 1931. This table was used in compiling Table 1 of this report, which lists historical earthquakes within the general area of the site.

Other references that were used include the "Preliminary Safety Analysis Report" (4) prepared by FUGRO, Inc. for Arizona Public Service Company Palo Verde Nuclear Generating Station west of Phoenix and Sturgul and Irwin's report on "Earthquake History of Arizona and New Mexico" (5).

The earthquakes listed in Table 1 are plotted on Figure 2. The figure covers an area of about 420 x 500 miles in Arizona, New Mexico, Utah and Colorado. As the data shows, the region of the site is one of very low seismicity.

Figure 2 shows that within a 100 mile radius of the site, only five earthquakes of intensity V or greater have been recorded during historic time. Of these, the closest epicenter to the site was an intensity VI earthquake reported about 40 miles to the southwest in 1910, while the intensity VI Ganado earthquake of January 16, 1950, was placed about 75 miles southeast of Black Mesa. The largest tremor ever reported in northern Arizona was intensity VII, occurring on January 15, 1906 near the north rim of the Grand Canyon.

4.4.2 Significant Geologic Structure

As discussed in Section 4.2, no faulting is mapped in the immediate area of the site. Minor faulting 40 to 50 miles north of the site is not considered capable of creating an earthquake of sufficient intensity to significantly affect the embankment.

Shown on Figure 2 are locations of significant faults in the general region of the site which are known to have been active during the Quaternary period (past one million years). These include the San Francisco Mountain fault west of Flagstaff and the Verde fault which has been mapped for 70 miles or more. These faults are located more than 100 miles southwest of the site. Also shown on Figure 2 are the north-south trending Sevier, Hurricane, Toroweap and Grand Wash fault zones in northwestern Arizona and southern Utah. These zones of normal faulting are close enough to the site to be of significance from a seismic risk standpoint. Their significance is discussed by Smith and Sbar (20).

4.4.3 Previous Seismic Zoning & Estimated Effect of Hypothetical Earthquakes

The northern portion of Arizona is located in Zone 2 on the Seismic Risk Map found in the current Uniform Building Code. This means that the general area has experienced in the past, and thus may experience in the future, moderate damage corresponding to intensity VII of the Modified Mercalli Scale. Richter (6) classified the general area as intensity VIII occasional in a study published in 1959. Based upon more detailed analysis, Algermissen (7) classified the general area of the site as intensity VII occasional. This type of zoning is very general in nature and must be controlled by the areas of higher risk within the zone. In a study by the U. S. Geological Survey, based on both statistical analysis of seismic history and evaluation of geology, Algermissen and Perkins (8) have estimated a 50 year return peak ground acceleration of less than 0.01g and a 90 percent probable peak ground acceleration of about

0.03g for the site. Recent studies by Bell Telephone Laboratories (9) estimated 100 year return peak ground acceleration of 0.03g for the site.

In a current study by the Applied Technology Council (15) directed toward development of seismic design methods for buildings, an EPA of less than 0.05g was estimated for the site. A report of on-going U. S. Geological Survey Studies (16), just published, estimated an EPA of less than 0.04g. For the latter two studies, the EPA's of 0.05g and 0.04g were the lowest contours reported. They state that for EPA's lower than these values, wind normally controls the lateral force requirements and, thus, lower contours are not significant in seismic risk evaluation. The EPA's in these two studies (15, 16) are both defined as values with a 90 percent probability of not being exceeded in 50 years.

Estimates of EPA reported by the U. S. Geological Survey in 1976 (16), in the general area of the site, are substantially lower than corresponding values reported in 1972 (8).

Based upon data summarized by Howell and Schultz (10), Bolt (11), Schnabel and Seed (12), Barosh (13) and Hays et al (14), it is possible to roughly estimate the effect of hypothetical earthquakes at the site. Maximum credible earthquakes for a given fault can be estimated, using this data, on the basis of length. The effects at sites away from the fault can then be assessed utilizing various attenuation curves.

The foregoing analysis is based on these techniques. Should an earthquake of magnitude 6 occur in the San Francisco Peaks area, about 120 miles southwest of the site, it would create an intensity of about 3.7 (MM) and a peak ground acceleration of about 0.02g. Bracketed duration (time during which acceleration is about 0.02g) would be 1 second at most. According to Schnabel and Seed (12), predominant period would be about 0.8 seconds considering the subsurface profile at this site.

Maximum credible earthquakes on the Sevier fault system, and other major fault zones in southwestern Utah, would produce peak ground accelerations of less than 0.02g with a predominant period of perhaps 1.0 second. These zones are 130 miles or more away from the site.

In summary, all data shows the site is in an area of very low seismicity and, thus, a very low level of seismic risk is involved.

5. STABILITY ANALYSIS

5.1 Assumed Soil Parameters

Shear strength parameters were estimated from the results of the direct shear tests performed under submerged conditions. The direct shear tests on submerged, remolded soils are believed to yield strength parameters which are lower than might be expected for the actual compacted embankment at present low moisture contents. Most of the embankment is below optimum water content as a result of the effectiveness of the plastic liner. Because of the low rate of strain and the soil type involved, the direct shear tests are believed to yield essentially effective stress parameters.

The effective shear strength and other parameters used in stability analyses are as follows:

$\emptyset' = 25^{o}$
C' = 100 lbs./sq.ft.
Density - Wet = 110 lbs./cu.ft.
Submerged = 58 lbs./cu.ft.

5.2 Seismic Design Considerations

As stated in Section 4.4.1, this site is in an area of very low seismicity. Based on assessment of this data, a seismic coefficient of 0.05g was selected for use in analysis.

5.3 Methods of Analysis

Using the geometry shown in Figure 3, slope stability analyses were made by various stability number methods and verified by manual calculation utilizing the traditional method of slices. The slope was assumed to be fully drained, i.e., no seepage forces present. This assumption is believed to represent present and probable future conditions. Steady-state seepage would develop only if the plastic liner were severely ruptured and then would be present only in very localized areas. The possibility of this condition is believed to be extremely remote.

Stability number methods published by Hoek and Bray (17) and Morgenstern and Bishop (18) were found to give minimum factors of safety.

5.4 Summary of Results

Based upon the analysis methods and assumed shear strength parameters described in Sections 5.1 and 5.3 above, the following factors of safety were computed.

Height	Slope	Factor of Safety
28'	1.7:1	1.23 (1.12)*

*Number in parentheses is the estimated factor of safety with 0.05g seismic coefficient.

The slope and embankment heights were taken from survey data furnished by Peabody Coal Company. A documentation of these figures is presented in Appendix C.

6. CONCLUSIONS & RECOMMENDATIONS

It is concluded that the dam embankment is safe for present conditions and foreseeable future operating conditions. It is our conclusion that very high factors of safety against slope failure exist for these conditions and thus no alterations of the embankment are necessary for safety reasons.

The absence of elevated moisture within the embankment and the absence of seepage at the toe clearly indicates that the lining is functioning well and no significant leakage is occurring. University of Arizona researchers believe that membrane lining of the type used for the project can be expected to perform for 25 years or more without deterioration, assuming proper soil cover. This is consistent with results of a study by the Bureau of Reclamation (19) which indicate a 10 mil PVC plastic lining buried for 10 years gave excellent performance. Bacteriological deterioration was slight, and strength and tensile properties were only slightly affected. PVC lining was also shown to be the most tear resistant of all plastic liners. The entire pond is enclosed by a chain link fence so there is little likelihood of livestock or wild animals damaging the membrane. Thus, it is concluded that the embankment is likely to perform as a dry slope for 25 years or more.

It is recommended that the condition of the soil cover be periodically inspected and, should the PVC lining become exposed due to erosion, the cover be replaced.

Even if the lining should develop major leaks, it is our conclusion a sufficiently high factor of safety against slope failure would exist. It is further concluded, considering the seepage gradients which would exist in the event of leakage, that the embankment would not be susceptible to piping or internal erosion.

Because of the low estimated EPA, it is concluded that the embankment would not have the potential for liquefaction, even if portions of it became saturated.

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TEST DRILLING EQUIPMENT & PROCEDURES

Drilling Equipment Truck mounted CME-55 drill rigs powered with 4 or 6 cylinder Ford industrial engines are used in advancing test borings. The 4 cylinder and 6 cylinder engines are capable of delivering about 4,350 and 6,500 foot/pounds torque to the drill spindle, respectively. The spindle is advanced with twin hydraulic rams capable of exerting 12,000 pounds downward force. Drilling through soil or softer rock is performed with 6½" O.D., 3¼" I.D. hollow stem auger or 4½" continuous flight auger. Carbide insert teeth are normally used on the auger bits so they can often penetrate rock or very strongly cemented soils which require blasting or very heavy equipment for excavation. Where refusal is experienced in auger drilling, the holes are sometimes advanced with tri-cone gear bits and NW rods using water or air as a drilling fluid.

Sampling Procedures Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 procedure. Two inch O.D., 1-3/8" I.D. samplers are used in many cases to obtain the standard penetration resistance. "Undisturbed" samples of firmer soils are often obtained with 3" O.D. samplers lined with 2.42" I.D. brass rings. Driving energy is generally recorded as the number of blows of a 140 pound 30 inch free fall drop hammer required to advance the samplers in 6 inch increments. However, in stratified soils, driving resistance sometimes is recorded in 2 or 3 inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and realistic penetration values obtained for consideration in design. These values are expressed in blows per foot on the logs. "Undisturbed" sampling of softer soils is sometimes performed with thin walled Shelby tubes (ASTM D1587). Where samples of rock are required, they are obtained by NX diamond core drilling (ASTM D2113). The tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings.

Boring Records Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares boring logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487) with appropriate group symbols being shown on the logs.

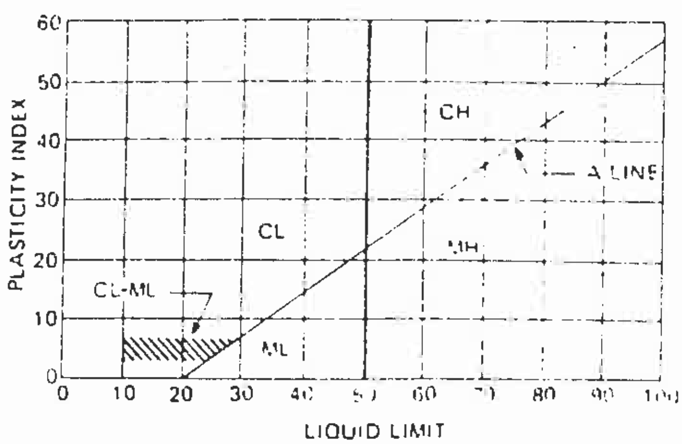
UNIFIED SOIL CLASSIFICATION SYSTEM

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 "Th Unified Soil Classification System" Corp of Engineers, US Army Technical Memorandum No. 3-357 (Revised Ap 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
					GP	Poorly 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		GM	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 seive)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "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 (Limits plot below "A" line & hatched zone on plasticity chart)	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50)			ML	Inorganic silts, clayey silts with sl plasticity.
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50)			MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts.
	CLAYS (Limits plot above "A" line & hatched zone on plasticity chart)	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy 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 ¾ in.
Fine gravel	¾ 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

TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY, CONSISTENCY OR FIRMNESS OF SOILS

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586-67 procedure using 2" O.D. - 1 3/8" I.D. samplers.

1. Relative Density. Terms for description of relative density of cohesionless, uncemented sands & sand-gravel mixtures.

N	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
50+	Very dense

2. Relative Consistency. Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.
16-30	Very stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

3. Relative Firmness. Terms for description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

N	Relative Firmness
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-50	Very firm
50+	Hard

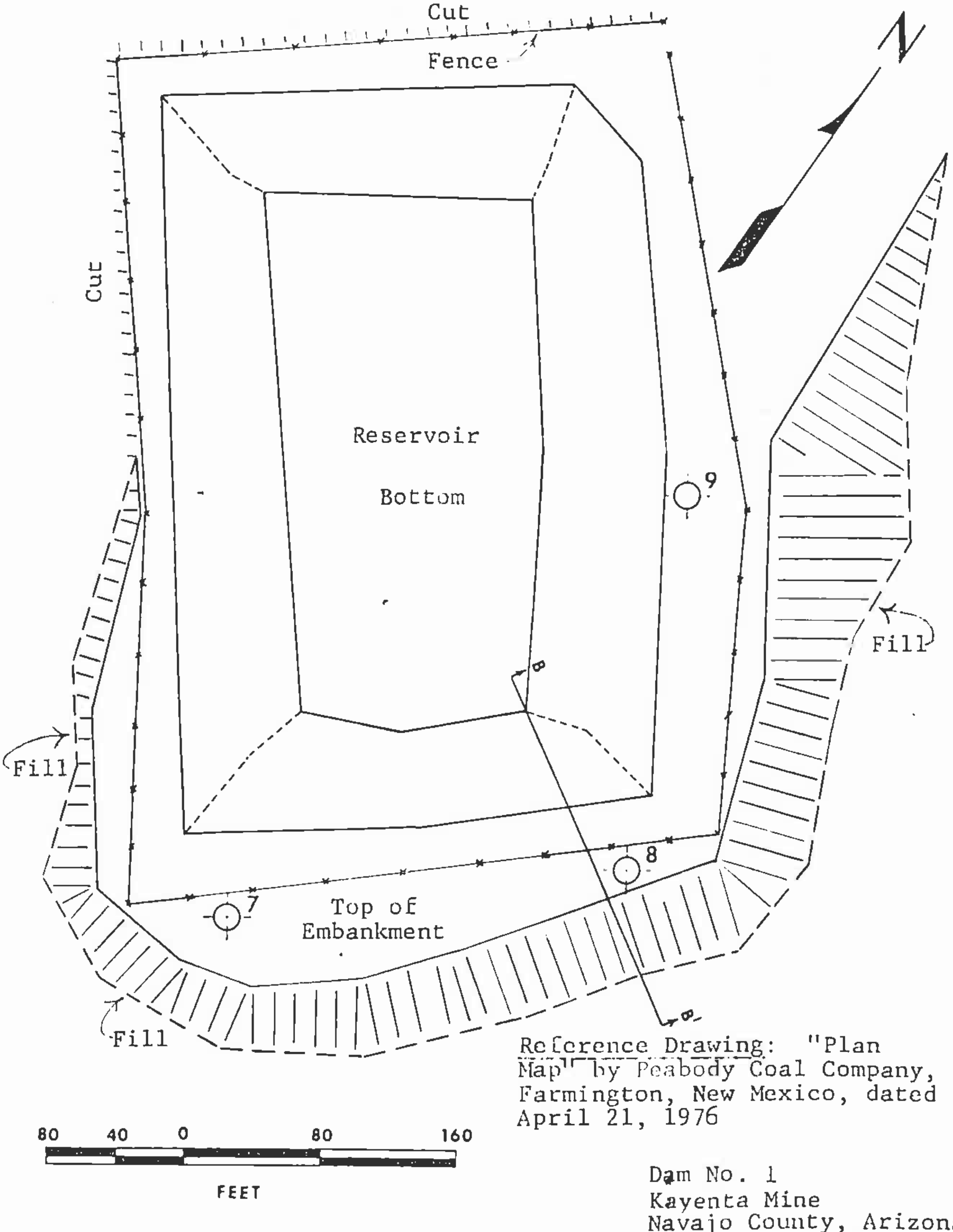
TERMINOLOGY FOR THE DESCRIPTION OF ROCK

General Property	Descriptive Term	Visual or Physical Properties
WEATHERING	VERY WEATHERED	Abundant fractures coated with oxides, carbonates, sulphates, mu etc., thorough discoloration, rock disintegration, mineral decomposition
	MODERATELY WEATHERED	Some fracture coating, moderate or localized discoloration, little to no effect on cementation, slight mineral decomposition
	SLIGHTLY WEATHERED	A few stained fractures, slight discoloration, little to no effect on cementation, no mineral decomposition
	FRESH	Unaffected by weathering agents, no appreciable change with depth
FRACTURING	INTENSELY FRACTURED	less than 1" spacing
	VERY FRACTURED	1" to 6" spacing
	MODERATELY FRACTURED	6" to 12" spacing
	SLIGHTLY FRACTURED	12" to 36" spacing
	SOLID	36" spacing or greater
STRATIFICATION	THINLY LAMINATED	less than 1/10"
	LAMINATED	1/10" to 1/2"
	VERY THINLY BEDDED	1/2" to 2"
	THINLY BEDDED	2" to 2 feet
	THICKLY BEDDED	more than 2 feet
HARDNESS	SOFT	Can be dug by hand and crushed by fingers
	MODERATELY HARD	Friable, can be gouged deeply with knife and will crumble readily under light hammer blows
	HARD	Knife scratch leaves dust trace, will withstand a few hammer blows before breaking
	VERY HARD	Scratched with knife with difficulty, difficult to break with hammer blows

SITE PLAN

SHOWING LOCATIONS OF TEST BORINGS

FRESH WATER DAM



Reference Drawing: "Plan Map" by Peabody Coal Company, Farmington, New Mexico, dated April 21, 1976

Dam No. 1
Kayenta Mine
Navajo County, Arizona
SHB Job No. E76-29A

SERGENT, HAUSKINS & BECKWITH

PROJECT Dam No. 1 Kayenta Mine

LOG OF TEST BORING NO. 7

JOB NO. E76-29A DATE 4-13-76

RIG TYPE CME-75
BORING TYPE 6½" Hollow Stem Auger
SURFACE ELEV. 6617.4'
DATUM Peabody Survey 4-21-

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 Percent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	1-5-4-5 (9)			SP-SM	loose	Embankment FILL SILTY SAND, small amount of gravel, fine grained, nonplastic, gray
			X	S	15-12-7 (19)			SC, CL & ML	very stiff	Embankment FILL thin lifts of CLAYEY SAND, CLAYEY SILT & CLAY, some gravel, coarse fragments are angular to subangular, high plasticity to non-plastic, 3'-6' - fill contains considerable carbonaceous material, color ranges from yel-low to gray to black
5			X	S	8-8-6 (14)					
			X	S	12-15-12 (27)			SP		
10			X	S	3-3-2 (5)				loose to medium dense	Embankment FILL mostly clean SAND, some gravel, few lifts clayey sand, fine grained, nonplastic, yellow
			X	S	9-10-18 (28)			SC	firm	Native Material CLAYEY SAND & GRAVEL, few cobbles, well grad-ed, subangular to subrounded, very low plasticity, yellow to brown
15				S	50/2"					
			X	S	36-40-50/2" (190)					SILTSTONE, moderately weathered, thinly to very thinly bedded, moderately hard, yellow to white
20										Stopped auger at 17' Sampler refused at 18'2"

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.

SERGENT, HAUSKINS & BECKWITH
CONSULTING SOIL AND FOUNDATION ENGINEERS
PHOENIX • TUCSON • ALBUQUERQUE • EL PASO

PROJECT Dam No. 1 - Kayenta Mine

JOB NO. E76-29A DATE 4-13-76

LOG OF TEST BORING NO. 6

RIG TYPE CME-75

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 6618.5'

DATUM Peabody Survey 4-21-76

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 Percent of Dry Wt.	Unified Soil Classification	Remarks	Visual Classification
0			X	S	4-7-10-11 (21)			SP-SM	medium dense	Embankment FILL SILTY SAND, considerable gravel, fine grained, very low plasticity to nonplastic, reddish-brown note: trace of carbonaceous material
5			X	U	41	102	7		very firm	Embankment FILL CLAYEY SAND & GRAVEL, few cobbles, coarse fragments of sandstone & shale are angular to subrounded, low to medium plasticity, reddish-brown to yellow
10			—	S	50/0" (no recovery)			SC-GC		
15			X	U	23	97	8			
								GC		Native Material CLAYEY GRAVEL, well graded, angular, low plasticity, reddish-yellow
20			X	S	50/5"					SANDSTONE, fine grained, slightly weathered, thinly bedded, reddish-white
										Auger refused at 19'6" Sampler refused at 19'11"

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.

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PROJECT - Dam No. 1 - Kayenta Mine

JOB NO. E76-29A DATE 4-13-76

LOG OF TEST BORING NO. 9

RIG TYPE CME-75

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 6619.6'

DATUM Peabody Survey 4-21

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 Percent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0										FILL
				S	2-4-5-8 (13)				moderately firm	SILTY SAND & GRAVEL, some clayey silt, few cobbles, fragments of sandstone are angular to subangular, low plasticity to nonplastic, reddish-brown
5				S	7-6-7 (13)			SM & ML-CL		
				A						
10				S	25-50/5"					
										SANDSTONE, fine grained, moderately to very weathered, thinly bedded, moderately hard, reddish-white
15				S	50/6"					
20				S	8-10-18 (28)					
										Stopped auger at 19' Stopped sampler at 20'6"
25										

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.[illegible] [illegible]led [illegible]

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LABORATORY TESTING PROCEDURES

Direct Shear Tests   Direct Shear Tests are run using a Clockhouse or Soiltest apparatus of the strain-control type. Shearing forces are applied at a rate deformation of approximately 0.05 inches per minute. The machine is designed to receive one of the one inch high 2.42 inch diameter specimens obtained by tube sampling. Generally, each sample is sheared under a normal load equivalent to the effective overburden pressure at the point of sampling. In some instances, samples are sheared at several normal loads to obtain the cohesion and angle of internal friction. When necessary, samples are saturated and/or consolidated before shearing in order to approximate the anticipated controlling field loading conditions.

...BUL...ON TE.. RES...S

Job No. E76-29A

Date

Client:

Project Dam No. 1 - Kaventa Mine

Navajo County, Arizona

Material

Source

HOLE NO	LOCATION	DEPTH	UNIFIED CLASS	LL	PI	SIEVE ANALYSIS - ACCUM % PASSING												LAB NO
						200	100	40	16	10	4	1/4	3/8	3/4	1	1½	2	
7	See Site Plan	2'-3½'	CL	29	11	58	72	81	82	82	84	86	87	87	87	100		29-150
7	See Site Plan	4½'-6'	CL-ML	24	5	51	70	78	81	82	85	86	88	91	91	100		29-151
9	See Site Plan	0-2'	ML		NP	50	80	94	95	95	96	97	99	100				29-160
9	See Site Plan	6'-9'	SM	22	3	43	76	94	95	96	98	99	99	100				29-162

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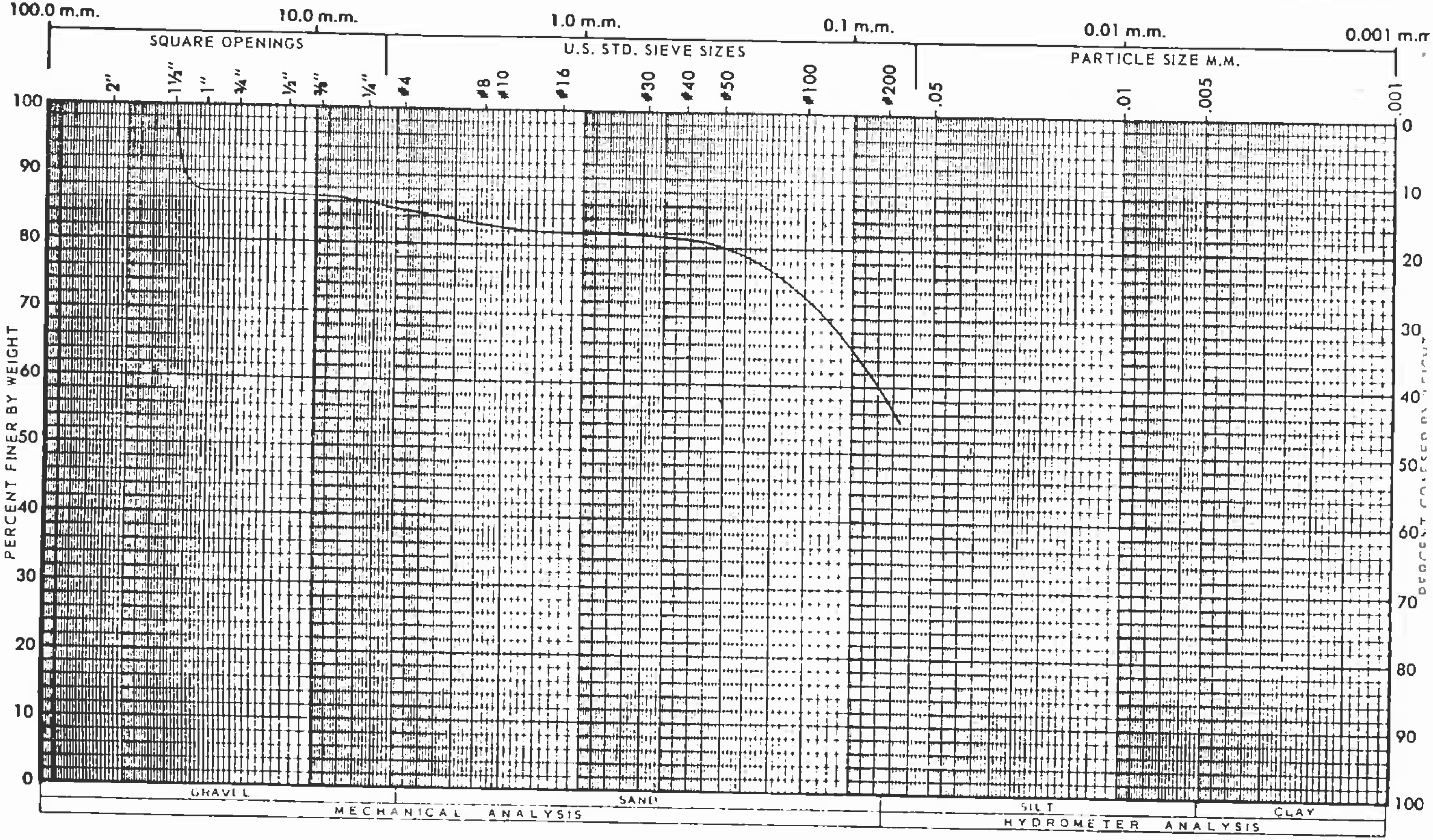
PARTICLE SIZE DISTRIBUTION CURVE

NO

PROJECT Dam No. 1 - Kayenta Mine **LOCATION** Navajo County, Arizona



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
A	Boring #7 @ 2'-3½'	29	11		CL	6-29-150

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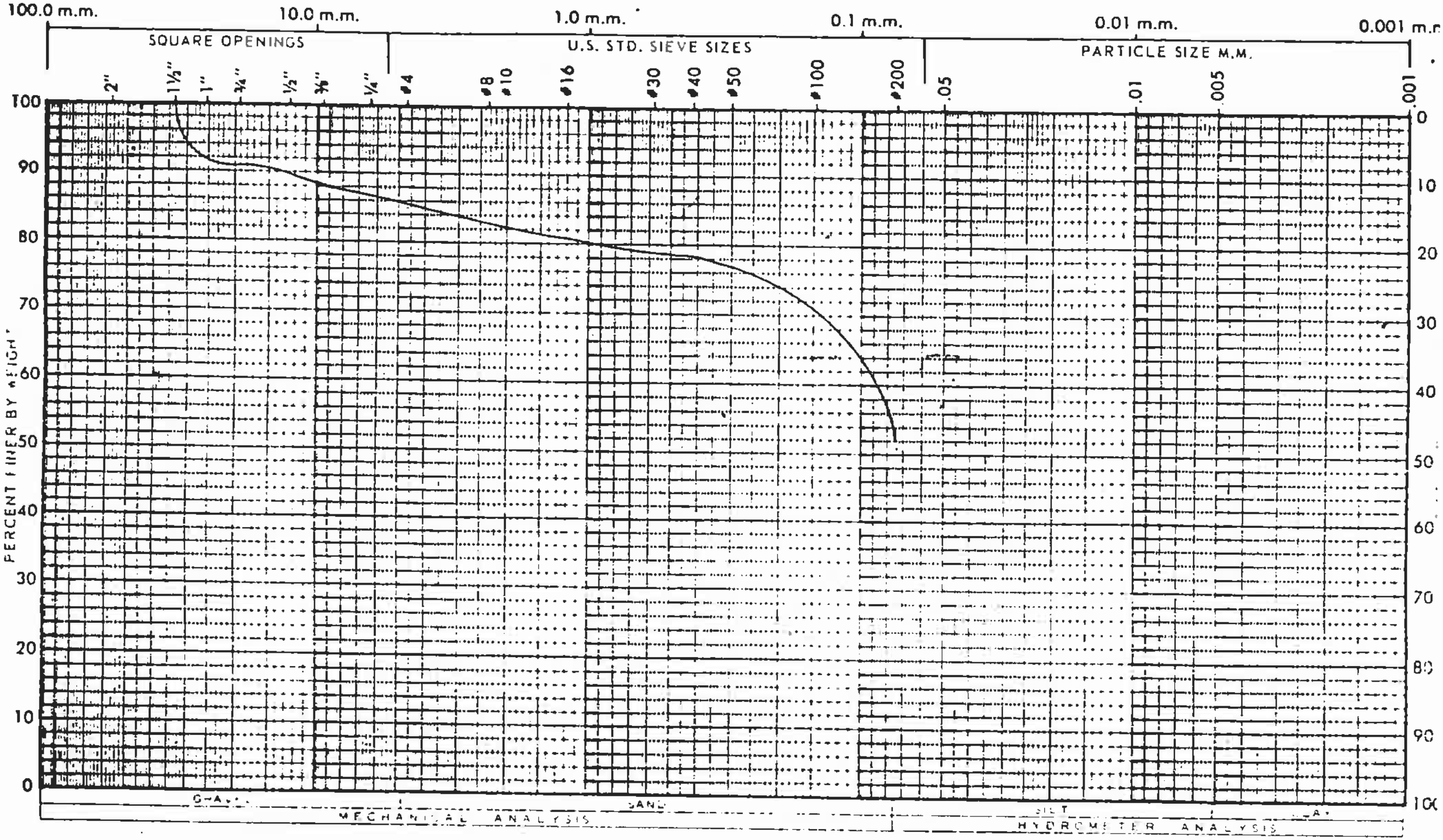
INC

PARTICLE SIZ NSTRIBUTION CURVE

PROJECT Dam No. 1 - Kayenta Mine LOCATION Navajo County, Arizona



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO
B	Boring #7 @ 4½'-6'	24	5		CL-ML	6-29-151

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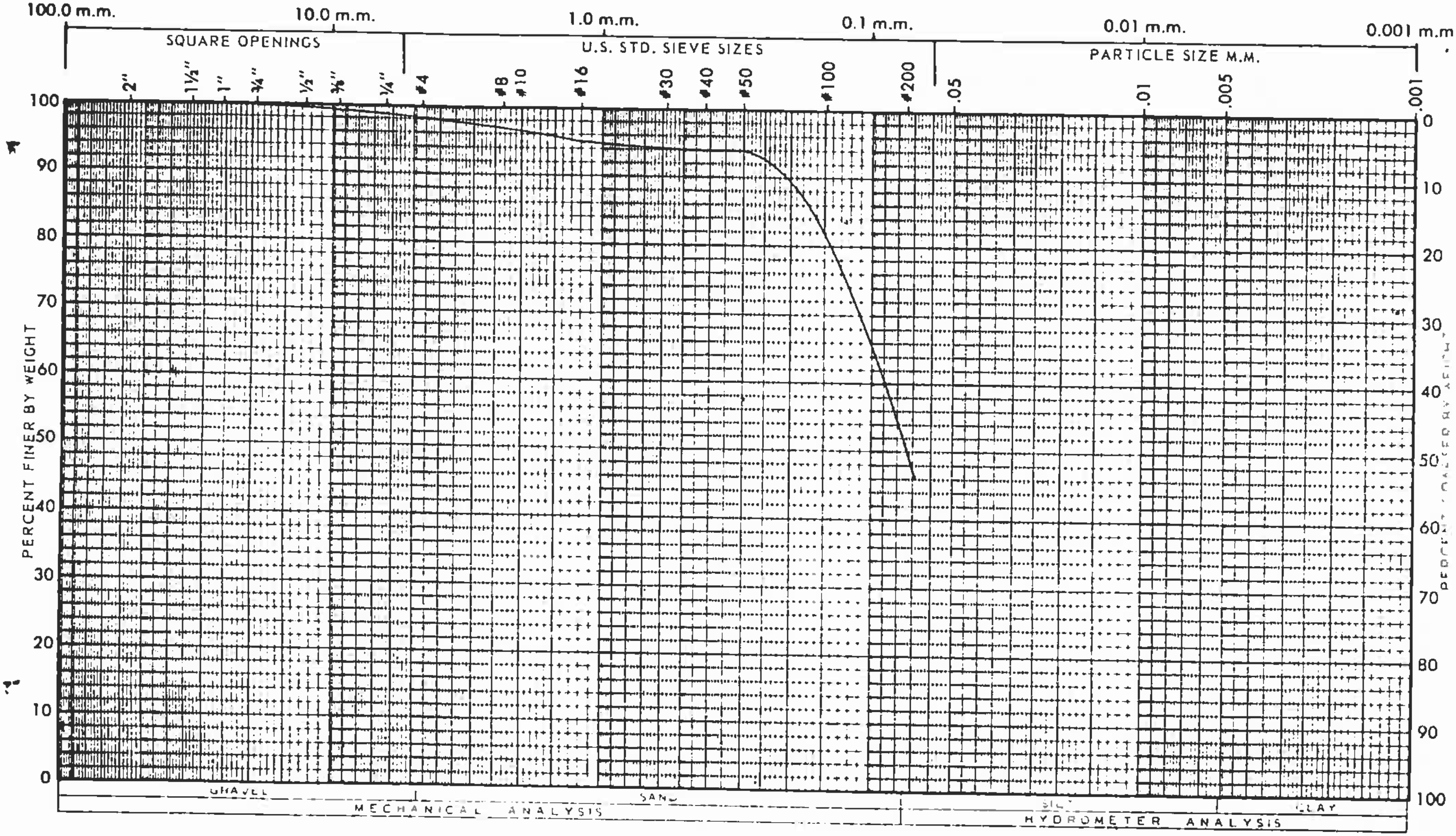
PARTICLE SIZE DISTRIBUTION CURVE

NO.

PROJECT Dam No. 1 - Kayenta Mine LOCATION Navajo County, Arizona



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
C	Boring #9 @ 0-2'		NP		ML	6-29-160

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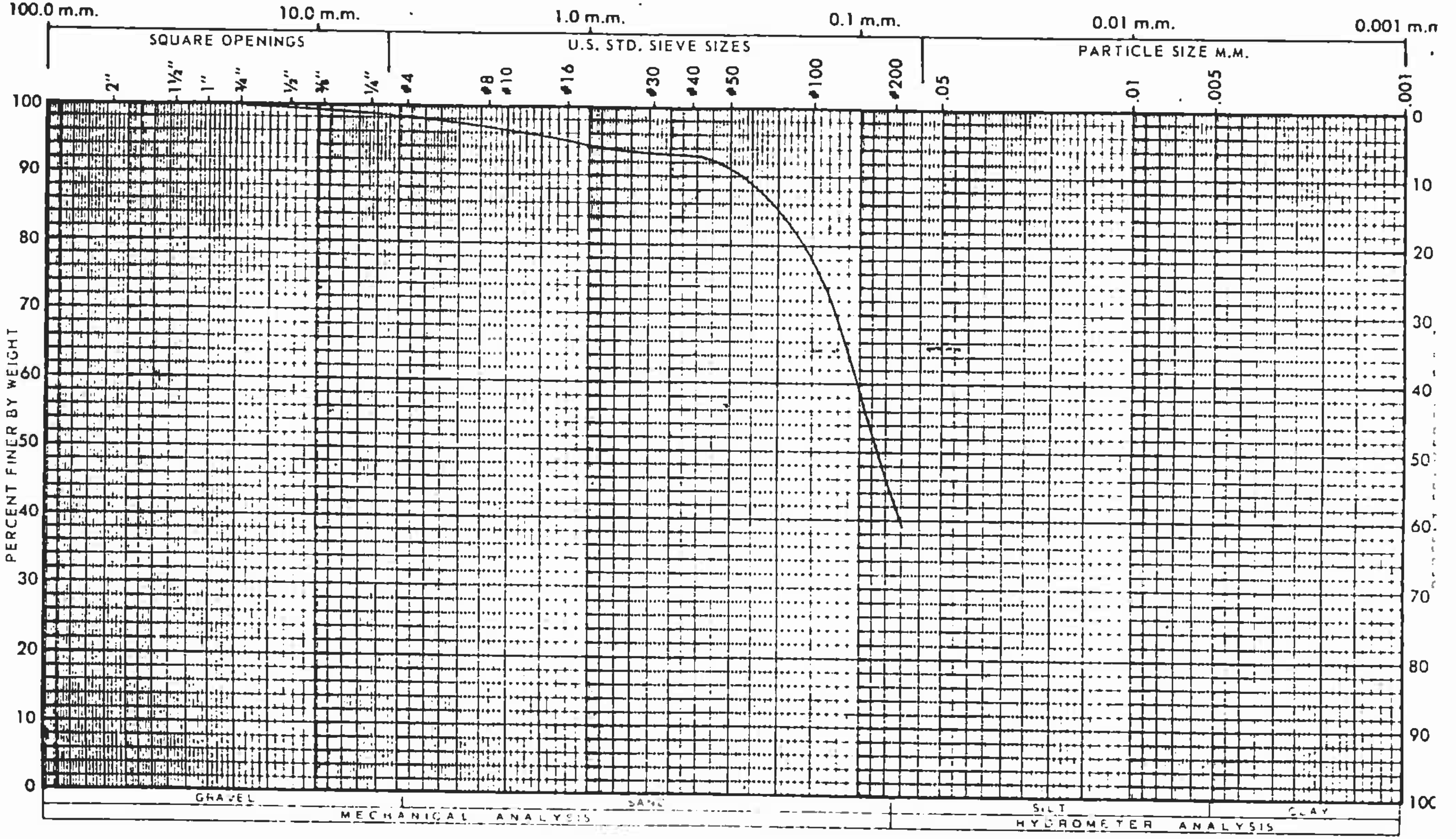
PARTICLE SIZt STRIBUTION CURVE

NO

PROJECT Dam No. 1 - Kayenta Mine LOCATION Navajo County, Arizona



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO
D	P ing #9 @ 6'-9'	22	3		SM	6-29-162

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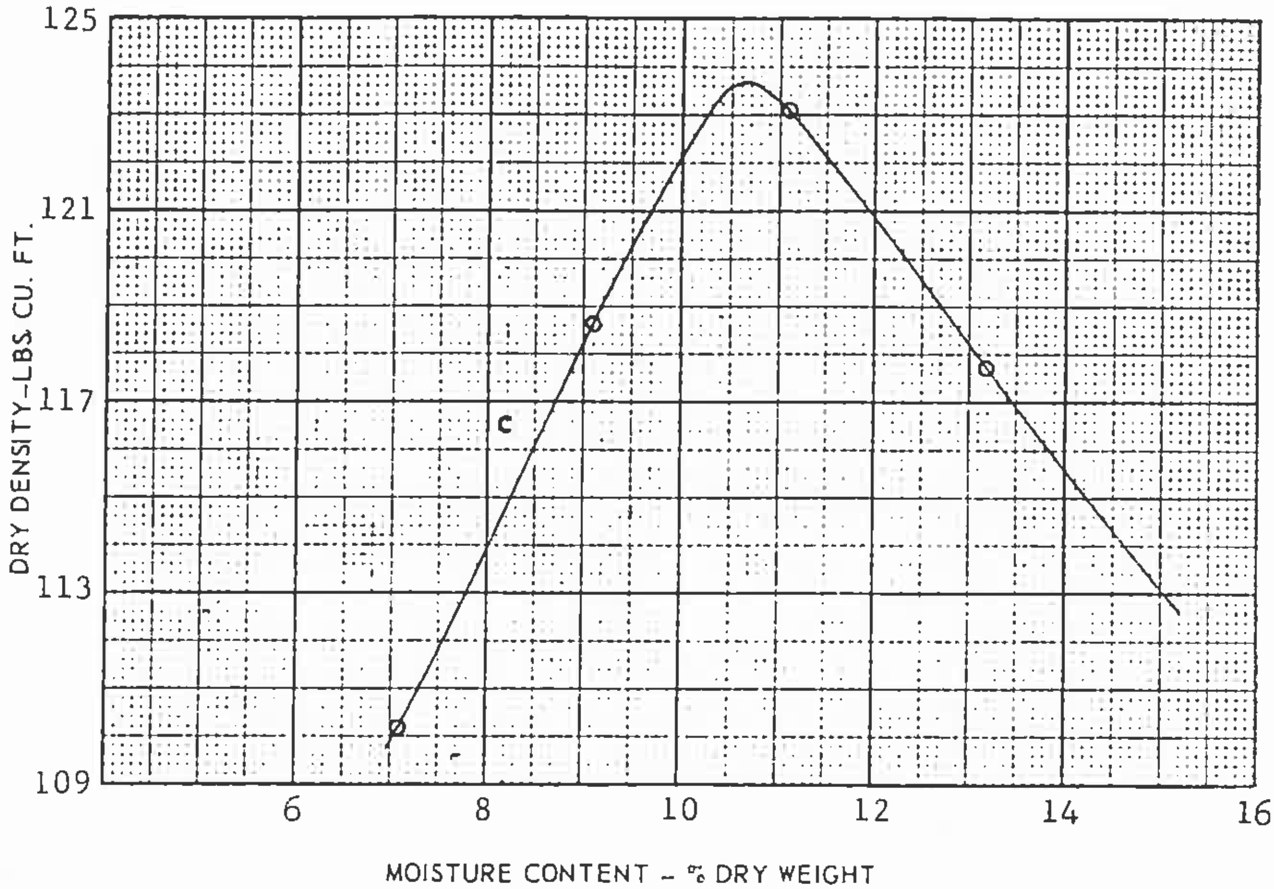
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Dam No. 1 Kayenta Mine JOB NO. E76-29A



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT	MAXIMUM DRY DENSITY LBS. CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
C	Boring No. 9 @ 6'-9'	10.6	123.6	ASTM D-698	A	29-162

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHO T99-61 and ASTM D 698-66T (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT LBS CU FT.
A	-#4	4"	4.58"	3	25	5.5 LBS	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS	12"	12,317
C	-3/4	4"	4.58"	3	25	5.5 LBS	12"	12,375
D	-3/4	6"	4.58"	3	56	5.5 LBS	12"	12,317

AASHO T180-61 and ASTM 1557-66T (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS	18"	55,986
C	-3/4	4"	4.58"	5	25	10.0 LBS	18"	56,250
D	-3/4	6"	4.58"	5	56	10.0 LBS	18"	55,986

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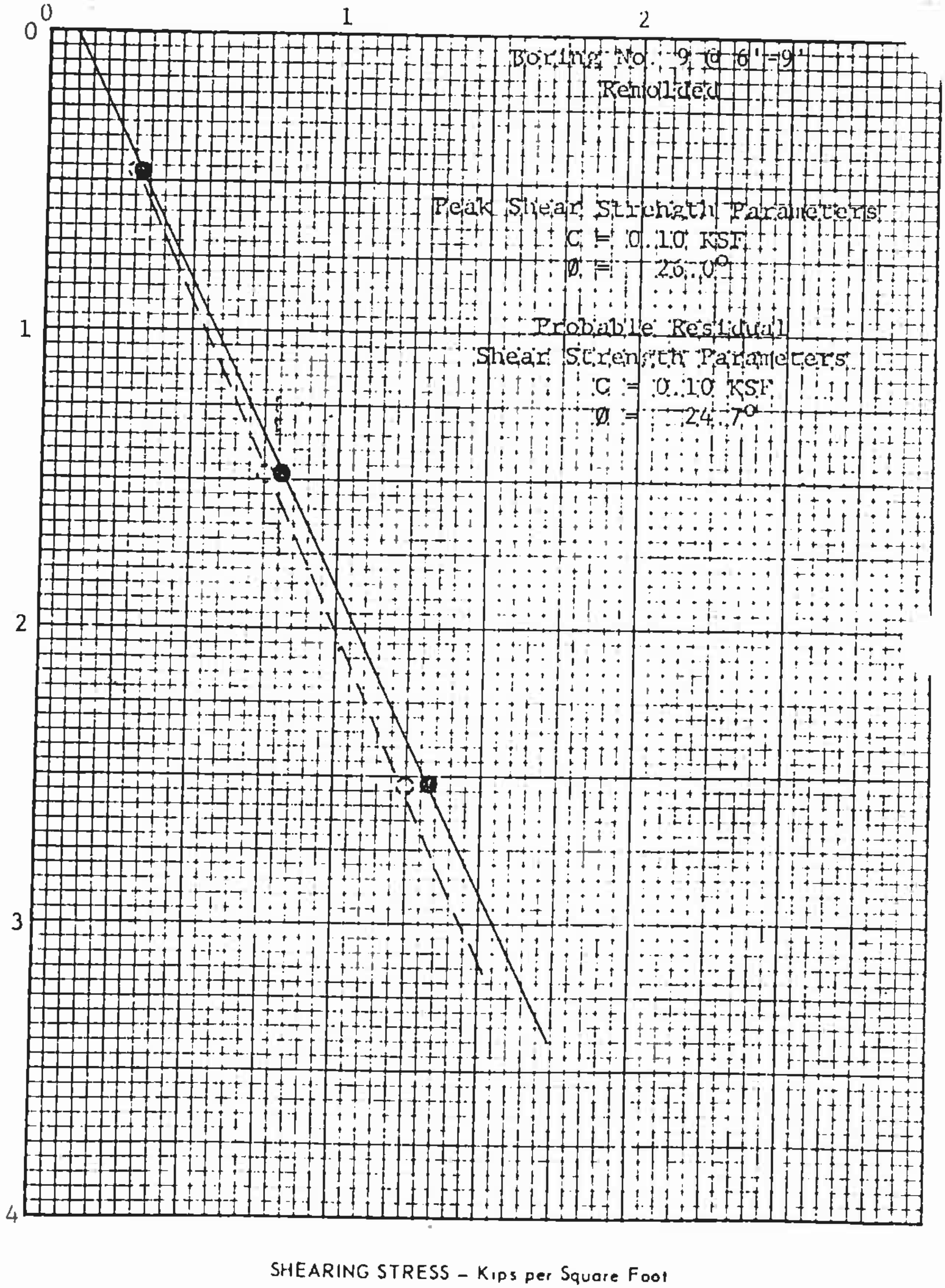
PROJECT Dam No. 1 - Kayenta Mine JOB NO. E76-29A
Lab No. 29-162



SOIL MOISTURE CONDITION
○ – INSITU
● – SUBMERGED

SERGENT, HAUSKINS & BECKWITH

REPORT OF LABORATORY TESTS

DATE ________

PROJECT Dam No. 1 - Kayenta Mine — JOB NO. E76-29A
LOCATION Navajo County, Arizona — LAB NO. 29-162
SAMPLE Boring No. 9 @ 6'-9' (Remolded)

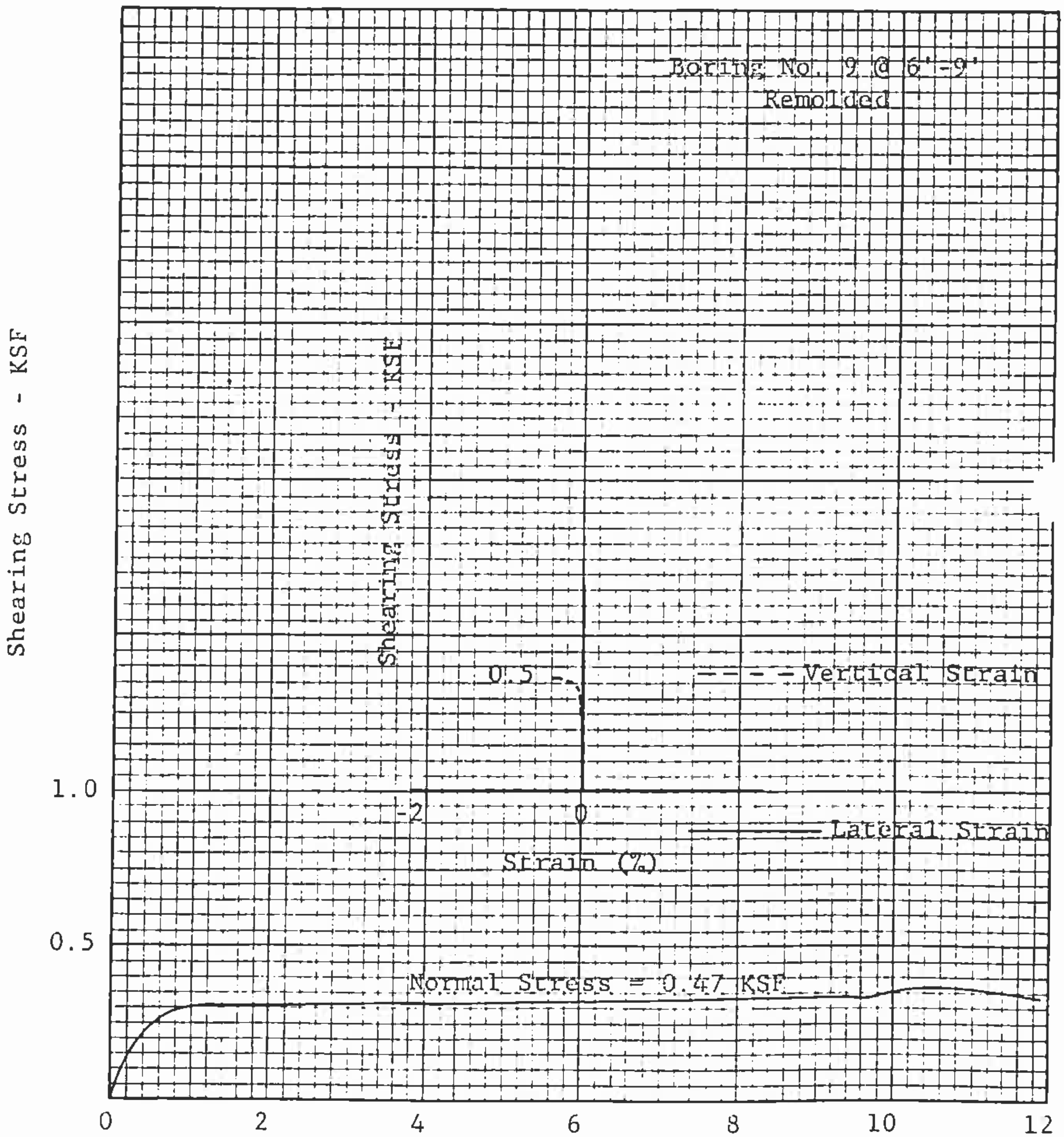
DIRECT SHEAR TESTS

In Situ - Point No. 1 (= ± 0.47 KSF)	
Initial Moisture Content	8.7 %
Dry Density (PCF)	103.6
Submerged	
Final Moisture Content	19.5 %
Maximum Vertical Strain @ T max.	(-) 0.001 inches
Shearing Stress, T max.	0.32 KSF
In Situ - Point No. 2 (= ± 1.47 KSF)	
Initial Moisture Content	8.8 %
Dry Density (PCF)	103.5
Submerged	
Final Moisture Content	19.0 %
Maximum Vertical Strain @ T max.	(-) 0.022 inches
Shearing Stress, T max.	0.81 KSF
In Situ - Point No. 3 (= ± 2.53 KSF)	
Initial Moisture Content	8.6 %
Dry Density (PCF)	103.7
Submerged	
Final Moisture Content	19.5 %
Maximum Vertical Strain @ T max.	(-) 0.035 inches
Shearing Stress, T max.	1.32 KSF

PROJECT Dam No. 1 - Kayenta Mine JOB NO. E76-29A

STRESS-STRAIN CURVES

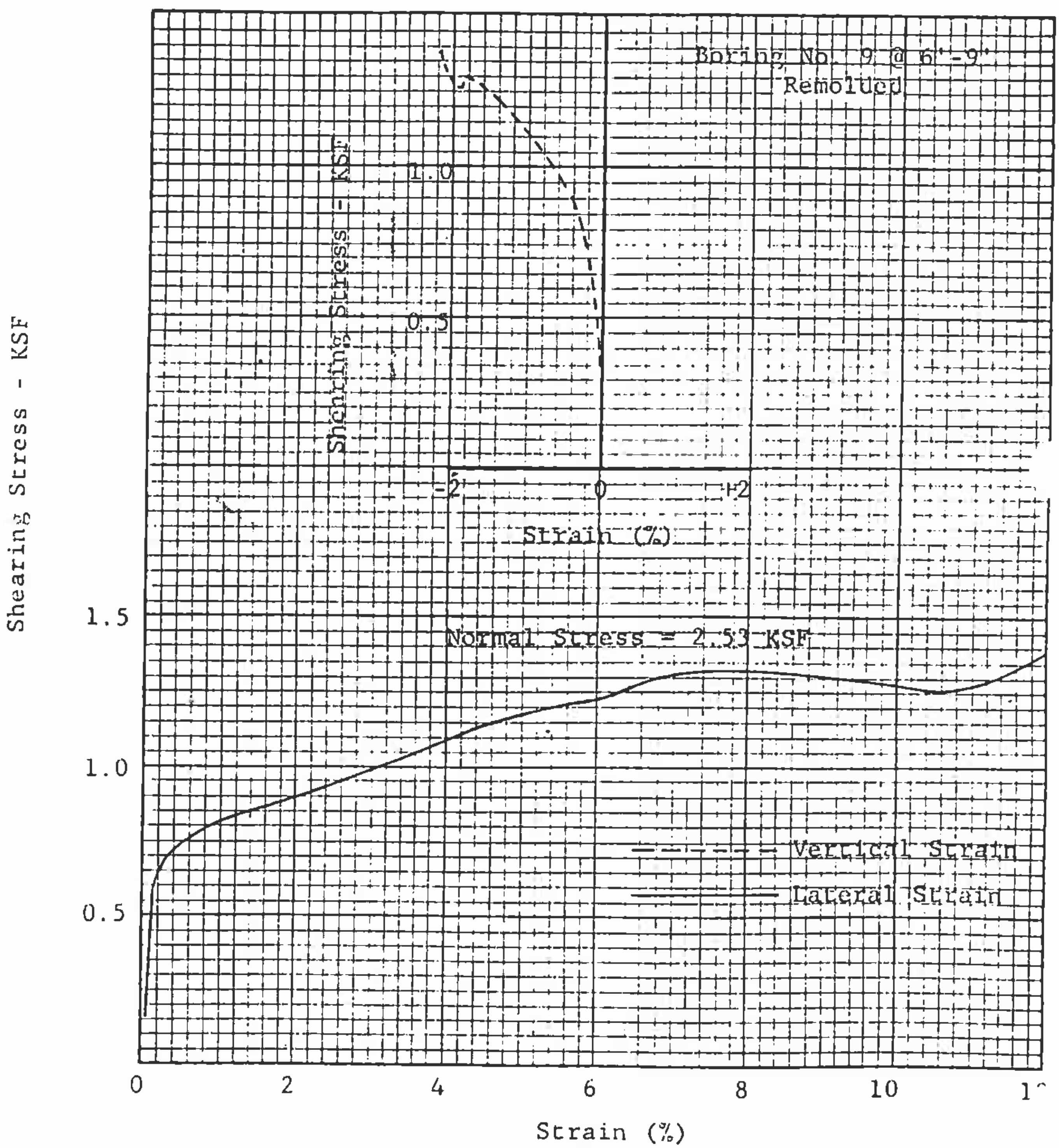
FROM DIRECT SHEAR TESTS



PROJECT Dam No. 1 - Kayenta Mine JOB NO. E76-29A

STRESS-STRAIN CURVES

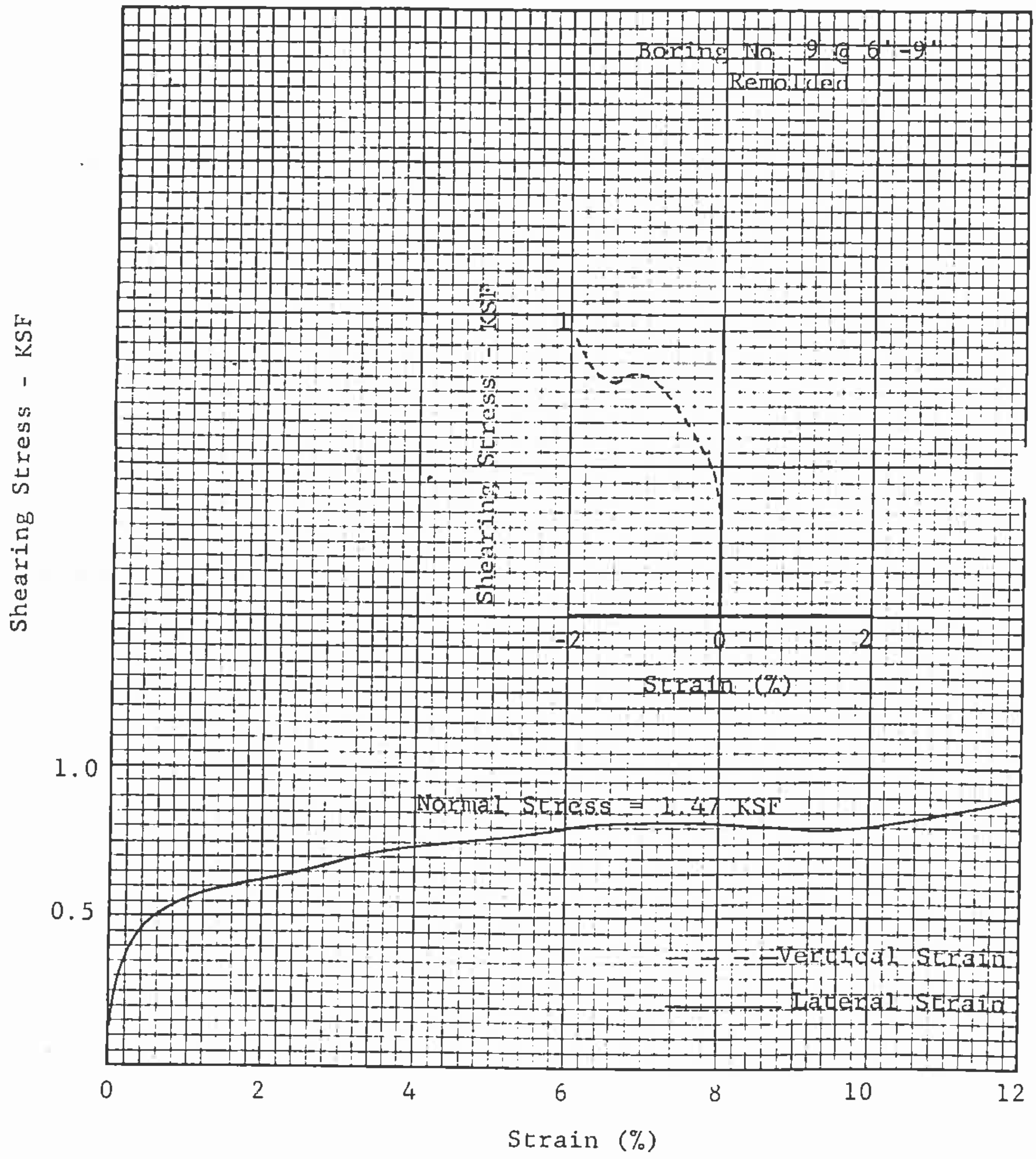
FROM DIRECT SHEAR TESTS



PROJECT Dam No. 1 - Kayenta Mine JOB NO. E76-29A

STRESS-STRAIN CURVES

FROM DIRECT SHEAR TESTS



PROJECT Dam No 1 Kayenta Mine JOB NO. E76-29A

LOCATION Black Mesa

SUBJECT Slope Stability Analysis - Hoek & Bray Charts * SHEET NO. 1

COMPUTED BY KC DATE 8/12/76 CHECKED BY ______ DATE ______

Given: Slope is 1.7:1 height = 28' $\angle = 30.5°$

Shear Strength Parameters

$\gamma_{wet} = 110$ pcf

$\phi' = 25°$

$c' = 100$ psf

The case to be analyzed is a dry slope, therefore use Hoeke's Chart No 1

Calculate the stability number to enter the chart.

$$SN = \frac{c}{\gamma H \tan \phi}$$

$$SN = \frac{100}{(110)(28)\tan 25°}$$

$SN = 0.07$

Go to the chart, get $\frac{\tan \phi}{F.S.}$, calculate F.S.

$\tan \phi / F = .38$

$$\therefore F = \frac{\tan 25°}{.38} = 1.23$$

* Ref: Rock Slope Engineering by Hoek & Bray JW, The Gresham Press, London, U.K. 1974 pp 214-22

F.S. = m − n r_u

where m, n are stability coefficients dependent on slope geometry, c' and ϕ', and r_u = pore pressure ratio = u/γh. For the case of no seepage r_u = 0 provided there are no zones of residual p.w.p. from construction

Parameters

Slope = 1.7:1 (30.5°)
height = 28'
γwet = 110
ϕ' = 25°
c' = 100

$SN = \frac{c'}{\gamma H} = \frac{(100)}{(110)(28)} = .032$

From Tables in Appendix A

For SN = 0 ϕ = 25°

slope	m
2:1	.733
3:1	1.349

For SN = .025 ϕ = 25°

slope	m
2:1	1.356
3:1	1.875

For SN = .05

slope	m
2:1	1.624
3:1	2.173

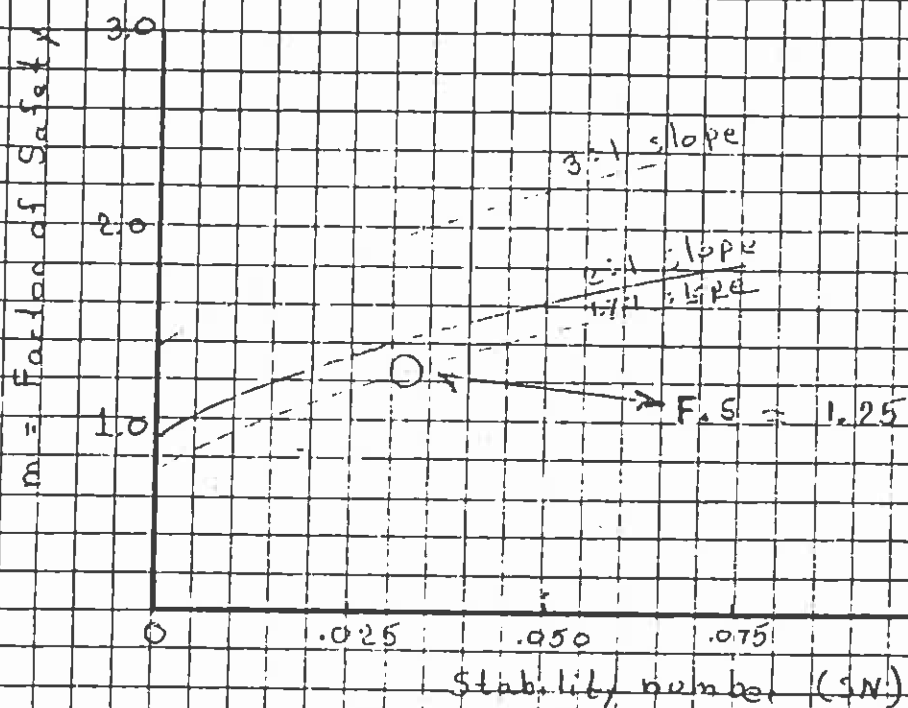
* Bishop, A.W. and Morgenstern, N. "Stability Coefficients for Earth Slopes" Geotechnique Volume 10, Number 4, pp 129-150.

PROJECT Dam No. 1 Kayenta Mine JOB NO. E76-29A

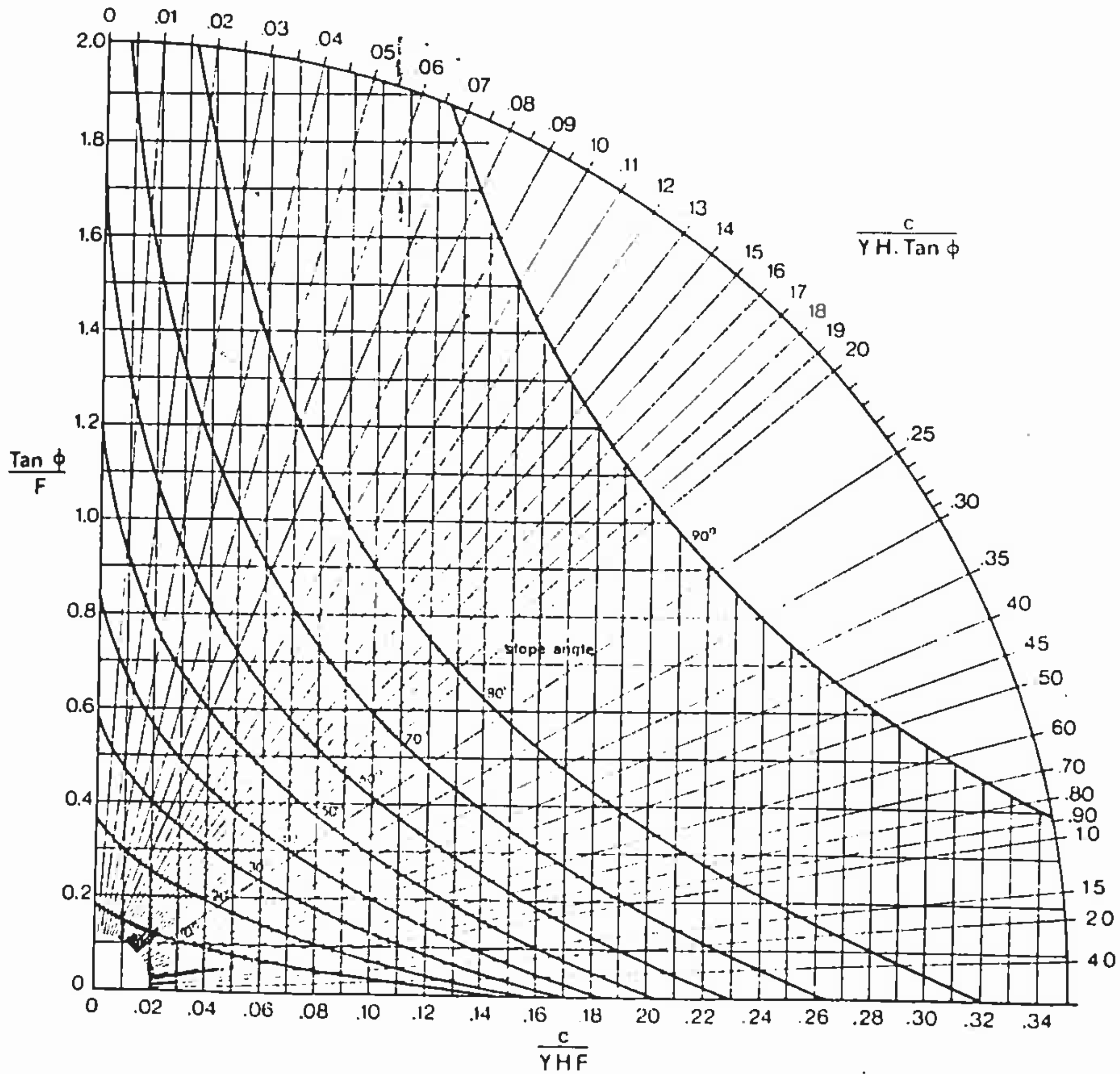
LOCATION Black Mesa

SUBJECT Slope Stability Analysis - Bishop & Morgenstern SHEET NO. 3

COMPUTED BY BC DATE 8/12/76 CHECKED BY ____ DATE ____



CIRCULAR FAILURE CHART NUMBER 1



Radius = 70.0'

$\widehat{C}$ = 439.82'

$\angle^{c-+}$ = 53.13°

$\angle^{o-f}$ = 43.26°

$\angle^{o-4}$ = 34.87°

$\angle^{o-3}$ = 25.39°

$\angle^{o-2}$ = 16.67°

$\angle^{o-1}$ = 8.24°

$\angle^{1}$ = 8.24°

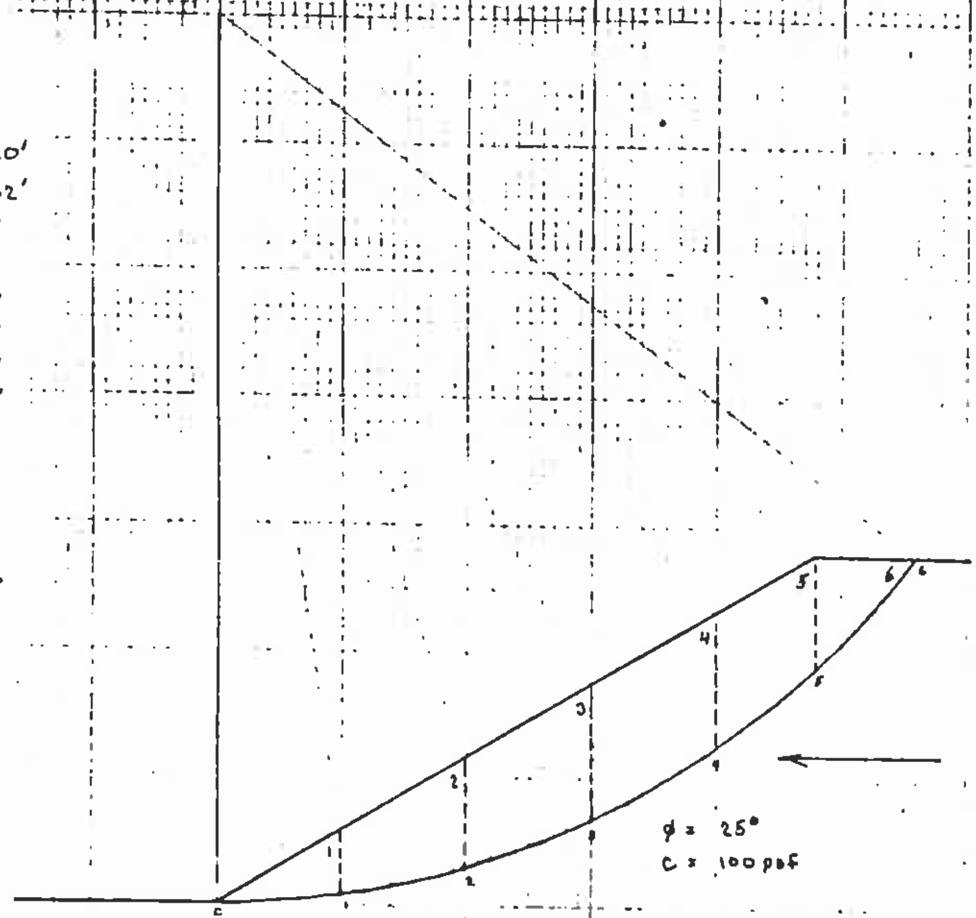
$\angle^{2}$ = 8.33°

$\angle^{3}$ = 8.8[illegible]°

$\angle^{4}$ = 9.48°

$\angle^{5}$ = 8.39°

$\angle^{6}$ = 9.87°



Scale 1" = 10'

i	Area ay	ft²	a_n ft	W_n	l_n	cl_n	α	Cos α	tan φ
1	27	27	[illegible]	[illegible]	10.66	[illegible]	5.25	.995	.4663
2	72	72	14	[illegible]	10.18	1018	12.8	.974	⁞
3	9[illegible]	9[illegible]	25	[illegible]	10.77	1077	20.4	[illegible]	⁞
4	107	10[illegible]	25	[illegible]	11.58	1158	[illegible]	.866	⁞
5	76	76	41	[illegible]	10.25	1025	41.4	.749	⁞
6	37	37	50	4070	12.06	1206	48.2	.666	↓

$$F.S = \frac{\Sigma RM}{\Sigma OM} = \frac{R(\Sigma cl_n + \Sigma W_n \cos\alpha \tan\phi)}{\sum_{i} W_n a_n}$$

i	$cl_n + W_n \cos\alpha \tan\phi$	$W_n a_n$
1	2384 ft-lb	19,600 ft²-lb
2	4615	126,720
3	5691	264,000
4	5922	411,960
5	3945	367,840
6	2470	203,500
	25027 ft-lb	1,393,610 ft²-lb

$$F.S = \frac{(70')(25{,}027)}{1{,}393{,}610} = 1.26$$

If we add an earthquake force of 0.05g times the mass at the approximate C.G. of the section (Moment Arm ≈ 58 ft)

$$F.S = \frac{(70)(25{,}027)}{(1{,}393{,}610) + (58)(46{,}650)(.05)} = 1.15$$

On the basis of this calculation, we can say that the effect of a 0.05g horizontal force is to reduce the S.F. to 0.91 times it static value

Dam No 1

Kayenta Mine

E76-2[illegible]

SERGENT, HAUSKINS & BECKWITH

C-5

Dam No. 1
Kayenta Mine
Navajo County, Arizona
SHB Job No. E76-29A

TABLE 1

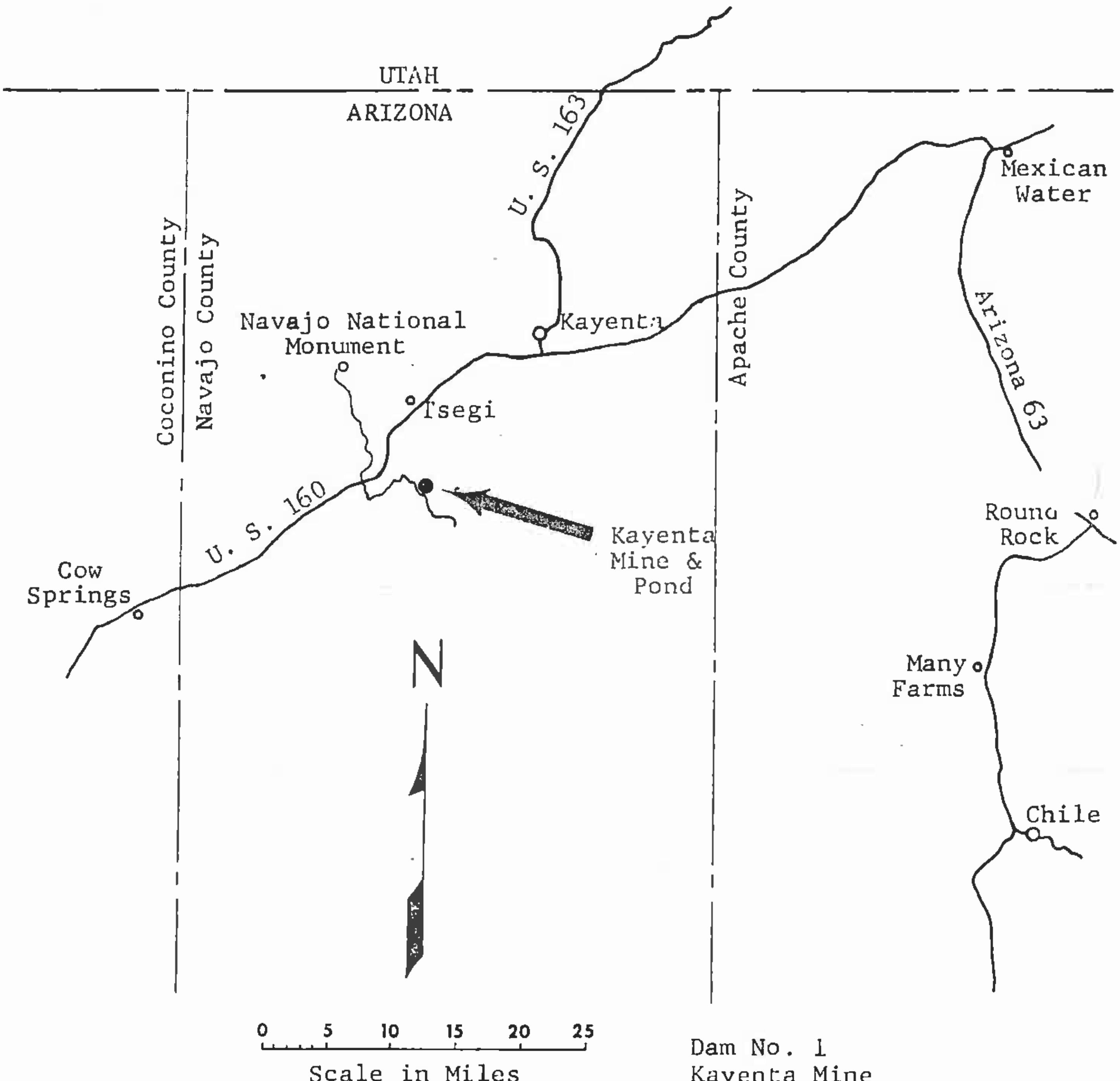
Earthquakes intensity V and above within the general region of Black Mesa through 1970. (From "Earthquake History of the United States", Dept. of Commerce Publication 41-1).

		Latitude	Longitude	Intensity
1873	July 30	38.3	112.7	VI
1887	Dec. 5	37.1	112.5	VI
1901	Nov. 13	38.7	112.1	VIII
1902	Nov. 17	37.4	113.5	VII
1910	Jan. 10-12	38.7	112.1	VI
1913	Nov. 11	38.2	107.7	V
1914	Dec. 20	37.6	113.8	V
1920	Nov. 25	37.1	113.5	V
1921	Sept. 29	38.8	112.2	VIII
1921	Sept. 29	38.8	112.2	VII
1921	Oct. 1	38.8	112.2	VIII
1928	Apr. 20	37.8	107.0	V
1933	Jan. 20	38.0	113.0	VI
1936	May 9	37.5	113.0	V-VI
1937	Feb. 17	38.0	112.5	V
1942	Aug. 30	37.7	113.0	VI
1944	Sept. 8	39.0	107.5	VI
1949	Nov. 1	37.2	113.3	VI
1953	Oct. 21	37.5	112.3	V
1955	Aug. 2	38.0	107.0	VI
1959	Feb. 27	38.0	112.5	VI
1959	July 21	37.0	112.5	VI
1960	Oct. 11	38.3	107.6	VI
1962	Feb. 15	36.9	112.4	V
1966	Jan. 22	37.0	107.0	VII
1967	Oct. 4	38.5	112.1	VII

Arizona		Latitude	Longitude	Intensity
1906	Jan. 25	35.2	111.7	VII
1910	Sept. 23	36.0	111.1	VI
1912	Aug. 18	36.5	111.5	VI-VII
1931	July 28	35.0	112.0	V
1935	Jan. 10	36.1	112.2	VI
1950	Jan. 16	35.5	109.5	VI
1959	Feb. 11	35.2	111.7	V
1959	July 21	37.0	112.5	VI
1959	Oct. 13	35.5	111.5	V
1962	Feb. 15	36.9	112.4	V

VICINITY MAP

FIGURE 1



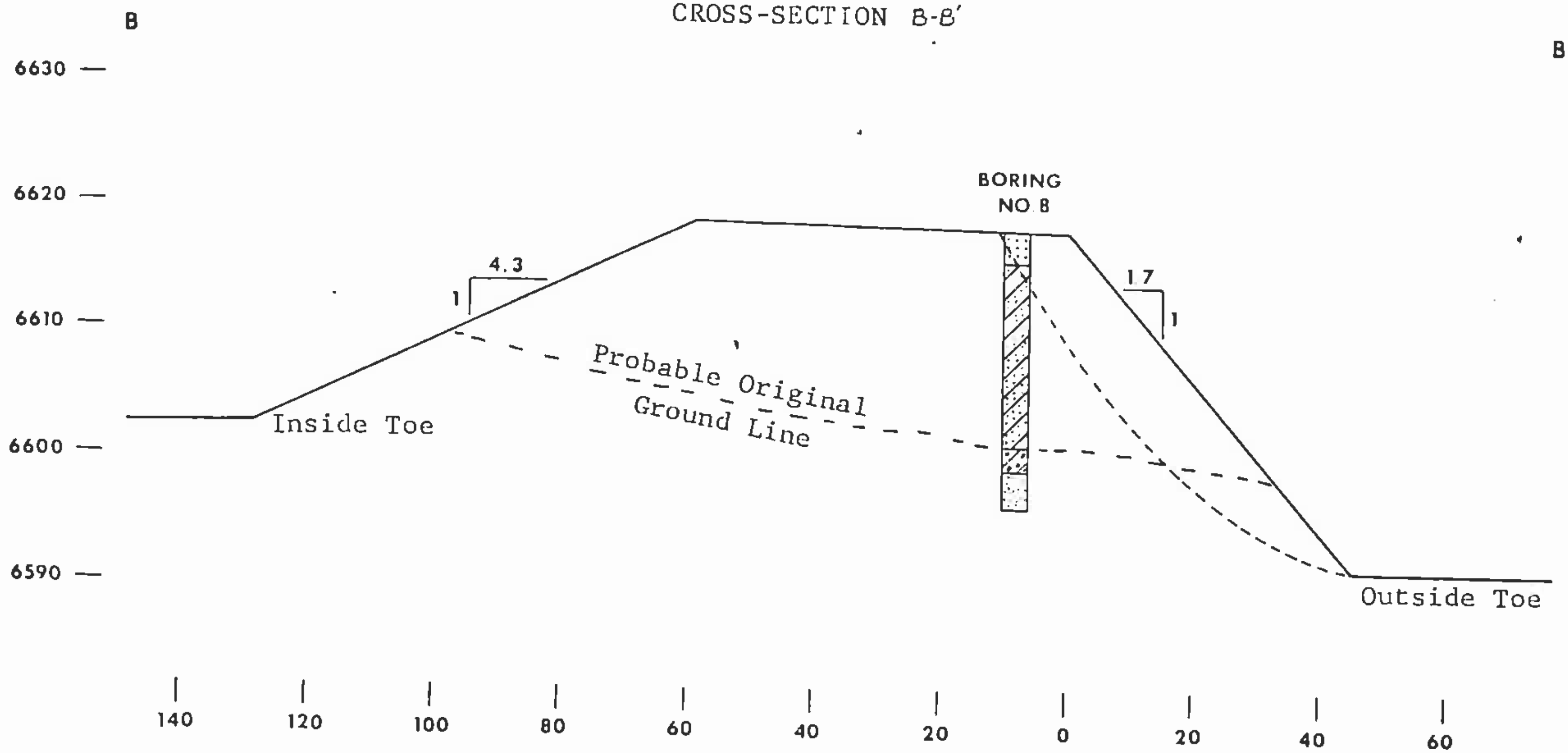
Dam No. 1
Kayenta Mine
Navajo County, Arizona
SHB Job No. E76-29A

SERGENT, HAUSKINS & BECKWITH

FIGURE 3

CROSS-SECTION OF SOUTH SIDE

CROSS-SECTION B-B′



Reference Drawing: "Cross-sections of Three Sided Dam" by Peabody Coal Company, Farmington, New Mexico, dated April 3, 1976

Dam No. 1
Kayenta Mine
Navajo County, Arizona
SHB Job No. E76-29A

SERGENT, HAUSKINS & BECKWITH

PEABODY COAL COMPANY

MSP DATA INPUT FORM

TITLE ____ PAGE 1

1	☒	DAMS 2	04/03/76	KAYENTA DAM NO 13 MESA 1 O. NO. 1211-AZ-9-0001
2	☐	AREA PRCT		
3	☒	BTM WIDTH	FEET	
	☐	BTM WIDTH		
4	☐	DN DATA		
5	☐	CLASS		
6	☐	COMMENT		
7	☐			
8	☐	OUTLETS		
9	☒	E.S. CREST		
	☐	E.S. CREST		
	☐	E.S. CREST		

S2 DATA INPUT FORM

TITLE ______

LEFT JUSTIFY ALL FIELDS

Line use indicator	Card	11–20	21–30	31–40	41–50	51–60	61–70	71–80
10 [X]	ES DATA	42	Spillway length: 80	Control section "n": .020	Side slope: 5.21	Exit channel: .020	1.90	
11 [X]	ES PROFILE	Profile number: 42	Distance pt 2: 20	Depth pt 2: 4.4	Distance pt 3: 40	Depth pt 3: 8.7		
12 [X]	ES PROFILE		Distance pt 4: 60	Depth pt 4: 13.2	Distance pt 5: 80	Depth pt 5: 17.3		
3 [ ]	ES PROFILE		Distance pt 6	Depth pt 6	Distance pt 7	Depth pt 7		
4 [ ]	ES RATING	Spillway type number	Stage increment	Any alphameric label				
[ ]	ES RATING							
[ ]	ES RATING							
[X]	KIRPICH							
[ ]	RPOINTS							
[ ]	P DIRECT		P 10A – IN	P 100A – IN	P 5H – IN	P 6H – IN		

S2 DATA INPUT FORM

B TITLE ______

LEFT JUSTIFY ALL FIELDS

Line	Indicator	Card	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6
20	☒	POOL DATA	ELEV	PERMANENT POOL: 6617.9	CREST PRINCIPAL SPILLWAY: 6617.9	FLOOD POOL SEDIMENT		
21	☐	PS COEFFS		"C" WEIR FIRST STAGE	"C" ORIFICE FIRST STAGE	"C" WEIR – HIGH STAGE	FILLET INCHES	
22	☐	PS DATA	NUMBER OF CONDUITS	LENGTH – FEET	DIAMETER OR WIDTH	BLANK OR HEIGHT	MANNING'S "N"	HYDRAULIC GRADIENT AT OUTLET
23	☐	PS INLET	HIGH STAGE CREST UNITS	ENTRANCE LOSS K_e	WEIR LENGTH – FT	CREST OF HIGH STAGE	ORIFICE HEIGHT – FT	ORIFICE LENGTH – FT
24	☐	PS FULL						
25	☒	PS RATING						
26	☒	PIOD PMP	CLIMATIC INDEX: 44.0	P 100: 2.9	PMP: 1.3	RATIO P…: 1.21	RATIO P_{H} DA/P_{M}: 1.49	
27	☐	ODIRECT		Q 10DA-IN	Q 100A-IN	Q ESH-IN	Q FSH-IN	
28	☐	Q IA+I		Ia – INCHES	INFILTRATION IN/HR			
29	☐	Q SCS						

MS2 DATA INPUT FORM

JOB TITLE ______

LEFT JUSTIFY ALL FIELDS

Line	Line use indicator	Cols 1–10	Cols 11–20	Cols 21–30	Cols 31–40	Cols 41–50	Cols 51–60	Cols 61–70	Cols 71–80
30	☐	STEPS TP	NO. OF STEPS						
31	☐	STØRM	NO. OF POINTS OR INFLOW HYD.	INFLOW HYD. TIME INCREMENT	STORM DURATION	STORM CN	STORM TC	STORM BASEFLOW	
32	☐	TC-15.3							
33	☐	TEMPLATE	TOP WIDTH	Z - UPSTREAM	Z - DOWNSTREAM	WAVE BERM WIDTH	STABILITY BERM WIDTH	DH MAXIMUM	
34	☒	WS DATA	(1) 1 (2) A	RUNOFF CURVE NUMBER: 49	DRAINAGE AREA IN SQ. MI.: 0.14	TC OR W/S LENGTH: 1140	BLANK OR W/S Δ ELEV.: 60.7	QUICK RETURN FLOW-CFS	
35	☐	WSP. ACCUR		DELTA ft	DELTA V				

(1) AREAL CORRECTION TYPE NUMBER
(2) DESIGN CLASS

1

PEABODY COAL COMPANY
DAMS2 DATA INPUT
MULTIPLE PASS FORM

LEFT JUSTIFY ALL FIELDS

JOB TITLE ____

1–10	DATA FIELD 1 (11–20)	DATA FIELD 2 (21–30)	DATA FIELD 3 (31–40)	DATA FIELD 4 (41–50)	DATA FIELD 5 (51–60)	61–70	71–80
COMMENT	ASSUMING POOL	TO BE 5	FT. HIGHER	THAN EXISTING	PRESENTLY		
*	RUNNING 6	HOUR STORMS	FIRST.				
GØ,STORM	CPC		2.0				
GØ,STORM	LPC		13.				
GØ,RAINS			1	10	2.		
COMMENT	RUN NO. 1						
END JØB							

LINE USE INDICATOR CHECK ONLY IF LAST PAGE OF INPUT ☒

DATE ____

PEABODY COAL COMPANY
STRUCTURE DATA
DAMS2 INPUT TABLE

JOB TITLE

LEFT JUSTIFY ALL FIELDS

LINE USE INDICATOR ☒

	STRUCTURE NAME		ANY ALPHABETIC LABEL	CARD IDENT.
STRUCTURE				

	ELEVATION FEET	SURFACE AREA A	DISCHARGE CFS	STORAGE VOL. AC-FT.		CARD IDENT.
	6600	0.00	0			
	6605	1.13	0			
	6610	1.53	0			
	6615	1.94	0			
	6611.9	2.40	0			
END TABLE						

CODE ONLY IF LAST PAGE OF TABLE ☒

```
CAMS2 XEC  6/23/76
     REV 06/18/73                KAYENTA    DAM NO.1   MFSA I.D. NO. 1211-AZ-9-0001

                 TOP OF DAM ELEV AT SOUTHEAST CORNER IS ELEV 6619

                 RUN GEN. STORM(6HR DURATION)
```

******************************* BASIC DATA *******************************

ARID-SEMIARID CLIMATE AREA   DESIGN CLASS A

STORM DISTRIBUTION.....GEN. 6 HOUR STORM DISTRIBUTION

P-100 2.90	PMP 13.00	P1DA/P6HR 1.210	P10DA/P1DA 1.490	CN 63.00	DA-SM 0.01	TC/L 680.00	-/H 80.70
CONDUITS 0.0	COND L 0.0	D/W 0.0	-/H 0.0	PS N 0.0	KI 0.0	WEIR L 0.0	TW EL 0.0
PERM POOL 6617.90	CREST PS 6617.50	FP SED 0.0	BASEFLOW 0.0	2ND STG 0.0	ORF H 0.0	ORF L 0.0	START 6617.90
FS1 6617.90	ES2 0.0	ES3 0.0	FS4 0.0	ES5 0.0	Z ES 521.00	EXIT N 0.020	EXIT S 0.019
ES TYPE 42	ES L 80	ES N 0.020	BW1 1.00	BW2 0.0	BW3 0.0	BW4 0.0	BW5 0.0

PROVIDED BY ES FILE

ES CODE 42080.020	INCREMENT 1.000			Q1 3.270	Q2 8.921	Q3 16.252	Q4 24.924
Q5 34.745	Q6 45.594	Q7 57.407	Q8 70.087	Q9 83.579	Q10 97.844	Q11 112.837	Q12 128.523

********************** DETAILED LIST OF BASIC DATA **********************

WEIR COEF. FOR ORIFICES........ 3.10	RATIO OF IA TO S(CH.10,NEH4).. 0.20	MIN ES BW WHEN MAX V/C GIVEN.. 20.0
WEIR COEF. FOR DROP INLET...... 3.10	TIME INCS TO PEAK OF UNIT HYD. 5.	DELTA BW WHEN MAX V/C GIVEN... 64.0
DISCHARGE COEF. FOR ORIFICES.. 0.60	NO. POINTS FOR DESIGN HYD..... 101	PRECISION OF BW SOLUTION...... 1.0
FILLET SIZE FOR BOX CONDUITS.. 6.00	ES-WSP CALC. DEPTH PRECISION. 0.005	PRECISION OF V/C SOLUTION..... 0.03
GRAVITATIONAL CONSTANT........ 32.16	ES-WSP PERMISSIBLE VEL.CHANGE. 0.05	

EMBANKMENT TEMPLATE	TOP WIDTH 0.0	UPSTREAM Z 2.5	DOWNSTREAM Z 2.5	WAVE BERM 10.0	STAB. BERM 0.0	OH MAX 0.0
RAINFALL EQUATION CONSTANTS CLASS A	K1 PSH 0.82	K1 ESH 1.00	K1 FBH 1.00	K2 PSH 0.0	K2 ESH 0.0	K2 FBH 0.12

DIMENSIONLESS UNIT HYDROGRAPH PEAK FACTOR = 484.0

0.0	0.030	0.100	0.190	0.310	0.470	0.660	0.820	0.930	0.990
1.000	0.990	0.930	0.860	0.780	0.680	0.560	0.460	0.390	0.330
0.280	0.240	0.207	0.177	0.147	0.127	0.107	0.090	0.077	0.065
0.055	0.047	0.040	0.034	0.029	0.025	0.021	0.018	0.015	0.013
0.011	0.009	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.001
0.0									

SCS DESIGN STORM RAINFALL DISTRIBUTION. (CHAPTER 21, NEH4 AND SCS EM-27)

0.0	0.013	0.027	0.042	0.059	0.078	0.099	0.122	0.147	0.180
0.230	0.380	0.530	0.625	0.670	0.705	0.736	0.764	0.790	0.814
0.836	0.856	0.875	0.893	0.910	0.927	0.942	0.957	0.972	0.986
1.000									

POINT ONE-HR. STORM ID NAME IS USBRG

0.0	0.170	0.400	0.880	1.000

GEN. 6 HOUR STORM DISTRIBUTION ID NAME IS GRBSU

0.0	0.120	0.260	0.420	0.710	0.890	1.000

```
CAMS2 XEC  6/23/76
     REV 06/18/73

*************************** 80-80 LIST OF INPUT DATA ****************************

CAMS2      04/03/76  KAYENTA    DAM NO.1  MESA I.C. NC. 1211-AZ-9-0001         3500
STRUCTURE                                                                      3500
                     6600       0.00      0                                    3500
                     6605       1.13      0                                    3500
                     6610       1.53      0                                    3500
                     6615       1.94      0                                    3500
                     6617.9     2.40      0                                    3500
                     6619       2.82      0                                    3500
ENDTABLE                                                                       3500
RAINTABLE USBRG      1.0        POINT ONE-HR. STORM                            3500
                     0.0        0.17      0.40      0.88      1.0              3500
ENDTABLE                                                                       3500
RAINTABLE GRBSU      6.0        GEN. 6 HOUR STORM DISTRIBUTION                 3500
                     0          0.12      0.26      0.42      0.71             3500
                     0.89       1.00                                           3500
ENDTABLE                                                                       3500
BTMWIDTH  FEET       1                                                         3500
DOTESTS                                                                        3500
ESCREST   ELEV       6617.9                                                    3500
ESDATA    42         80         .020      521       .020      1.90             3500
ESPROFILE 42         20         4.4       40        8.7                        3500
ESPROFILE            60         13.0      80        17.3                       3500
KIRPICH                                                                        3500
POOLDATA  ELEV       6617.9     6617.9                                         3500
PSRATING                                                                       3500
P100,PMP  .448       2.9        13        1.21      1.49                       3500
WSDATA    1A         63         .014      680.0     80.7                       3500
COMMENT   TOP OF DAM ELEV AT SOUTHEAST CORNER IS ELEV 6619                     3500
COMMENT   RUN GEN. STORM(6HR DURATION)                                         3500
STORM     30.0                  6.0                                            3500
GO,STORM  LPC        GRBSU      2.9  100yr                      6617.9         3500
STORM     35.0                  6.0                                            3500
GO,STORM  LPC        GRBSU      13.0  PMP                       6617.9         3500
COMMENT   ROUTE ONE-HR PT STORM                                                3500
STORM     30.0                  1.0                                            3500
GO,STORM  LPC        USBRG      2.7  100yr                      6617.9         3500
STORM     35.0                  1.0                                            3500
GO,STORM  LPC        USBRG      9.5  PMP                        6617.9         3500
GO,TDD               6619       6617.9    0                                    3500
COMMENT   WATERSHED IS PREDOMINANTLY RANGE IN FAIR CONDITION                   3500
COMMENT   RUN NO. 11  ROUTE BOTH DURATION STORMS                               3500
ENDJOB                                                                         3500

*********************************************************************************
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CAMS2 XEQ 6/23/76 KAYENTA DAM NO.1 MESA I.D. NO. 1211-AZ-9-0001 PASS 1
REV 06/18/73 PAGE 2

PERM POOL	6617.90 FT	24.4 ACFT	2.40 AC	
CREST PS	6617.90 FT	24.4 ACFT	2.40 AC	
SED ACCUM	6617.90 FT	24.4 ACFT	2.40 AC	
ES CREST	6617.90 FT	24.4 ACFT	2.40 AC	
PS STORAGE	0.0 ACFT			
STARTING E	6617.90 FT	24.4 ACFT	2.40 AC	0.0 CFS

STORM HYD D= 6.00 HR , P= 2.90 IN Q= 0.39 IN
TC= 0.04 HR CN= 63.00 V= 0.3 ACFT
PEAK 1.6 CFS AT 4.02 HRS

****

RATING TABLE NUMBER 2

	E FEET	Q CFS	V AC FT	A ACRE
1	6617.90	0.0	24.44	2.40
2	6617.90	0.0	24.44	2.40
3	6617.90	0.0	24.44	2.40
4	6617.90	0.0	24.44	2.40
5	6617.90	0.0	24.44	2.40
6	6617.90	0.0	24.44	2.40
7	6617.90	0.0	24.44	2.40
8	6617.90	0.0	24.44	2.40
9	6617.90	0.0	24.44	2.40
10	6617.90	0.0	24.44	2.40
11	6617.90	0.0	24.44	2.40
12	6617.90	0.0	24.44	2.40
13	6617.90	0.0	24.44	2.40
14	6617.95	9.48	24.57	2.42
15	6618.01	29.88	24.70	2.44
16	6618.11	86.18	24.94	2.48
17	6618.23	185.29	25.25	2.53
18	6618.45	438.54	25.82	2.61
19	6618.72	857.75	26.55	2.71
20	6619.00	1549.03	27.31	2.82

TYPE	BW	EMAX	VMAX	AMAX	HP	V-ES	Q-PS	Q-ES	Q-TOT	D/C	V/C	S/C	S/C.25	O-ES
STORM HYD	1.0	6617.91	24.5	2.4	0.01	0.0	0.	1.	1.	0.05	1.24	0.016	0.022	3.8

PLOT 1 IN = 10. CFS EXIT SLOPE = 0.019
0. 10. 20. 30. 40. 50. 60. 70. EXIT
I I I I I I I I VEL

T	I	O	E	V	A	EXIT VEL
0.0	0	0	6617.9	24.4	2.4 .	0.0
0.21	0	0	6617.9	24.4	2.4 .	0.0
0.42	0	0	6617.9	24.4	2.4 .	0.0
0.64	0	0	6617.9	24.4	2.4 .	0.0
0.85	0	0	6617.9	24.4	2.4 .	0.0
1.06	0	0	6617.9	24.4	2.4 .	0.0
1.27	0	0	6617.9	24.4	2.4 .	0.0
1.48	0	0	6617.9	24.4	2.4 .	0.0

******************************* BASIC DATA *************************

ARID-SEMIARID CLIMATE AREA DESIGN CLASS A

STORM DISTRIBUTION.....GEN. 6 HOUR STORM DISTRIBUTION

P-100 2.90	PMP 13.00	P1DA/P6HR 1.210	P10DA/P1DA 1.490	CN 63.00	DA-SM 0.01	TC/L 80.00	-/H 80.70
CONDUITS 0.0	COND L 0.0	D/W 0.0	-/H 0.0	PS N 0.0	KI 0.0	FIR L 0.0	TW EL 0.0
PERM POOL 6617.90	CREST PS 6617.90	FP SEC 0.0	BASEFLOW 0.0	2ND STG 0.0	ORF H 0.0	ORF L 0.0	START 6617.90
ES1 6617.90	ES2 0.0	ES3 0.0	ES4 0.0	ES5 0.0	Z ES 521.00	EXIT N 0.020	EXIT S 0.019
ES TYPE 42	ES L 80	ES N 0.020	BW1 1.00	BW2 0.0	BW3 0.0	BW4 0.0	BW5 0.0

PROVIDED BY ES FILE

ES CODE 42080.020	INCREMENT 1.000			Q1 3.270	Q2 8.921	Q3 6.252	Q4 24.924
Q5 34.745	Q6 45.594	Q7 57.407	Q8 70.087	Q9 83.579	Q10 97.844	Q11 2.837	Q12 128.523

********************** DETAILED LIST OF BASIC DATA ****************

WEIR COEF. FOR ORIFICES....... 3.10	RATIO OF IA TO S(CH.10,NEH4).. 0.20	MIN ES BW W	MAX V/C GIVEN.. 20.0
WEIR COEF. FOR DROP INLET..... 3.10	TIME INCS TO PEAK OF UNIT HYD. 5.	DELTA BW WH	AX V/C GIVEN... 64.0
DISCHARGE COEF. FOR ORIFICES.. 0.60	NO. POINTS FOR DESIGN HYD..... 101	PRECISION O	SOLUTION...... 1.0
FILLET SIZE FOR BOX CONDUITS.. 6.00	ES-WSP CALC. DEPTH PRECISION. 0.005	PRECISION C	C SOLUTION..... 0.03
GRAVITATIONAL CONSTANT....... 32.16	ES-WSP PERMISSIBLE VEL.CHANGE. 0.05		

EMBANKMENT TEMPLATE	TOP WIDTH 0.0	UPSTREAM Z 2.5	DOWNSTREAM Z 2.5	WAVE BERM S 10.0	BERM .0	DH MAX 0.0
RAINFALL EQUATION CONSTANTS CLASS A	K1 PSH 0.82	K1 ESH 1.00	K1 FBH 1.00	K2 PSH 0.0	ESH .0	K2 FBH 0.12

DIMENSIONLESS UNIT HYDROGRAPH   PEAK FACTOR = 484.0

0.0	0.030	0.100	0.190	0.310	0.470	0.660	0.820	0.930	0.990
1.000	0.990	0.930	0.860	0.780	0.680	0.560	0.460	0.390	0.330
0.280	0.240	0.207	0.177	0.147	0.127	0.107	0.090	0.077	0.065
0.055	0.047	0.040	0.034	0.029	0.025	0.021	0.018	0.015	0.013
0.011	0.009	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.001
0.0									

SCS DESIGN STORM RAINFALL DISTRIBUTION. (CHAPTER 21, NEH4 AND SCS FM-27)

0.0	0.013	0.027	0.042	0.059	0.078	0.099	0.122	0.147	0.180
0.230	0.380	0.530	0.625	0.670	0.705	0.736	0.764	0.790	0.814
0.836	0.856	0.875	0.893	0.910	0.927	0.942	0.957	0.972	0.986
1.000									

POINT ONE-HR. STORM   ID NAME IS USBRG

0.0	0.170	0.400	0.880	1.000

GEN. 6 HOUR STORM DISTRIBUTION   ID NAME IS GRBSU

0.0	0.120	0.260	0.420	0.710	0.890	1.000

```
DAMS2 XEQ  6/23/76              KAYENTA   DAM NO.1  MESA I.D. NO. 1211-AZ-9-0001                    PASS    2
     REV 06/18/73                                                                                   PAGE    2

           PERM POOL        6617.90 FT      24.4 ACFT      2.40 AC

           CREST PS         6617.90 FT      24.4 ACFT      2.40 AC

           SED ACCUM        6617.90 FT      24.4 ACFT      2.40 AC

           ES CREST         6617.90 FT      24.4 ACFT      2.40 AC

           PS STORAGE           0.0 ACFT

           STARTING E       6617.90 FT      24.4 ACFT      2.40 AC        0.0 CFS

           STORM HYD       D=    6.00 HR     P= 13.00 IN     Q=  7.90 IN
                          TC=    0.04 HR    CN=  63.00       V=       5.9 ACFT
                PEAK            27.5 CFS AT     3.97 HRS

*******************************************************************************

                                RATING TABLE NUMBER  2
                       E            Q             V            A
                      FEET         CFS          AC FT        ACRE
                  1  6617.90        0.0         24.44         2.40
                  2  6617.90        0.0         24.44         2.40
                  3  6617.90        0.0         24.44         2.40
                  4  6617.90        0.0         24.44         2.40
                  5  6617.90        0.0         24.44         2.40
                  6  6617.90        0.0         24.44         2.40
                  7  6617.90        0.0         24.44         2.40
                  8  6617.90        0.0         24.44         2.40
                  9  6617.90        0.0         24.44         2.40
                 10  6617.90        0.0         24.44         2.40
                 11  6617.90        0.0         24.44         2.40
                 12  6617.90        0.0         24.44         2.40
                 13  6617.90        0.0         24.44         2.40
                 14  6617.95        9.48        24.57         2.42
                 15  6618.01       29.88        24.70         2.44
                 16  6618.11       86.18        24.94         2.48
                 17  6618.23      185.29        25.25         2.53
                 18  6618.45      438.54        25.82         2.61
                 19  6618.72      857.75        26.55         2.71
                 20  6619.00     1549.03        27.31         2.82

  TYPE       BW    EMAX     VMAX    AMAX    HP    V-ES    Q-PS    Q-ES   Q-TOT   D/C    V/C    S/C   S/C.25   D-ES
STORM HYD   1.0  6618.00    24.7     2.4   0.10    0.2     0.      27.     27.   0.15   2.23  0.011  0.015    6.0

             PLOT                                 1 IN =    10. CFS
                                                  0.        10.       20.       30.       40.       50.       60.   EXIT SLOPE = 0.019
   T          I        O      E        V       A  I          I         I         I         I         I         I        70. EXIT
                                                                                                                          I   VEL
  0.0         0        0 6617.9      24.4    2.4 .                                                                            0.0
  0.18        0        0 6617.9      24.4    2.4 .                                                                            0.0
  0.36        0        0 6617.9      24.4    2.4 .                                                                            0.0
  0.54        0        0 6617.9      24.4    2.4 .                                                                            0.0
  0.72        0        0 6617.9      24.4    2.4 .                                                                            0.0
  0.90        1        0 6617.9      24.4    2.4 .I                                                                           0.0
  1.08        2        1 6617.9      24.5    2.4 .EI                                                                          0.95
  1.26        4        2 6617.9      24.5    2.4 . E I                                                                        1.29
                                                                                                                              1.51
```

```
 1.81    7    6 6617.9   24.5  2.4 .     EI                                                                 [illegible]
 1.99    7    7 6617.9   24.5  2.4 .     E                                                                  1.91
 2.17    9    8 6617.9   24.5  2.4 .       EI                                                               1.99
 2.35   10    9 6617.9   24.6  2.4 .        EI                                                              2.05
 2.53   11   10 6618.0   24.6  2.4 .         EI                                                             2.12
 2.71   11   11 6618.0   24.6  2.4 .          E                                                             2.15
 2.89   12   12 6618.0   24.6  2.4 .           E                                                            2.18
 3.07   22   17 6618.0   24.6  2.4 .               E    I                                                   2.38
 3.25   24   24 6618.0   24.7  2.4 .                      E                                                 2.57
 3.43   25   25 6618.0   24.7  2.4 .                       E                                                2.59
 3.61   26   26 6618.0   24.7  2.4 .                        E                                               2.58
 3.79   27   26 6618.0   24.7  2.4 .                        EI                                              2.64
 3.97   28   27 6618.0   24.7  2.4 .                         XX                                             2.64
 4.15   17   22 6618.0   24.7  2.4 .               I    E                                                   2.51
 4.34   18   17 6618.0   24.6  2.4 .               EI                                                       2.37
 4.52   18   18 6618.0   24.6  2.4 .                E                                                       2.37
 4.70   18   18 6618.0   24.6  2.4 .                E                                                       2.39
 4.88   18   18 6618.0   24.6  2.4 .                E                                                       2.37
 5.06   12   15 6618.0   24.6  2.4 .          I  E                                                          2.28
 5.24   11   11 6618.0   24.6  2.4 .         E                                                              2.14
 5.42   11   11 6618.0   24.6  2.4 .         E                                                              2.15
 5.60   11   11 6618.0   24.6  2.4 .         E                                                              2.16
 5.78   11   11 6618.0   24.6  2.4 .         E                                                              2.12
 5.96   11   11 6618.0   24.6  2.4 .         E                                                              2.13
 6.14    0    7 6617.9   24.5  2.4 .     E                                                                  1.87
   T     I    O      E      V    A  I         I         I         I         I         I         I         I   VEL
                                    0.       10.       20.       30.       40.       50.       60.       70.  EXIT
```

DAMS2 XEQ 6/23/76
REV 06/18/73

KAYENTA DAM NO.1 MESA I.D. NO. 1211-AZ-9-0001

ROUTE ONE-HR PT STORM

******************************* BASIC DATA *******************************

ARID-SEMIARID CLIMATE AREA   DESIGN CLASS A

STORM DISTRIBUTION.....POINT ONE-HR. STORM

P-100 2.90	PMP 13.00	P1DA/P6HR 1.210	P100A/P10A 1.490	CN 63.00	DA-SM 0.01	TC/L 680.00	-/H 80.70
CONDUITS 0.0	COND L 0.0	D/H 0.0	-/H 0.0	PS N 0.0	KI 0.0	WEIR L 0.0	TW EL 0.0
PERM POOL 6617.90	CREST PS 6617.90	FP SED 0.0	BASEFLOW 0.0	2ND STG 0.0	ORF H 0.0	ORF L 0.0	START 6617.90
FS1 6617.90	ES2 0.0	ES3 0.0	ES4 0.0	ES5 0.0	Z FS 521.00	EXIT N 0.020	EXIT S 0.019
FS TYPE 42	ES L 80	ES N 0.020	BW1 1.00	BW2 0.0	BW3 0.0	BW4 0.0	BW5 0.0

PROVIDED BY ES FILE

ES CODE 42080.020	INCREMENT 1.000			Q1 3.270	Q2 8.921	Q3 16.252	Q4 24.924
Q5 34.745	Q6 45.594	Q7 57.407	Q8 70.087	Q9 83.579	Q10 97.844	Q11 112.837	Q12 128.523

********************* DETAILED LIST OF BASIC DATA *********************

WEIR COEF. FOR ORIFICES........ 3.10   RATIO OF IA TO S(CH.10,NEH4).. 0.20   MIN ES BW WHEN MAX V/C GIVEN.. 20.0

WEIR COEF. FOR DROP INLET..... 3.10   TIME INCS TO PEAK OF UNIT HYD. 5.   DELTA BW WHEN MAX V/C GIVEN... 64.0

DISCHARGE COEF. FOR ORIFICES.. 0.60   NO. POINTS FOR DESIGN HYD..... 101   PRECISION OF BW SOLUTION...... 1.0

FILLET SIZE FOR BOX CONDUITS.. 6.00   ES-WSP CALC. DEPTH PRECISION. 0.005   PRECISION OF V/C SOLUTION..... 0.03

GRAVITATIONAL CONSTANT....... 32.16   ES-WSP PERMISSIBLE VEL.CHANGE. 0.05

EMBANKMENT TEMPLATE	TOP WIDTH 0.0	UPSTREAM Z 2.5	DOWNSTREAM Z 2.5	WAVE BERM 10.0	STAB. BERM 0.0	DH MAX 0.0
RAINFALL EQUATION CONSTANTS CLASS A	K1 PSH 0.82	K1 ESH 1.00	K1 FBH 1.00	K2 PSH 0.0	K2 ESH 0.0	K2 FBH 0.12

DIMENSIONLESS UNIT HYDROGRAPH PEAK FACTOR = 484.0

0.0	0.030	0.100	0.190	0.310	0.470	0.660	0.820	0.930	0.990
1.000	0.990	0.930	0.860	0.780	0.680	0.560	0.460	0.390	0.330
0.280	0.240	0.207	0.177	0.147	0.127	0.107	0.090	0.077	0.065
0.055	0.047	0.040	0.034	0.029	0.025	0.021	0.018	0.015	0.013
0.011	0.009	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.001
0.0									

SCS DESIGN STORM RAINFALL DISTRIBUTION. (CHAPTER 21, NEH4 AND SCS EM-27)

0.0	0.013	0.027	0.042	0.059	0.078	0.099	0.122	0.147	0.180
0.230	0.380	0.530	0.625	0.670	0.705	0.736	0.764	0.790	0.814
0.836	0.856	0.875	0.893	0.910	0.927	0.942	0.957	0.972	0.986
1.000									

POINT ONE-HR. STORM ID NAME IS USBRG

0.0	0.170	0.400	0.880	1.000

GEN. 6 HOUR STORM DISTRIBUTION ID NAME IS GRBSU

0.0	0.120	0.260	0.420	0.710	0.890	1.000

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DAMS2 XEC  6/23/76
  REV 06/18/73                     KAYENTA    DAM NO.1   MESA I.D. NO. 1211-AZ-9-0001
                                                                                              PASS   3
          PERM POOL       6617.90 FT      24.4 ACFT      2.40 AC                              PAGE   2
          CREST PS        6617.90 FT      24.4 ACFT      2.40 AC
          SED ACCUM       6617.90 FT      24.4 ACFT      2.40 AC
          ES CREST        6617.90 FT      24.4 ACFT      2.40 AC
          PS STORAGE         0.0 ACFT                    2.40 AC
          STARTING E      6617.90 FT      24.4 ACFT
          STORM HYD     D=    1.00 HR                    2.40 AC          0.0 CFS
                       TC=    0.04 HR   P=   2.70 IN
             PEAK           12.6 CFS AT CN=  63.00       Q=  0.31 IN
                                              0.75 HRS   V=     0.2 ACFT
*****************************************************************************************

                                RATING TABLE NUMBER  2
                        E              Q              V              A
                      FEET            CFS           AC FT          ACRE
                  1  6617.90          0.0           24.44          2.40
                  2  6617.90          0.0           24.44          2.40
                  3  6617.90          0.0           24.44          2.40
                  4  6617.90          0.0           24.44          2.40
                  5  6617.90          0.0           24.44          2.40
                  6  6617.90          0.0           24.44          2.40
                  7  6617.90          0.0           24.44          2.40
                  8  6617.90          0.0           24.44          2.40
                  9  6617.90          0.0           24.44          2.40
                 10  6617.90          0.0           24.44          2.40
                 11  6617.90          0.0           24.44          2.40
                 12  6617.90          0.0           24.44          2.40
                 13  6617.90          0.0           24.44          2.40
                 14  6617.95          0.0           24.44          2.40
                 15  6618.01          9.48          24.57          2.40
                 16  6618.11         29.88          24.70          2.42
                 17  6618.23         86.18          24.94          2.44
                 18  6618.45        185.29          25.25          2.48
                 19  6618.72        438.54          25.82          2.53
                 20  6619.00        857.75          26.55          2.61
                                   1549.03          27.31          2.71
                                                                   2.82
   TYPE
 STORM HYD    BW      EMAX      VMAX    AMAX     HP     V-ES    Q-PS    Q-ES    Q-TOT    D/C    V/C     S/C    S/C.25    D-ES
              1.0    6617.93    24.5     2.4    0.04    0.1      0.      6.      6.     0.08    1.66   0.013   0.018     1.2
          PLOT
                                                 1 IN =     10. CFS
    T        I      O     E          V      A    0.         10.       20.      30.      40.      50.     60.      70.  EXIT
   0.0       0      0  6617.9      24.4    2.4 . I          I         I        I        I        I       I        I    VEL
   0.04      0      0  6617.9      24.4    2.4 .                                                EXIT SLOPE = 0.019        0.0
   0.08      0      0  6617.9      24.4    2.4 .                                                                          0.0
   0.12      0      0  6617.9      24.4    2.4 .                                                                          0.0
   0.16      0      0  6617.9      24.4    2.4 .                                                                          0.0
   0.20      0      0  6617.9      24.4    2.4 .
   0.24      0      0  6617.9      24.4    2.4 .
   0.28      0      0  6617.9      24.4    2.4 .
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0.39     0     0 6617.9    24.4    2.4 .                                                                            0.0
0.43     0     0 6617.9    24.4    2.4 .                                                                            0.0
0.47     0     0 6617.9    24.4    2.4 .                                                                            0.0
0.51     0     0 6617.9    24.4    2.4 .                                                                            0.0
0.55     1     0 6617.9    24.4    2.4 .I                                                                           0.0
0.59     3     0 6617.9    24.4    2.4 .  I                                                                         0.71
0.63     6     1 6617.9    24.5    2.4 .E    I                                                                      0.59
0.67     8     2 6617.9    24.5    2.4 . E     I                                                                    1.27
0.71    10     4 6617.9    24.5    2.4 .   E     I                                                                  1.48
0.75    13     5 6617.9    24.5    2.4 .    E        X                                                              1.66
0.79     7     6 6617.9    24.5    2.4 .     XI                                                                     1.83
0.83     4     6 6617.9    24.5    2.4 .   I E                                                                      1.85
0.87     4     6 6617.9    24.5    2.4 .   I E                                                                      1.85
0.91     4     5 6617.9    24.5    2.4 .   IE                                                                       1.84
0.95     4     5 6617.9    24.5    2.4 .   IE                                                                       1.79
0.98     4     5 6617.9    24.5    2.4 .   IE                                                                       1.78
1.02     3     5 6617.9    24.5    2.4 .  I E                                                                       1.75
1.06     0     4 6617.9    24.5    2.4 .   E                                                                        1.73
1.10     0     3 6617.9    24.5    2.4 .  E                                                                         1.66
1.14     0     3 6617.9    24.5    2.4 .  E                                                                         1.58
  T      I     O      E      V      A  I         I         I         I         I         I         I         I     1.50
                                       0.        10.       20.       30.       40.       50.       60.       70.    VEL
                                                                                                                    EXIT
```

****************************** BASIC DATA ******************************

ARID-SEMIARID CLIMATE AREA

DESIGN CLASS A

STORM DISTRIBUTION.....POINT ONE-HR. STORM

P-100 2.90	PMP 13.00	P1DA/P6HR 1.210	P100A/P1DA 1.490	CN 63.00	DA-SM 0.01	TC/L 680.00	-/H 80.70
CONDUITS 0.0	COND L 0.0	D/W 0.0	-/H 0.0	PS N 0.0	KI 0.0	WEIR L 0.0	TW EL 0.0
PERM POOL 6617.90	CREST PS 6617.90	FP SED 0.0	BASEFLOW 0.0	2ND STG 0.0	ORF H 0.0	ORF L 0.0	START 6617.90
ES1 6617.90	ES2 0.0	ES3 0.0	ES4 0.0	ES5 0.0	Z ES 521.00	EXIT N 0.020	EXIT S 0.019
ES TYPE 42	ES L 80	ES N 0.020	BW1 1.00	BW2 0.0	BW3 0.0	BW4 0.0	BW5 0.0

PROVIDED BY ES FILE

ES CODE 42080.020	INCREMENT 1.000			Q1 3.270	Q2 8.921	Q3 16.252	Q4 24.924
Q5 34.745	Q6 45.554	Q7 57.407	Q8 70.087	Q9 83.579	Q10 97.844	Q11 112.837	Q12 128.523

********************* DETAILED LIST OF BASIC DATA *********************

WEIR COEF. FOR ORIFICES....... 3.10
WEIR COEF. FOR DROP INLET..... 3.10
DISCHARGE COEF. FOR ORIFICES.. 0.60
FILLET SIZE FOR BOX CONDUITS.. 6.00
GRAVITATIONAL CONSTANT....... 32.16

RATIO OF IA TO S(CH.10,NEH4).. 0.20
TIME INCS TO PEAK OF UNIT HYD. 5.
NO. POINTS FOR DESIGN HYD..... 101
ES-WSP CALC. DEPTH PRECISION. 0.005
ES-WSP PERMISSIBLE VEL.CHANGE. 0.05

MIN ES BW WHEN MAX V/C GIVEN.. 20.0
DELTA BW WHEN MAX V/C GIVEN... 64.0
PRECISION OF BW SOLUTION...... 1.0
PRECISION OF V/C SOLUTION..... 0.03

EMBANKMENT TEMPLATE	TOP WIDTH 0.0	UPSTREAM Z 2.5	DOWNSTREAM Z 2.5	WAVE BERM 10.0	STAB. BERM 0.0	DH MAX 0.0
RAINFALL EQUATION CONSTANTS CLASS A	K1 PSH 0.82	K1 FSH 1.00	K1 FBH 1.00	K2 PSH 0.0	K2 ESH 0.0	K2 FBH 0.12

DIMENSIONLESS UNIT HYDROGRAPH   PEAK FACTOR = 484.0

0.0	0.030	0.100	0.190	0.310	0.470	0.660	0.820	0.930	0.990
1.000	0.990	0.930	0.860	0.780	0.680	0.560	0.460	0.390	0.330
0.280	0.240	0.207	0.177	0.147	0.127	0.107	0.090	0.077	0.065
0.055	0.047	0.040	0.034	0.029	0.025	0.021	0.018	0.015	0.013
0.011	0.009	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.001
0.0									

SCS DESIGN STORM RAINFALL DISTRIBUTION. (CHAPTER 21, NEH4 AND SCS EM-27)

0.0	0.013	0.027	0.042	0.059	0.078	0.099	0.122	0.147	0.180
0.230	0.380	0.530	0.625	0.670	0.705	0.736	0.764	0.790	0.814
0.836	0.856	0.875	0.893	0.910	0.927	0.942	0.957	0.972	0.986
1.000									

POINT ONE-HR. STORM

0.0	0.170	0.400	0.880	1.000

ID NAME IS USBRG

GEN. 6 HOUR STORM DISTRIBUTION

0.0	0.120	0.260	0.420	0.710	0.890	1.000

ID NAME IS GRBSU

PERM POOL	6617.90 FT	24.4 ACFT	2.40 AC	
CREST PS	6617.90 FT	24.4 ACFT	2.40 AC	
SED ACCUM	6617.90 FT	24.4 ACFT	2.40 AC	
ES CREST	6617.90 FT	24.4 ACFT	2.40 AC	
PS STORAGE	0.0 ACFT			
STARTING E	6617.90 FT	24.4 ACFT	2.40 AC	0.0 CFS

STORM HYD D= 1.00 HR P= 9.50 IN Q= 4.88 IN
TC= 0.04 HR CN= 63.00 V= 3.6 ACFT
PEAK 125.6 CFS AT 0.74 HRS

****

RATING TABLE NUMBER 2

	E FEET	Q CFS	V AC FT	A ACRE
1	6617.90	0.0	24.44	2.40
2	6617.90	0.0	24.44	2.40
3	6617.90	0.0	24.44	2.40
4	6617.90	0.0	24.44	2.40
5	6617.90	0.0	24.44	2.40
6	6617.90	0.0	24.44	2.40
7	6617.90	0.0	24.44	2.40
8	6617.90	0.0	24.44	2.40
9	6617.90	0.0	24.44	2.40
10	6617.90	0.0	24.44	2.40
11	6617.90	0.0	24.44	2.40
12	6617.90	0.0	24.44	2.40
13	6617.90	0.0	24.44	2.40
14	6617.95	9.48	24.57	2.42
15	6618.01	29.88	24.70	2.44
16	6618.11	86.18	24.94	2.48
17	6618.23	185.29	25.25	2.53
18	6618.45	438.54	25.82	2.61
19	6618.72	857.75	26.55	2.71
20	6619.00	1549.03	27.31	2.82

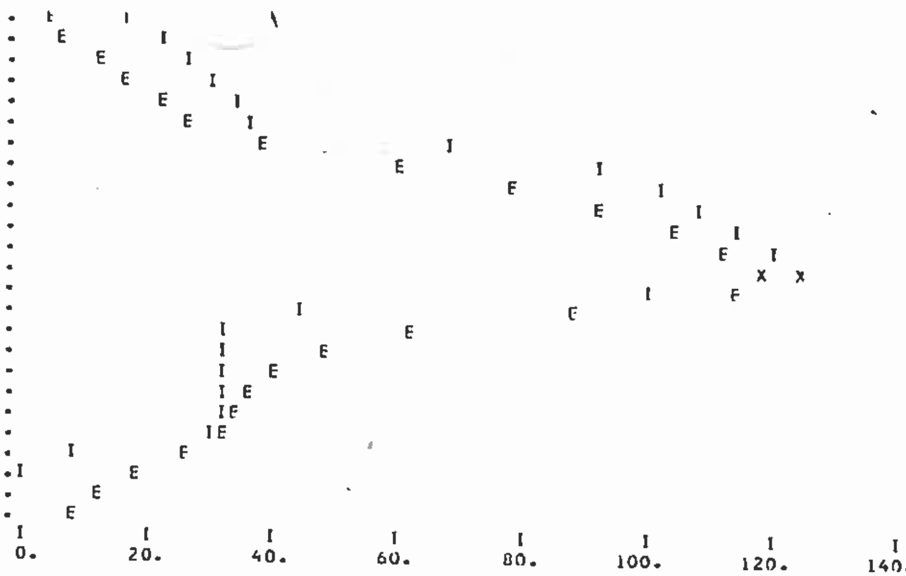
TYPE	BW	EMAX	VMAX	AMAX	HP	V-ES	Q-PS	Q-ES	Q-TOT	D/C	V/C	S/C	S/C.25	D-ES
STORM HYD	1.0	6618.14	25.0	2.5	0.25	0.6	0.	120.	120.	0.28	3.00	0.009	0.012	1.2

PLOT 1 IN = 20. CFS EXIT SLOPE = 0.019

0. 20. 40. 60. 80. 100. 120. 140.

T	I	O	E	V	A	PLOT	EXIT VEL
0.0	0	0	6617.9	24.4	2.4	.	0.0
0.03	0	0	6617.9	24.4	2.4	.	0.0
0.07	0	0	6617.9	24.4	2.4	.	0.0
0.10	0	0	6617.9	24.4	2.4	.	0.0
0.13	0	0	6617.9	24.4	2.4	.	0.0
0.17	0	0	6617.9	24.4	2.4	.	0.0
0.20	0	0	6617.9	24.4	2.4	.	0.0
0.24	3	0	6617.9	24.4	2.4	.I	0.61
[illegible]							0.93

T	I	O	E	V	A	VEL EXIT
0.34	[illegible]	5	6617.9	24.5	2.4	1.79
0.37	24	8	6617.9	24.6	2.4	1.97
0.40	28	13	6618.0	24.6	2.4	2.21
0.44	32	19	6618.0	24.6	2.4	2.44
0.47	35	24	6618.0	24.7	2.4	2.55
0.50	39	29	6618.0	24.7	2.4	2.68
0.54	71	41	6618.0	24.8	2.4	2.92
0.57	93	61	6618.1	24.8	2.5	3.19
0.60	104	79	6618.1	24.9	2.5	3.41
0.64	111	95	6618.1	25.0	2.5	3.54
0.67	116	106	6618.1	25.0	2.5	3.67
0.71	121	114	6618.1	25.0	2.5	3.71
0.74	126	120	6618.1	25.0	2.5	3.77
0.77	102	116	6618.1	25.0	2.5	3.72
0.81	45	89	6618.1	25.0	2.5	3.49
0.84	35	64	6618.1	24.9	2.5	3.25
0.87	33	49	6618.0	24.8	2.5	3.02
0.91	33	41	6618.0	24.8	2.4	2.93
0.94	33	37	6619.0	24.7	2.4	2.84
0.97	34	35	6619.0	24.7	2.4	2.82
1.01	33	34	6618.0	24.7	2.4	2.79
1.04	10	29	6618.0	24.7	2.4	2.67
1.07	2	21	6618.0	24.6	2.4	2.46
1.11	0	14	6618.0	24.6	2.4	2.24
1.14	0	9	6617.9	24.6	2.4	2.04



****************************** BASIC DATA ******************************

ARID-SEMIARID CLIMATE AREA

DESIGN CLASS A

STORM DISTRIBUTION.....POINT ONE-HR. STORM

P-100 2.90	PMP 13.00	P1DA/P6HR 1.210	P100A/P1DA 1.490	CN 63.00	DA-SM 0.01	TC/L 680.00	-/H 80.70
CONDUITS 0.0	COND L 0.0	D/W 0.0	-/H 0.0	PS N 0.0	KI 0.0	WFIR L 0.0	TW EL 0.0
PERM POOL 6617.90	CREST PS 6617.90	FP SED 0.0	BASEFLOW 0.0	2ND STG 0.0	ORF H 0.0	ORF L 0.0	START 6617.90
ES1 6617.90	ES2 0.0	ES3 0.0	ES4 0.0	ES5 0.0	Z ES 521.00	EXIT N 0.020	EXIT S 0.019
ES TYPE 42	ES L 80	ES N 0.020	BW1 1.00	BW2 0.0	BW3 0.0	BW4 0.0	BW5 0.0

PROVIDED BY ES FILE

ES CODE 42080.020	INCREMENT 1.000			Q1 3.270	Q2 8.921	Q3 16.252	Q4 24.924
Q5 34.745	Q6 45.594	Q7 57.407	Q8 70.087	Q9 83.579	Q10 97.844	Q11 112.837	Q12 128.523

********************** DETAILED LIST OF BASIC DATA **********************

WEIR COEF. FOR ORIFICES........ 3.10	RATIO OF IA TO S(CH.10,NEH4).. 0.20	MIN ES BW WHEN MAX V/C GIVEN.. 20.0
WEIR COEF. FOR DROP INLET...... 3.10	TIME INCS TO PEAK OF UNIT HYD. 5.	DELTA BW WHEN MAX V/C GIVEN... 64.0
DISCHARGE COEF. FOR ORIFICES.. 0.60	NO. POINTS FOR DESIGN HYD..... 101	PRECISION OF BW SOLUTION...... 1.0
FILLET SIZE FOR BOX CONDUITS.. 6.00	ES-WSP CALC. DEPTH PRECISION. 0.005	PRECISION OF V/C SOLUTION..... 0.03
GRAVITATIONAL CONSTANT........ 32.16	ES-WSP PERMISSIBLE VEL.CHANGE. 0.05	

EMBANKMENT TEMPLATE	TOP WIDTH 0.0	UPSTREAM Z 2.5	DOWNSTREAM Z 2.5	WAVE BERM 10.0	STAB. BERM 0.0	DH MAX 0.0
RAINFALL EQUATION CONSTANTS CLASS A	K1 PSH 0.82	K1 ESH 1.00	K1 FBH 1.00	K2 PSH 0.0	K2 ESH 0.0	K2 FBH 0.12

DIMENSIONLESS UNIT HYDROGRAPH

PEAK FACTOR = 484.0

0.0	0.030	0.100	0.190	0.310	0.470	0.660	0.820	0.930	0.990
1.000	0.950	0.930	0.860	0.780	0.680	0.560	0.460	0.390	0.330
0.280	0.240	0.207	0.177	0.147	0.127	0.107	0.090	0.077	0.065
0.055	0.047	0.040	0.034	0.029	0.025	0.021	0.018	0.015	0.013
0.011	0.009	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.001
0.0									

SCS DESIGN STORM RAINFALL DISTRIBUTION. (CHAPTER 21, NEH4 AND SCS EM-27)

0.0	0.013	0.027	0.042	0.059	0.078	0.099	0.122	0.147	0.180
0.230	0.380	0.530	0.625	0.670	0.705	0.736	0.764	0.790	0.814
0.836	0.856	0.875	0.893	0.910	0.927	0.942	0.957	0.972	0.986
1.000									

POINT ONE-HR. STORM

0.0	0.170	0.400	0.880	1.000

ID NAME IS USBRG

GEN. 6 HOUR STORM DISTRIBUTION

0.0	0.120	0.260	0.420	0.710	0.890	1.000

ID NAME IS GRBSU

ODT TEST 6600.00 FT 0.0 ACFT 0.0 CFS
CONTROL IS 0.0 DETENTION STORAGE

*****DRAWDOWN TEST ELEVATION CANNOT BE REACHED.
CDT TEST USED 6617.90 FT 24.4 ACFT 0.0 CFS

DRAWDOWN TIME = 0.02 DAYS (LIMIT = 0.0 DAYS)

****

RATING TABLE NUMBER 1

	E FEET	Q CFS	V AC FT	A ACRE
1	6600.00	0.0	0.0	0.0
2	6605.00	0.0	2.82	1.13
3	6610.00	0.0	9.47	1.53
4	6615.00	0.0	18.15	1.94
5	6617.90	0.0	24.44	2.40
6	6619.00	0.0	27.31	2.82

CAMS2 XEC 6/23/76
REV 06/18/73

KAYENTA DAM NO.1 MESA I.D. NO. 1211-AZ-9-0001

WATERSHED IS PREDOMINANTLY RANGE IN FAIR CONDITION

RUN NO. 11 ROUTE BOTH DURATION STORMS

DAMS2.....JCB NO. 1 COMPLETE

KAYENTA   DAM NO.1 MESA I.D. NO. 1211-AZ-9-0001

1 STRUCTURE(S) ANALYZED

4 HYDROGRAPHS ROUTED

0 TRIAL ROUTINGS

****

```
DAMS2.....RUN CCMPLETE

                                        H A S P    S Y S T E M    L O G

$ 11.15.49 JOB  39 -- TV300     -- BEGINNING EXEC - PART 2 - CLASS B
*11.21.38 JOB  39 TV300       JOB TIME LIMIT EXPIRED - GIVING 2 MORE MINS
*11.27.35 JOB  39 TV300       JOB TIME LIMIT EXPIRED - GIVING 2 MORE MINS
$ 11.31.00 JOB  39 -- TV300     -- END EXEC          847 LINES        0 CARDS.


HASP-II JCB STATISTICS --     48 CARDS READ --     857 LINES PRINTED --     0 CARDS PUNCHED --  15.17 MINUTES EXECUTION TIME
```

file copy

```
TV300    **HASP-II.......END JOB  39.....11.49.01 AM 23 JUN 76....TV300   .......PRODTN B 483 11 00000.............    ..END JOB  39
TV300    **HASP-II.......END JOB  39.....11.49.01 AM 23 JUN 76....TV300   .......PRODTN B 483 11 00000.............    ..END JOB  39
TV300    **HASP-II.......END JOB  39.....11.49.01 AM 23 JUN 76....TV300   .......PRODTN B 483 11 00000.............    ..END JOB  39
```

DAMS2.....RUN COMPLETE

DATE 6-24-76

PEABODY ENGINEERING OFFICE SOUTHWESTERN AREA (Farmington, N.M.)

Attached herewith are your hydrologic analyses for the following impoundment:

NAME Kayenta Mine (Fresh Water) Reservoir, Navaho County, Arizona

MESA I. D. # 1211-AZ-9-0001

As you may recall, the "DAMS 2" Computer Program, Version 2, February 1971, U. S. Dept. of Agriculture, Soil Conservation Service, was used to perform these flood routing analyses. The User's Guide, Technical Release 48, describes the program operation, input data requirements, options and output, and is available from the Soil Conservation Service.

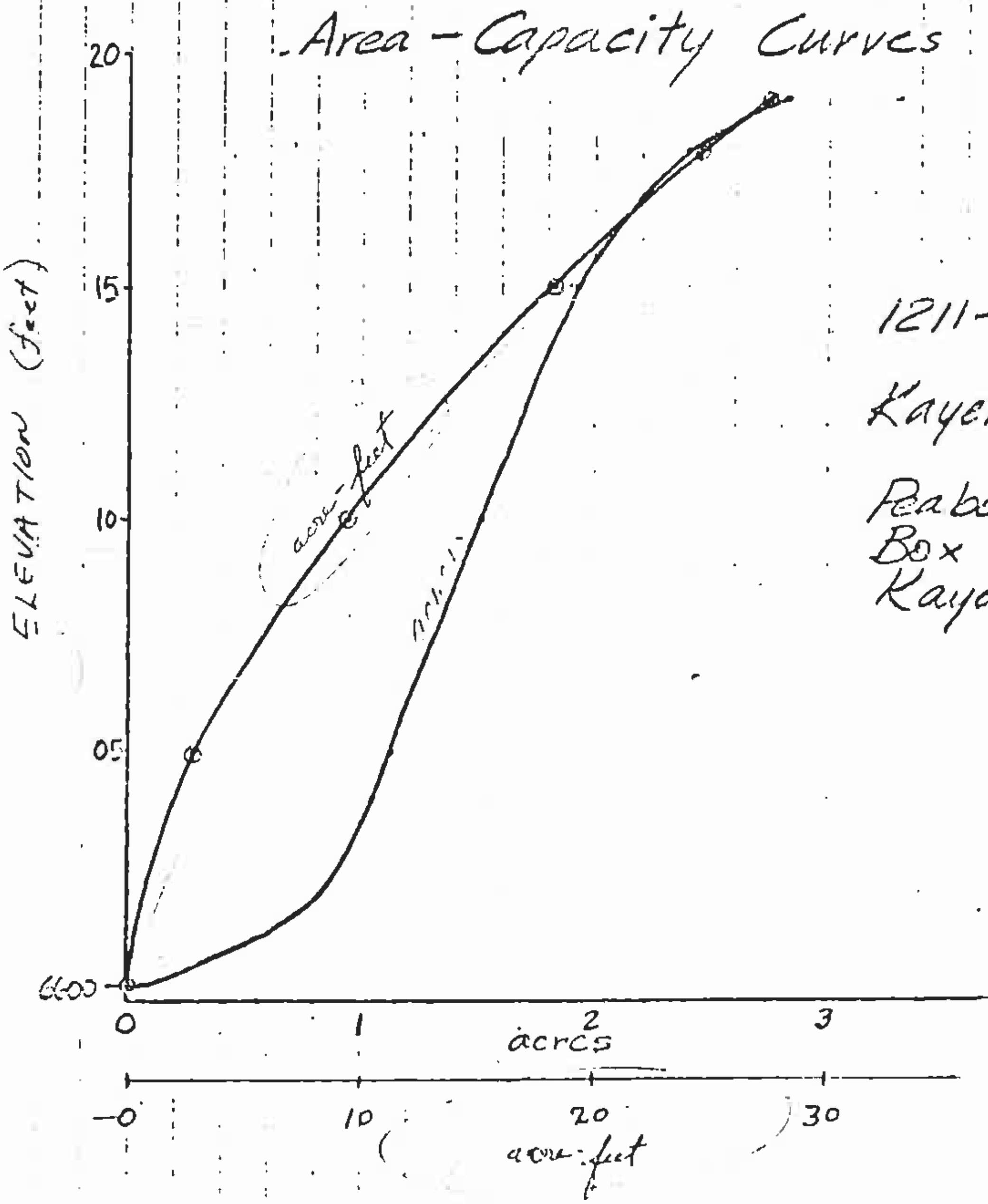
The impoundments, associated hydraulic facilities and watershed were analyzed for the following appropriate, required storms. The impoundment and associated facilities meet or exceed pertinent MESA standards.

Storm	Rainfall/Duration	Freeboard*	Drawdown Time
OPP-General	2.9"/6 hr.	1.1'	Less than 10 days
PMP-General	13.0"/6 hr.	1.0'	Less than 10 days
OPP-Thunderstorm	2.7"/1 hr.	1.1'	Less than 10 days
PMTS	9.5"/1 hr.	0.9'	Less than 10 days

* Difference between maximum reservoir water surface elevation and elevation of lowest point on the crest of the dam. The analyses were made using an ultra-conservative assumption that the pool was at elevation 6617.9 immediately before the storm occurred.

D. M. Schlueter
F. X. Kaiser
Peabody - St. Louis

Note - According to table 6.6, page 6.62, MESA "Engineering and Design Manual - Coal Refuse Disposal Facilities," a structure, such as the above, which is located in a rural/desert area where failure might cause only slight damage, such as to an isolated ranch building, forest or desert lands, or minor roads (LOW hazard potential), in view of the appropriate SMALL impoundment size category, the OPP is the indicated applicable design storm.



1211-AZ-9-0001

Kayenta Mine Reservoir

Peabody Coal Company
Box 606
Kayenta, Arizona 86033

8/25/76

added on -
volume as well as
area is req'd.
to be plotted
FYK 8-31-76

1211 - AZ - 9 - 0001

EXHIBIT E : AREA-CAPACITY CURVE

CERTIFICATION

TO WHOM IT MAY CONCERN:

RE: Kayenta Mine (Fresh Water) Reservoir
MESA I. D. #1211-AZ-9-0001
Navajo County, Arizona

Based on recently completed slope stability investigations, hydrologic analyses, historical information, and apparent present conditions, the subject facility should perform satisfactorily, as a whole, under current maximum design conditions.

Registered Professional Engineer
CERTIFICATE NO.
9157
LAWRENCE M.
BRENNAN
DATE SIGNED 8-31-76
Arizona U. S. A.

Lawrence M. Brennan
Professional Engineer #9157

Aug 31, 1976
(Date)

U.S. DEPARTMENT OF LABOR
MINE SAFETY AND HEALTH ADMINISTRATION
Mailing Address:
P.O. Box 25367, DFC
Denver, Colorado 80225
Street Address:
730 Simms
Lakewood, Colorado

DEPARTMENT OF LABOR · UNITED STATES OF AMERICA

Coal Mine Safety & Health
District 9

MAR 1979
RECEIVED
Peabody Coal Co.
Permits &
C[illegible]

March 28, 1979

S. Dennis Dawson
Supervisor, Permits & Compliance
Peabody Coal Company
Arizona Division
2224 E. Cedar Avenue, Suite A
Flagstaff, Arizona 86001

RE: Kayenta Fresh Water Pond
I.D. # 1211-AZ-9-0001
Kayenta Mine
I.D. No. 02-01195

Dear Mr. Dawson:

The plan to place a 12 inch CMP pipe in your pond has been received and placed on file in this office. This is acceptable for overflow control.

Thank you for your attention to this matter.

Sincerely yours,

Harold E. Dolan

Harold E. Dolan
Supervisory Mining Engineer

BLACK MESA MINE RESERVOIR (J-7 DAM)

30CFR 77.216-2 PLAN

SERGENT, HAUSKINS & BECKWITH CONSULTING SOIL AND FOUNDATION ENGINEERS
APPLIED SOIL MECHANICS • ENGINEERING GEOLOGY • MATERIALS ENGINEERING
B. DWAINE SERGENT, P.E. JOHN B. HAUSKINS, P.E. GEORGE H. BECKWITH, P.E.
DALE V. HEDENKOP, P.E. ROBERT D. BOOTH, P.E. BENNY E. McMILLAN, P.E.
JOHN J. MORAN, P.E. DONALD G. METZGER, GEOL. BUD WOODWARD

August 27, 1976

Peabody Coal Company
P. O. Box 23
117 East Ute Street
Farmington, New Mexico 87401

SHB Job No. E76-29B

Attention: Roger Dewey, P.E.

Re: Dam No. 3
Black Mesa Mine
Navajo County, Arizona

Gentlemen,

Our Geotechnical Investigation Report on the referenced project is herewith submitted. Included in this report are the results of subsurface exploration and laboratory analysis, along with a discussion of our engineering analysis and our conclusions and recommendations.

Should any questions arise concerning this report, we would be pleased to discuss them with you.

Respectfully submitted,
Sergent, Hauskins & Beckwith Engineers

By [signature]
Robert W. Crossley, P.E.

Reviewed by [signature]
George H. Beckwith, P.E.

Copies: Addressee (4)
Peabody Coal Company
St. Louis, Missouri
Attn: Francis X. Kaiser, Jr., P.E. (1)

REPLY TO 3940 W. CLARENDON, PHOENIX, ARIZONA 85019
PHOENIX (602) 272-6848 ALBUQUERQUE (505) 345-5606 EL PASO (915) 591-8188 TUCSON (602) 884-9333

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REPORT

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APPENDIX C

SHB Job No. E76-29B

1. INTRODUCTION

This report is submitted pursuant to a geotechnical investigation made by this firm of J-7 Dam, MESA I.D. No. 1211-AZ-9-0003, a major haul road embankment crossing a sizeable natural drainage channel at the Peabody Coal Company Black Mesa Mine in Navajo County, Arizona. The general location of the site is shown on Figure 1*.

An objective of this investigation was to evaluate the physical properties of embankment materials and of the soil and rock beneath the embankment in order to analyze the safety of the dam. A second objective was to provide recommendations for any remedial measures which might be necessary to bring the impoundment in full compliance with current "Design Guidelines for Coal Refuse Piles and Water, Sediment or Slurry Impoundments and Impounding Structures" published by the United States Department of the Interior, Mining Enforcement and Safety Administration.

The scope of our investigation was limited to analysis of geotechnical factors affecting dam stability. It is understood that Peabody Coal Company is performing the necessary hydrological analysis.

*Figures and illustrations are presented in Appendix C.

2. PROJECT DESCRIPTION

Details of the project were provided to us by Roger Dewey, P.E., and Reynaldo Armijo, staff engineer, of Peabody Coal Company.

The J-7 embankment was constructed in 1973 as part of the network of haul roads connecting the various coal excavations with the crusher plant. At that time, a subsurface investigation for the embankment was performed by the engineering division of Peabody Coal Company.

It is understood that prior to construction, all loose earth, scoria and carbonaceous shale (smut) was removed from the abutments and near centerline of the dam and replaced with compacted clay fill. A 60 foot wide keyway was constructed along the centerline axis of the dam to provide a seepage cutoff.

The crest of the dam is at elevation 6382, 77 feet above the original elevation of the stream channel (elevation 6305) at the centerline. In addition, berms 3 to 6 feet high have been built adjacent to the roadway across the crest of the dam to provide traffic protection. A typical cross section and axis profile of the dam are presented as Figures 3 and 4 of this report.

Runoff from the watershed (an area of approximately 20 square miles) is impounded on the east side of the dam. Egress is provided by a spillway channel crossing the haul road 500 feet past the south abutment of the dam. Bottom elevation of the spillway is 6372.

At the time of our investigation, in early spring 1976, the water level in the reservoir was 6355 feet. As previously stated, a detailed hydrological analysis of the J-7 Pond will be performed by Peabody Coal Company. In this report, the stability analyses are given for the reservoir level as stated above and for the case of the reservoir, filled to bottom elevation of the spillway. These assumptions are arbitrary in nature and should in no way be taken to suggest a judgment on our part as to the likelihood of occurrence of such conditions. Projections of future reservoir levels are not within the scope of this report.

3. INVESTIGATION

3.1 Subsurface Exploration

The subsurface exploration program, which was planned and executed by this firm in order to provide the necessary geotechnical information, consisted of a total of six exploratory borings. The borings were advanced using 6 5/8" O.D., 3¼" I.D., hollow stem auger through the dam embankment into the rock which provides the foundation for the embankment. In all borings, the drilling was continued until it was certain that intact rock had been encountered. Standard penetration testing or open-end drive sampling was performed at intervals of 5 feet or less in these borings.

The results of the field investigation are presented in Appendix A which includes a site plan showing boring locations, logs of the test borings and a brief description of drilling and sampling equipment and procedures.

The subsurface exploration was supervised by Robert W. Crossley, staff engineer of this firm, who located the borings, continuously examined and logged drill cuttings and drive samples, and prepared the boring logs.

3.2 Laboratory Analysis

Moisture content determinations were made on selected tube samples recovered, while dry densities were determined for the 2.42 inch diameter open-end drive samples. The results of these tests are shown on the boring logs.

Grain-size analysis and Atterberg Limits tests were performed on selected samples to aid in soil classification. In addition, moisture-density, direct shear, unconfined compression, consolidation and remolded permeability tests were performed on the selected samples in order to evaluate engineering properties of the materials. Results of these tests are presented in Appendix B along with a brief description of the testing procedures.

3.3 Site Inspection

The site was visited on April 14, 1976, by principal engineer, George H. Beckwith and Robert Crossley of this firm, along with Messrs. Roger Dewey, Francis Kaiser and Reynaldo Armijo of Peabody Coal Company. The purpose of this visit was to observe the present condition of the pond and to perform a brief reconnaissance of the adjacent topography and geology.

3.4 Survey of Borings

Topographic data of the J-7 Dam was furnished to us by Peabody Coal Company of Kayenta, Arizona on a plate dated April 13, 1976.

4. GEOLOGY, EMBANKMENT & SEISMICITY

4.1 Aerial & Site Geology

Black Mesa, in the area of investigation, is composed of rocks of Jurassic and Cretaceous ages. The surface slopes gently to the southwest. The uppermost formation of Black Mesa is the Wepo Formation, which has been eroded into parallel ridges and narrow valleys. O'Sullivan et al (1)* describe the Wepo as alternating siltstone, mudstone, coal, and sandstone beds, and as 304 to 743 feet in thickness.

4.2 Geologic History & Structure

According to O'Sullivan et al (1), the Wepo Formation was deposited primarily in a continental environment in which siltstones, mudstones, coal and sandstones were laid down. Locally, some marine sandstones are interbedded in the formation.

*Numbers in parentheses correspond to references listed at end of report.

Following deposition of the Wepo Formation and younger formations of Cretaceous age, the Navajo Country was affected by a structural period during late Cretaceous and early Tertiary time - the Laramide Orogeny. This resulted in an assortment of folds; such as basin downwarps, uplifts, monoclines, anticlines and synclines (2). One of the downwarps is the Black Mesa Basin. Black Mesa is a dissected highland in the structural center of this basin. In late Tertiary and Quaternary time, the Navajo Country was upwarped and locally faulted.

Maps prepared by Cooley et al (2) show that the Wepo Formation of the northern part of Black Mesa has been warped by gentle monoclines and synclines and has not been broken by faults. The nearest faults are shown as 30 to 50 miles north-northwest from the area of investigation, and these trend from eastward to northeastward. Two east trending faults, about 4 to 5 miles long, are about 30 miles from the site. Several northeast trending faults as long as 12 miles occur about 40 miles from the site.

4.3 Embankment Soils & Foundation

4.3.1 Description of Soils & Rock

The embankment was found to be comprised predominantly of clay, clayey sand and clayey gravel with a few thin lifts of cohesionless silty sand and gravel mixtures. There is a considerable amount of carbonaceous material mixed with the clay and gravel, particularly below the elevation of 6340. Penetration test data indicates the embankment materials are generally firm to very firm. However, a few zones of loose material were present.

Beneath the embankment, a few feet of native soil was encountered in borings 1, 2 and 3 near the center of the dam. These consisted of sandy clays and clayey sands in borings 2 and 3. In boring 1, 6½ feet of channel alluvium was encountered. It appears that all borings are outside or at the edge of the cutoff trench.

Weathered shales and sandstones of the Wepo Formation were encountered in all borings. In boring 5, an inch of scoria over soft shale was found.

4.3.2 Moisture & Seepage

Within the embankment, moisture contents were generally slightly below the plastic limit, although lifts dominated by cohesionless material often appeared to be very dry. A groundwater table was encountered in borings 1, 2 and 5 at elevations 6312, 6312 and 6317, respectively. In all cases, this phreatic surface occurred in channel alluvium or other native material. There was no indication of saturation within the embankment fill.

Seepage through the channel alluvium beneath the embankment and cutoff trench is taking place at a very nominal rate. At the time of our investigation, a trickle of water was seen exiting a few feet downstream from the toe of embankment at approximate elevation 6295. There is no indication of erosion or distress of the toe due to this seepage.

4.3.3 Piping Potential

Sherard et al (3) have published a rough empirical relationship of observed piping and soil types. In this system, soils are ranked according to their resistance to piping; 1 being most resistant and 8 being least resistant. Using this criteria, the embankment and soil foundation materials probably would fall into categories 2 to 4. The rock foundation materials would have extremely high resistance to internal erosion.

4.4 Seismology

4.4.1 Seismic History of the Area

Research was made of the seismic history of the general area of the site. Principal source of information was "Earthquake History of the United States" by Coffman and Von Hake (4). It presents a table listing earthquakes in the Western Mountain Region with intensities equal to or greater and V on the Modified Mercalli Intensity Scale of 1931. This table was used in compiling Table 1 of this report, which lists historical earthquakes within the general area of the site.

Other references that were used include the "Preliminary Safety Analysis Report" (5) prepared by FUGRO, Inc. for Arizona Public Service Company Palo Verde Nuclear Generating Station west of Phoenix and Sturgul and Irwin's report on "Earthquake History of Arizona and New Mexico" (6).

The earthquakes listed in Table 1 are plotted on Figure 2. The figure covers an area of about 420 by 500 miles in Arizona, New Mexico, Utah and Colorado. As the data shows, the region of the site is one of very low seismicity.

Figure 2 shows that within a 100 mile radius of the site, only five earthquakes of intensity V or greater have been recorded during historic time. Of these, the closest epicenter to the site was an intensity VI earthquake reported about 40 miles to the southwest in 1910, while the intensity VI Ganado earthquake of January 16, 1950, was placed about 75 miles southeast of Black Mesa. The largest tremor ever reported in northern Arizona was intensity VII, occurring on January 15, 1906 near the north rim of the Grand Canyon.

4.4.2 Significant Geologic Structure

As discussed in Section 4.2, no faulting is mapped in the immediate area of the site. Minor faulting 30 to 50 miles north of the site is not considered capable of creating an earthquake of sufficient intensity to significantly affect the embankment.

Shown on Figure 2 are locations of significant faults in the general region of the site which are known to have been active during the Quaternary period (past one million years). These include the San Francisco Mountain fault west of Flagstaff and the Verde fault which has been mappe l for 70 miles or more. These faults are located more than 100 miles southwest of the site. Also shown on Figure 2 are the north-south trending Sevier, Hurricane, Toroweap and Grand Wash fault zones in northwestern Arizona and southern Utah. These zones of normal faulting are close enough to the site to be of significance from a seismic risk standpoint. Their significance is discussed by Smith and Sbar (7).

4.4.3 Previous Seismic Zoning & Estimated Effect of Hypothetical Earthquakes

The northern portion of Arizona is location in Zone 2 on the Seismic Risk Map found in the current Uniform Building Code. This means that the general area has experienced in the past, and thus may experience in the future, moderate damage corresponding to intensity VII of the Modified Mercalli Scale. Richter (8) classified the general area as intensity VIII occasional in a study published in 1959. Based upon more detailed analysis, Algermissen (9) classified the general area of the site as intensity VII occasional. This type of zoning is very general in nature and must be controlled by the areas of higher risk within the zone. In a study by the U. S. Geological Survey, based on both statistical analysis of seismic history and evaluation of geology, Algermissen and Perkins (10) have estimated a 50 year return peak ground acceleration of less than 0.01g and a 90 percent probable peak ground acceleration of about 0.03g for the site. Recent studies by Bell Telephone Laboratories (11) estimated 100 year return peak ground acceleration of 0.03g for the site.

In a current study by the Applied Technology Council (12) directed toward development of seismic design methods for buildings, an EPA of less than 0.05g was estimated for the site. A report of on-going U. S. Geological Survey Studies (13), just published, estimated an EPA of less than 0.04g. For the latter two studies, the EPA's of 0.05g and 0.04g were the lowest contours reported. They state that for EPA's lower than these values, wind normally controls the lateral force requirements for buildings and, thus, lower contours are not significant for building design purposes. The EPA's in these two studies (12, 13) are both defined as values with a 90 percent probability of not being exceeded in 50 years.

Estimates of EPA reported by the U. S. Geological Survey in 1976 (13), in the general area of the site, are substantially lower than corresponding values reported in 1972 (10).

Based upon data summarized by Howell and Schultz (14), Bolt (15), Schnabel and Seed (16), Barosh (17) and Hays et al (18), it is possible to roughly estimate the effect of hypothetical earthquakes at the site. Maximum credible earthquakes for a given fault can be estimated, using this data, on the basis of length. The effects at sites away from the fault can then be assessed utilizing various attenuation curves.

The foregoing analysis is based on these techniques. Should an earthquake of magnitude 6 occur in the San

Francisco Peaks area, about 120 miles southwest of the site, it would create an intensity of about 3.7 (MM) and a peak ground acceleration of about 0.02g. Bracketed duration (time during which acceleration is about 0.02g) would be 1 second at most. According to Schnabel and Seed (16), predominant period would be about 0.8 seconds considering the subsurface profile at this site.

Maximum credible earthquakes on the Sevier fault system, and other major fault zones in southwestern Utah, would produce peak ground accelerations of less than 0.02g with a predominant period of perhaps 1.0 second. These zones are 130 miles or more away from the site.

In summary, all data shows the site is in an area of very low seismicity and, thus, a very low level of seismic risk is involved.

5. STABILITY ANALYSIS

5.1 Assumed Soil Parameters

Shear strength parameters were estimated from the results of the direct shear tests performed under submerged conditions on both undisturbed and remolded samples of typical materials from the embankment. The direct shear tests on submerged soils are believed to yield strength parameters which compare favorably with the actual parameters for the embankment materials at their present moisture contents. Because of the low rate of strain and soil type involved, the direct shear tests are believed to yield essentially effective stress parameters.

The effective shear strength and other parameters used in stability analyses are as follows:

Upper Embankment (Above Elevation 6340)

$\emptyset' = 25^{o}$
C' = 400 psf
Density - In Situ = 110 pcf
Saturated = 130 pcf

Lower Embankment (Below Elevation 6340)

$\emptyset' = 20^{o}$
C' = 350 psf
Density - In Situ = 115 pcf
Saturated = 135 pcf

Foundation Materials

$\emptyset' = 30^{o}$
C' = 1,000 psf
Density - In Situ &
Saturated = 140 pcf

5.2 Seismic Design Considerations

As stated in Section 4.4.1, this site is in an area of very low seismicity. Based on assessment of this data, a seismic coefficient of 0.05g was selected for use in analysis.

5.3 Methods of Analysis

Using the geometry shown in Figure 4, slope stability analyses were made using SSTAB1, a general computer program for slope stability analyses, available from the University of Texas (19), and developed by Stephen G. Wright. The program utilizes a limit equilibrium procedure of slices, to calculate a factor of safety, which satisfies all conditions of static equilibrium. In this procedure, the resultant side forces acting on each slice are assumed parallel, as first introduced by E. Spencer. The solution for factor of safety is obtained by iteration and required successive approximations for the factor of safety and side force inclination in order to satisfy the equilibrium boundary conditions.

In addition, a stability number method published by Hoek and Bray (20) was employed to analyze segments of the upstream and downstream slopes. For further verification and to analyze effects of a seismic force, one critical circle was examined by manual calculation utilizing the traditional method of slices.

5.4 Summary of Results

Based upon the analysis methods and assumed shear strength parameters described in Sections 5.1 and 5.3 above, the following factors of safety were computed.

Upstream Slope - Dry

Height	Slope	Factor of Safety
32 feet	3.1:1	2.91

Upstream Slope - Sudden Drawdown*

Height	Slope	Factor of Safety
32 feet	3.1:1	Approximately 2.60 (See trials 2 & 3)

Downstream Slope -
Dry Slope, Static Conditions

Height	Slope	Factor of Safety
80 feet	3 segments as shown (Figure 5)	Approximately 2.30 (See trial 5)

Downstream Slope - Dry
Seismic Force = 0.05g

Height	Slope	Factor of Safety
80 feet	3 segments as shown (Figure 5)	1.98

*In this analysis, using SSTAB1, it was assumed the water level in the reservoir was at spillway elevation (6372) for a sufficient period of time for material in the face of the embankment to become saturated. A sudden drawdown to elevation 6348 was analyzed because on any upstream slope, this is the worst set of static conditions which can possibly be injected into a slope stability problem. The high safety factor shown is evidence of the inherent stability of the present embankment.

The slope and embankment heights were taken from survey data furnished by Peabody Coal Company. A documentation of these figures is presented in Appendix C.

6. CONCLUSIONS & RECOMMENDATIONS

It is concluded the dam embankment is safe for present conditions and foreseeable future operating conditions.

It is our conclusion that very high factors of safety against slope failure exist for these conditions and, thus, no alterations of the embankment are necessary for safety reasons.

Even in the event that maximum pool evaluation is reached, complete saturation of the embankment would take many years to accomplish due to its high clay content. Therefore, the development of a high phreatic surface within the dam, or seepage on the downstream face, is considered highly unlikely.

The danger of piping in the embankment foundation is considered minimal. This is due to low exit velocities which are associated with such a shallow seepage gradient, as well as the considerable amount of clay in the soil and weathered rock which are found beneath the dam.

Because of the low estimated EPA, as well as the internal cohesion of the embankment materials, it is concluded the embankment would not have the potential for liquefaction, even if portions of it became saturated.

REFERENCES

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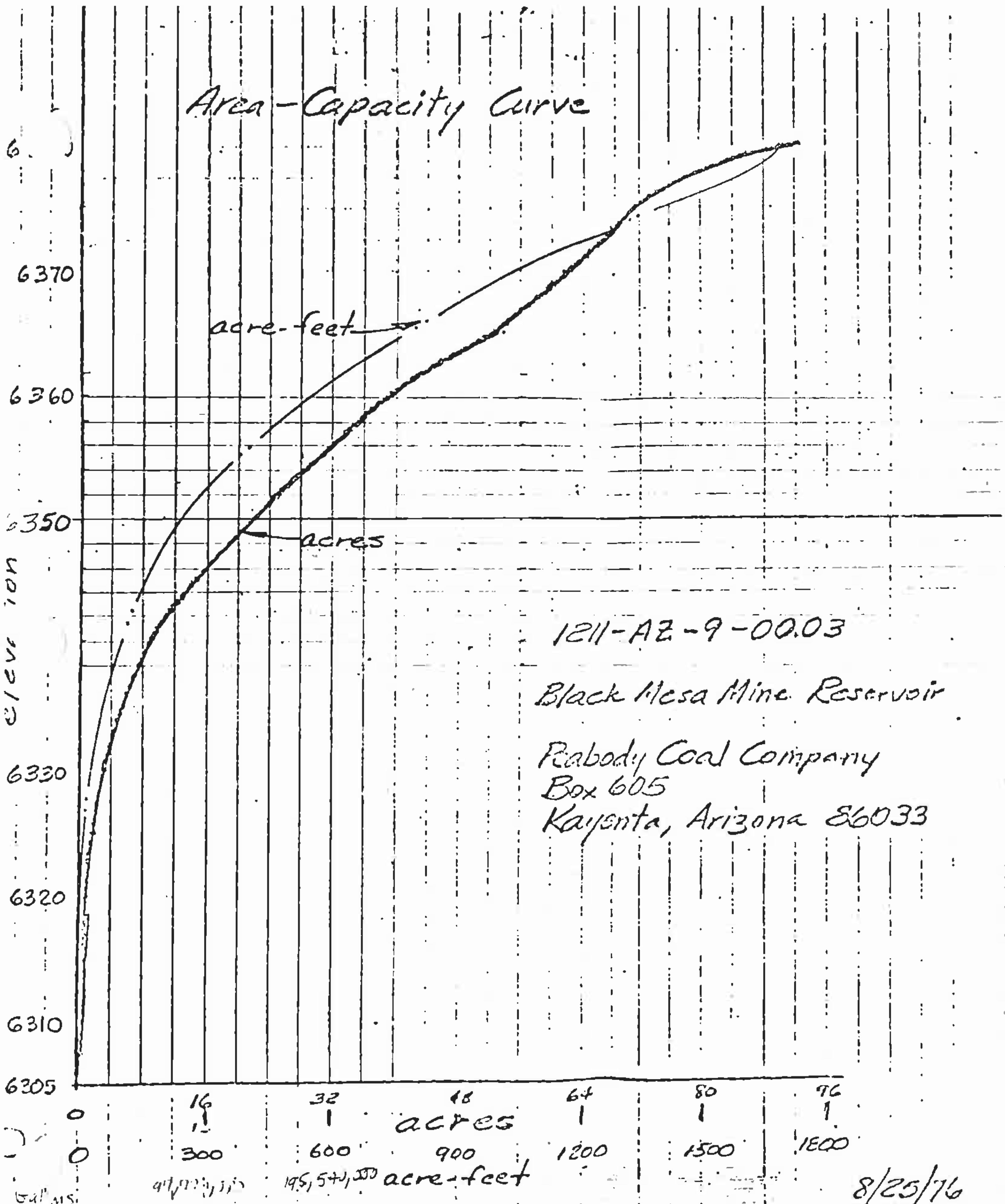
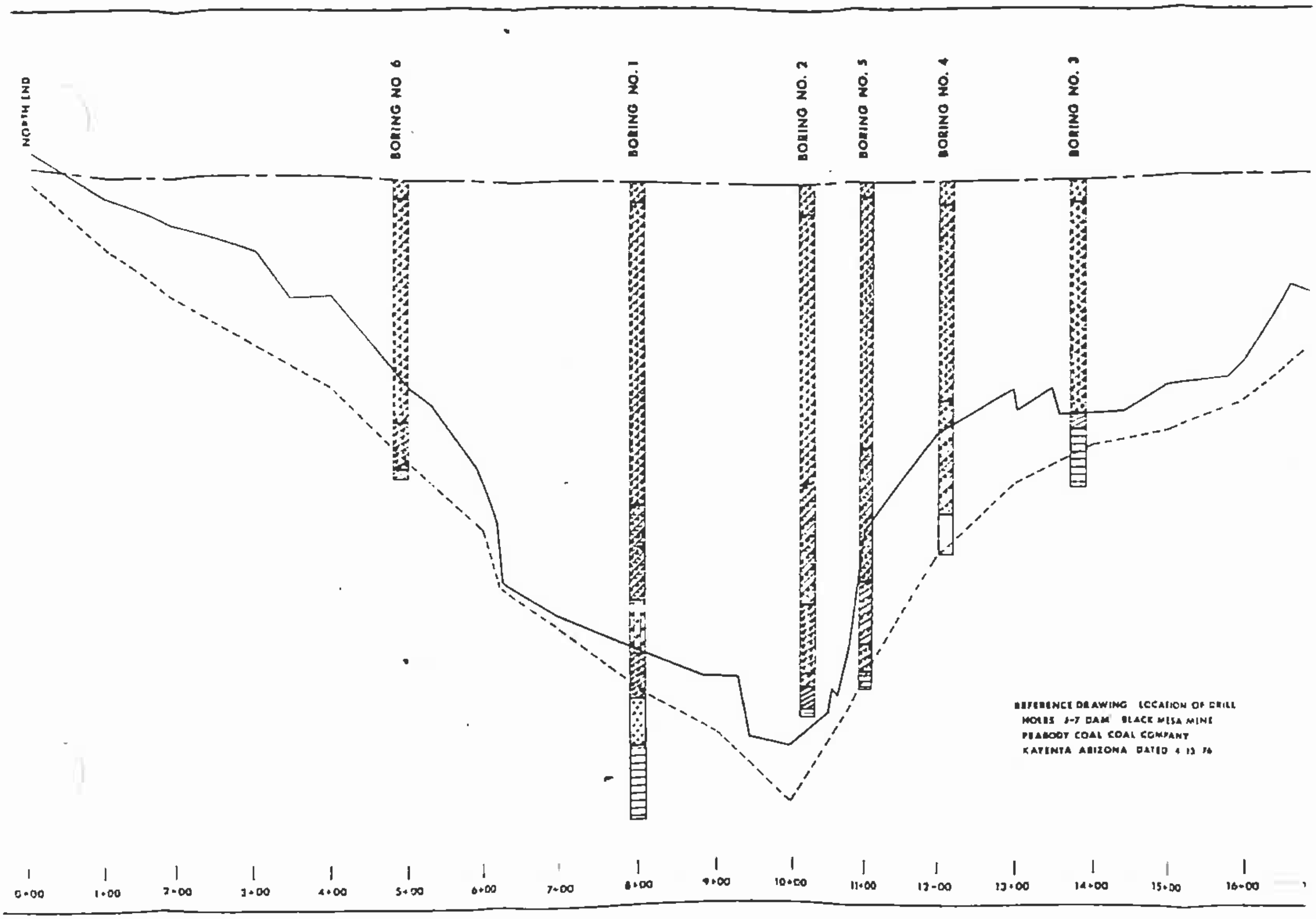
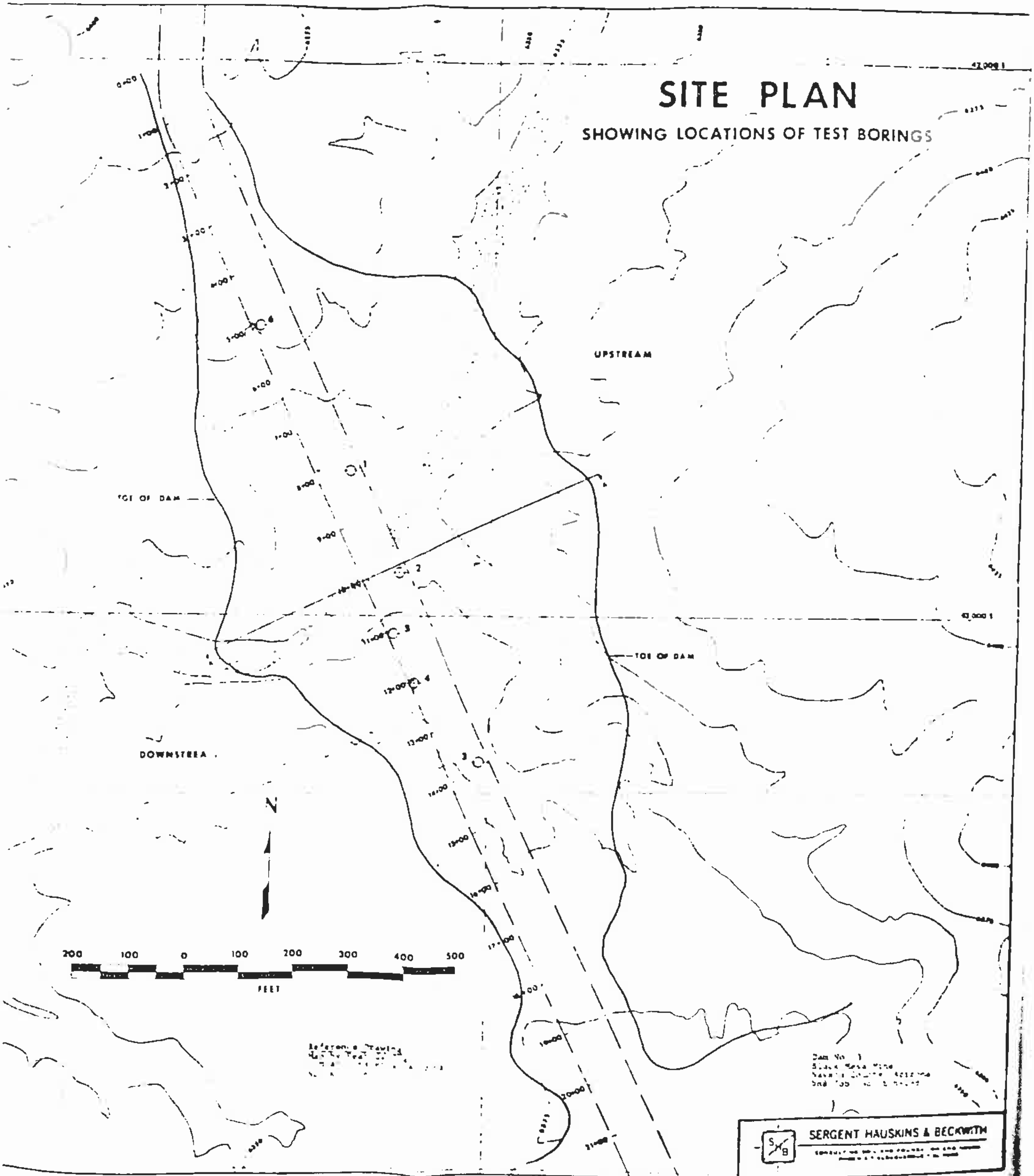


1211 – AZ – 9 – 0003 Rev. 9/14/77

EXHIBIT E : AREA – CAPACITY CURVE


NORTH END
BORING NO 6
BORING NO. 1
BORING NO. 2
BORING NO. 5
BORING NO. 4
BORING NO. 3
REFERENCE DRAWING LOCATION OF DRILL
HOLES J-7 DAM BLACK MESA MINE
PEABODY COAL COAL COMPANY
KAYENTA ARIZONA DATED 4 13 76
0+00
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00
10+00
11+00
12+00
13+00
14+00
15+00
16+00


SITE PLAN
SHOWING LOCATIONS OF TEST BORINGS
UPSTREAM
TOE OF DAM
TOE OF DAM
DOWNSTREA
200 100 0 100 200 300 400 500
FEET
SERGENT HAUSKINS & BECKWITH

Date 6-22-76

Peabody Engineering Office KAYENTA ARIZONA

Attached herewith are your hydrologic analyses for the following impoundment.

Name BLACK MESA J-7 DAM

MESA I.D.# 1211-AZ-9-0003

As you may recall, the "DAMS 2" Computer Program, Version 2, February 1971, U. S. Dept. of Agriculture, Soil Conservation Service, was used to perform these flood routing analyses. The User's Guide, Technical Release 48, describes the program operation, input data requirements, options and output, and is available from the Soil Conservation Service.

The impoundments, associated hydraulic facilities and watershed were analyzed for the following appropriate, required storms. The impoundment and associated facilities meet or exceed pertinent MESA standards.

Storm	Rainfall/Duration	Freeboard*	Drawdown Time
GENERAL 100YR	2.9"/6 HRS	6.4'	LESS THAN 10 days
GENERAL PMP	13.0"/6 HRS	0.9'	LESS THAN 10 days
THUNDERSTORM 100yr	2.7"/1 HRS	6.4'	LESS THAN 10 days
THUNDERSTORM PMTS	9.5"/1 HRS	0.9'	LESS THAN 10 days

* Difference between maximum reservoir water surface elevation and elevation of lowest point on the crest of the dam.

D. M. Schlueter
F. X. Kaiser
Peabody - St. Louis

The indicated hydrologic analysis and performance of this impoundment is in accordance with current, prudent engineering practices for the passage of runoff from the designed storm which exceeds the storage capacity of the impoundment.

Certified by ____________________

Registered Professional Engineer # ____________

Date ____________________

EXHIBIT F

```
DAMS2 XEC  6/15/76
      REV 06/18/73

*************************** 80-80 LIST OF INPUT DATA ****************************

      DAMS2      04/03/76  BLACK MESA.  J-7 DAM  MESA I.C. 1211-AZ-9-0003              3400
      STRUCTURE                                                                         3400
                          6305      0          0                                        3400
                          6310      .12        0                                        3400
                          6315      .80        0                                        3400
                          6320      1.29       0                                        3400
                          6325      2.11       0                                        3400
                          6330      3.48       0                                        3400
                          6335      5.62       0                                        3400
                          6340      9.33       0                                        3400
                          6345      14.66      0                                        3400
                          6350      22.10      0                                        3400
                          6355      30.83      0                                        3400
                          6360      39.71      0                                        3400
                          6365      49.94      0                                        3400
                          6370      61.79      0                                        3400
                          6373.6    67.51      0                                        3400
                          6380      92.45      0                                        3400
      ENDTABLE                                                                          3400
      RAINTABLE USBRG     1.0       POINT ONE HOUR STORM                                3400
                          0.0       0.17       0.40       0.88       1.0                3400
      ENDTABLE                                                                          3400
      RAINTABLE GRBSU     6.0       GEN. 6 HOUR STORM DISTRIBUTION                      3400
                          0         0.12       0.26       0.42       0.71               3400
                          0.85      1.00                                                3400
      ENDTABLE                                                                          3400
      BTMWIDTH  FEET      282                                                           3400
      DOTESTS                                                                           3400
      ESCREST   ELEV      6373.6                                                        3400
      ESDATA    41        585       0.025      25         0.025      3.33               3400
      ESPROFILE 41        35        0.5        100        1.2                           3400
      ESPROFILE           282       3.9        377        4.2                           3400
      ESPROFILE           500       7.0        585        25.7                          3400
      KIRPICH                                                                           3400
      POOLDATA  ELEV      6373.6    6373.6                                              3400
      PSRATING                                                                          3400
      P100,PMP  .440      2.5       13         1.21       1.49                          3400
      WSDATA    1A        44        14.41      32000      726.4                         3400
      COMMENT   NOW ROUTE  GEN 6-HR STORM                                               3400
      STORM     30.0                6.0                                                 3400
      GO,STORM  LPC       GRBSU     2.9                              6373.6             3400
      STORM     35.0                6.0                                                 3400
      GO,STORM  LPC       GRBSU     13.0                             6373.6             3400
      COMMENT   ROUTE ONE-HR PT STORM                                                   3400
      STORM     30.0                1.0                                                 3400
      GO,STORM  LPC       USBRG     2.7                              6373.6             3400
      STORM     35.0                1.0                                                 3400
      GO,STORM  LPC       USBRG     9.5                              6373.6             3400
      GO,TOD              6380      6373.6     0                                        3400
                                                                                        3400
```

```
DAMS2 XEQ  6/15/76
      REV 06/18/73

      **************************** 80-80 LIST OF INPUT DATA ****************************

      COMMENT   TOP OF DAM ELEV  6380                                                3400
      COMMENT   RUN BOTH DURATION STORMS (RUN 10)                                    3400
      ENDJOB                                                                         3400

      ***************************************************************************************
```

DAMS2 XEQ 6/15/76
REV 06/18/73 BLACK MESA J-7 DAM MESA I.D. 1211-AZ-?-0303

NOW ROUTE GEN 6-HR STORM

****************************** BASIC DATA ******************************

ARID-SEMIARID CLIMATE AREA DESIGN CLASS A

STORM DISTRIBUTION.....GEN. 6 HOUR STORM DISTRIBUTION

P-100	PMP	P1DA/P6HR	P10DA/P1DA	CN	DA-SM	TC/L	-/H
2.90	13.00	1.210	1.490	44.00	14.41	32000.00	726.40
CONDUITS	COND L	D/W	-/H	PS N	KI	WEIR L	TW EL
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERM POOL	CREST PS	FP SED	BASEFLOW	2ND STG	ORF H	ORF L	START
6373.60	6373.60	0.0	0.0	0.0	0.0	0.0	6373.60
FS1	FS2	FS3	FS4	FS5	Z ES	EXIT N	EXIT S
6373.60	0.0	0.0	0.0	0.0	25.00	0.025	0.033
ES TYPE	ES L	ES N	BW1	BW2	BW3	BW4	BW5
41	595	0.025	282.00	0.0	0.0	0.0	0.0

PROVIDED BY ES FILE

ES CODE	INCREMENT			Q1	Q2	Q3	Q4
41585.025	1.000			2.441	7.276	13.779	21.666
Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
30.734	40.888	51.996	64.012	76.959	90.519	104.943	120.074

********************** DETAILED LIST OF BASIC DATA **********************

WEIR COEFF. FOR ORIFICES....... 3.10   RATIO OF IA TO SCH.10,NEH4).. 0.20   MIN ES BW WHEN MAX V/C GIVEN.. 20.0

WEIR COEFF. FOR DROP INLET..... 3.10   TIME INCS TO PEAK OF UNIT HYD. 5.   DELTA BW WHEN MAX V/C GIVEN... 64.0

DISCHARGE COEF. FOR ORIFICES.. 0.60   NO. POINTS FOR DESIGN HYD..... 101   PRECISION OF BW SOLUTION...... 1.0

FILLET SIZE FOR BOX CONDUITS.. 6.00   ES-WSI CALC. DEPTH PRECISION. 0.005   PRECISION OF V/C SOLUTION..... 0.03

GRAVITATIONAL CONSTANT........32.16   ES-WSP PERMISSIBLE VEL.CHANGE. 0.05

	TOP WIDTH	UPSTREAM Z	DOWNSTREAM Z	WAVE BERM	STAB. BERM	DH MAX
EMBANKMENT TEMPLATE	0.0	2.5	2.5	10.0	0.0	0.0

RAINFALL EQUATION CONSTANTS	K1 PSH	K1 ESH	K1 FBH	K2 PSH	K2 ESH	K2 FBH
CLASS A	0.82	1.00	1.00	0.0	0.0	0.12

DIMENSIONLESS UNIT HYDROGRAPH PEAK FACTOR = 484.0

0.0	0.030	0.100	0.150	0.310	0.470	0.660	0.820	0.930	0.990
1.000	0.990	0.930	0.860	0.780	0.680	0.560	0.460	0.390	0.330
0.280	0.240	0.207	0.177	0.147	0.127	0.107	0.090	0.077	0.065
0.055	0.047	0.040	0.034	0.029	0.025	0.021	0.018	0.015	0.013
0.011	0.009	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.001
0.0									

SCS DESIGN STORM RAINFALL DISTRIBUTION. (CHAPTER 21, NEH4 AND SCS TR-27)

0.0	0.013	0.027	0.042	0.059	0.078	0.099	0.122	0.147	0.180
0.230	0.380	0.530	0.625	0.670	0.705	0.736	0.764	0.790	0.814
0.836	0.856	0.875	0.893	0.910	0.927	0.942	0.957	0.972	0.986
1.000									

POINT ONE HOUR STORM ID NAME IS USBPG

0.0	0.170	0.400	0.880	1.000

GEN. 6 HOUR STORM DISTRIBUTION ID NAME IS GRBSU

0.0	0.120	0.260	0.420	0.710	0.890	1.000

DAMS2 XFC 6/15/76 BLACK MESA J-7 DAM MESA I.D. [illegible]
REV 06/18/73

PERM POOL	6373.60 FT	1287.7 ACFT	67.91 AC
CREST PS	6373.60 FT	1287.7 ACFT	67.91 AC
SED ACCUM	6373.60 FT	1287.7 ACFT	67.91 AC
ES CREST	6373.60 FT	1287.7 ACFT	67.91 AC
PS STORAGE	0.0 ACFT		
STARTING E	6373.60 FT	1287.7 ACFT	67.91 AC	0.0 CFS

STORM HYD D= 6.00 HR P= 2.90 IN Q= 0.01 IN
TC= 1.64 HR CN= 44.00 V= 7.3 ACFT
PEAK 54.8 CFS AT 6.59 HRS

****

RATING TABLE NUMBER 2

	E FEET	Q CFS	V AC FT	A ACRE
1	6373.60	0.0	1287.73	67.91
2	6373.60	0.0	1287.73	67.91
3	6373.60	0.0	1287.73	67.91
4	6373.60	0.0	1287.73	67.91
5	6373.60	0.0	1287.73	67.91
6	6373.60	0.0	1287.73	67.91
7	6373.60	0.0	1287.73	67.91
8	6373.60	0.0	1287.73	67.91
9	6373.60	0.0	1287.73	67.91
10	6373.60	0.0	1287.73	67.91
11	6373.60	0.0	1287.73	67.91
12	6373.60	0.0	1287.73	67.91
13	6373.60	0.0	1287.73	67.91
14	6373.91	222.95	1309.41	69.12
15	6374.23	454.76	1331.75	70.35
16	6374.81	1044.22	1373.06	72.57
17	6375.52	2135.64	1425.05	75.26
18	6376.80	5074.15	1524.61	80.17
19	6378.40	10300.64	1657.92	86.31
20	6380.00	17325.74	1801.07	92.45

TYPE	BW	EMAX	VMAX	AMAX	HP	V-ES	V-PS	Q-ES	[illegible]	DZ	V/C	S/C	S/C.25	D-ES
STORM HYD	282.0	6373.65	1290.8	68.1	0.04	2.1	0.	32.	32.	0.07	1.54	0.022	0.030	8.9

PLOT 1 IN = 10. CFS
EXIT SLOPE = 0.033

T	I	O	E	V	A	0.	10.	20.	30.	40.	50.	60.	70.	EXIT VEL
0.0	0	0	6373.6	1287.7	67.9	.								0.0
0.39	0	0	6373.6	1287.7	67.9	.								0.0
0.78	0	0	6373.6	1287.7	67.9	.								0.0
1.16	0	0	6373.6	1287.7	67.9	.								0.0
1.55	0	0	6373.6	1287.7	67.9	.								0.0
1.94	0	0	6373.6	1287.7	67.9	.								0.0
2.33	0	0	[illegible]	[illegible]	[illegible]									0.0

```
 3.10            0 6373.6   1287.7   67.9 .
 3.49            0 6373.6   1287.7   67.9 .
 3.88            0 6373.6   1287.7   67.9 .
 4.26     0      0 6373.6   1287.7   67.9 .
 4.65     0      0 6373.6   1287.7   67.9 .

IHC210I PROGRAM INTERRUPT(P) OLD PSW IS     FF35110F62030145
 5.04     0      0 6373.6   1287.7   67.9 .
 5.43     3      0 6373.6   1287.7   67.9 .  I                                                               0.02
 5.81    15      3 6373.6   1288.0   67.9 .  E         I                                                     0.41
 6.20    39     10 6373.6   1288.7   68.0 .        E                                                         0.72*
 6.59    55     20 6373.6   1289.7   68.0 .               E               I                                  1.09
 6.98    48     29 6373.6   1290.6   68.1 .                                              X                   1.45
 7.36    31     32 6373.6   1290.8   68.1 .                      E                 I                         1.70
 7.75    17     30 6373.6   1290.6   68.1 .                        IX                                        1.75
 8.14     9     25 6373.6   1290.1   68.0 .                  I     E                                         1.71
 8.53     5     20 6373.6   1289.7   68.0 .        I              E                                          1.56
 8.91     3     15 6373.6   1289.2   68.0 .     I              E                                             1.45
 9.30     2     12 6373.6   1288.9   68.0 .  I          E                                                    1.31
 9.69     1      9 6373.6   1288.6   68.0 . I       E                       .                                1.20
10.08     1      7 6373.6   1288.4   67.9 .I      E                                                          1.05
10.46     0      5 6373.6   1288.2   67.9 .     E                                                            0.95
10.85     0      3 6373.6   1288.1   67.9 .  E                                                               0.85
11.24     0      3 6373.6   1287.7   67.9 .  E                                                               0.76*
  T       I      O    E        V       A  I         I         I         I         I         I         I      0.68
                                          0.       10.       20.       30.       40.       50.       60.     70. VEL
                                                                                                                EXIT
```

****************************** BASIC DATA ******************************

ARID-SEMIARID CLIMATE AREA DESIGN CLASS A

STORM DISTRIBUTION.....GEN. 6 HOUR STORM DISTRIBUTION

P-100	PMP	P1DA/P6HR	P10DA/P1DA	CN	DA-SM	TC/L	-/H
2.90	13.00	1.210	1.490	44.00	14.41	32000.00	726.40
CONDUITS	COND L	D/W	-/H	PS N	KI	WEIR L	TW EL
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERM POOL	CREST PS	FP SED	BASEFLOW	2ND STG	ORF H	ORF L	START
6373.60	6373.60	0.0	0.0	0.0	0.0	0.0	6373.60
ES1	ES2	ES3	ES4	ES5	Z ES	EXIT N	EXIT S
6373.60	0.0	0.0	0.0	0.0	25.00	0.025	0.033
ES TYPE	ES L	ES N	BW1	BW2	BW3	BW4	BW5
41	585	0.025	282.00	0.0	0.0	0.0	0.0

PROVIDED BY ES FILE

ES CODE	INCREMENT			Q1	Q2	Q3	Q4
41585.025	1.000			2.441	7.276	13.779	21.666
Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
30.734	40.888	51.996	64.012	76.858	90.510	104.943	120.074

********************** DETAILED LIST OF BASIC DATA **********************

WEIR COEF. FOR ORIFICES....... 3.10
WEIR COEF. FOR DROP INLET..... 3.10
DISCHARGE COEF. FOR ORIFICES.. 0.60
FILLET SIZE FOR BOX CONDUITS.. 6.00
GRAVITATIONAL CONSTANT....... 32.16

RATIO OF IA TO S(CN.10,N(H4).. 0.20
TIME INCS TO PEAK OF UNIT HYD. 5.
NO. POINTS FOR DESIGN HYD..... 101
ES-WSP CALC. DEPTH PRECISION. 0.005
ES-WSP PERMISSIBLE VEL.CHANGE. 0.05

MIN ES BW WHEN MAX V/C GIVEN.. 20.0
DELTA BW WHEN MAX V/C GIVEN... 64.0
PRECISION OF BW SOLUTION...... 1.0
PRECISION OF V/C SOLUTION..... 0.03

	TOP WIDTH	UPSTREAM Z	DOWNSTREAM Z	WAVE BERM	STAB. BERM	DH MAX
EMBANKMENT TEMPLATE	0.0	2.5	2.5	10.0	0.0	0.0
	K1 PSH	K1 ESH	K1 FBH	K2 PSH	K2 ESH	K2 FBH
RAINFALL EQUATION CONSTANTS CLASS A	0.92	1.00	1.00	0.0	0.0	0.12

DIMENSIONLESS UNIT HYDROGRAPH PEAK FACTOR = 484.0

0.0	0.030	0.100	0.190	0.310	0.470	0.660	0.820	0.930	0.990
1.000	0.990	0.930	0.860	0.780	0.680	0.560	0.460	0.390	0.330
0.280	0.240	0.207	0.177	0.147	0.127	0.107	0.090	0.077	0.065
0.055	0.047	0.040	0.034	0.029	0.025	0.021	0.018	0.015	0.013
0.011	0.009	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.001
0.0									

SCS DESIGN STORM RAINFALL DISTRIBUTION. (CHAPTER 21, NEH4 AND SCS TR-27)

0.0	0.013	0.027	0.042	0.059	0.078	0.099	0.122	0.147	0.180
0.230	0.380	0.530	0.625	0.670	0.705	0.736	0.764	0.790	0.814
0.836	0.856	0.875	0.893	0.910	0.927	0.942	0.957	0.972	0.986
1.000									

POINT ONE HOUR STORM ID NAME IS USERG

0.0	0.170	0.400	0.880	1.000

GEN. 6 HOUR STORM DISTRIBUTION ID NAME IS GR6SU

0.0	0.120	0.260	0.420	0.710	0.850	1.000

DAMS2 XEQ 6/15/76
REV 06/18/73

BLACK MESA J-7 DAM MESA I.D. 1211-A7-9-0003

PERM POOL	6373.60 FT	1287.7 ACFT	67.91 AC	
CREST PS	6373.60 FT	1287.7 ACFT	67.91 AC	
SED ACCUM	6373.60 FT	1287.7 ACFT	67.91 AC	
ES CREST	6373.60 FT	1287.7 ACFT	67.91 AC	
PS STORAGE	0.0 ACFT			
STARTING E	6373.60 FT	1287.7 ACFT	67.91 AC	0.0 CFS

STORM HYD D= 6.00 HR P= 13.00 IN Q= 4.71 IN
TC= 1.64 HR CN= 44.00 V= 3586.7 ACFT
PEAK 13513.3 CFS AT 4.96 HRS

****

RATING TABLE NUMBER 2

	E FEET	Q CFS	V AC FT	A ACRE
1	6373.60	0.0	1287.73	67.91
2	6373.60	0.0	1287.73	67.91
3	6373.60	0.0	1287.73	67.91
4	6373.60	0.0	1287.73	67.91
5	6373.60	0.0	1287.73	67.91
6	6373.60	0.0	1287.73	67.91
7	6373.60	0.0	1287.73	67.91
8	6373.60	0.0	1287.73	67.91
9	6373.60	0.0	1287.73	67.91
10	6373.60	0.0	1287.73	67.91
11	6373.60	0.0	1287.73	67.91
12	6373.60	0.0	1287.73	67.91
13	6373.60	0.0	1287.73	67.91
14	6373.91	222.95	1309.41	69.12
15	6374.23	454.76	1331.75	70.35
16	6374.81	1044.22	1373.06	72.57
17	6375.52	2135.64	1425.03	75.26
18	6376.80	5074.19	1524.61	80.17
19	6378.40	10300.64	1657.92	86.31
20	6380.00	17325.74	1801.07	92.45

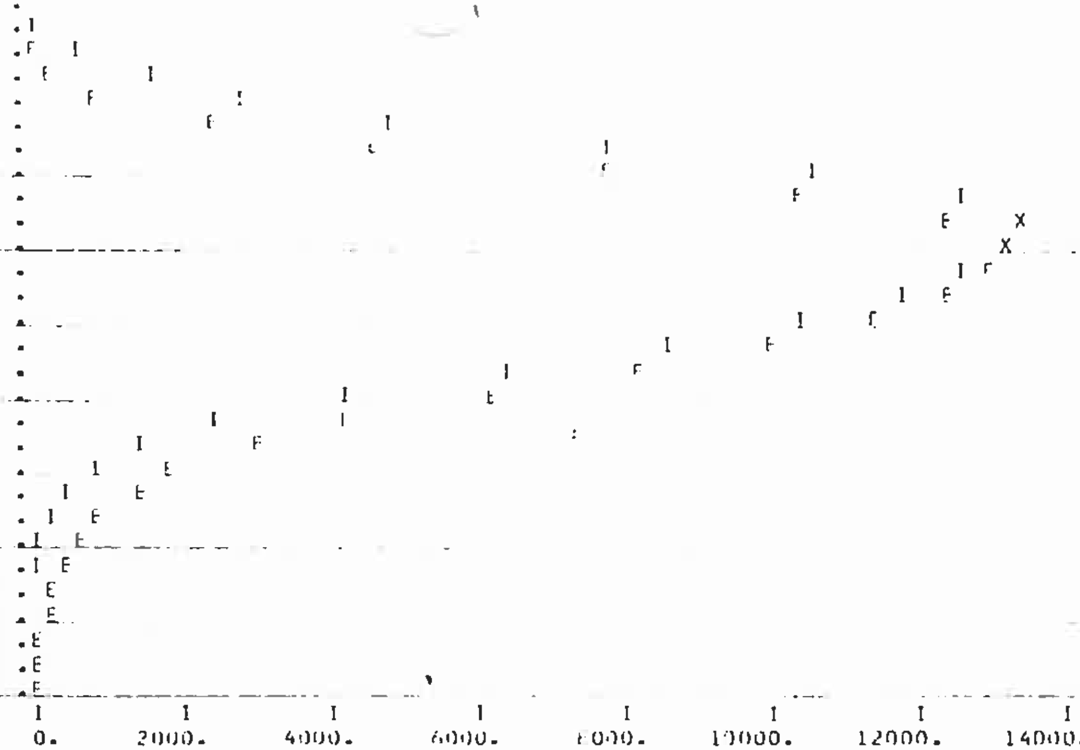
TYPE	HW	EMAX	VMAX	AMAX	DP	V-ES	Q-ES	Q-PS	Q-TOT	D/C	V/C	S/C	S/C.25	D-ES
STORM HYD	282.0	6379.10	1719.5	89.0	5.50	431.3	0.	13325.	13325.	3.44	10.52	0.006	0.003	9.1

PLOT 1 IN = 2000. CFS

EXIT SLOPE = 0.033

T	I	O	E	V	A	0. 2000. 4000. 6000. 8000. 10000. 12000. 14000.	EXIT VEL
0.0	0	0	6373.6	1287.7	67.9	.	0.0
0.33	0	0	6373.6	1287.7	67.9	.	0.0
0.66	0	0	6373.6	1287.7	67.9	.	0.0
0.99	0	0	6373.6	1287.7	67.9	.	0.0

T	I	O	E	V	A	EXIT VEL
1.65		0	[illegible]	[illegible]	[illegible]	[illegible]
1.98		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2.31	[illegible]	47	[illegible]	[illegible]	[illegible]	[illegible]
2.64	843	175	[illegible]	1304.8	68.9	[illegible]
2.97	1740	453	6374.2	1331.6	70.3	[illegible]
3.31	3044	1095	6374.8	1375.7	72.7	[illegible]
3.64	5098	2507	6375.7	1437.6	75.9	[illegible]
3.97	7913	4805	6376.7	1515.5	79.7	12.23
4.30	10779	7912	6377.7	1597.0	83.6	14.63
4.63	12780	10652	6378.5	1665.1	86.6	16.25
4.96	13513	12654	6378.9	1705.9	88.4	17.26
5.29	13466	13325	6379.1	1719.5	89.0	17.57
5.62	12856	13193	6379.1	1716.9	88.9	17.51
5.95	11918	12546	6378.9	1703.7	88.3	17.21
6.28	10687	11548	6378.7	1683.3	87.4	16.72
6.61	8873	10151	6378.4	1654.1	86.1	[illegible]
6.94	6557	8452	6377.8	1610.8	84.2	[illegible]
7.27	4318	6350	6377.2	1557.1	81.7	13.53
7.60	2608	4466	6376.5	1504.0	79.2	[illegible]
7.93	1593	3107	6375.9	1457.9	76.9	10.41
8.26	979	2077	6375.5	1422.3	75.1	[illegible]
8.59	591	1501	6375.1	1394.8	73.7	7.91
8.92	352	1043	6374.8	1372.9	72.6	6.88
9.25	207	794	6374.6	1355.5	71.6	6.20
9.59	122	588	6374.4	1341.1	70.8	5.53
9.92	67	434	6374.2	1329.7	70.2	4.90
10.25	35	339	6374.1	1320.6	69.7	4.45
10.58	17	261	6374.0	1313.1	69.3	4.02
10.91	6	199	6373.9	1307.1	69.0	3.63
11.24	0	151	6373.8	1302.4	68.7	3.25



DAMS2 XEQ 6/15/76
REV 06/18/73

BLACK MESA J-7 DAM MESA I.D. 1211-17-9-0003

ROUTE ONE-HR PT STORM

****************************** BASIC DATA ******************************

ARID-SEMIARID CLIMATE AREA DESIGN CLASS A

STORM DISTRIBUTION.....POINT ONE HOUR STORM

P-100	PMP	PIDA/PEMP	PIDDA/PIDA	CN	DA-SM	TC/L	-/H
2.90	13.00	1.210	1.490	44.00	14.41	32000.00	726.40
CONDUITS	**COND L**	**D/W**	**-/H**	**PS N**	**KI**	**WEIR L**	**TW EI**
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERM POOL	**CREST PS**	**FP SED**	**BASEFLOW**	**2ND STG**	**ORF H**	**ORF L**	**START**
6373.60	6373.60	0.0	0.0	0.0	0.0	0.0	6373.60
ES1	**ES2**	**ES3**	**ES4**	**ES5**	**Z ES**	**EXIT N**	**EXIT S**
6373.60	0.0	0.0	0.0	0.0	25.00	0.025	0.033
ES TYPE	**ES L**	**ES N**	**BW1**	**BW2**	**BW3**	**BW4**	**BW5**
41	585	0.025	282.00	0.0	0.0	0.0	0.0

PROVIDED BY ES FILE

ES CODE	INCREMENT			Q1	Q2	Q3	Q4
41585.025	1.000			2.441	7.276	13.775	21.666
Q5	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
30.734	40.888	51.996	64.012	76.858	90.519	104.943	120.074

*********************** DETAILED LIST OF BASIC DATA ***********************

WEIR COEF. FOR ORIFICES....... 3.10 RATIO OF IA TO S(CN.10,CN100).. 0.20 MIN ES BW WHEN MAX V/C GIVEN.. 20.0

WEIR COEF. FOR DROP INLET..... 3.10 TIME INCS TO PEAK OF UNIT HYD.. 5. DELTA BW WHEN MAX V/C GIVEN... 20.0

DISCHARGE COEF. FOR ORIFICES.. 0.60 NO. POINTS FOR DESIGN HYD..... 101 PRECISION OF BW SOLUTION...... 1.0

FILLET SIZE FOR BOX CONDUITS.. 5.00 ES-WSP CALC. DEPTH PRECISION. 0.005 PRECISION OF V/C SOLUTION..... 0.03

GRAVITATIONAL CONSTANT........ 32.16 ES-WSP PERMISSIBLE VEL.CHANGE. 0.05

EMBANKMENT TEMPLATE	TOP WIDTH	UPSTREAM Z	DOWNSTREAM Z	WAVE BERM	STAB. BERM	DH MAX
	0.0	2.5	2.5	10.0	0.0	0.0
RAINFALL EQUATION CONSTANTS CLASS A	**K1 PSH**	**K1 ESH**	**K1 FBH**	**K2 PSH**	**K2 ESH**	**K2 FBH**
	0.92	1.03	1.30	0.0	0.0	0.12

DIMENSIONLESS UNIT HYDROGRAPH PEAK FACTOR = 484.0

0.0	0.030	0.100	0.190	0.310	0.470	0.660	0.320	0.930	0.990
1.000	0.990	0.930	0.860	0.790	0.680	0.560	0.460	0.390	0.330
0.280	0.240	0.207	0.177	0.147	0.127	0.107	0.090	0.077	0.065
0.055	0.047	0.040	0.034	0.029	0.025	0.021	0.018	0.015	0.013
0.011	0.009	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.001
0.0									

SCS DESIGN STORM RAINFALL DISTRIBUTION (CHAPTER 21, NEH4 AND SCS EM-27)

0.0	0.013	0.027	0.042	0.059	0.075	0.096	0.122	0.147	0.180
0.230	0.380	0.530	0.625	0.670	0.705	0.735	0.764	0.790	0.814
0.836	0.856	0.875	0.893	0.910	0.927	0.942	0.957	0.972	0.986
1.000									

POINT ONE HOUR STORM ID NAME IS USEPG

0.0	0.170	0.400	0.880	1.000

GEN. 6 HOUR STORM DISTRIBUTION ID NAME IS [illegible]

0.0	0.120	0.260	0.420	0.710	[illegible]	1.000

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DAMS2 XEQ  6/15/76              BLACK MESA   J-7 DAM  MESA I.D. 1211-AZ-0-0003                        PASS  3
     REV 06/18/73                                                                                     PAGE  2

         PERM POOL       6373.60 FT    1287.7 ACFT     67.91 AC

         CREST PS        6373.60 FT    1287.7 ACFT     67.91 AC

         SED ACCUM       6373.60 FT    1287.7 ACFT     67.91 AC

         ES CREST        6373.60 FT    1287.7 ACFT     67.91 AC

         PS STORAGE          0.0 ACFT

         STARTING E      6373.60 FT    1287.7 ACFT     67.91 AC        0.0 CFS

         STORM HYD      D=    1.00 HR     P=  2.70 IN      Q=  0.00 IN
                       TC=    1.64 HR    CN=  44.00        V=       1.4 ACFT
              PEAK         11.6 CFS AT    1.94 HRS

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RATING TABLE NUMBER 2

	E	Q	V	A
	FEET	CFS	AC FT	ACRE
1	6373.60	0.0	1287.73	67.91
2	6373.60	0.0	1287.73	67.91
3	6373.60	0.0	1287.73	67.91
4	6373.60	0.0	1287.73	67.91
5	6373.60	0.0	1287.73	67.91
6	6373.60	0.0	1287.73	67.91
7	6373.60	0.0	1287.73	67.91
8	6373.60	0.0	1287.73	67.91
9	6373.60	0.0	1287.73	67.91
10	6373.60	0.0	1287.73	67.91
11	6373.60	0.0	1287.73	67.91
12	6373.60	0.0	1287.73	67.91
13	6373.60	0.0	1287.73	67.91
14	6373.91	222.95	1309.41	69.12
15	6374.23	454.76	1331.75	70.35
16	6374.81	1044.22	1373.06	72.57
17	6375.52	2135.44	1425.03	75.26
18	6376.80	5074.19	1524.61	80.17
19	6378.40	10300.64	1657.92	86.31
20	6380.00	17325.74	1801.07	92.45

TYPE	HW	EMAX	VMAX	AMAX	HP	V-ES	V-PS	Q-ES	Q-TOT	V/C	V/A	S/C	S/C.25	D-ES
STORM HYD	292.0	6373.61	1288.4	67.9	0.01	0.6	0.	0.	[illegible]	0.02	0.01	0.041	0.042	0.0

```
      PLOT                                    1 IN =      10. CFS                                   EXIT SLOPE = 0.033
                                            0.       10.       20.       30.       40.       50.       60.       70.  EXIT
    T        I       O       E        V       A      I         I         I         I         I         I         I    VEL
   0.0       0       0  6373.6   1287.7    67.9 .                                                                     0.0
   0.22      0       0  6373.6   1287.7    67.9 .                                                                     0.0
                                                                                                                      0.0
```

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IHC2101 F[illegible]   [illegible] HE[illegible] DSW IS   [illegible]
  0.86          0 6373.6  1287.7  67.9 .                                                      [illegible]
  1.08          0 6373.6  1287.7  67.9 . I                                                    [illegible]
  1.29     5    1 6373.6  1287.7  67.9 .F     I                                               [illegible]
  1.51     9    2 6373.6  1287.7  67.9 . F        I                                           [illegible]
  1.72    11    3 6373.6  1288.1  67.9 .   F          I                                       0.72*
  1.94    12    5 6373.6  1288.2  67.9 .       F          X                                   0.83
  2.15    10    6 6373.6  1288.3  67.9 .         F    I                                       0.90
  2.37     3    6 6373.6  1288.3  67.9 .         F I                                          0.76
  2.58     6    6 6373.6  1288.4  67.9 .          X                                           0.73
  2.80     4    6 6373.6  1288.3  67.9 .      I F                                             0.53
  3.01     3    6 6373.6  1288.3  67.9 .   I    E                                             0.90
  3.23     2    5 6373.6  1288.2  67.9 . I    F                                               0.89
  3.44     2    5 6373.6  1288.2  67.9 . I    F                                               0.82
  3.66     1    4 6373.6  1288.1  67.9 .I   E                                                 0.80*
  3.87     1    4 6373.6  1288.1  67.9 .I   E                                                 0.73*
  4.09     1    3 6373.6  1288.0  67.9 .I F                                                   0.72*
  4.30     0    3 6373.6  1287.7  67.9 .  E                                                   0.67
  4.52     0    2 6373.6  1287.7  67.9 . F                                                    0.67
  4.73     0    2 6373.6  1287.7  67.9 . F                                                    0.63
  4.95     0    2 6373.6  1287.7  67.9 . E                                                    0.58
  5.16     0    1 6373.6  1287.7  67.9 .E                                                     0.55
  5.38     0    1 6373.6  1287.7  67.9 .E                                                     0.52
  5.59     0    1 6373.6  1287.7  67.9 .E                                                     0.50
  5.81     0    1 6373.6  1287.7  67.9 .E                                                     0.49
  6.02     0    1 6373.6  1287.7  67.9 .F                                                     0.49
  6.24     0    1 6373.6  1287.7  67.9 .F                                                     0.41
    T      I    O     F        V     A I        I        I        I        I        I        I        I   VFL
                                       0.      10.      20.      30.      40.      50.      60.      70. EXIT
```

DAMS2 XEQ 6/15/76 BLACK MESA J-7 DAM MESA I.D. 1211-AZ-9-0003 PASS 4
REV 06/18/73 PAGE 1

******************************** BASIC DATA ********************************

ARID-SEMIARID CLIMATE AREA.. DESIGN CLASS A

STORM DISTRIBUTION.....POINT ONE HOUR STORM

P-100	PMP	P1DA/P6HR	P100A/P1DA	CN	DA-SM	-/H	-/H
2.90	13.00	1.210	1.490	44.00	14.41	32000.00	726.40
CONDUITS	COND L	D/W	-/H	PS N	KI	WEIR L	TW EL
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERM POOL	CREST PS	EP SED	BASEFLOW	2ND STG	OSE H	[illegible] L	START
6373.60	6373.60	0.0	0.0	0.0	0.0	0.0	6373.60
ES1	ES2	ES3	ES4	ES5	Z ES	EXIT N	EXIT S
6373.60	0.0	0.0	0.0	0.0	25.00	0.025	0.033
ES TYPE	ES L	ES N	BW1	BW2	BW3	BW4	BW5
41	585	0.025	282.00	0.0	0.0	0.0	0.0

PROVIDED BY ES FILE

ES CODE	INCREMENT			Q1	Q2	Q3	Q4
41585.025	1.000			2.441	7.276	13.779	21.666
Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
30.734	40.888	51.996	64.012	76.[illegible]8	90.519	104.[illegible]43	120.074

********************** DETAILED LIST OF BASIC DATA **********************

WEIR COEF. FOR ORIFICES....... 3.10 RATIO OF IA TO S(CN.10,MIN4).. 0.20 MIN ES HW WHEN MAX V/C GIVEN.. 20.0

WEIR COEF. FOR DROP INLET..... 3.10 TIME INCS TO PEAK OF UNIT HYD. 5. DELTA HW WHEN MAX V/C GIVEN... 44.0

DISCHARGE COEF. FOR ORIFICES.. 0.60 NO. POINTS FOR DESIGN HYD..... 101 PRECISION OF HW SOLUTION...... 1.0

FILLET SIZE FOR BOX CONDUITS.. 6.00 ES-WSP CALC. DEPTH PRECISION. 0.005 PRECISION OF V/C SOLUTION..... 0.03

GRAVITATIONAL CONSTANT....... 32.16 ES-WSP PERMISSIBLE VEL.CHANGE. 0.05

EMBANKMENT TEMPLATE	TOP WIDTH	UPSTREAM Z	DOWNSTREAM Z	WAVE BERM	STAB. BERM	BH MAX
	0.0	2.5	2.5	10.0	0.0	0.0
RAINFALL EQUATION CONSTANTS	K1 PSH	K1 ESH	K1 FBH	K2 PSH	K2 ESH	K2 FBH
CLASS A	0.72	1.00	1.00	0.0	0.0	0.12

130

DIMENSIONLESS UNIT HYDROGRAPH PEAK FACTOR = 484.0

0.0	0.030	0.100	0.190	0.310	0.470	0.660	0.820	0.930	0.990
1.000	0.990	0.930	0.860	0.780	0.680	0.560	0.460	0.390	0.330
0.280	0.240	0.207	0.177	0.147	0.127	0.107	0.090	0.077	0.065
0.055	0.047	0.040	0.034	0.029	0.025	0.021	0.018	0.015	0.013
0.011	0.009	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.001
0.0									

SCS DESIGN STORM RAINFALL DISTRIBUTION. (CHAPTER 21, NEH4 AND SCS EM-27)

0.0	0.013	0.027	0.042	0.059	0.078	0.099	0.122	0.147	0.180
0.230	0.380	0.530	0.625	0.670	0.705	0.736	0.764	0.790	0.814
0.836	0.856	0.875	0.893	0.910	0.927	0.942	0.957	0.972	0.986
1.000									

POINT ONE HOUR STORM ID NAME IS USBRG

0.0	0.170	0.400	0.880	1.000

GEN. 6 HOUR STORM DISTRIBUTION ID NAME IS GRBSU

0.0	0.120	0.260	0.420	0.710	0.890	1.000

DAMS2 [illegible] [illegible]

PERM POOL	6373.60 FT	1287.7 ACFT	67.91 AC
CREST PS	6373.60 FT	1287.7 ACFT	67.91 AC
SED ACCUM	6373.60 FT	1287.7 ACFT	67.91 AC
ES CREST	6373.60 FT	1287.7 ACFT	67.91 AC
PS STORAGE	0.0 ACFT		
STARTING E	6373.60 FT	1287.7 ACFT	67.91 AC

0.0 CFS

STORM HYD D= 1.00 HR P= 9.50 IN Q= 2.46 IN
TC= 1.64 HR CN= 44.00 V= 1869.3 ACFT
PEAK 15068.3 CFS AT 1.65 HRS

****

RATING TABLE NUMBER 2

	E FEET	Q CFS	V AC FT	A ACRE
1	6373.60	0.0	1287.73	67.91
2	6373.60	0.0	1287.73	67.91
3	6373.60	0.0	1287.73	67.91
4	6373.60	0.0	1287.73	67.91
5	6373.60	0.0	1287.73	67.91
6	6373.60	0.0	1287.73	67.91
7	6373.60	0.0	1287.73	67.91
8	6373.60	0.0	1287.73	67.91
9	6373.60	0.0	1287.73	67.91
10	6373.60	0.0	1287.73	67.91
11	6373.60	0.0	1287.73	67.91
12	6373.60	0.0	1287.73	67.91
13	6373.60	0.0	1287.73	67.91
14	6373.91	222.95	1309.41	69.12
15	6374.23	454.76	1331.75	70.35
16	6374.81	1044.22	1373.06	72.57
17	6375.52	2135.64	1425.03	75.26
18	6376.80	5074.19	1524.61	80.17
19	6378.40	10300.64	1657.92	86.31
20	6380.00	17325.74	1801.07	92.45

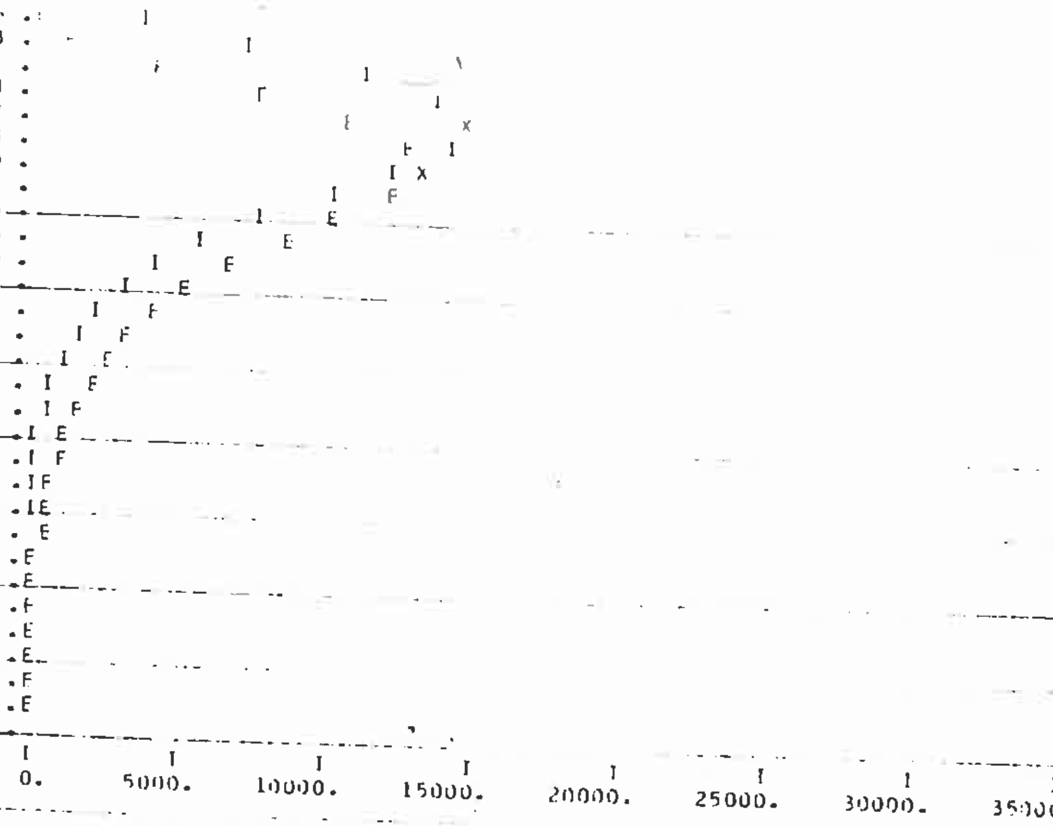
TYPE	BW	EMAX	VMAX	AMAX	HP	V-ES	Q-PS	Q-ES	Q-TOT	D/C	V/C	S/C	S/C.25	D-ES
STORM HYD	282.0	6379.11	1720.2	89.0	5.51	432.5	0.	13350.	13350.	3.44	10.53	0.008	0.009	6.4

PLOT 1 IN = 5000. CFS EXIT SLOPE = 0.033

T	I	O	E	V	A	EXIT VEL
0.0	0	0	6373.6	1287.7	67.9	0.0
0.19	0	0	6373.6	1287.7	67.9	0.0
0.37	24	2	6373.6	1287.7	67.9	0.0
0.55	266	22	6373.6	1289.9	68.0	0.63
0.73	1467	145	6373.8	1301.8	68.7	1.52
0.92	3819	526	6374.3	1336.8	70.6	3.14
1.10	7508	1727	6375.3	1405.6	74.3	5.24
1.28	11475	4431	6376.5	1502.8	79.1	8.35
1.47	14190	8118	6377.7	1602.2	83.8	11.86
1.65	15068	11248	6378.6	1677.2	87.2	14.76
1.83	14373	13131	6379.1	1715.6	88.8	16.57

```
  0.      5000.     10000.     15000.     20000.     25000.     30000.     35000.
  I         I          I          I          I          I          I          I
```

T	I	O	F	V	A	VEL EXIT
0.92	[illegible]	[illegible]	[illegible]	1336.[illegible]	70.6	[illegible]
1.10		1727	[illegible]	1405.[illegible]	74.3	[illegible]
1.28	1	4431	6376.5	1502.8	79.1	[illegible]
1.47	14.	8118	6377.7	1602.2	83.8	[illegible]
1.65	15068	11246	6378.6	1677.2	87.2	11.86
1.83	14373	13131	6379.1	1715.6	88.8	14.75
2.02	12726	13258	6379.1	1720.2	89.0	16.57
2.20	10299	12357	6378.9	1699.8	88.1	17.43
2.39	7779	10557	6378.5	1663.2	86.5	17.58
2.57	5816	8794	6377.9	1619.5	84.6	17.12
2.75	4412	7108	6377.4	1576.5	82.6	16.20
2.94	3393	5639	6377.0	1539.0	80.8	15.19
3.12	2578	4555	6376.6	1507.0	79.3	14.08
3.30	1981	3723	6376.2	1478.8	77.9	12.95
3.49	1493	2997	6375.9	1454.2	76.7	11.99
3.67	1133	2381	6375.6	1433.3	75.7	11.13
3.85	863	1940	6375.4	1415.7	74.8	10.27
4.04	656	1616	6375.2	1400.3	74.0	9.43
4.22	502	1331	6375.0	1386.7	73.3	8.73
4.40	385	1087	6374.8	1375.1	72.7	8.14
4.59	295	929	6374.7	1365.0	72.1	7.56
4.77	224	798	6374.6	1355.8	71.6	6.99
4.95	168	681	6374.5	1347.6	71.2	6.59
5.14	131	577	6374.4	1340.3	70.8	6.21
5.32	101	487	6374.3	1334.0	70.5	5.84
5.50	76	421	6374.2	1328.5	70.2	5.48
5.69	50	368	6374.1	1323.4	69.9	5.13
5.87	25	320	6374.0	1318.8	69.6	4.84
6.05	7	276	6374.0	1314.5	69.4	4.61
6.24	0	236	6373.9	1310.7	69.2	4.36
						4.10
						3.87



****************************** BASIC DATA ******************************

ARID-SEMIARID CLIMATE AREA DESIGN CLASS A

STORM DISTRIBUTION.....POINT ONE HOUR STORM

P-100	PMP	P1DA/P6HR	P10DA/P1DA	CN	DA-SM	TC/L	-/H
2.90	13.00	1.210	1.490	44.00	14.41	32000.00	726.40
CONDUITS	COND L	D/W	-/H	PS %	KI	WEIR L	TW EL
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERM POOL	CREST PS	FP SED	BASEFLOW	2ND STG	ORF H	ORF L	START
6373.60	6373.60	0.0	0.0	0.0	0.0	0.0	6373.60
ES1	ES2	ES3	ES4	ES5	Z ES	EXIT N	EXIT S
6373.60	0.0	0.0	0.0	0.0	25.00	0.025	0.033
ES TYPE	ES L	ES N	BW1	BW2	BW3	BW4	BW5
41	585	0.025	292.00	0.0	0.0	0.0	0.0

PROVIDED BY FS FILE

ES CODE	INCREMENT			Q1	Q2	Q3	Q4
41585.025	1.000			2.441	7.276	13.779	21.666
Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
30.734	40.888	51.996	64.012	76.858	90.519	104.943	120.074

********************** DETAILED LIST OF BASIC DATA **********************

WEIR COEF. FOR ORIFICES....... 3.10 RATIO OF IA TO S(CN.10,NEH4).. 0.20 MIN ES BW WHEN MAX V/C GIVEN.. 20.0

WEIR COEF. FOR DROP INLET..... 3.10 TIME INC. TO PEAK OF UNIT HYD. 5. DELTA BW WHEN MAX V/C GIVEN.... 64.0

DISCHARGE COEF. FOR ORIFICES.. 0.60 NO. POINTS FOR DESIGN HYD..... 101 PRECISION OF BW SOLUTION...... 1.0

FILLET SIZE FOR BOX CONDUITS.. 6.00 ES-WSP CALC. DEPTH PRECISION. 0.005 PRECISION OF V/C SOLUTION..... 0.03

GRAVITATIONAL CONSTANT....... 32.16 ES-WSP PERMISSIBLE VEL.CHANGE. 0.05

	TOP WIDTH	UPSTREAM Z	DOWNSTREAM Z	WAVE BERM	STAB. BERM	DH MAX
EMBANKMENT TEMPLATE	0.0	2.5	2.5	10.0	0.0	0.0

RAINFALL EQUATION CONSTANTS	K1 PSH	K1 ESH	K1 FBH	K2 PSH	K2 ESH	K2 FBH
CLASS A	0.82	1.00	1.00	0.0	0.0	0.12

DIMENSIONLESS UNIT HYDROGRAPH

PEAK FACTOR = 484.0

0.0	0.030	0.100	0.190	0.310	0.470	0.660	0.820	0.930	0.990
1.000	0.990	0.930	0.860	0.780	0.680	0.560	0.460	0.390	0.330
0.280	0.240	0.207	0.177	0.147	0.127	0.107	0.090	0.077	0.065
0.055	0.047	0.040	0.034	0.029	0.025	0.021	0.018	0.015	0.013
0.011	0.009	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.001
0.0									

SCS DESIGN STORM RAINFALL DISTRIBUTION. (CHAPTER 21, NEH4 AND SCS EM-27)

0.0	0.013	0.027	0.042	0.059	0.074	0.099	0.122	0.147	0.180
0.230	0.380	0.530	0.625	0.670	0.705	0.736	0.764	0.790	0.814
0.836	0.856	0.875	0.893	0.910	0.927	0.942	0.957	0.972	0.986
1.000									

POINT ONE HOUR STORM

ID NAME IS USBRG

0.0	0.170	0.400	0.880	1.000

GEN. 6 HOUR STORM DISTRIBUTION

ID NAME IS GRBSU

0.0	0.120	0.260	0.470	0.710	0.890	1.000

130

DAMS2 XEQ 6/15/7?
REV 06/18/73

BLACK MESA J-7 DAM MESA I.D. 1211-47-9-0003

PASS 5
PAGE 2

DOT TEST 6305.00 FT 0.0 ACFT 0.0 CFS
CONTROL IS 0.0 DETENTION STORAGE

*****DRAWDOWN TEST ELEVATION CANNOT BE REACHED.
DOT TEST USED 6373.60 FT 1287.7 ACFT 0.0 CFS

DRAWDOWN TIME = 0.02 DAYS (LIMIT = 0.0 DAYS)

****

RATING TABLE NUMBER 1

	E FEET	Q CFS	V AC FT	A ACRE
1	6305.00	0.0	0.0	0.0
2	6310.00	0.0	0.30	0.12
3	6315.00	0.0	2.60	0.80
4	6320.00	0.0	7.82	1.29
5	6325.00	0.0	16.32	2.11
6	6330.00	0.0	30.30	3.48
7	6335.00	0.0	53.05	5.62
8	6340.00	0.0	90.42	9.33
9	6345.00	0.0	150.40	14.66
10	6350.00	0.0	242.30	22.10
11	6355.00	0.0	374.62	30.93
12	6360.00	0.0	550.97	39.71
13	6365.00	0.0	775.10	49.94
14	6370.00	0.0	1054.42	61.79
15	6373.60	0.0	1287.73	67.91
16	6380.00	0.0	1901.07	92.45

DAMS2 XEQ 6/15/76
REV 06/10/73

BLACK MESA J-7 DAM MESA I.D. 1211-AZ-9-0003

TOP OF DAM ELEV 6380

RUN BOTH DURATION STORMS (RUN 10)

DAMS2.....JOB NO. 1 COMPLETE

BLACK MESA J-7 DAM MESA I.D. 1211-AZ-9-0003

1 STRUCTURE(S) ANALYZED

4 HYDROGRAPHS ROUTED

0 TRIAL ROUTINGS

****

CERTIFICATION

TO WHOM IT MAY CONCERN:

RE: Black Mesa Mine (Fresh Water) Reservoir
MESA I. D. #1211-AZ-9-0003
Navaho County, Arizona

Based on recently completed slope stability investigations, hydrologic analyses, historical information, and apparent present conditions, the subject facility should perform satisfactorily, as a whole, under current maximum design conditions.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
9157
LAWRENCE M. BRENNAN
DATE SIGNED 9-14-76
Arizona U. S. A.

Lawrence M. Brennan
Professional Engineer #9157

Sept 14, 1976
(Date)

EXHIBIT H

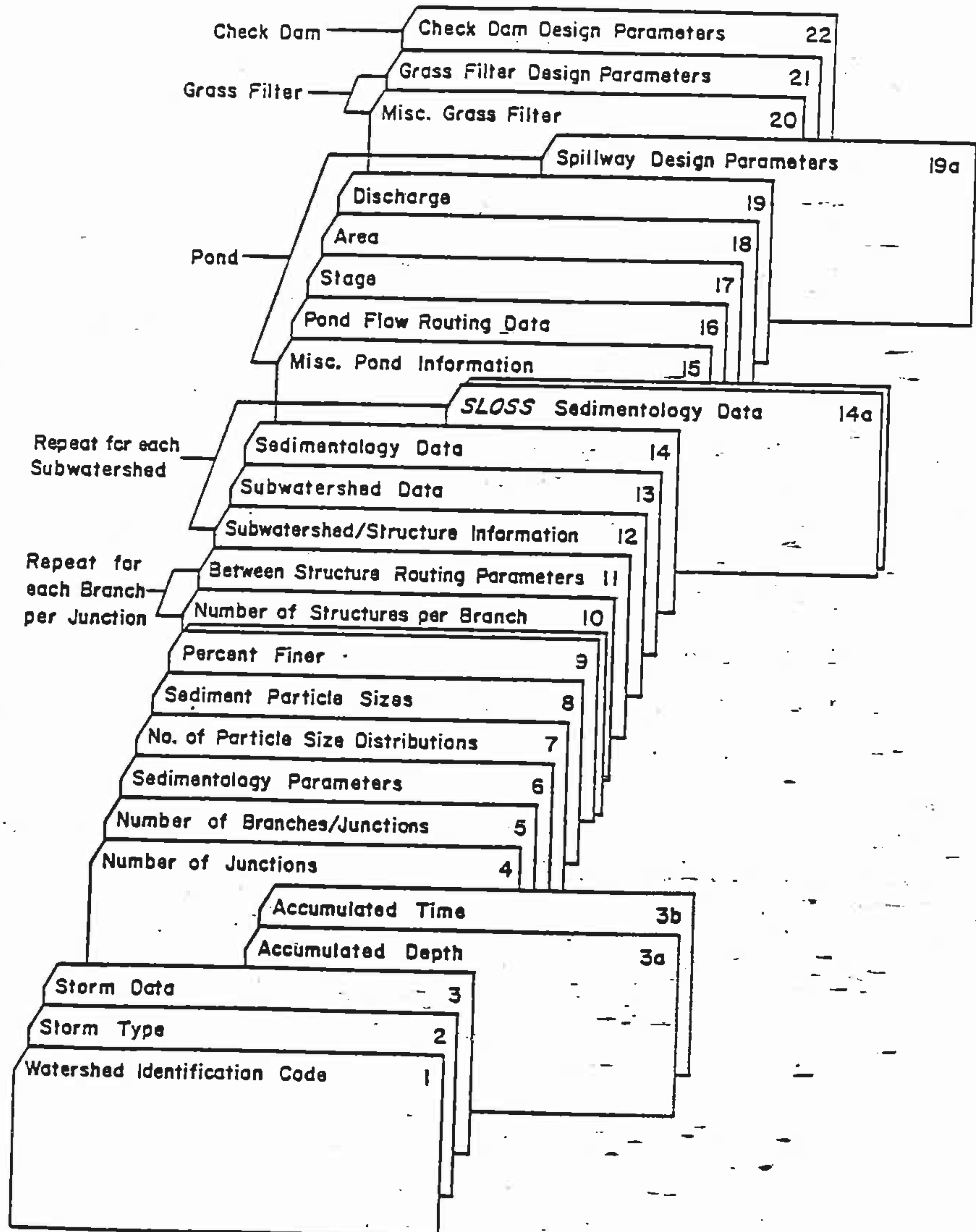
ATTACHMENT S

TYPICAL SEDIMENTATION POND'S SEDIMOT II

AND SEDCAD+ INPUTS

BATCH INPUT

The SEDIMOT II Model was developed to run as a batch job on the IBM/370/165 and the HP3000 systems. Also, an interactive version is available on the HP3000 system. The interactive program can be used to produce a data file that is directly compatible with either the IBM or HP batch system. It is expected that the user may use the interactive version to produce the initial data file for a particular problem and then simply modify a few lines in the file to evaluate alternative designs or management schemes. Alternatively, the user may utilize the coding sheet and work sheets to directly produce an input data file that may be used on either the HP or the IBM system.



Code Card Sequence for Batch Input

CARD CODE 1	WATERSHED IDENTIFICATION CODE			
1 5	10	15	. . . .	56 60

Any alpha-numeric character (i.e. A - Z or 1 - 9) is acceptable

CARD CODE 2	STORM TYPE	FORMAT I8
ITYPE	NRPIV	
1 8	16	

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
ITYPE:	Storm Type	1	3	2
	1 - SCS's Type I	2 - SCS's Type II	3 - Input Storm	
NRPIV:	No. of Depth, Time Values	2	50	None

CARD CODE 3 STORM DATA FORMAT F8.2

P	SDUR	DELTSW	P30INT
1–8	16	24	32

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
P:	Rainfall Depth (inch)	0	15.	None
SDUR:	Storm Duration (hr)	1.	24.	None
DELTSW:	Storm Time Increment	0.1	1.	0.1
P30INT:	Max. 30 Min. Intensity	0.	500.	None

CARD CODE 3a ACCUMULATED DEPTH, FORMAT F8.2

RTAB1(1)	RTAB1(2)	RTAB1(3)	. . . . .	RTAB1(NRPIV)
1–8	16	24		73–80

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
RTAB1(I):	Accum. Depth of Rainfall	0.	P.	None

Use Card 3a only if ITYPE = 3 on Card 2. Otherwise, skip Cards 3a and 3b completely.

CARD CODE 3b ACCUMULATED TIME FORMAT F8.2

RTAB2(1)	RTAB2(2)	RTAB2(3)	. . . . .	RTAB2(NRPIV)
1–8	16	24		73–80

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
RTAB2(I):	Accum. Time of Rainfall	0.	SDUR	None

CARD CODE 4 NUMBER OF JUNCTIONS FORMAT I8

NOJ	IHYDR
1 8	16

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
NOJ:	Number of Junctions	1	5(15)*	1
IHYDR:	Hydrology only or both Hydrology and Sedimentology Option	1	2	1

*IBM 370 version

CARD CODE 5 NUMBER OF BRANCHES/JUNCTIONS FORMAT I8

NOB(I)	NOB(2)	NOB(3)		NOB(NOJ)
1 8	16	24	. . . . . .	33 40

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
NOB(I):	Number of Branches per Junction	1	3	1

The following group of cards (Card Codes 6 - 9) are used in the sedimentology section. If you are using the "Hydrology Only" option (IHYDR = 1) skip Card Code 6 - 9.

CARD CODE 6	SEDIMENTOLOGY PARAMETERS		FORMAT F8.2
SG	APLUSI	SBSG	
1–8	9–16	17–24	

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
SG:	Specific Gravity	1.	3.	2.5
APLUS1:	Coeff. for Distributing Sediment Load	1.	2.	1.5
SBSG:	Submerged Bulk Specific Gravity Used in Imhoff Cone Calculations	1.	1.75	1.25

CARD CODE 7	NUMBER OF PARTICLE SIZE DISTRIBUTIONS	FORMAT I8
NPSD	NDVPC	
1–8	9–16	

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
NPSD:	No. of Particle Size Distributions	1	10	1
NDVPC:	No. of Data Values per Particle Distribution	2	15	2

CARD CODE 8	SEDIMENT PARTICLE SIZES			FORMAT F8.4
PS(1)	PS(2)	PS(3)		PS(NDVPC)
1 8	16	24		73 80
.	.	.	. . . .	.

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
PS(I):	Particle Size Value	.0001	250.	None

The Largest Sized Particles are Entered First
Particle Sizes are in Units of Millimeters
A Single Particle Size Data Set is used for all Percent Finer Distributions

CARD CODE 9	PERCENT FINER			FORMAT F8.2
PF(1,1)	PF(1,2)	PF(1,3)		PF(1,NDVPC)
1 8	16	24		73 80
.	.	.	. . . .	.
⋮	⋮	⋮		⋮
PF(NPSD,1)	PF(NPSD,2)	PF(NPSD,3)		PF(NPSD,NDVPC)
1 8	16	24		73 80
.	.	.	. . . .	.

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
PF(I, J):	Percent Finer Values	0.	100.	None

Percent Finer Values are Entered for Each Particle Size Distribution. If There are More Than Ten Values per Distribution Two Cards Will Be Used For Each Distribution. Card Code 9 Will Be Repeated For Each of the Particle Size Distribution.

CARD CODE 10	NUMBER OF STRUCTURES PER BRANCH		FORMAT I8
NOS(I,1)	NOS(I,2)	NOS(I,NOB(I))	
1–8	16	24	

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
NOS(I, J):	Number of Structures per Branch (I) for each Junction (J)	1	4	1

CARD CODE 11	BETWEEN STRUCTURE ROUTING PARAMETERS			FORMAT F8.2
TIME(I,1)	RK(I,1)	RX(I,1)		TIME(I,NOS)
1–8	16	24	. . . . . .	73–80
RK(I,NOS)	RX(I,NOS)			
1–8	16			

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
TIME(I,J,K):	Travel Time Between Structures (hr)	0.	5.	.06
RK(I,J,K):	Muskingum's K Between Structures (hr)	0.	5.	.06
RX(I,J,K):	Muskingum's X Between Structures (hr)	0.	5.	None

Card Code 11 is repeated for each of the Branches per Junction listed on Card Code 5. Time, RK, and RX are repeated on Card 11 for each Structure on a Given Branch.

CARD CODE 12	SUBWATERSHED/STRUCTURE INFORMATION			FORMAT I8
NSWS	CNTROL	IPRINT	ISUBSP	IPRIN2
1–8	16	24	32	40

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
NSWS:	Number of Subwatersheds per Structure	0	14(29)*	1
CNTROL:	Type of Sediment Control Structure	1	4	1
	1 - Null, 2 - Pond, 3 - Grass Filter, 4 - Check Dam			
IPRINT:	Print Control Variable for Total Drainage Area	1	3	1
	1 - summary table, 2 - hydrograph, sediment graph, and particle size distribution arrays, 3 - no output			
ISUBSP:	Print Control Variable for the Drainage Area Between Previous Structure or Junction. Options are Identical to those of IPRINT.	1	3	1
IPRIN2:	Print Option for Subwatershed Inputs	1	2	2
	1 - Input Tables, 2 - No Tables			

*IBM 370 version

Repeat Code Cards 12, 13, and 14 for each Branch of Each Junction.

CARD CODE 13	SUBWATERSHED DATA			FORMAT F8.3
PARAH(I,1)	PARAH(I,2)	PARAH(I,3)		PARAH(I,9)
1 … 8	16	24		65 … 72
.	.	.	. . . .	.

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
PARAH(I,1):	Subwatershed Area (acres)	0.	5000.	None
PARAH(I,2):	Curve Number	0.01	100.	None
PARAH(I,3):	Time of Concentration (hr)	0.	3.	None
PARAH(I,4):	Travel Time (to Structure)	0.	5.	.06
PARAH(I,5):	Muskingum's K (to Structure)	0.	5.	.06
PARAH(I,6):	Muskingum's X (to Structure)	0.	5.	None
PARAH(I,7):	Hydrology Print Option	1.	2.	1.
PARAH(I,8):	Hydraulic Surface Condition	1.	3.	None
PARAH(I,9):	Number of Flow Segments if PARAH(I,9) = 0, MUSLE will be used. If PARAH(I,9) = 1-6, SLOSS will be used.	0.	6.	None

Repeat Code Cards 13 and 14 or 14a for each subwatershed.

CARD CODE 14 SEDIMENTOLOGY DATA FORMAT F8.3

PARAS(I,J,1)	PARAS(I,J,2)	PARAS(I,J,3)	PARAS(I,J,4)	PARAS(I,J,5)
1 – 8	16	24	32	40

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
PARAS(I,J,1):	Soil Erodibility Factor	0.	.8	None
PARAS(I,J,2):	Length of Slope (ft)	0.	800.	None
PARAS(I,J,3):	Average Slope (%)	0.	100.	None
PARAS(I,J,4):	Control Practice Factor	0.	1.7	None
PARAS(I,J,5):	Particle Size Distribution Selection	1	NPSD	None

CARD CODE 14a *SLOSS* SEDIMENTOLOGY DATA FORMAT F8.3

PARAS(I,J,1)	PARAS(I,J,2)	PARAS(I,J,3)	. . . . .	PARAS(I,J,8)
1 – 8	16	24		57 – 64

PARAS(I,1) - PARAS(I,5) are Same as Code Card 14.

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
PARAS(I,J,6):	Sediment Surface Condition	1.	3.	None
PARAS(I,J,7):	Segment Area	0.	PARAH(I,1)	None
PARAS(I,J,8):	Steepness Factor	1.	50.	50.

Repeat Code Card 14a for Each Flow Segment

CARD CODE 15 MISCELLANEOUS POND INFORMATION FORMAT F8.2

DELPLG	FIX	DEAD
1–8	16	24

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
DELPLG:	Time Increment of the Routed Hydrograph in Hours	DELPLG	5.0	DELTAT
FIX:	Nonideal Settling Correction Factor.	0.1	2.0	1.0
DEAD:	Percent of Permanent Pool That is Dead Space	0.	100.	40.

Cards 15 through 19a are used for Sediment Basin Inputs

CARD CODE 16 POND FLOW ROUTING DATA FORMAT I8

FLOW	FRACTN	NSP	NRHP	ISDO	IPRINT	NCSTR
1–8	16	24	32	40	48	56

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
FLOW:	Outflow Withdrawal Option: 1 – uniform 2 – bed 3 – surface	1	4	1
FRACTN:	Inflow Vertical Concentration 0 – completely mixed 1 – density current	0	1	0
NSP:	Number of Stage Point (max=24)	2	24	None
NRHP:	No. of Routed Hydrograph Points	2	500	500
ISDO:	Stage-Discharge Option 1 – input 2 – SEDIMOT II calculates values → PIPE [illegible]	1	2	1
IPRINT:	Print Control Options 1 – summary tables 2 – hydrograph, sediment graph and particle size distr., 3 – no output	1	3	1
NCSTR:	Continuous Stirred Type Reactors or DEPOSITS 0 – DEPOSITS 1 – 10 CSTRS	0	10	0

CARD CODE 17	STAGE			FORMAT F8.2
STAGE(1)	STAGE(2)	STAGE(3)		STAGE(NSP)
1 – 8	16	24	. . . . . .	73 – 80

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
STAGE(I):	Pond Stage Values (ft)	0	100.	None

First Stage Value Should be Zero

CARD CODE 18	AREA			FORMAT F8.3
AREA(1)	AREA(2)	AREA(3)		AREA(NSP)
1 – 8	16	24	. . . . . .	73 – 80

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
AREA(I):	Pond Area Values (ac)	0.	9999.	None

List the Area Values Corresponding to Each Stage Value

CARD CODE 19	DISCHARGE			FORMAT F8.2
DISCH(1)	DISCH(2)	DISCH(3)		DISCH(NSP)
1 – 8	16	24	. . . . . .	73 – 80

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
DISCH(J):	Pond Discharge Values (cfs)	0.	1500.	None

At Least Two Stage Points Must Have Zero Discharge
The Last Zero Discharge Stage Corresponds to the Stage of the Principal Spillway

CARD CODE 19a SPILLWAY DESIGN PARAMETERS FORMAT F8.3

BDIA	RDIA	ELOSS	BLOSS	FRLEN	WCOE	OCOE	MN
1–8	16	24	32	40	48	56	64

HDROP	EPS
65–72	80

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
BDIA:	Barrel Diameter (inches)	3.	60.	None
RDIA:	Riser Diameter (inches)	3.	60.	None
ELOSS:	Pipe Flow Entrance Loss Coef.	0.	3.	1.
BLOSS:	Pipe Flow Bend Loss Coef.	0.	2.	.5
FRLEN:	Pipe Length (ft)	2.	500.	None
WCOE:	Weir Flow Coefficient	1.	10.	3.1
OCOE:	Orifice Flow Coefficient	.1	2.	0.6
MN:	Manning's n of Pipe	.01	.06	.025
HDROP:	Head Drop Between Inlet and Outlet (ft)	.01	100.	None
EPS:	Stage of Principal Spillway (ft)	.01	100.	None

CARD CODE 20 MISCELLANEOUS GRASS FILTER FORMAT F8.2

SEG	RPRINT	BSG	DINIT
1–8	16	24	32

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
SEG:	Number of Segments (max=3)	1.	3.	1.
RPRINT:	Print Code: 1-summary, 2-hydrograph, etc., 3-no output	1.	3.	1.
BSG:	Bulk Specific Gravity of Deposited Sediment	0.5	3.	1.25
DINIT:	Initial Depth of Sediment in Zone D	0.	0.8	0.

CARD CODE 21 GRASS FILTER DESIGN PARAMETERS FORMAT F8.4

MN(I)	GHGHT(I)	LEN(I)	SPAC(I)	SSC(I)	WIDTH(I)	INFILL(I)	MEI(I)
1–8	16	24	32	40	48	56	64

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
MN(I)	Grass Filter Manning's Roughness Coefficient	.003	.017	None
GHGHT(I):	Grass Height	0.1	9.0	None
LEN(I):	Grass Filter Length	1.0	500.	None
SPAC(I):	Average Grass Spacing	0.1	3.0	None
SSC(I):	Grass Filter Slope	.01	20.	None
WIDTH(I):	Grass Filter Width	1.0	500.	None
INFILL(I):	Grass Filter Infiltration Rate	0.0	4.0	None
MEI(I):	Grass Stiffness Factor	.002	250.	None

CARD CODE 22 — CHECK DAM DESIGN PARAMETERS — FORMAT F8.3

SLOPE	POR	MN	Z	H	VPRINT
1–8	16	24	32	40	48

Variable Name	Variable Description	Lower Limit	Upper Limit	Default Value
SLOPE	Channel Bed Slope	.0001	50.	None
POR	Checkdam Porosity (%)	0.01	1.0	None
MN	Manning's Coefficient	.01	.15	None
Z:	Channel Sideslope	.5	10.	None
H:	Checkdam Height (ft)	.01	20.	None
VPRINT:	Checkdam Print Option: 1-summary table, 2-hydrograph, etc., 3-no output	1.	3.	1.

Typical SEDCAD^{+} Input

Impoundments

Line Code	Parameter	Typical Input
	Time of day of file creation	System Input
	Date of file creation	System Input
	Name of person creating file	As Applicable
	Watershed identification code	As Applicable
2	Storm Type ; "0"	2;0
3	P1; P2; SDUR1; SDUR2; Time Increment; "1"	3; 2.1; 1.9; 0; 24; 6; 0; 0.1; 0
	P1=Precip. depth in inches of initial storm	
	P2=Precip. depth of em. spillway storm (arbitrary if no em. spillway)	
	SDUR1=Storm duration of intial storm	
	SDUR2=Storm duration of em. spillway storm	
4	Number of Junctions; Hydrology option	1;2
	Hydrology option - 1 = Hydrology only 2 = Hyd. & Sedimentology	
5	Number of branches on J1; on J2; on J3 ...	1
6	Specific gravity; "1.5"; Submerged bulk spec. grav.	2.5; 1.5; 1.25
7	No. of particle size dist; No. of data values per dist. If running hydrology only, use "1"; "2" (dummy values)	1; 15
8	Particle size 1; PS 2; PS3 ...	As applicable; As applicable; ... etc.
9	Percent finer 1 for dist. 1; PF 2 for dist. 1, ... If running hydrology only, use "100"; "0" (dummy values) [Repeat 9 for up to 4 distributions]	As measured; As measured; ... etc.

Typical SEDCAD+ Input

. Impoundments

Line Code	Parameter	Typical Input
10	No. of structures on J1, B1 [; No. on J1, B2 (; No. on J1, B3)]	1
11	Travel time, Musk. K; Musk. X [Repeat 10 & 11 for all structures]	0; 0; 0
12	No. of SWS for structure; structure type; "1"; "1"; hydrograph print opt hydrograph print option - "1"=No, "2"=Yes	1; 2; 2; 1; 1
13	SWS area; curve number; t. conc; travel time; MK; MX; "1"; hydrologic response type (1,2,3); RUSLE or MUSLE or SLOSS For hydrology only, travel time = 0 For only 1 SWS, MK & MX = 0 If using RUSLE, use "-1" If using MUSLE, use "0" If using SLOSS, use number of segments	As measured; As determined; As calculated; 0; 0; 0; 1; 2; 0
14	K factor; length; slope; CP factor; Part. dist. #;"0"; "0"; "0" [; surf. cond; seg area; "50"] [For Hydrology ONLY, enter "0"; ""0"; "0"; "0" "0"] *[Brackets indicate SLOSS input parameters - Repeat 14 for each SLOSS segment] [Repeat 13 & 14 for each No. of SWS for the structure] Enter Structure Data [NULL structure return to line code 12]:	As determined; As measured; As calculated; As determined; 1

Typical SEDCAD+ Input

Impoundments

Line Code	Parameter	Typical Input
	POND:	
15	Time increment; "1"; dead space; volume; elev; ems volume - 0 = no volume calculated by digitizer 1 = volume to follow - calculated by digitizer elev - 0 = no elevation data entered (only stage data) 1 = elevation data to follow ems - 0 = no emergency spillway at this structure 1 = emergency spillway and parameters will follow	0.1; 1; 20; 0; 1; 1
16	"1"; "0"; # stage points; "500"; discharge opt; hydrograph print opt; CSTRS hydrograph print option - "1"=No, "2"=Yes Discharge opt - 1 = input own discharge 2 = Drop inlet 3 = trickle tube 4 = perforated riser CSTRS - number of continuous stirred type reactors: "0" if running hydrology only! (will not run unless this is 0) "0" if running DEPOSITS (hydrology & sedimentology) "2" if running CSTRs (hydrology & sedimentology)	1; 0; As measured; 500; 1; 1; 2; 0
17	Elev 1, elev. 2, ... up to number of stage points [This line is skipped if elev in line code 15 is 0]	As applicable, As applicable, ... etc.
18	Stage 1, stage 2, ... up to number of stage points	As applicable; As applicable, ... etc.
19	Area 1, area 2, ... up to number of stage points	As applicable, As applicable, ... etc.

Typical SEDCAD+ Input

Impoundments

Line Code	Parameter	Typical Input
20	Length of emergency spillway; Stage of em. spillway. If stage is to be set at calculated peak stage, then "0" [This line is skipped if ems in line code 15 is 0]	As applicable, As applicable
21	"1"; outslope; sideslope ratio; bottom width; safety factor [This line is skipped if ems in line code 15 is 0]	1; As applicable; 3; As applicable; 1.2
22	discharge 1, disch. 2, ... up to no. of stage points [Only for discharge option #1]	0; 0 ... etc.
23	barrel dia.; riser dia; "1"; "0.5"; pipe length; "3.1"; "0.6"; Manning's n of pipe; Head drop; Stage of Princ. spillway [Only for discharge option #2 - Drop Inlet]	As applicable when Drop Inlet is used
	Repeat line code 23 [Only for discharge option #4 - Perf. Riser]	
24	Initial stage of orifices; number of orifices per stage [Only for discharge option #4 - Perf. Riser]	Used with Drop Inlet Spillways Only
25	orifice dia. at stage 1; stage 2, ... to number of stages [Only for discharge option #4 - Perf. Riser]	Used with Drop Inlet Spillways Only
26	barrel dia.; pipe slope; pipe length; Manning's n; Stage of Princ. spillway [Only for discharge option #3 - Trickle Tube]	Used with Trickle Tube Only
27	"Reserved variables - do not change" [This line is skipped if volume in line code 15 is 0]	Not Applicable
28	"Reserved variables - do not change" [This line is skipped if volume in line code 15 is 0]	Not Applicable
	[Return to line code 12 for next structure]	

Typical SEDCAD+ Input

Impoundments

Line Code	Parameter	Typical Input
	GRASS FILTER:	
29	No. of filter segs; hydrograph print opt; bulk specific gravity; initial depth of sediment hydrograph print option - "1"=No, "2"=Yes	Generally Not Applicable to Impoundment Design
30	Manning's n; grass height; filter length; grass spacing; filter slope; filter width; infiltration rate; stiffness factor [Repeat line code 30 for each filter segment] [Return to line code 12 for next structure]	Generally Not Applicable to Impoundment Design
	CHECK DAM:	
31	bed slope; porosity; Manning's n; sideslope; dam height; hydrograph print opt hydrograph print option - "1"=No, "2"=Yes [Return to line code 12 for next structure]	Generally Not Applicable to Impoundment Design
	NONERODIBLE DIVERSION:	
32	shape; bed slope; sideslopes; Manning's n; bottom width; top width [top width only applicable to parabolic channels] [Return to line code 12 for next structure]	Generally Not Applicable to Impoundment Design
	ERODIBLE DIVERSION:	
33	shape; bed slope; sideslopes; Manning's n; bottom width; top width; method method - "1" = limiting velocity, "2" = tractive force	Generally Not Applicable to Impoundment Design
34	permissible velocity/tractive force [Return to line code 12 for next structure]	Generally Not Applicable to Impoundment Design

Typical SEDCAD+ Input

Impoundments

Line Code	Parameter	Typical Input
	VEGETATED DIVERSION:	
35	shape; bed slope; sideslopes; bottom width; velocity Retardance Class 1 (capacity) Retardance Class 2 (stability) [Return to line code 12 for next structure]	Generally Not Applicable to Impoundment Design
	RIPRAP DIVERSION:	
36	shape; bed slope; sideslopes; bottom width; safety factor [Return to line code 12 for next structure]	Generally Not Applicable to Impoundment Design
	CULVERT:	
37	max. headwater; pipe slope; length; Manning's n [Return to line code 12 for next structure]	Generally Not Applicable to Impoundment Design

ATTACHMENT T

WATER PERSISTENCE CALCULATIONS

PERMANENT IMPOUNDMENT

J2-A

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J2-A

A_D: 2661.3 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

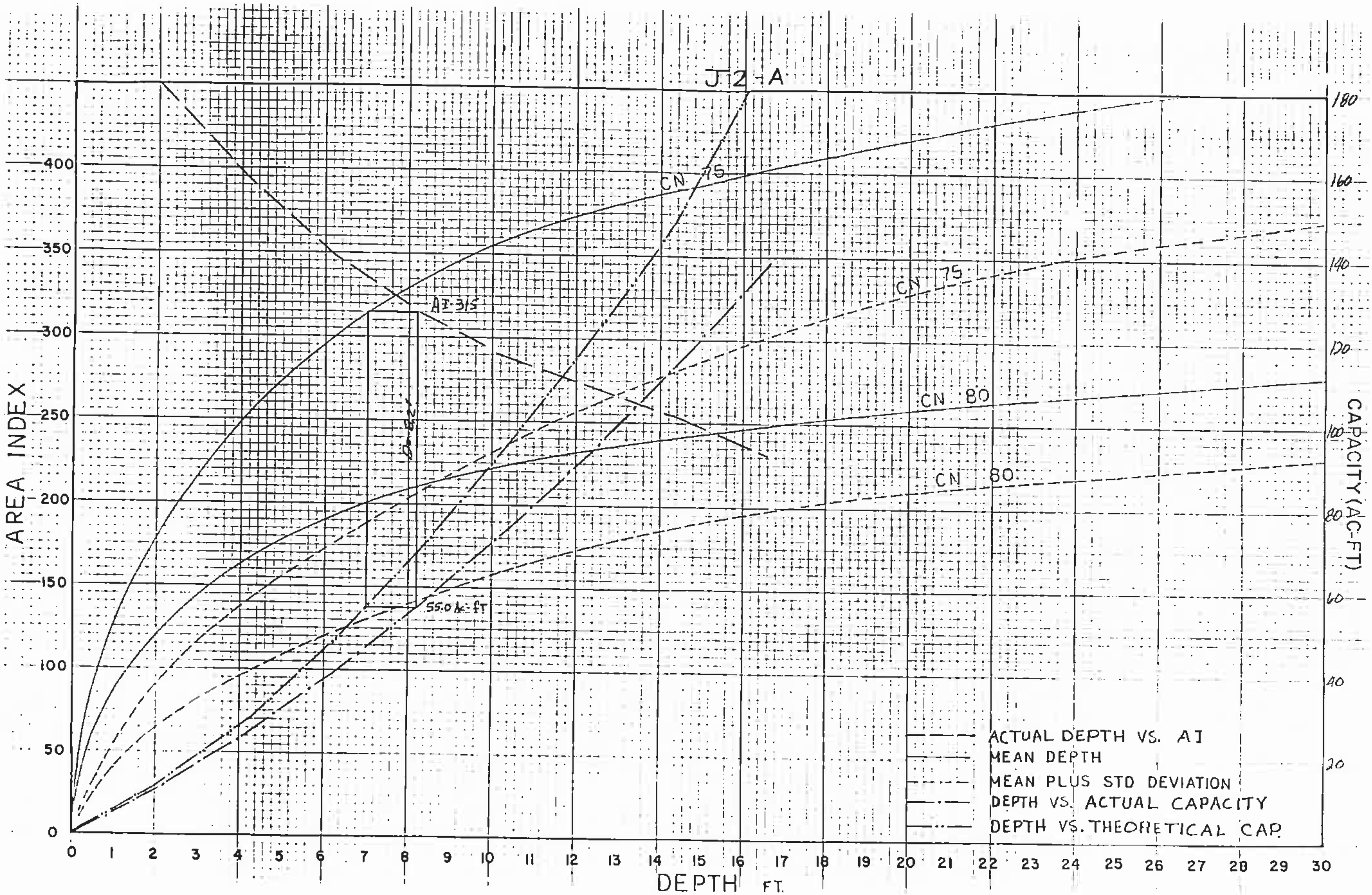
AI: Area Index = A_B/A_P

Notes: MSHA Impoundment

Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6332	5.23	2656.07	0	508	0
2	6334	5.99	2655.31	12.0	443	11.3
4	6336	6.84	2654.46	27.4	388	24.1
6	6338	7.68	2653.62	46.1	346	38.6
8	6340	8.49	2652.81	67.9	313	54.8
10	6342	9.22	2652.08	92.2	288	72.5
12	6344	9.85	2651.45	118.2	269	91.6
14	6346	10.44	2650.86	146.2	254	111.9
16.3	6348.3	11.54	2649.76	188.1	230	137.4

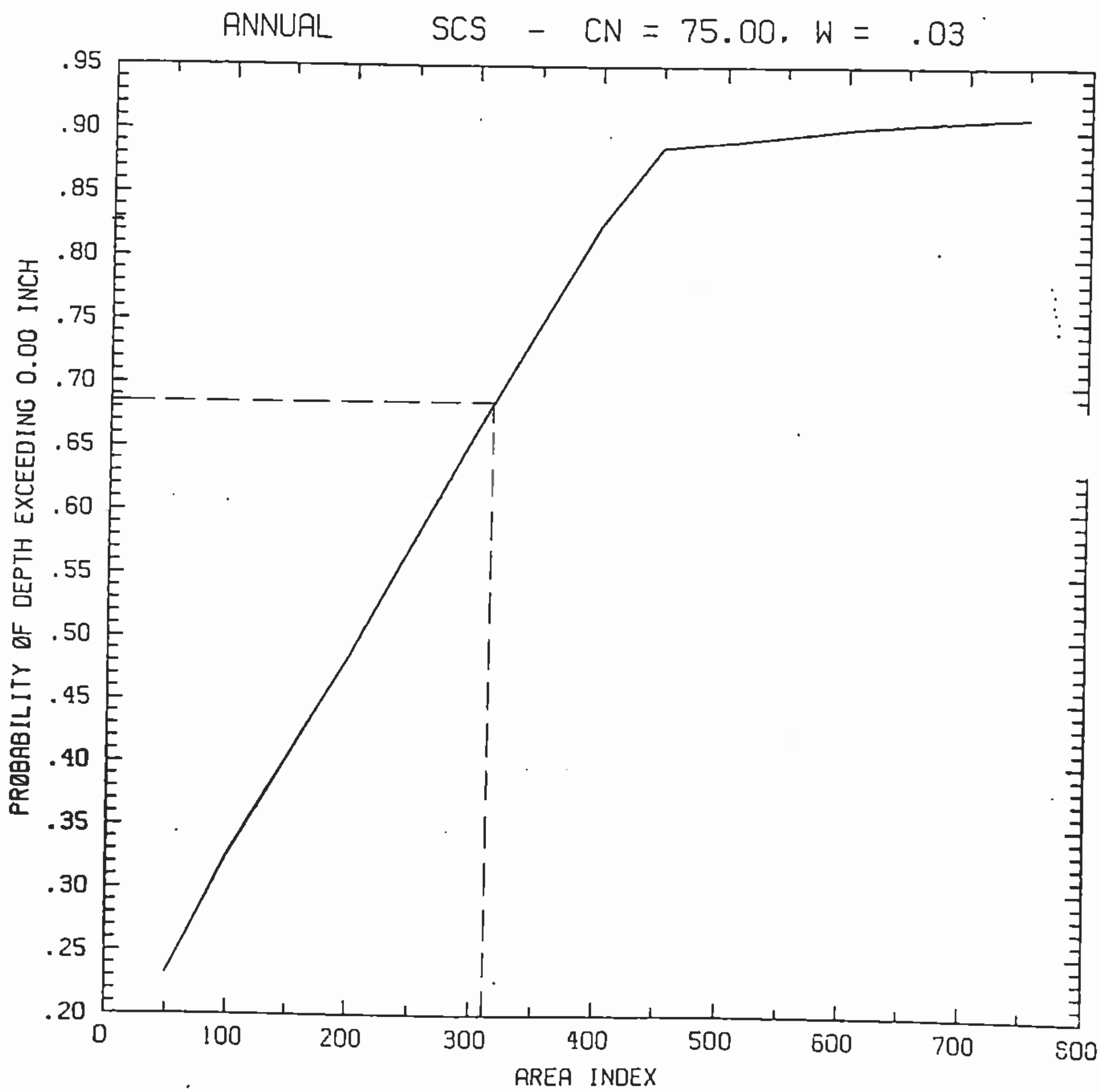
Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	8.2 ft.	--
	Minimum Depth (MIN)	--	3.0 ft.
	Actual Capacity	55.0 ac-ft.	17.9 ac-ft.
	AI	315	415
Plate 2 or 3:	Probability	69%	78%



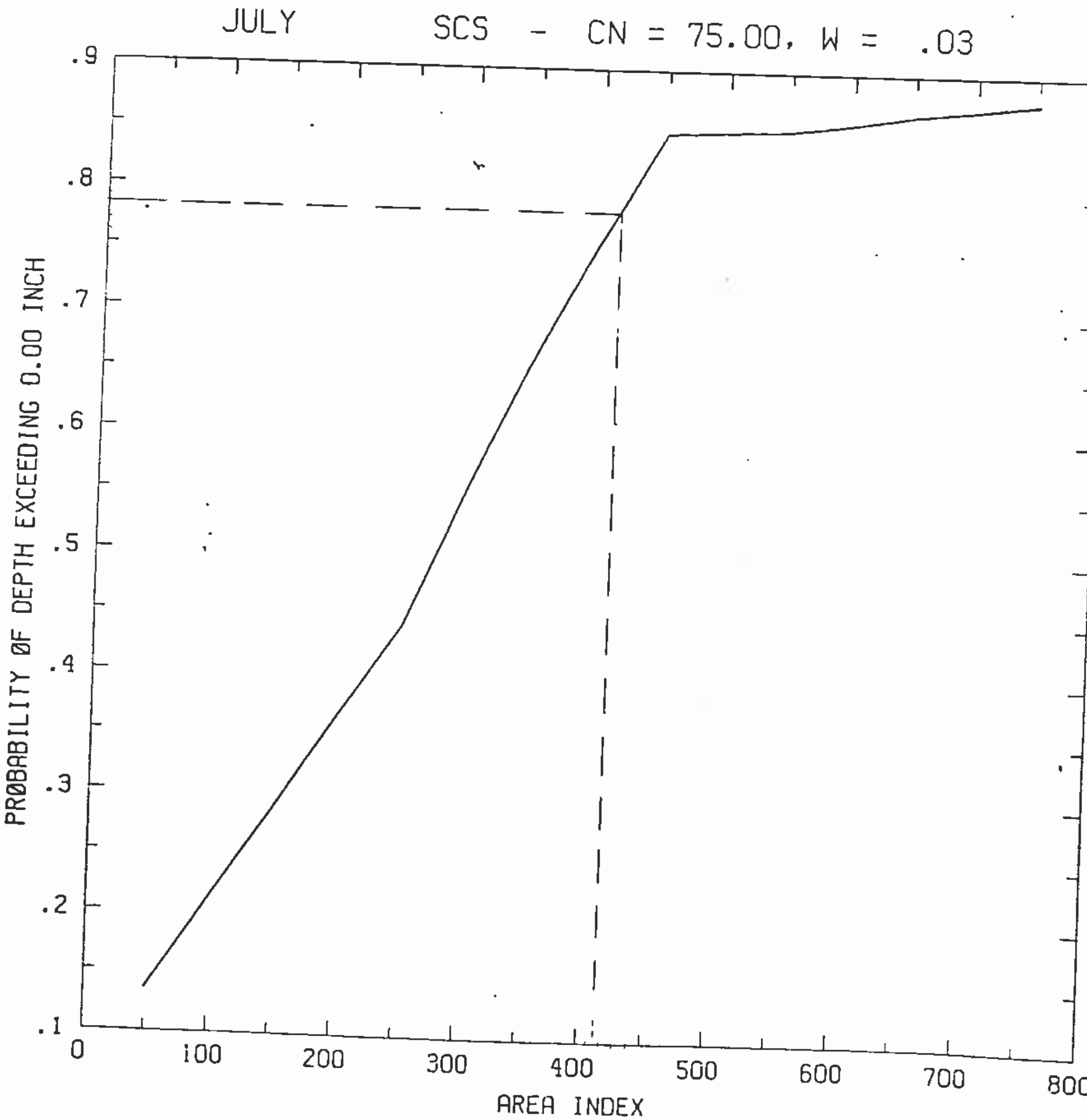
J 2 - A
AREA INDEX
CAPACITY (AC-FT)
DEPTH FT.
CN 75
CN 75
CN 80
CN 80
AI-315
55.0 Ac-ft
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

J2-A



Annual Mean Depth
Plate 2

J2-A



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

J3-D

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J3-D

A_D: 318.0 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

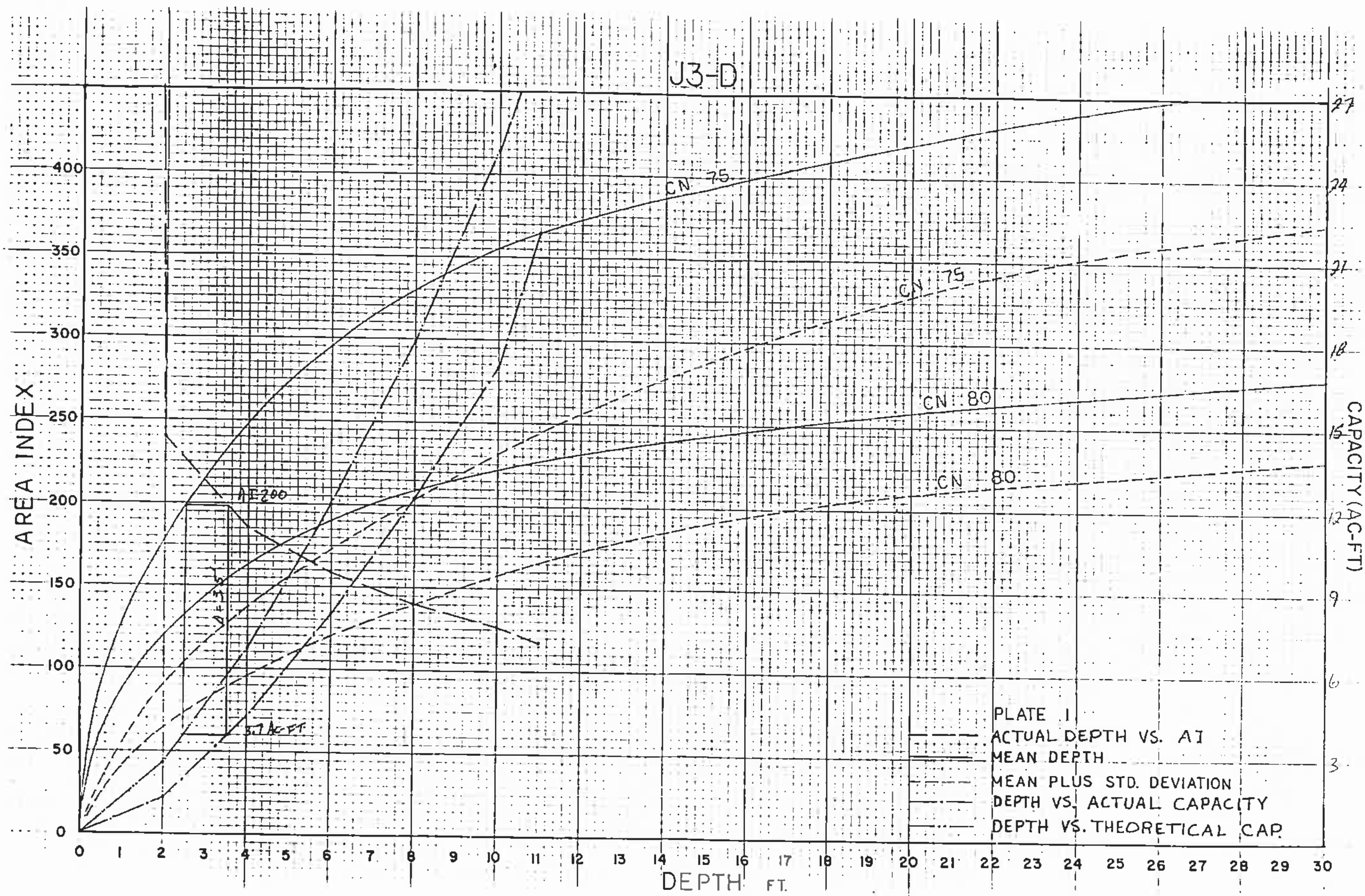
AI: Area Index = A_B/A_P

Notes: Existing Impoundment

Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6458	0.075	317.925	0	4261	0
2	6460	1.314	316.686	2.6	241	1.3
4	6462	1.699	316.301	6.8	186	4.3
6	6464	1.997	316.003	12.0	158	8.0
8	6466	2.244	315.755	17.9	141	12.3
10	6468	2.491	315.509	24.9	127	17.0
11	6469	2.703	315.297	29.7	117	22.2

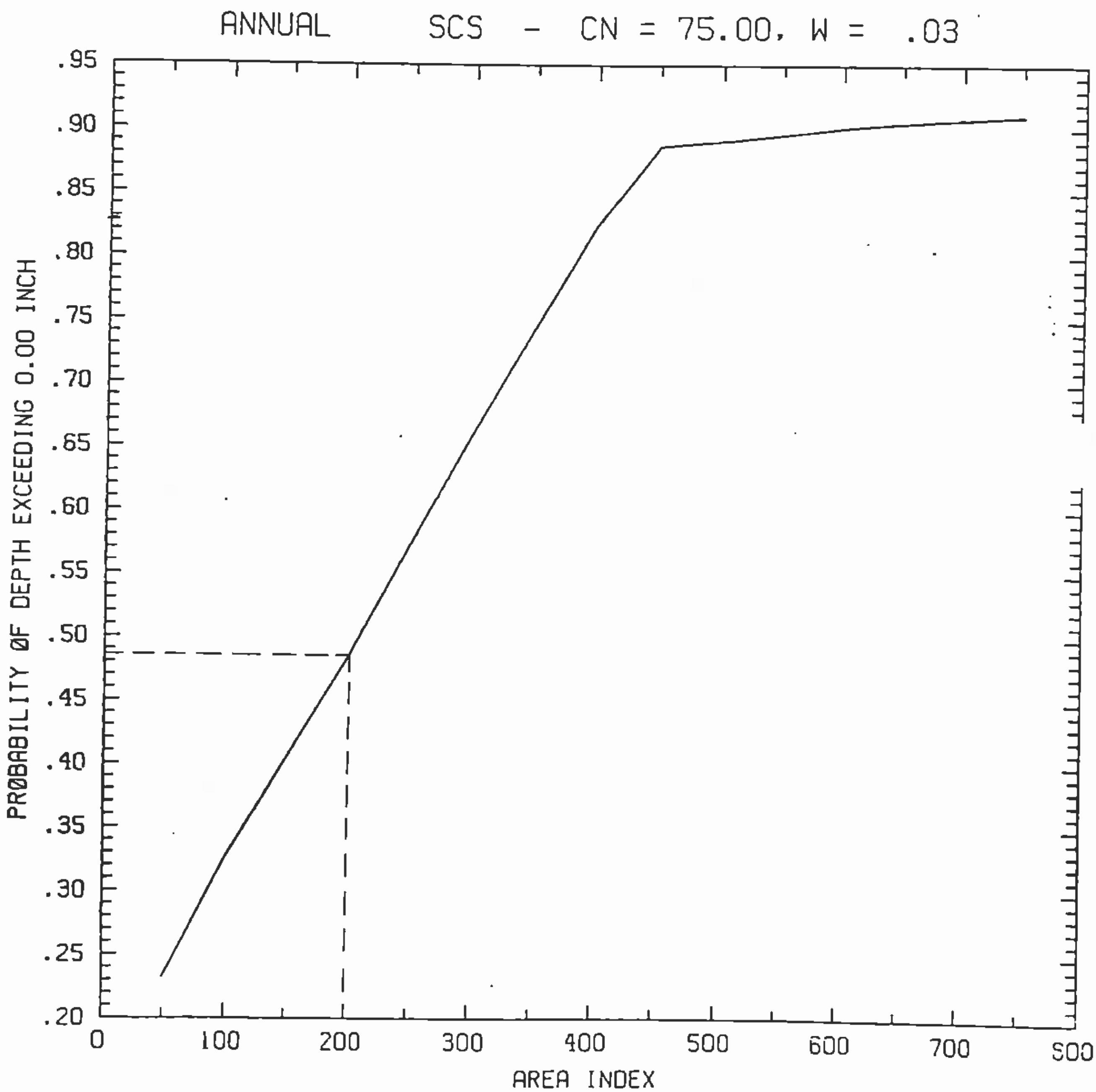
Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	3.5 ft.	--
	Minimum Depth (MIN)	--	3.0 ft.
	Actual Capacity	3.7 ac-ft.	2.8 ac-ft.
	AI	200	214
Plate 2 or 3:	Probability	49%	39%



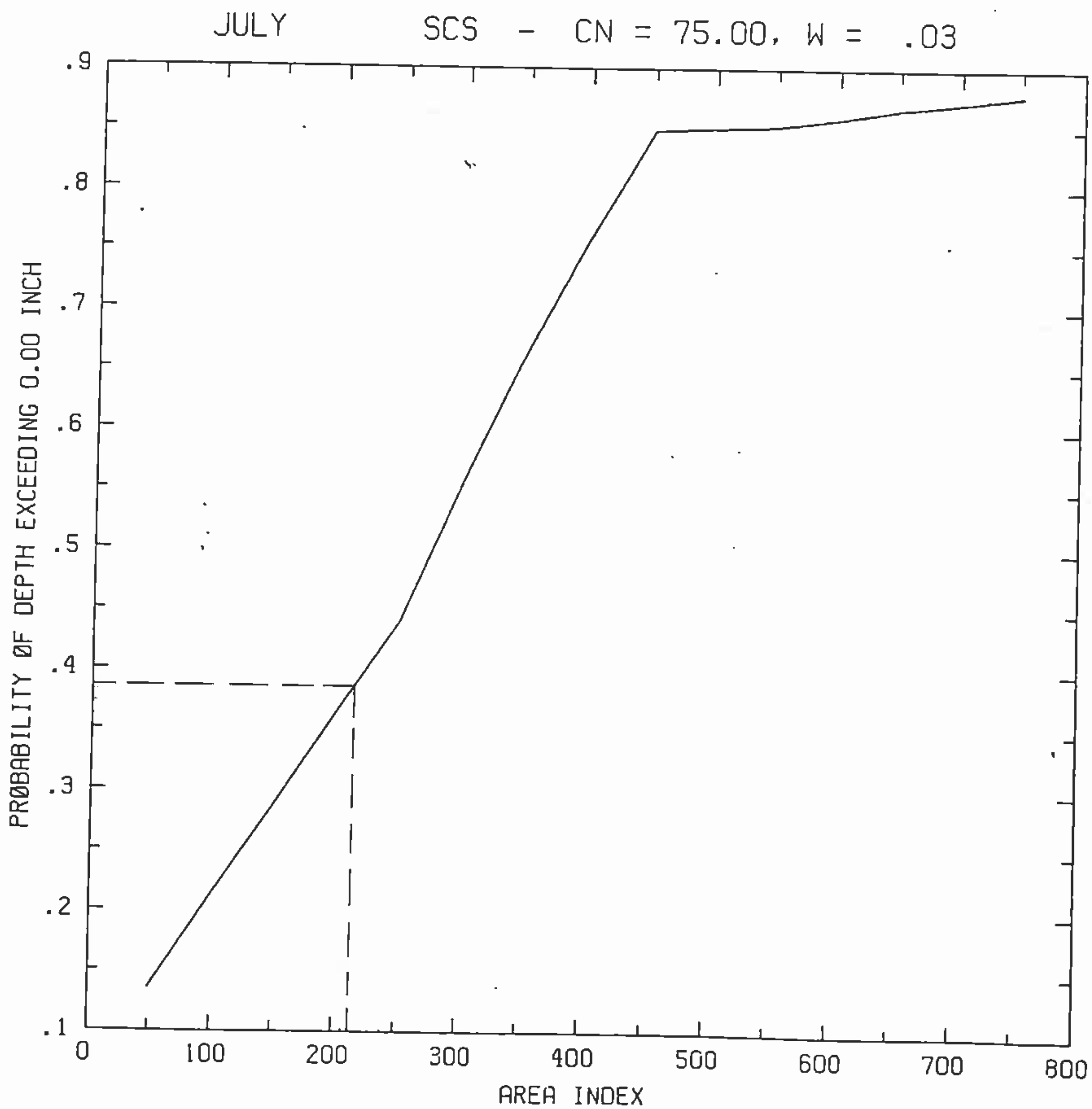
J3-D
AREA INDEX
DEPTH FT.
CAPACITY (AC-FT)
CN 75
CN 75
CN 80
CN 80
AI 200
3.7 Ac-Ft
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

J3-D



Annual Mean Depth
Plate 2

J3-D



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

J3-E

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J3-E

A_D: 251.3 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

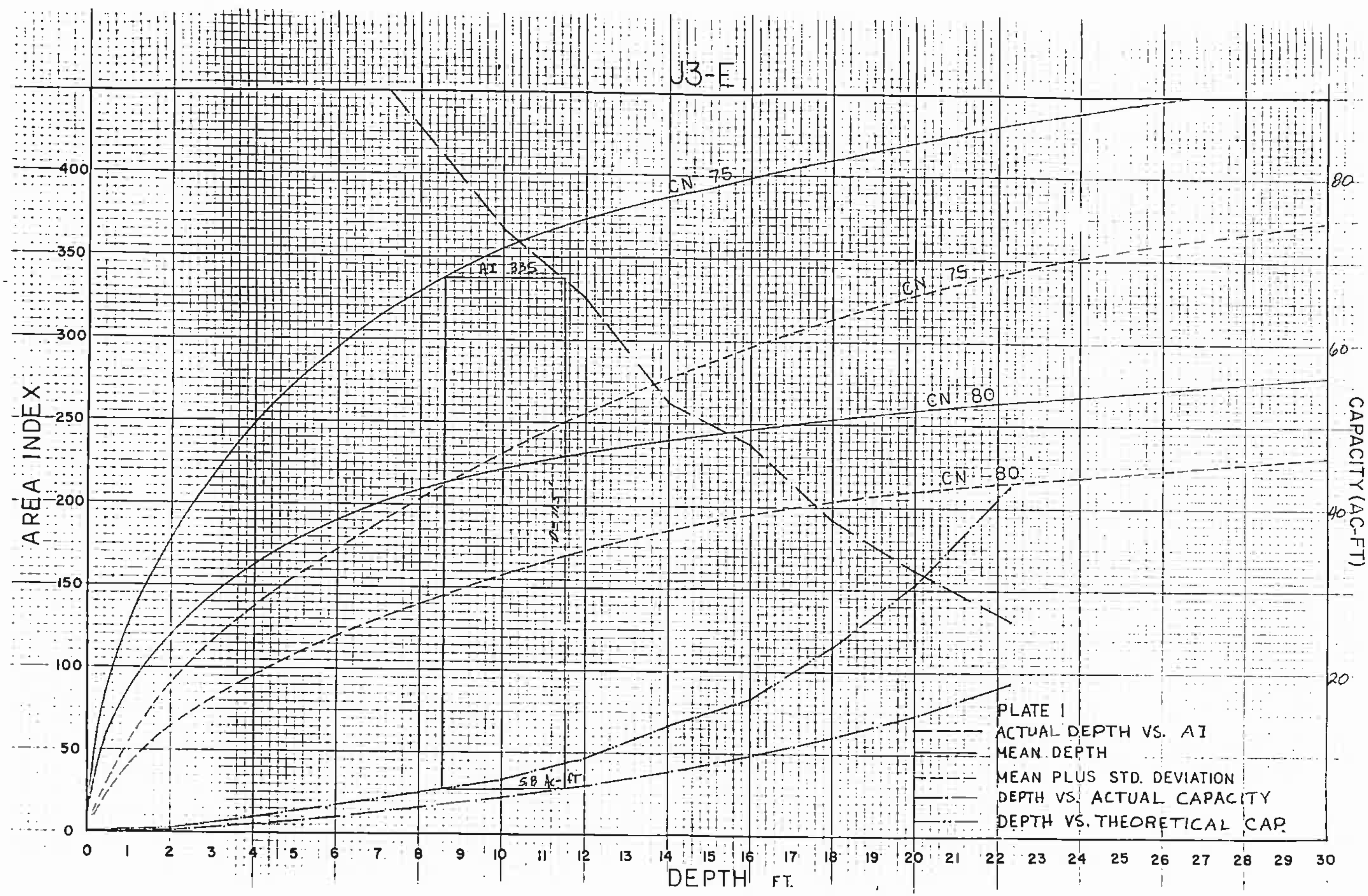
AI: Area Index = A_B/A_P

Notes: Existing Impoundment

Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6508	0.001	251.299	0	251,299	0
2	6510	0.381	251.919	0.8	659	0.4
6	6514	0.512	250.788	3.1	490	2.2
10	6518	0.682	250.618	6.8	368	4.6
12	6520	0.770	250.530	9.2	325	6.0
14	6522	0.950	250.350	13.3	263	7.7
16	6524	1.054	250.246	16.9	237	9.7
18	6526	1.297	249.003	23.3	193	12.1
20	6528	1.530	249.770	30.6	163	14.9
22.3	6530.3	1.908	249.392	42.5	131	18.9

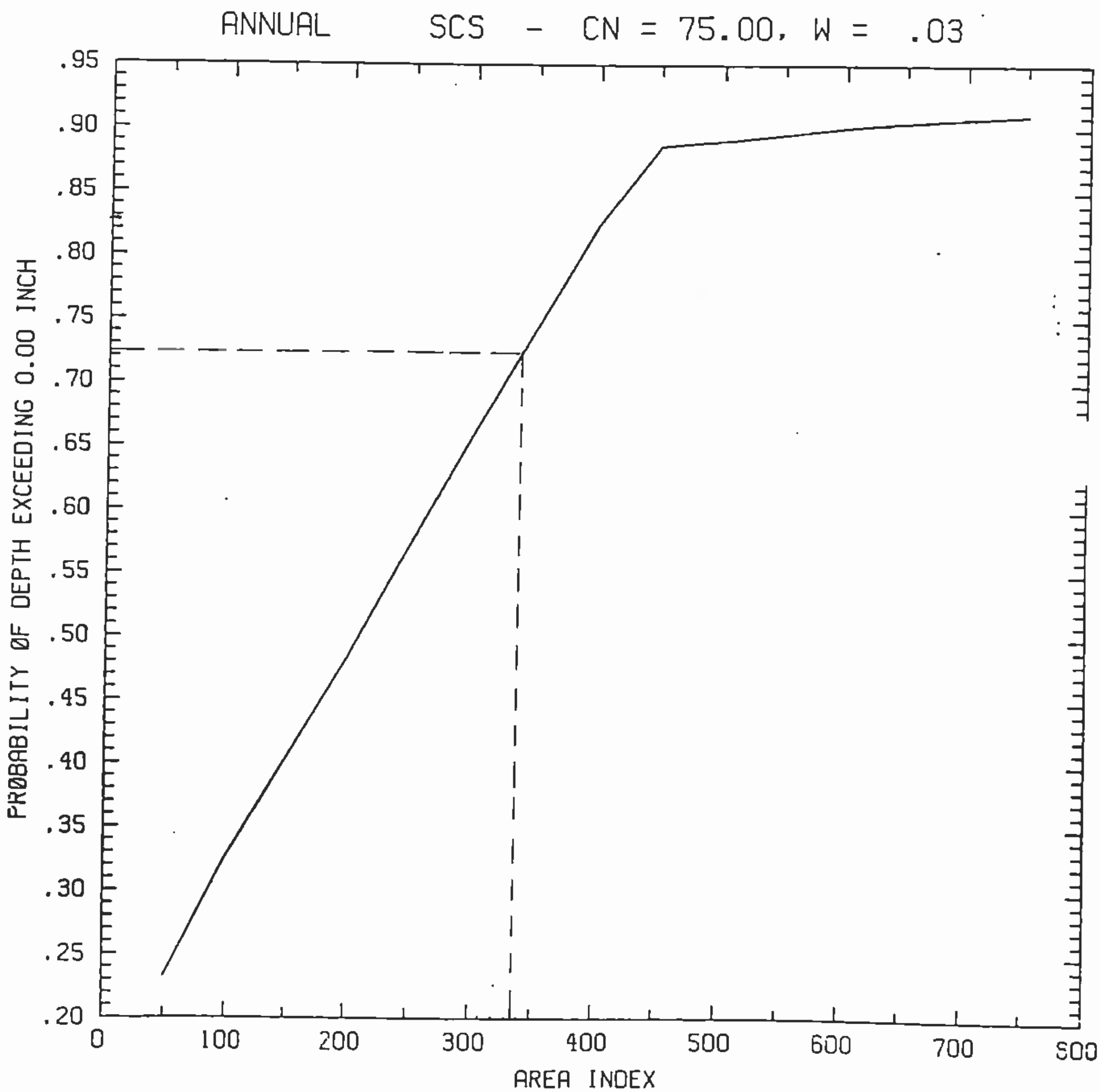
Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	11.5 ft.	--
	Minimum Depth (MIN)	--	6.0 ft.
	Actual Capacity	5.8 ac-ft.	2.2 ac-ft.
	AI	335	490
Plate 2 or 3:	Probability	72%	85%



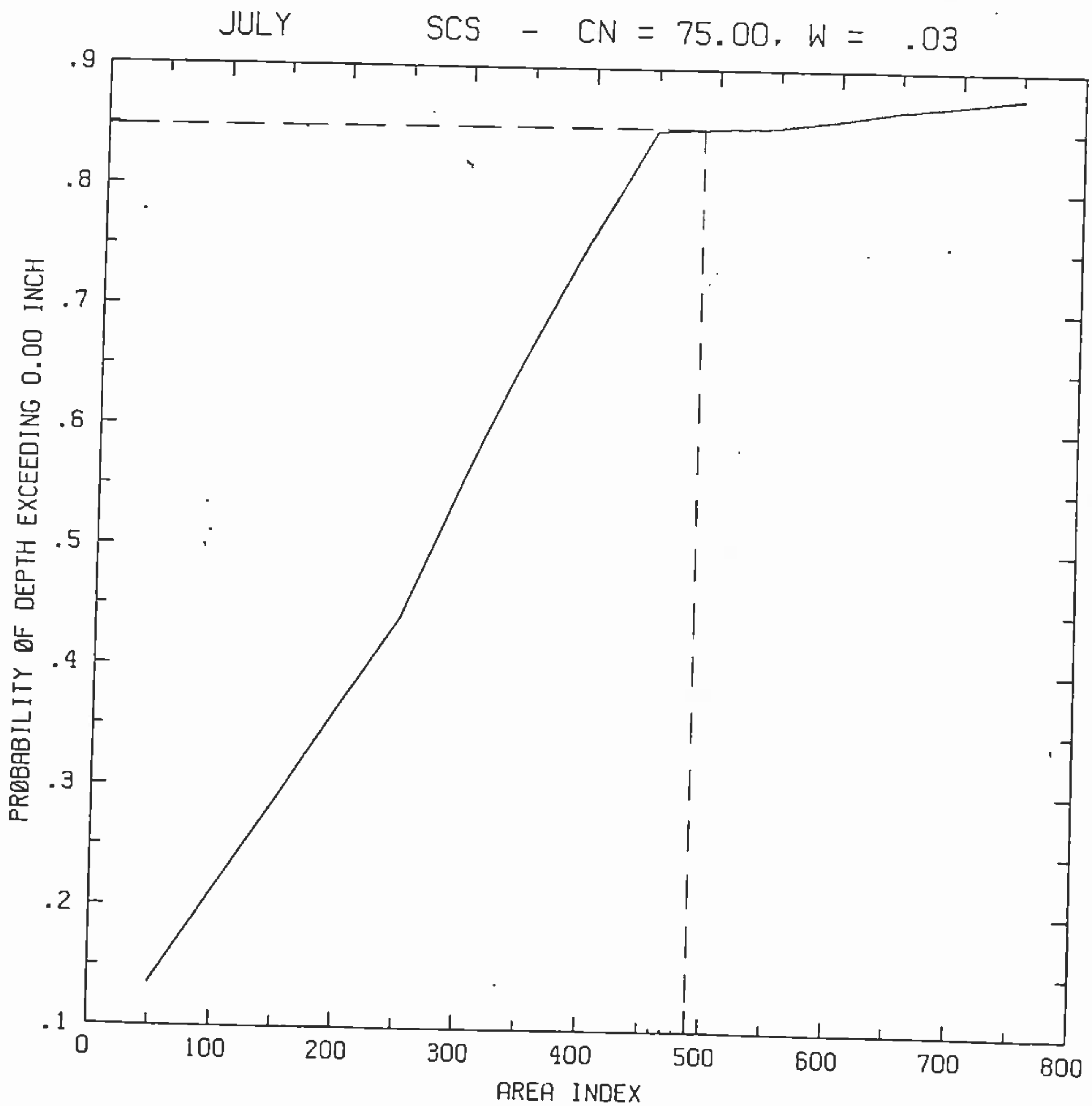
U3-E
AREA INDEX
0
50
100
150
200
250
300
350
400
CAPACITY (AC-FT)
20
40
60
80
DEPTH FT.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
CN 75
CN 75
CN 80
CN 80
AI 335
58 Ac-Ft
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

J3-E



Annual Mean Depth
Plate 2

J3-E



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

J3-G

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J3-G

A_D: 89.0 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

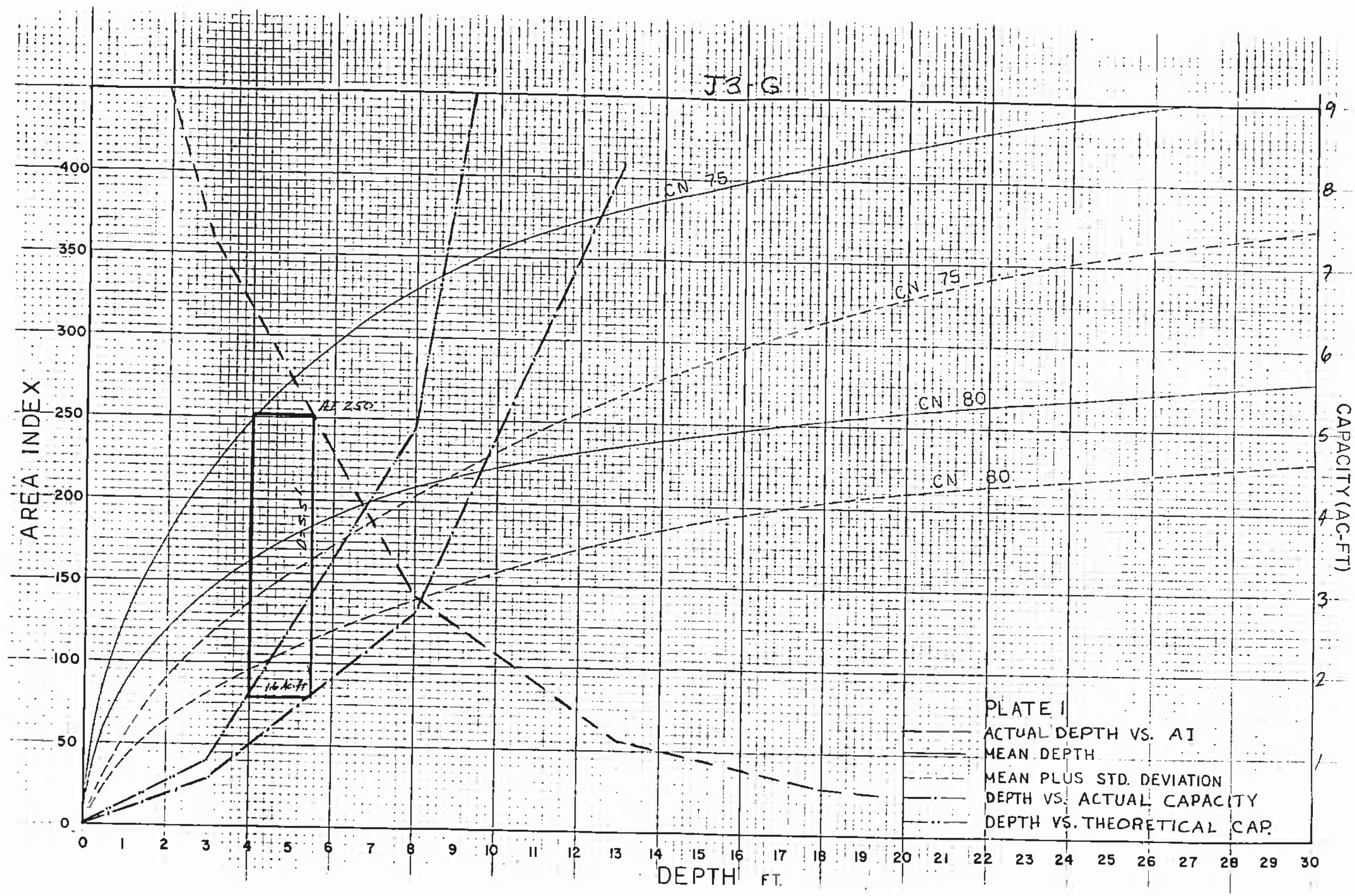
AI: Area Index = A_B/A_P

Notes: Existing Internal Impoundment

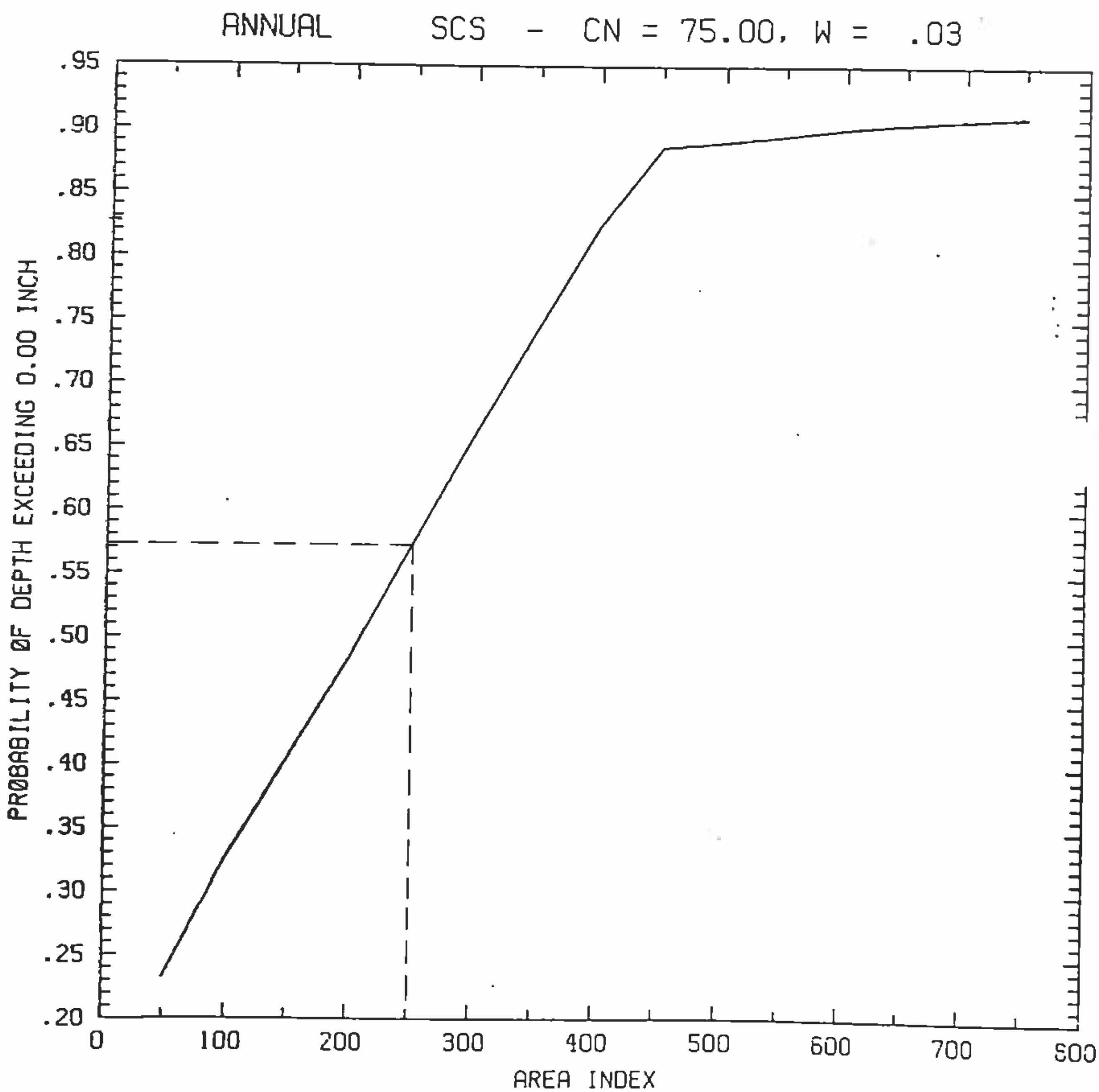
Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6472	0.050	88.950	0	1779	0
3	6475	0.249	88.751	0.7	356	0.5
8	6480	0.615	88.385	4.9	144	2.7
13	6485	1.573	87.427	20.4	56	8.1
18	6490	3.006	85.994	54.1	29	19.6
23	6495	4.668	84.332	107.4	18	38.8
28	6500	6.614	82.386	185.2	13	67.0
33	6505	8.811	80.189	290.8	9	105.5

Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	5.5 ft.	--
	Minimum Depth (MIN)	--	6.5 ft.
	Actual Capacity	1.6 ac-ft.	2.0 ac-ft.
	AI	250	208
Plate 2 or 3:	Probability	57%	37%

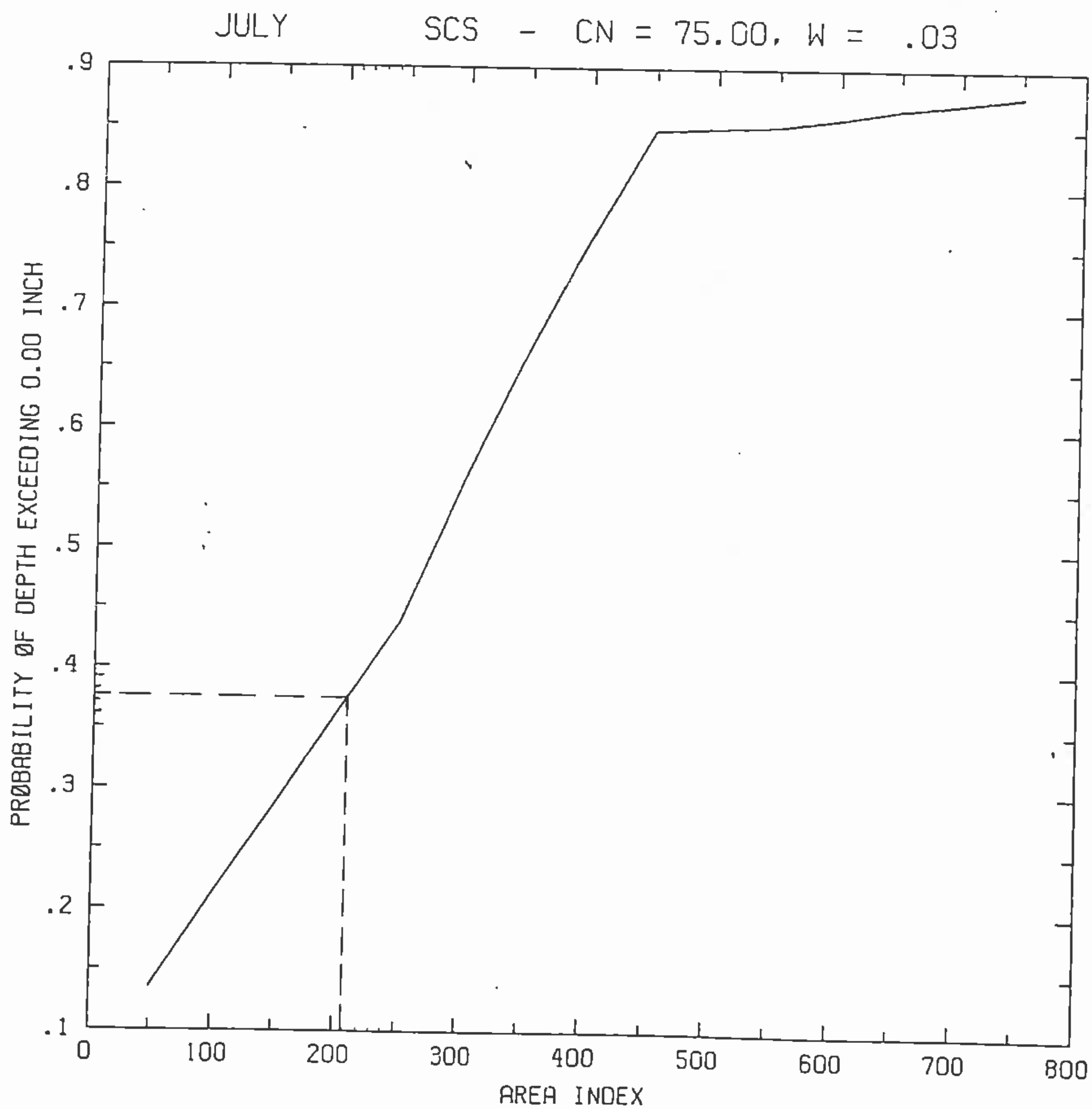

J3 G
AREA INDEX
DEPTH FT.
CAPACITY (AC-FT)
CN 75
CN 75
CN 80
CN 80
AI 250
1.6 Ac-Ft
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

J3-G



Annual Mean Depth
Plate 2

J3-G



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

J-7 DAM

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J-7 Dam

A_D: 5385.0 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

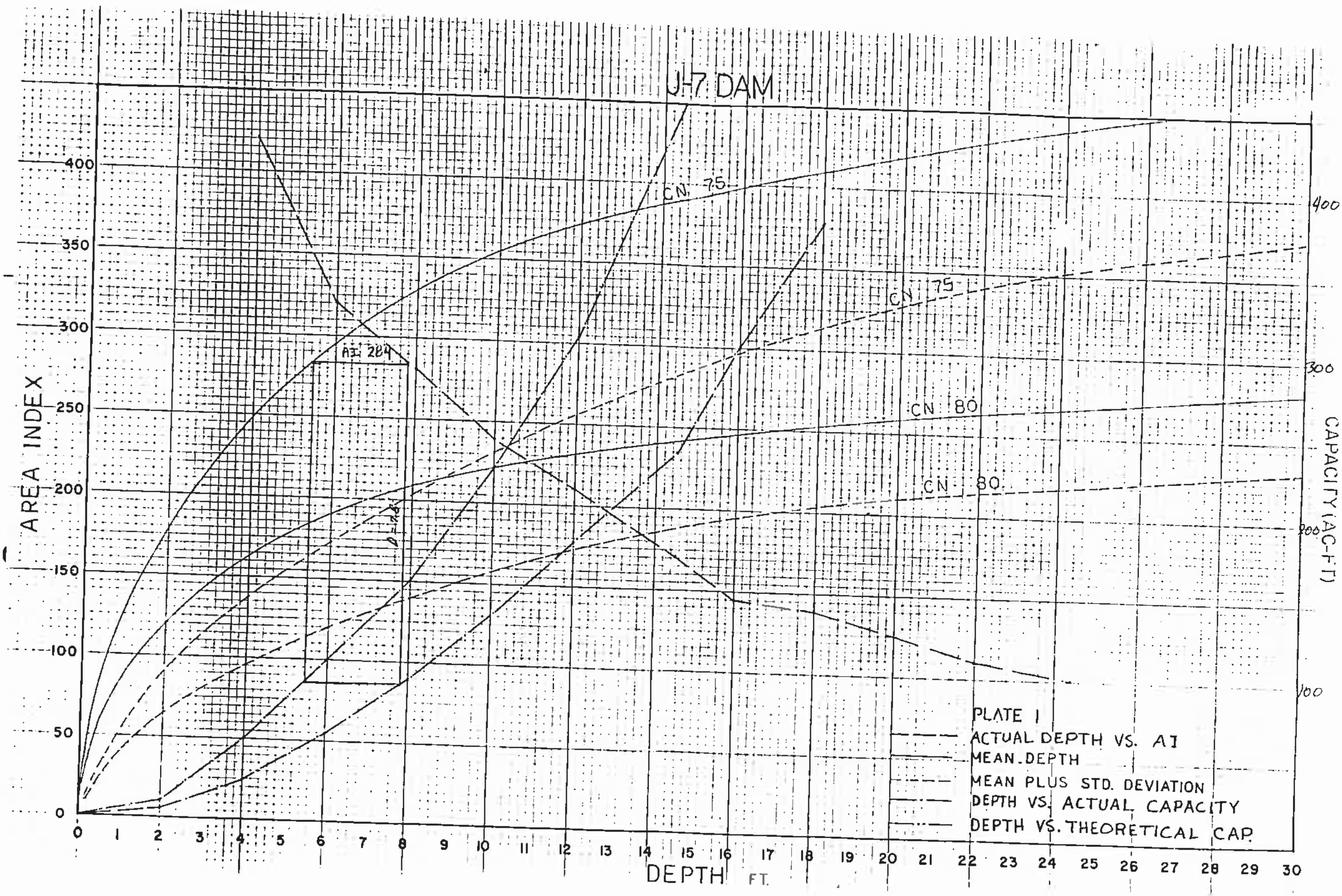
AI: Area Index = A_B/A_P

Notes: MSHA Impoundment

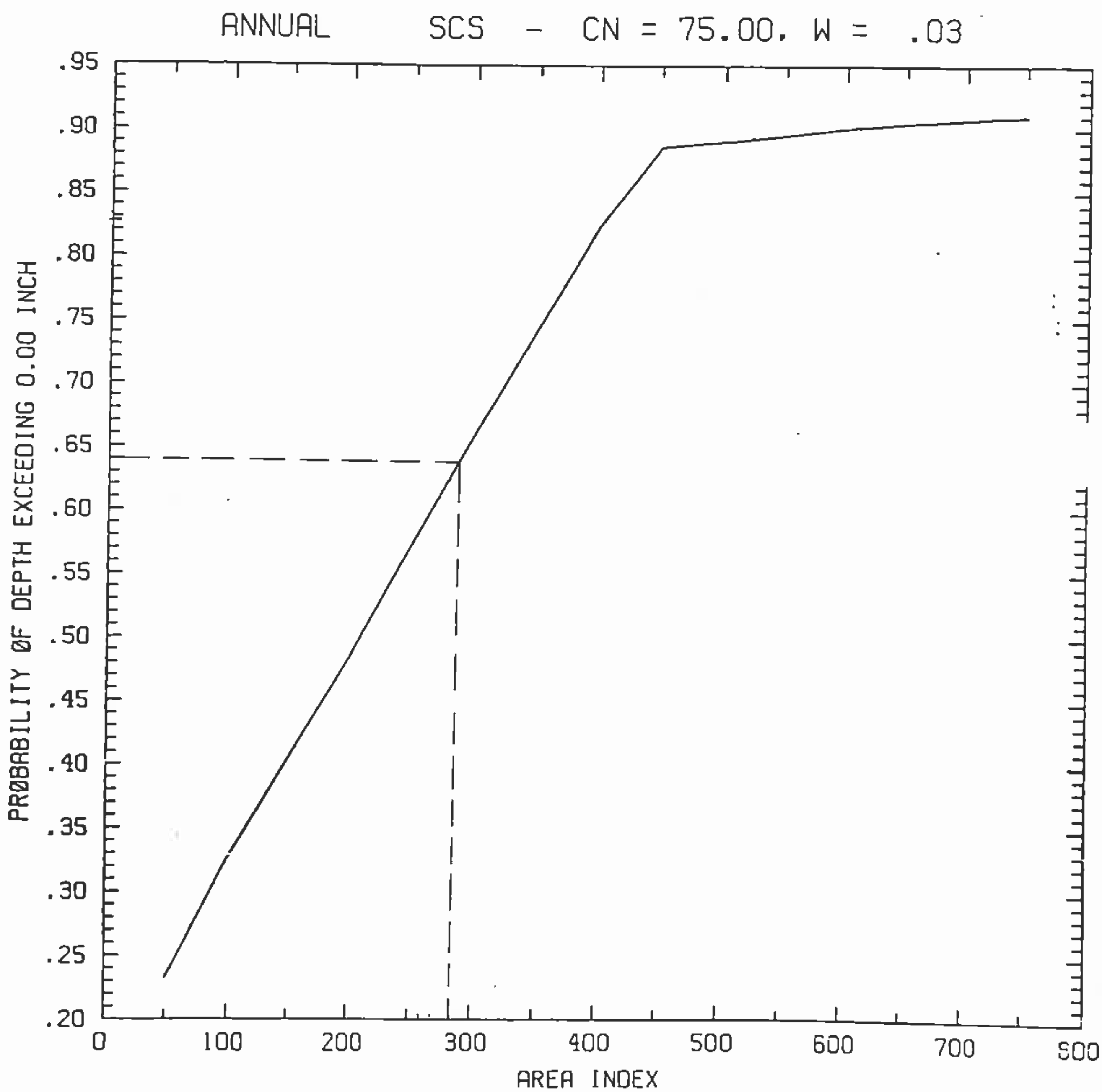
Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6344	0.308	5384.692	0	17,483	0
2	6346	5.792	5379.208	11.6	929	6.1
4	6348	12.717	5372.283	50.9	422	24.6
6	6350	16.720	5368.28	100.3	321	54.0
8	6352	18.978	5366.022	151.8	283	89.7
10	6354	22.348	5362.652	223.5	240	131.1
12	6356	25.346	5359.654	304.2	212	178.8
14.5	6358.5	31.034	5353.966	450.0	173	235.1
16	6360	36.582	5348.4	585.3	146	302.8
18	6362	38.393	5346.607	691.1	139	377.7
22	6366	47.287	5337.713	1040.3	113	549.1
24.4	6368.4	52.547	5332.453	1282.1	102	669.0

Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	7.8 ft.	--
	Minimum Depth (MIN)	--	3.0 ft.
	Actual Capacity	86.0 ac-ft.	15.0 ac-ft
	AI	284	581
Plate 2 or 3:	Probability	64%	86%

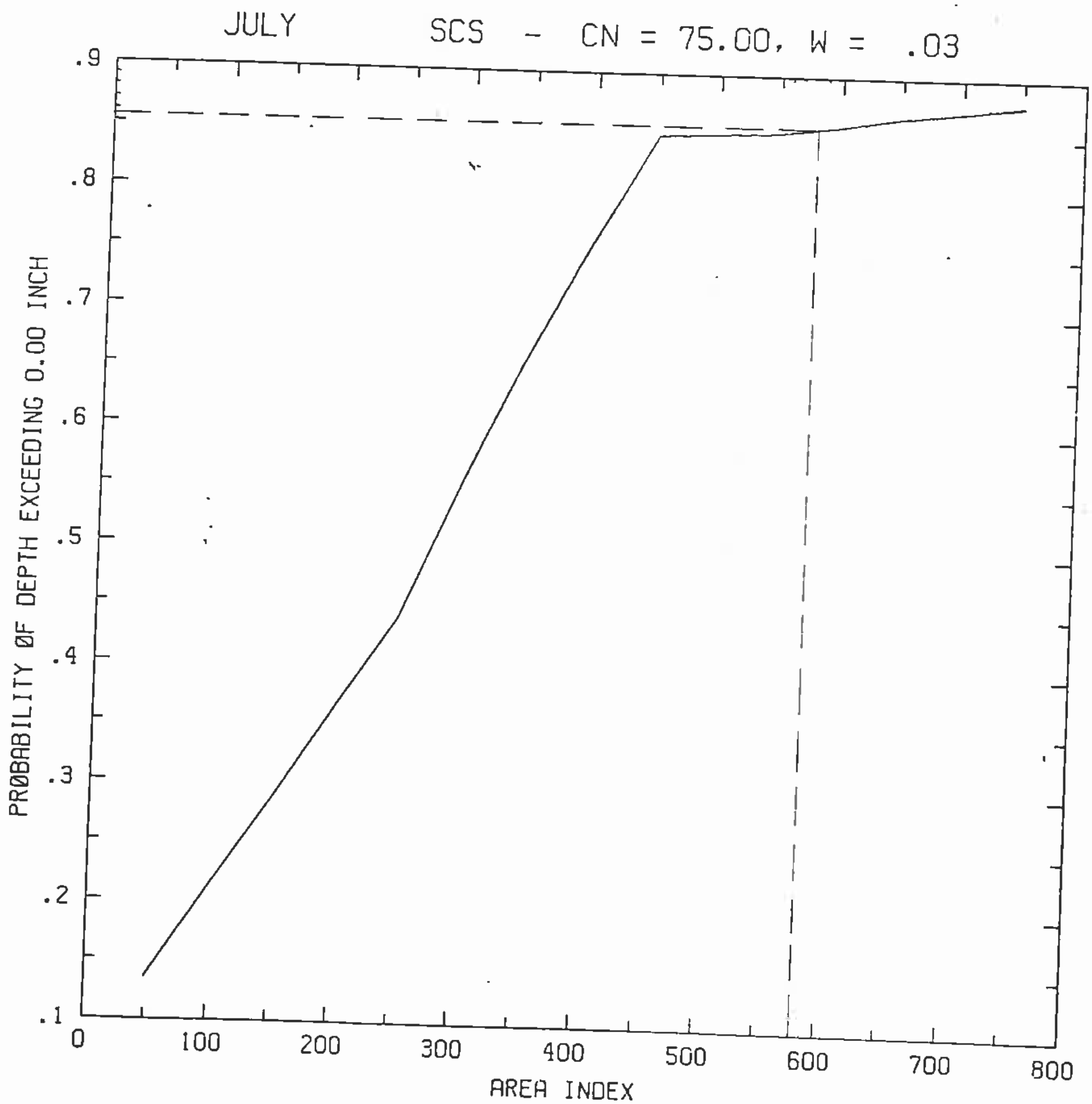

J-7 DAM
AREA INDEX
DEPTH FT.
CAPACITY (AC-FT)
CN 75
CN 75
CN 80
CN 80
AI 284
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

J-7 DAM



Annual Mean Depth
Plate 2

J-7 DAM



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

J7-JR

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J7-JR

A_D: 3832.4 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

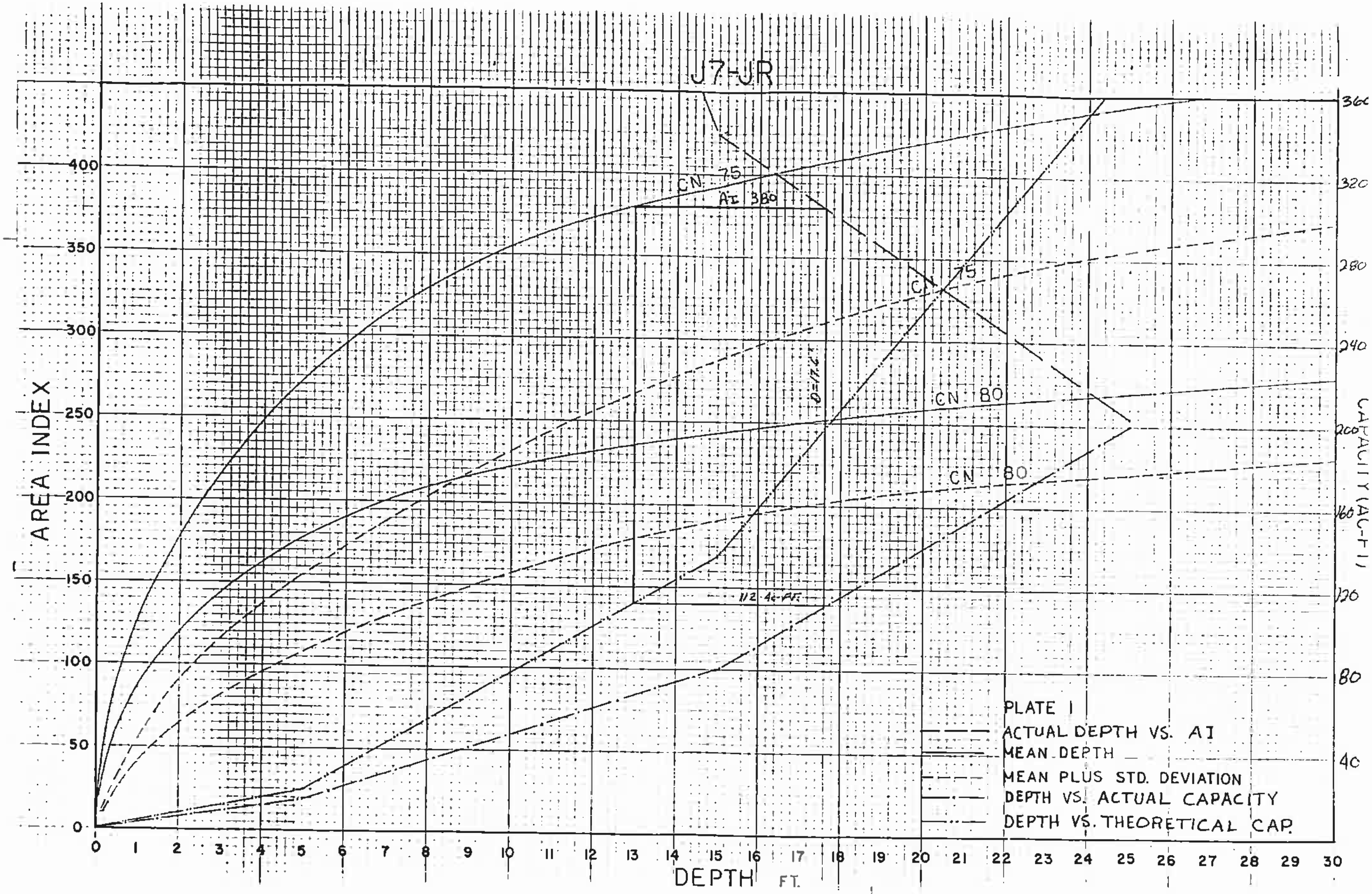
AI: Area Index = A_B/A_P

Notes: Proposed MSHA Impoundment

Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6955	2.00	3830.40	0	1915	0
3	6958	3.20	3829.2	9.6	1197	8.2
5	6960	4.0	3828.4	20.0	957	15.0
15	6970	9.0	3832.4	135.0	425	80.0
25	6980	15.0	3817.4	375.0	254	200.0

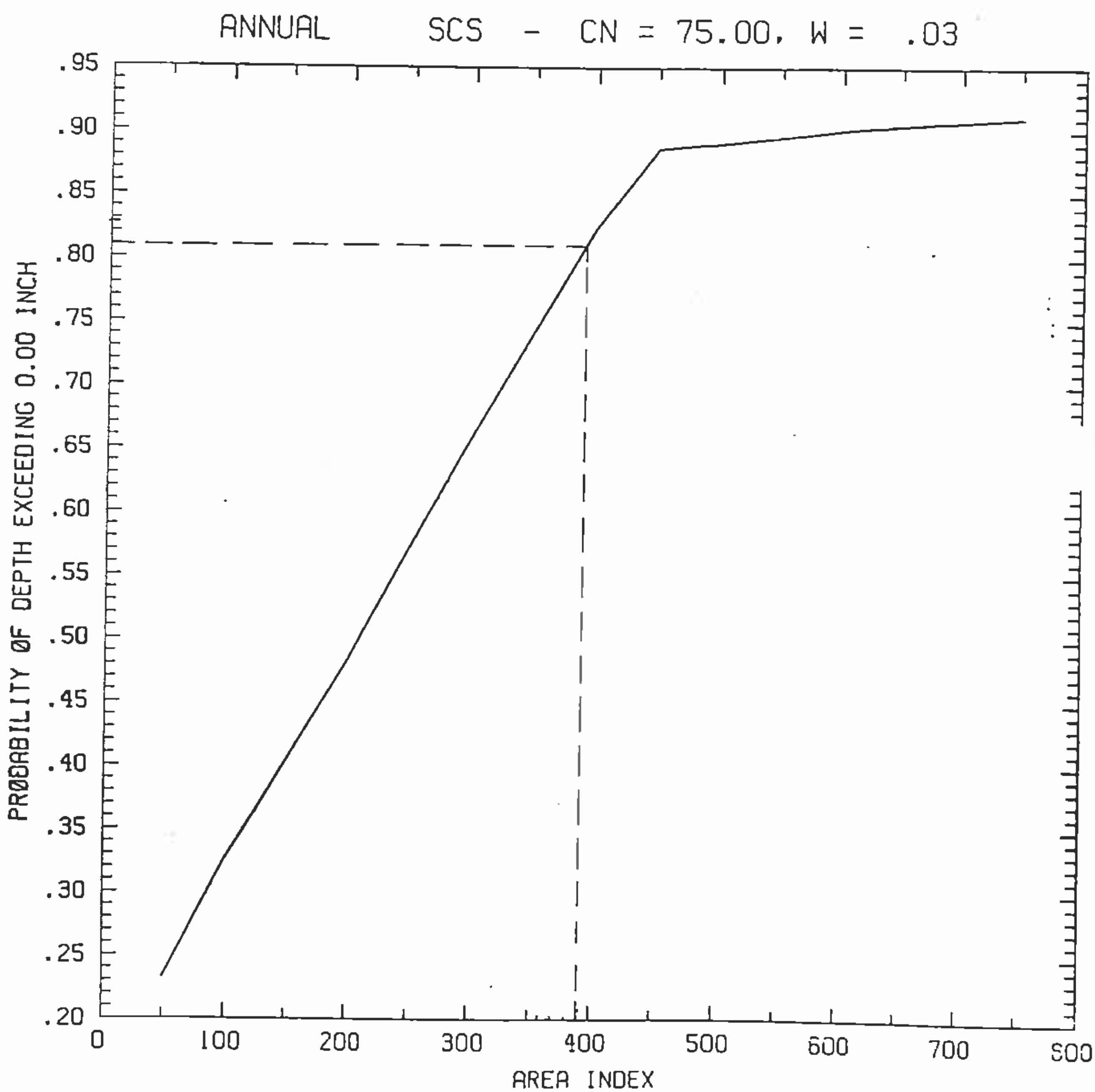
Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	17.6 ft.	--
	Minimum Depth (MIN)	--	3.0 ft.
	Actual Capacity	112 ac-ft.	8.2 ac-ft
	AI	380	1197
Plate 2 or 3:	Probability	81%	88+%



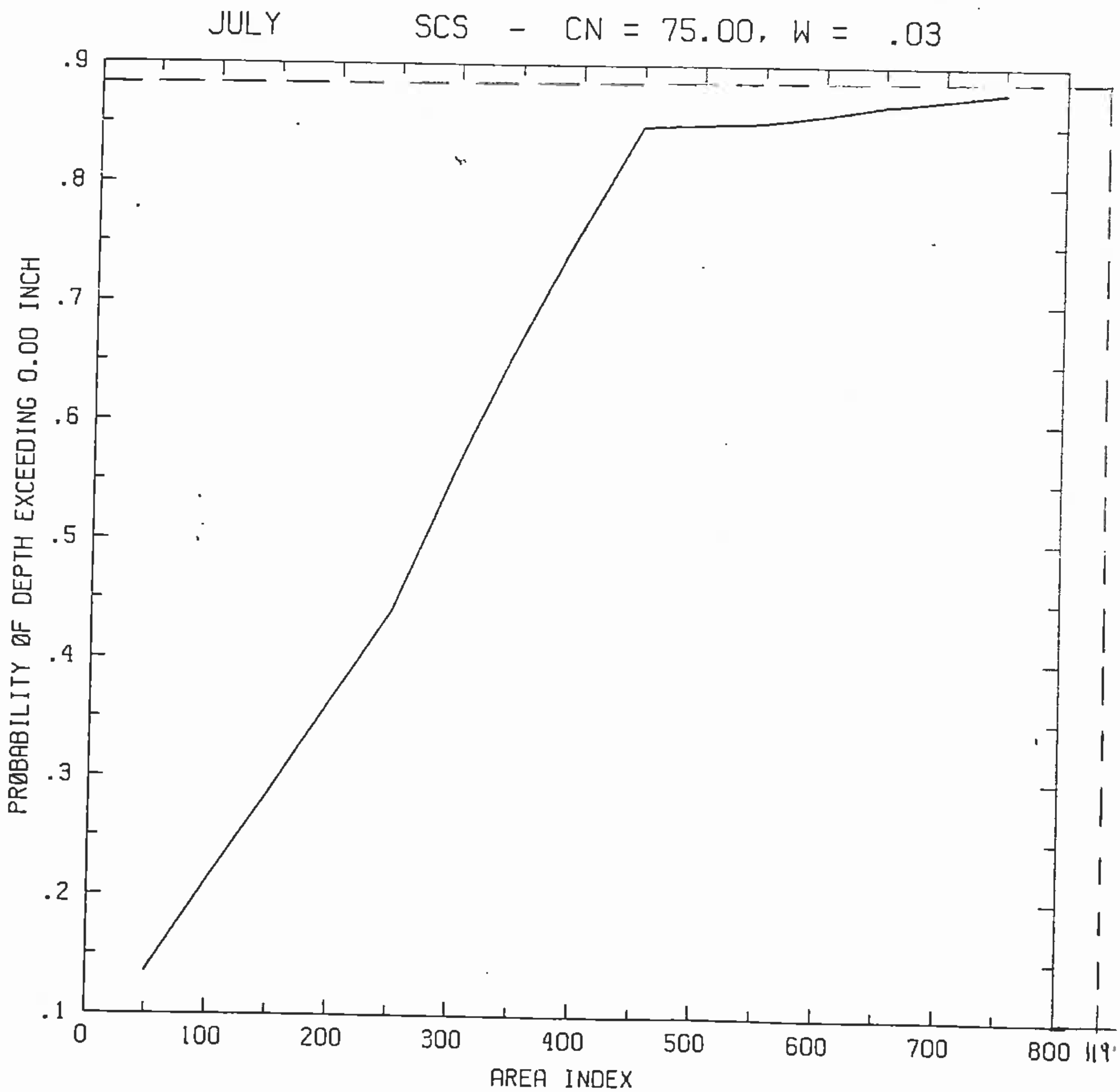
J7-JR
AREA INDEX
0
50
100
150
200
250
300
350
400
DEPTH FT.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
CAPACITY (AC-FT)
40
80
120
160
200
240
280
320
360
CN 75
AI 380
CN 75
CN 80
CN 80
D=17.6'
112 Ac-Ft.
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

J7-JR



Annual Mean Depth
Plate 2

J7-JR



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

J7-R

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J7-R

A_D: 325.9 Acres

Depth: From Bottom Elevation

A_B: Watershed Area = $A_D - A_P$

A_D: Total Drainage Area

Theoretical Capacity: A_P x Depth

A_P: Surface Area of Pond

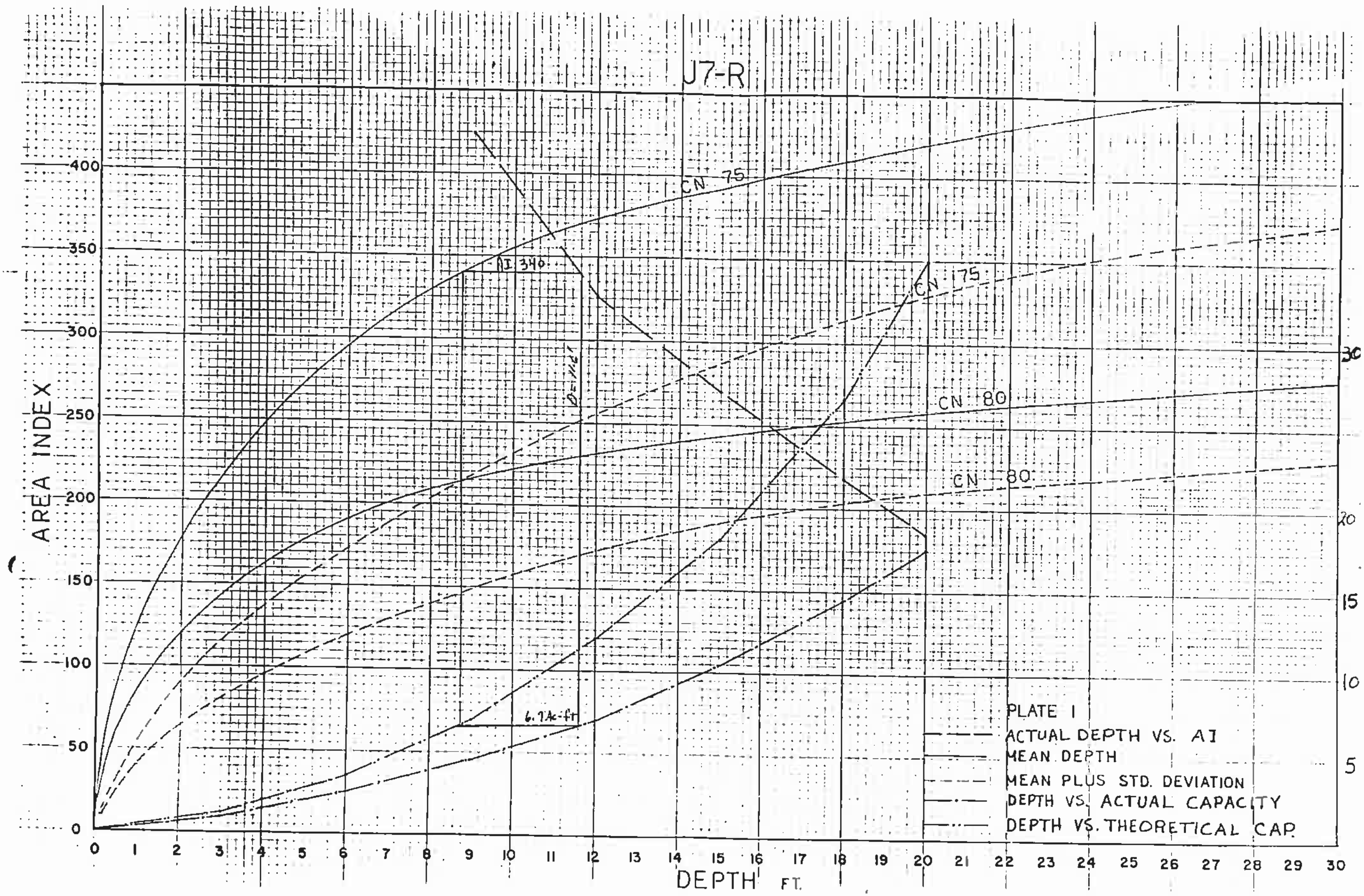
AI: Area Index = A_B/A_P

Notes: Proposed Impoundment

Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	N/A	0.276	325.624	0	1180	0
0.3		0.422	325.478	1.3	771	1.0
.6		0.597	325.303	3.6	545	2.5
9		0.766	325.134	6.9	426	4.5
12		0.922	324.908	11.9	328	7.1
15		1.205	324.695	18.1	270	10.4
18		1.483	324.417	26.7	219	14.4
20		1.745	324.155	34.9	186	17.6

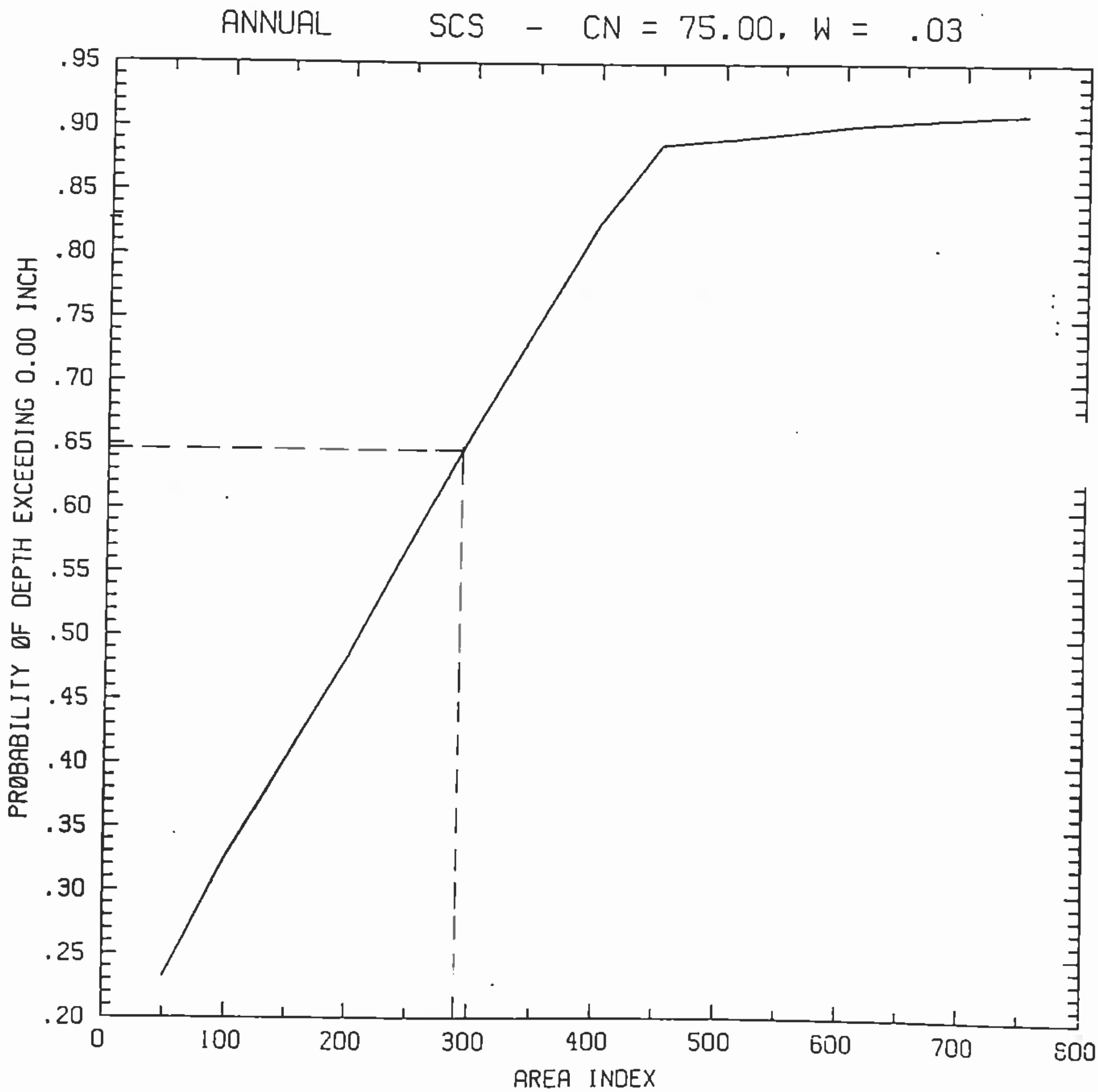
Results: Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

		AMD	MIN
Plate 1:	Annual Mean Depth (AMD)	11.6 ft	--
	Minimum Depth (MIN)		5.0 Ft
	Actual Capacity	--	2.0 Ac-ft
	AI	340	630
Plate 2 or 3:	Probability	65%	87%



J7-R
AREA INDEX
0
50
100
150
200
250
300
350
400
DEPTH FT.
0 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
5
10
15
20
30
CN 75
CN 75
CN 80
CN 80
AI 340
6.7Ac-ft
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

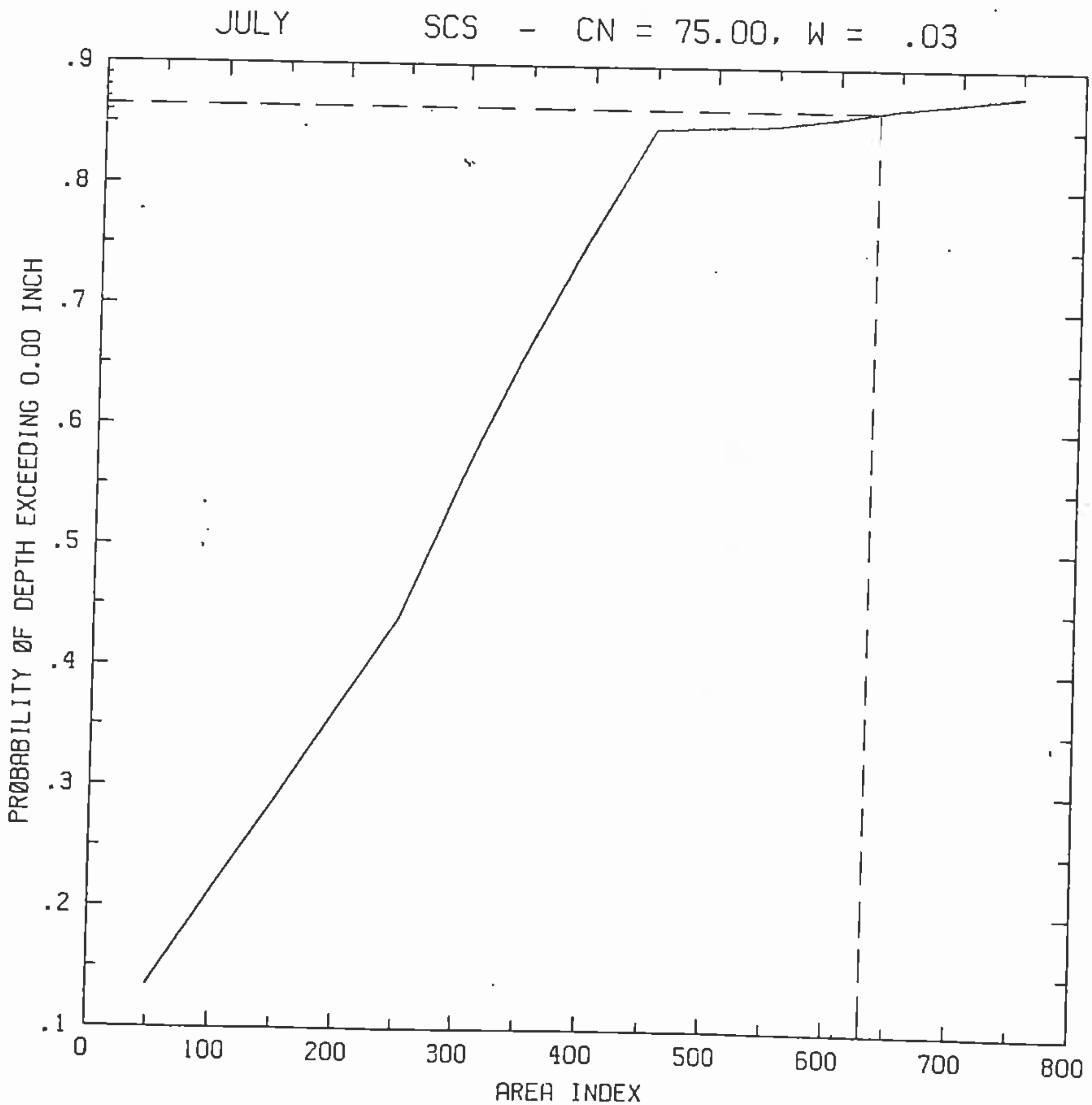
J7-R



Annual Mean Depth

Plate 2

J7-R



Minimum Depth

Plate 3

PERMANENT IMPOUNDMENT

J16-A

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J16-A

A_D: 2684.0 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = A_D - A_P

Theoretical Capacity: A_P x Depth

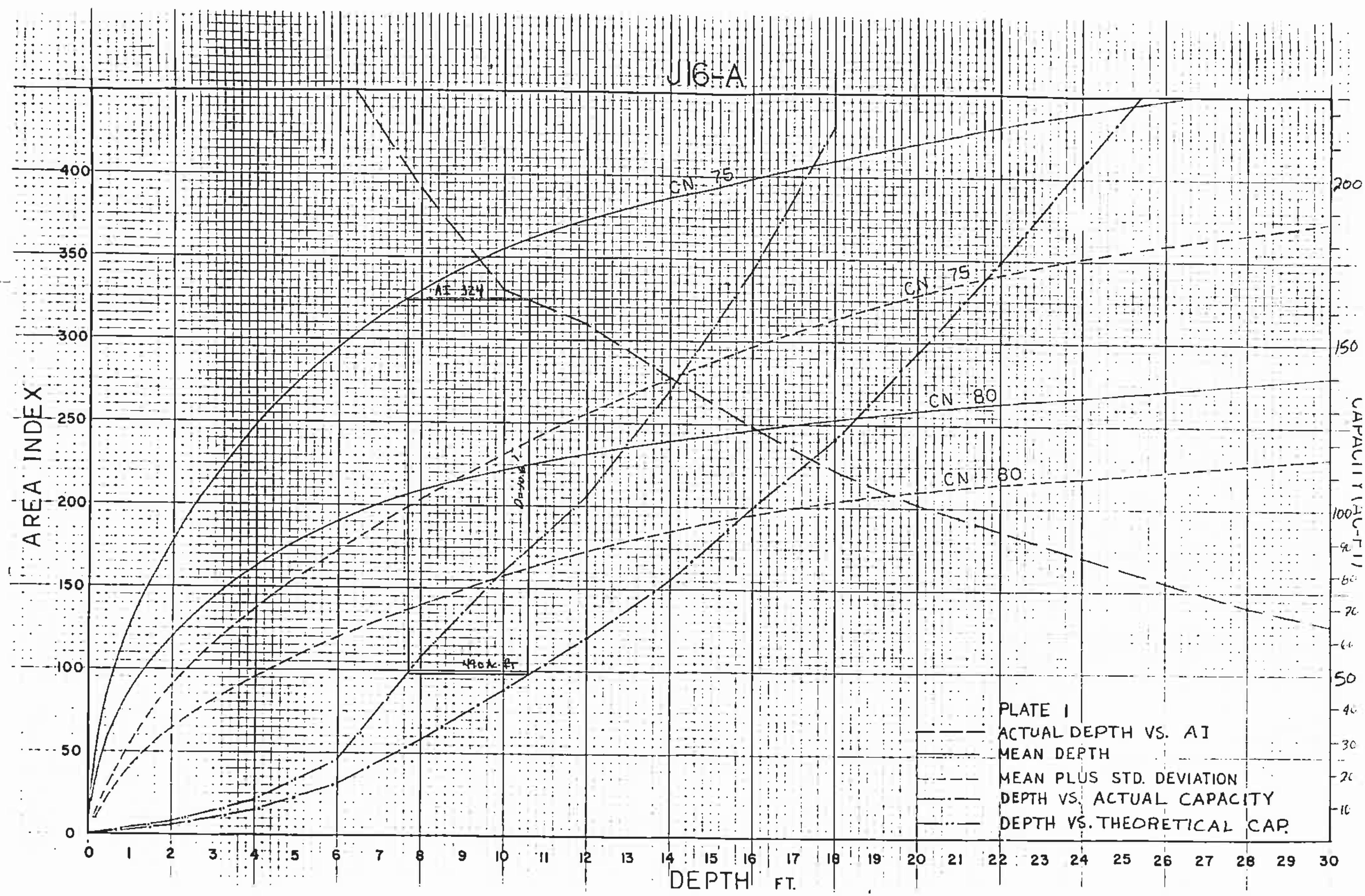
AI: Area Index = A_B/A_P

Notes: MSHA Impoundment

Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6604	0.922	2683.078	0	2910	0
2	6606	2.110	2681.890	4.2	1271	3.0
4	6608	2.728	2681.272	10.9	983	7.9
6	6610	5.761	2678.239	23.0	465	16.4
8	6612	6.828	2677,172	54.6	392	28.9
10	6614	8.097	2675.903	81.0	331	43.9
12	6616	8.622	2675.378	103.5	310	60.6
14	6618	9.603	2674.397	134.4	279	78.8
16	6620	10.774	2673.226	172.4	248	99.2
18	6622	11.947	2672.053	215.0	224	121.9
20	6624	13.106	2670.894	262.1	204	147.0
22	6626	14.206	2669.794	312.5	188	174.3
24	6628	15.519	2668.481	372.5	172	204.0
26	6630	17.047	2666.953	443.2	156	236.6
28	6632	18.649	2665.351	522.2	142	272.3
30	6634	20.420	2663.580	612.6	130	311.3

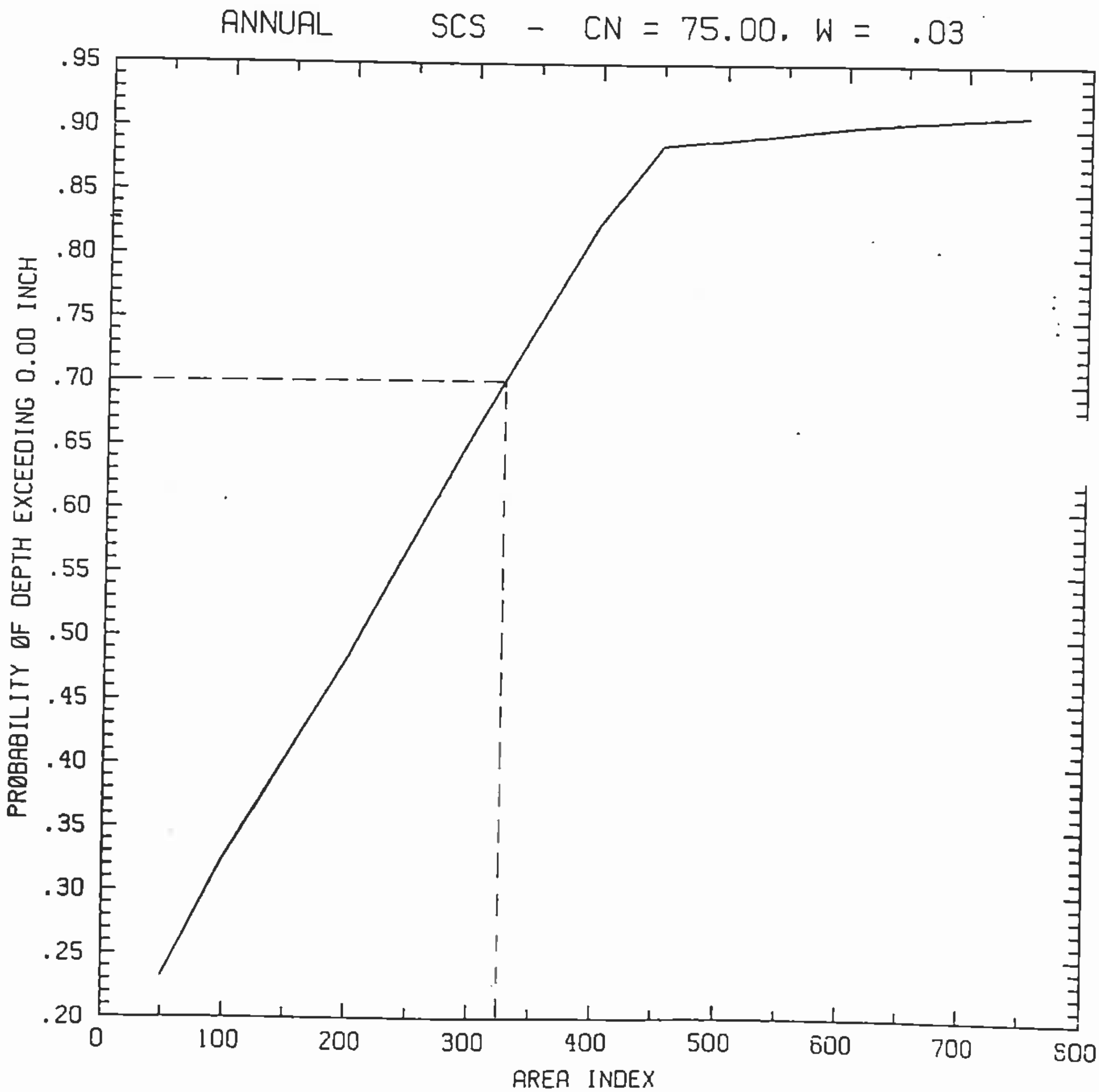
Results: Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD) Minimum Depth (MIN) Actual Capacity AI	10.6 ft -- 49.0 Ac-ft 324	-- 3.0 ft 5.1 Ac-ft 1108
Plate 2 or 3:	Probability	70%	88+%



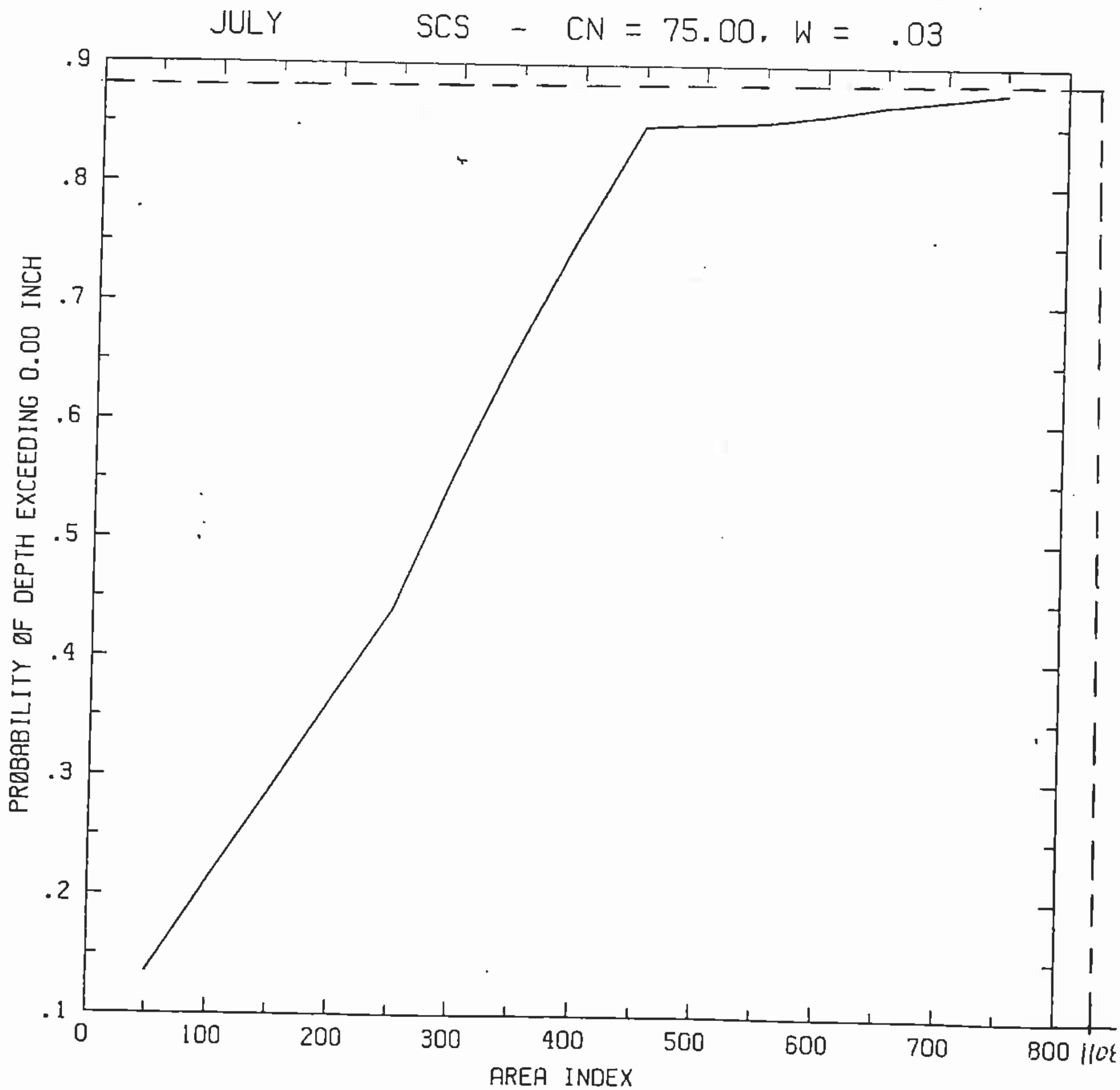
J16-A
AREA INDEX
DEPTH FT.
CAPACITY (AC-FT)
CN 75
CN 75
CN 80
CN 80
AI 324
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

J16-A



Annual Mean Depth
Plate 2

J16-A



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

J16-G

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J16-G

A_D: 272.0 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

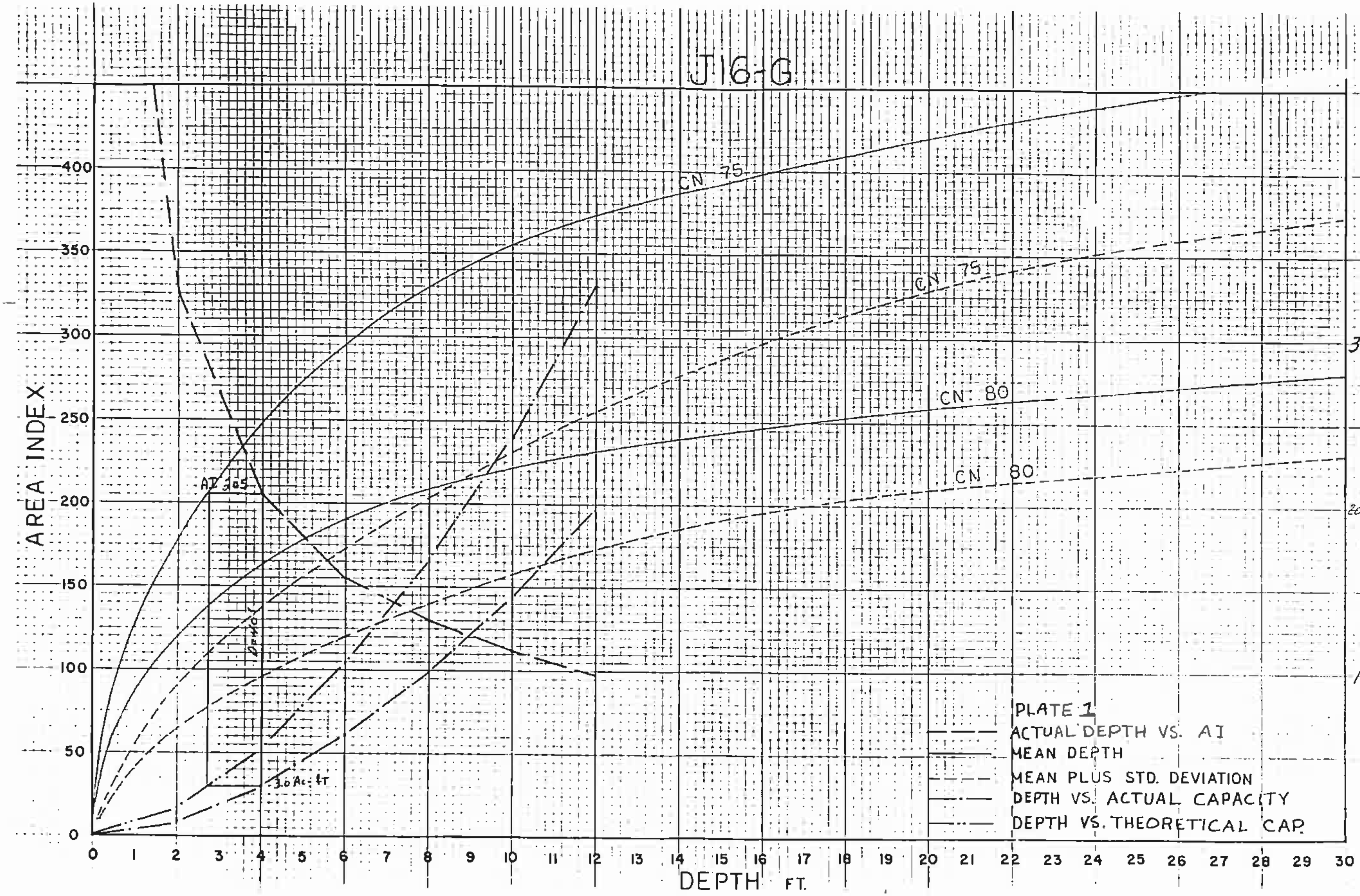
AI: Area Index = A_B/A_P

Notes: Existing Impoundment

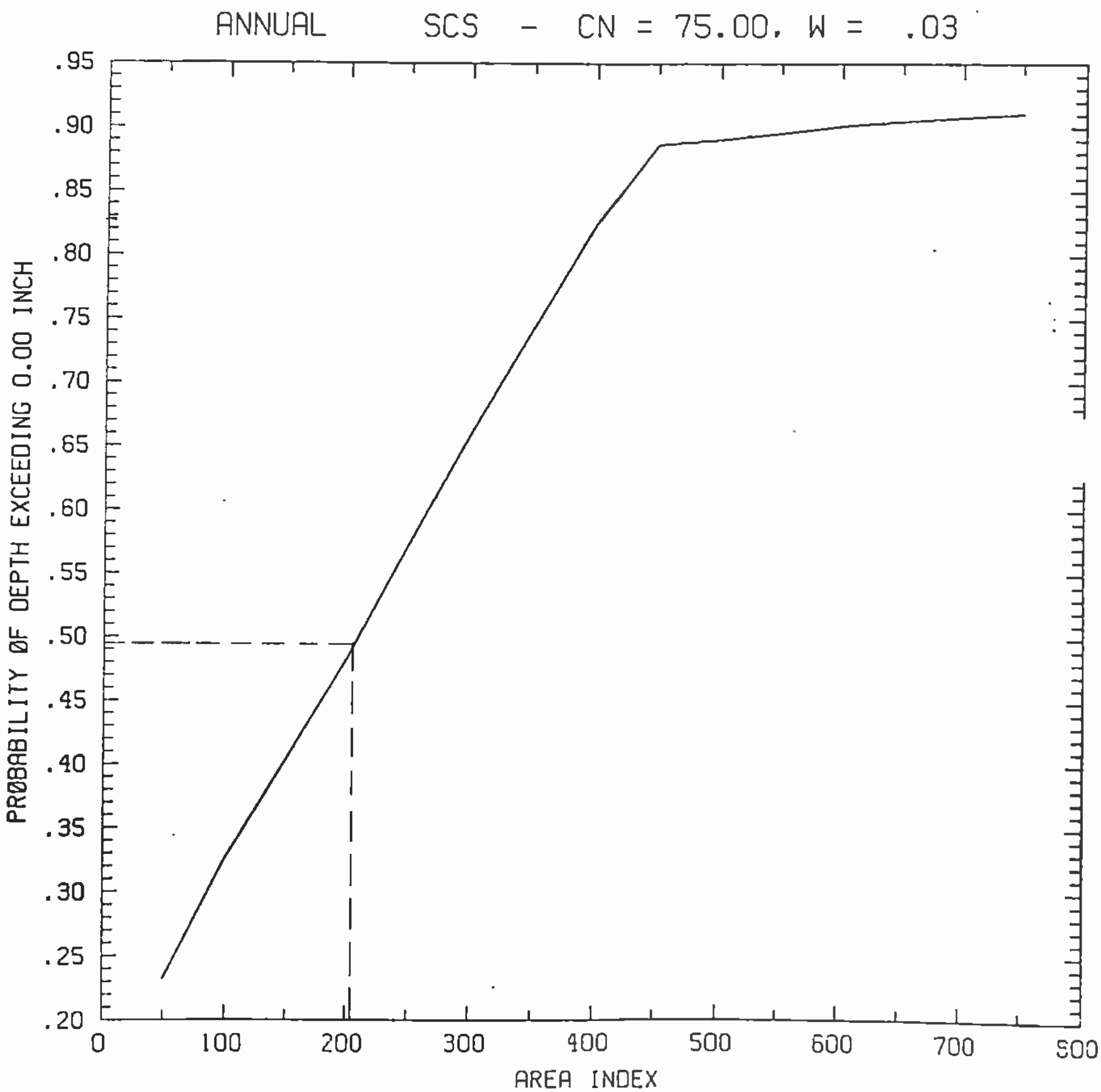
Depth (ft)	Elevation (MSL)	A_P (AC)	A_B (AC)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6564	0.063	271.937	0	4317	0
2	6566	0.829	271.171	1.7	327	0.9
4	6568	1.312	270.688	5.2	206	3.0
6	6570	1.742	270.259	10.4	155	6.1
8	6572	2.091	269.909	16.7	129	9.9
10	6574	2.400	269.600	24.0	112	14.4
12	6576	2.747	269.253	33.0	98	19.6

<u>Results</u> Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	4.0 ft	--
	Minimum Depth (MIN)	--	3.0 ft
	Actual Capacity	3.0 Ac-ft	2.0 Ac-ft
	AI	205	267
Plate 2 or 3:	Probability	49%	48%


J16-G
AREA INDEX
CAPACITY (AC-FT)
DEPTH FT.
CN 75
CN 75
CN 80
CN 80
AI 205
3.0 Ac-Ft
PLATE 1
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

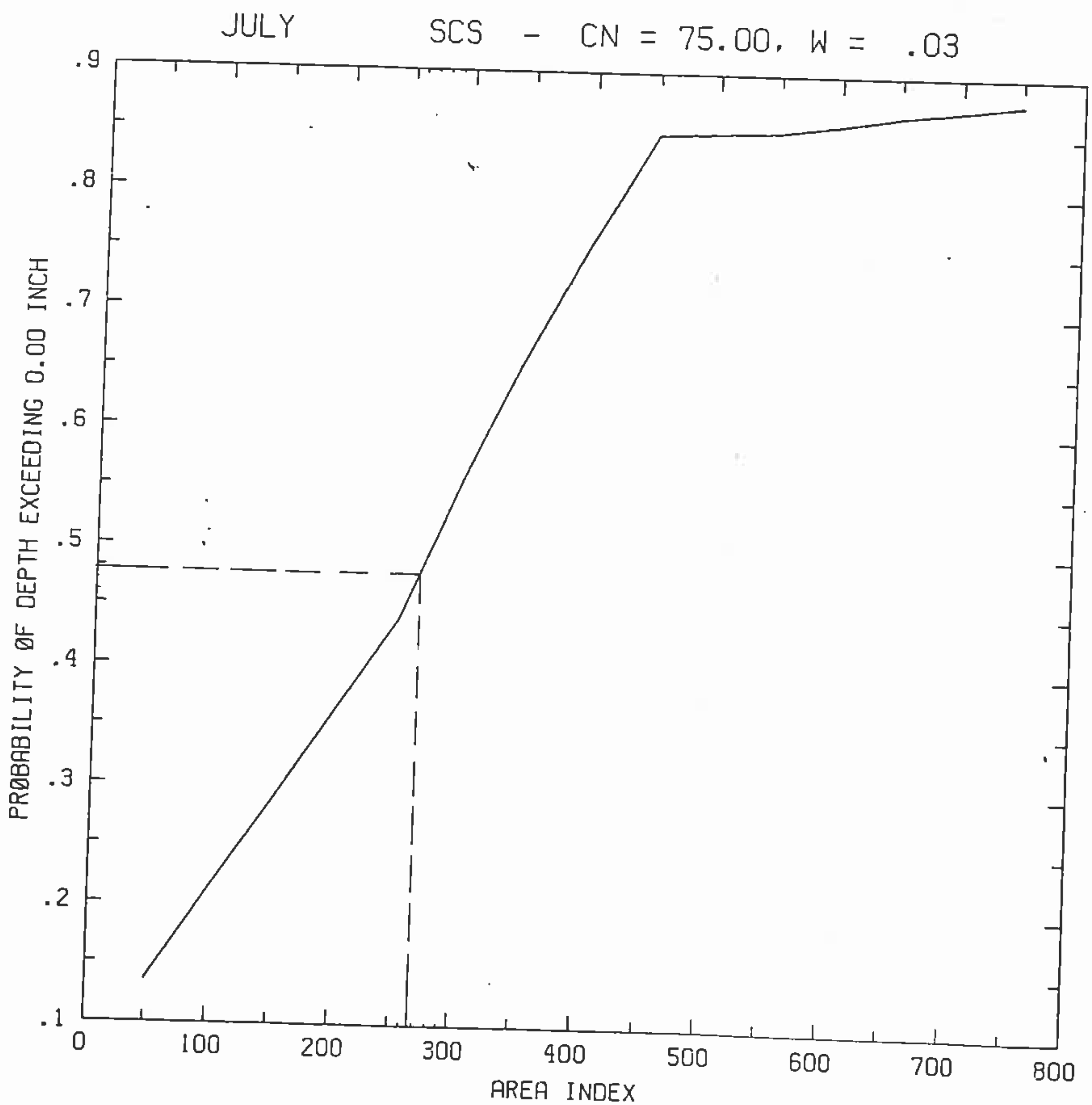
J16-G



Annual Mean Depth

Plate 2

J16-G



Minimum Depth

Plate 3

PERMANENT IMPOUNDMENT

J16-L

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J16-L

A_D: 6373.0 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

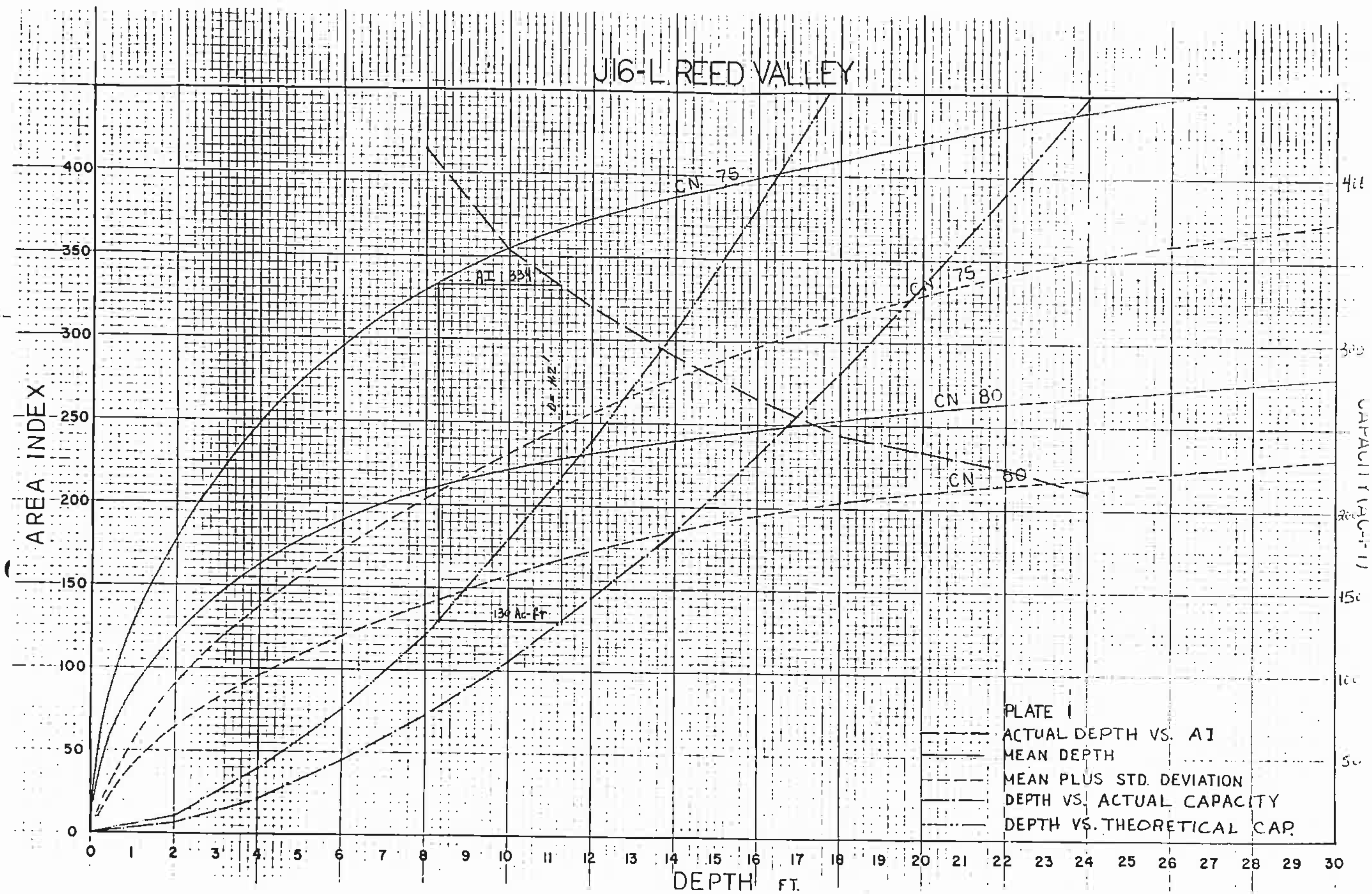
AI: Area Index = A_B/A_P

Notes: MSHA Impoundment

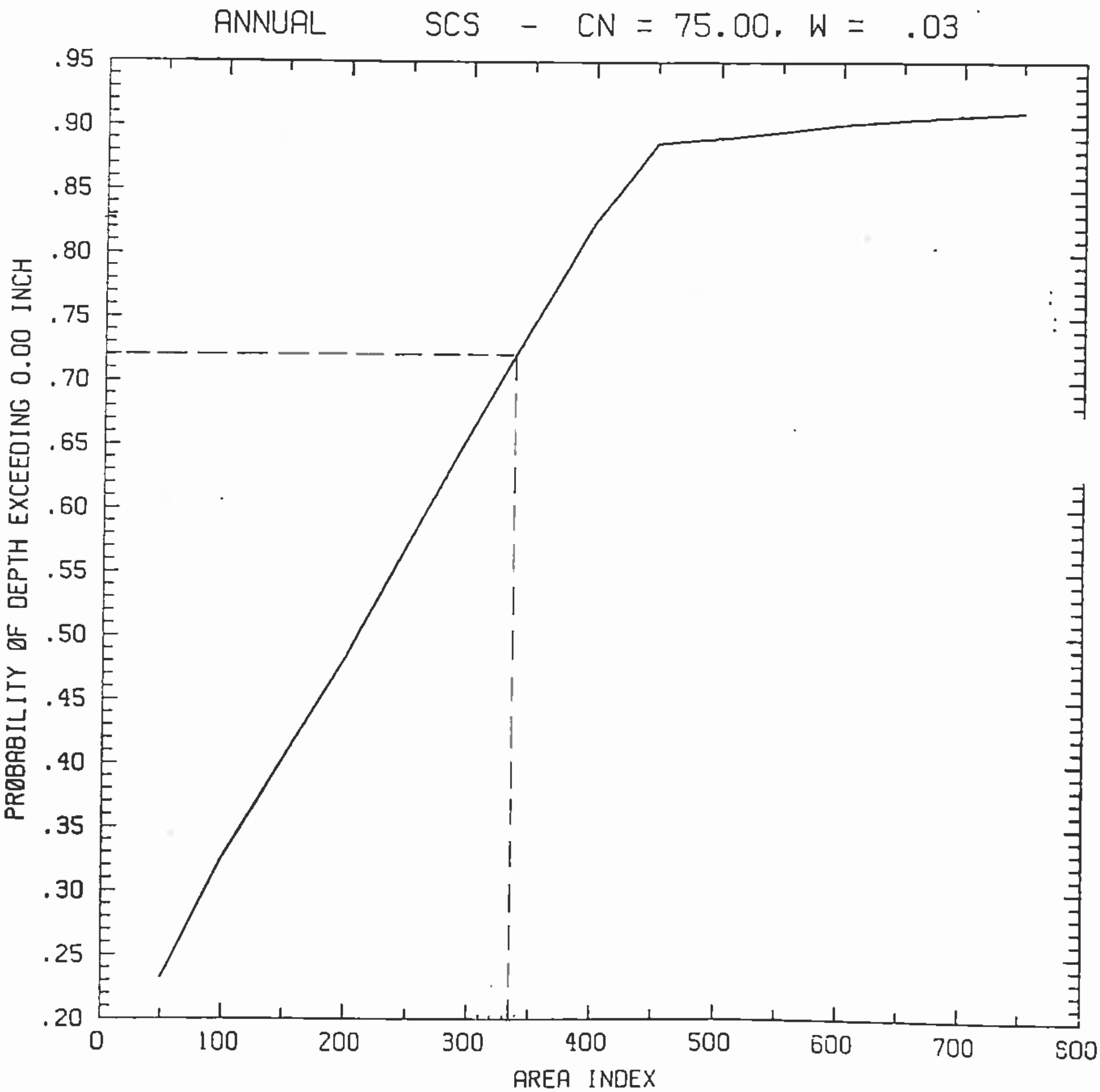
Depth (ft)	Elevation (MSL)	A_P (AC)	A_B (AC)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6546	1.286	6371.7	0	4955	0
2	6548	5.934	6367.066	11.9	1073	7.2
4	6550	9.755	6363.245	39.0	652	22.9
6	6552	12.752	6360.248	76.5	499	45.4
8	6554	15.333	6357.667	122.7	415	73.5
10	6556	17.912	6355.088	179.1	355	106.7
12	6558	19.902	6353.098	238.8	319	144.6
14	6560	21.882	6351.118	306.3	290	186.3
16	6562	23.858	6349.142	381.7	266	232.1
18	6564	25.987	6347.013	467.8	244	281.9
20	6566	26.924	6346.076	538.5	236	334.8
22	6568	28.320	6344.680	623.0	224	390.1
24	6570	29.788	6343.212	714.9	213	448.2
25.2	6571.2	30.815	6342.185	776.5	206	484.6

Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD) Minimum Depth (MIN) Actual Capacity AI	11.2 ft -- 130 Ac-ft 334	-- 3.0 ft 14.0 Ac-ft 811
Plate 2 or 3:	Probability	72%	88%

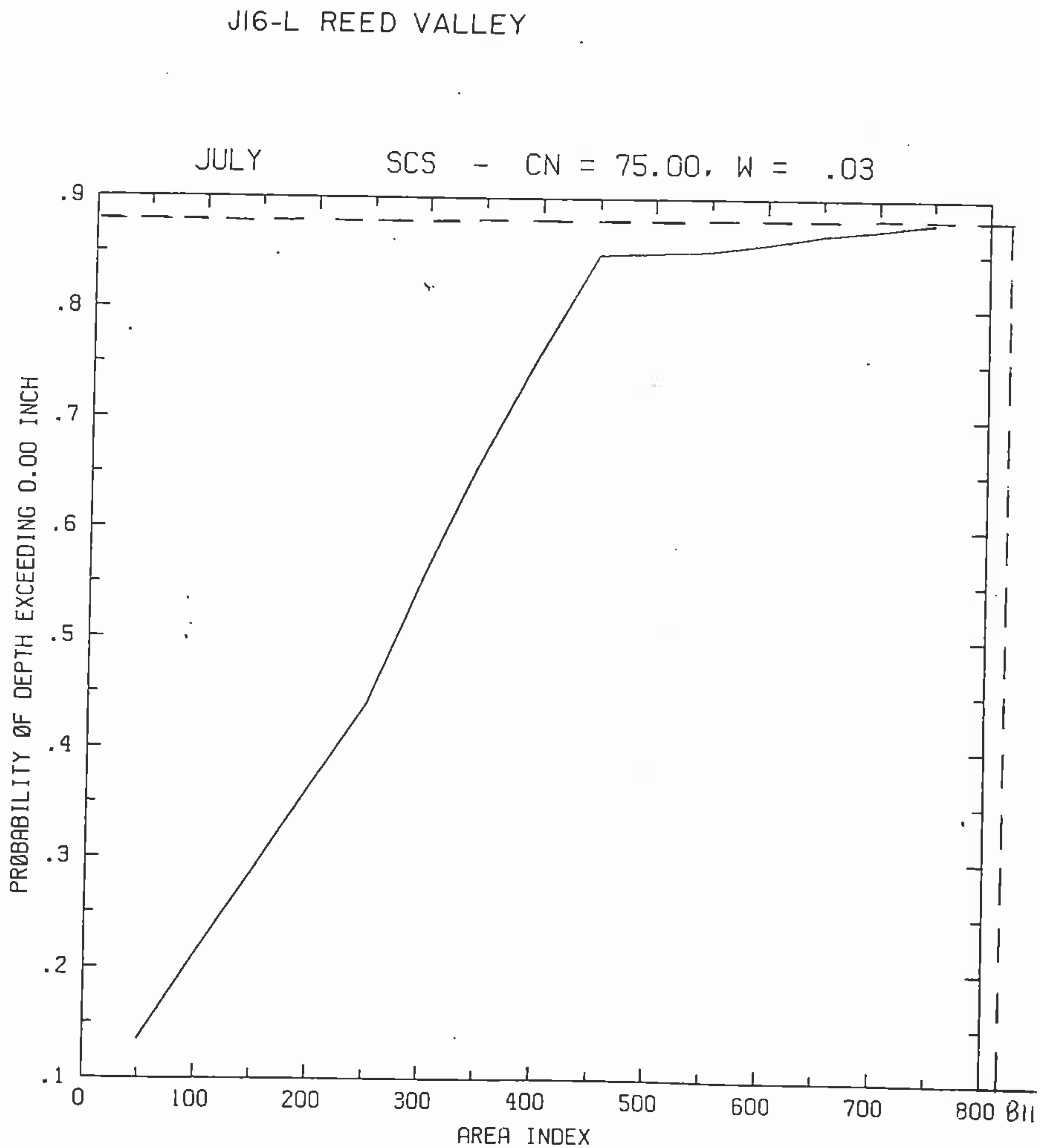

J16-L REED VALLEY
AREA INDEX
DEPTH FT.
CAPACITY (AC-FT)
CN 75
CN 80
CN 75
CN 80
AI 334
D = 11.2'
130 Ac-Ft
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

J16-L REED VALLEY



Annual Mean Depth

Plate 2



Minimum Depth

Plate 3

PERMANENT IMPOUNDMENT

J19-RA

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J19-RA

A_D: 781.3 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

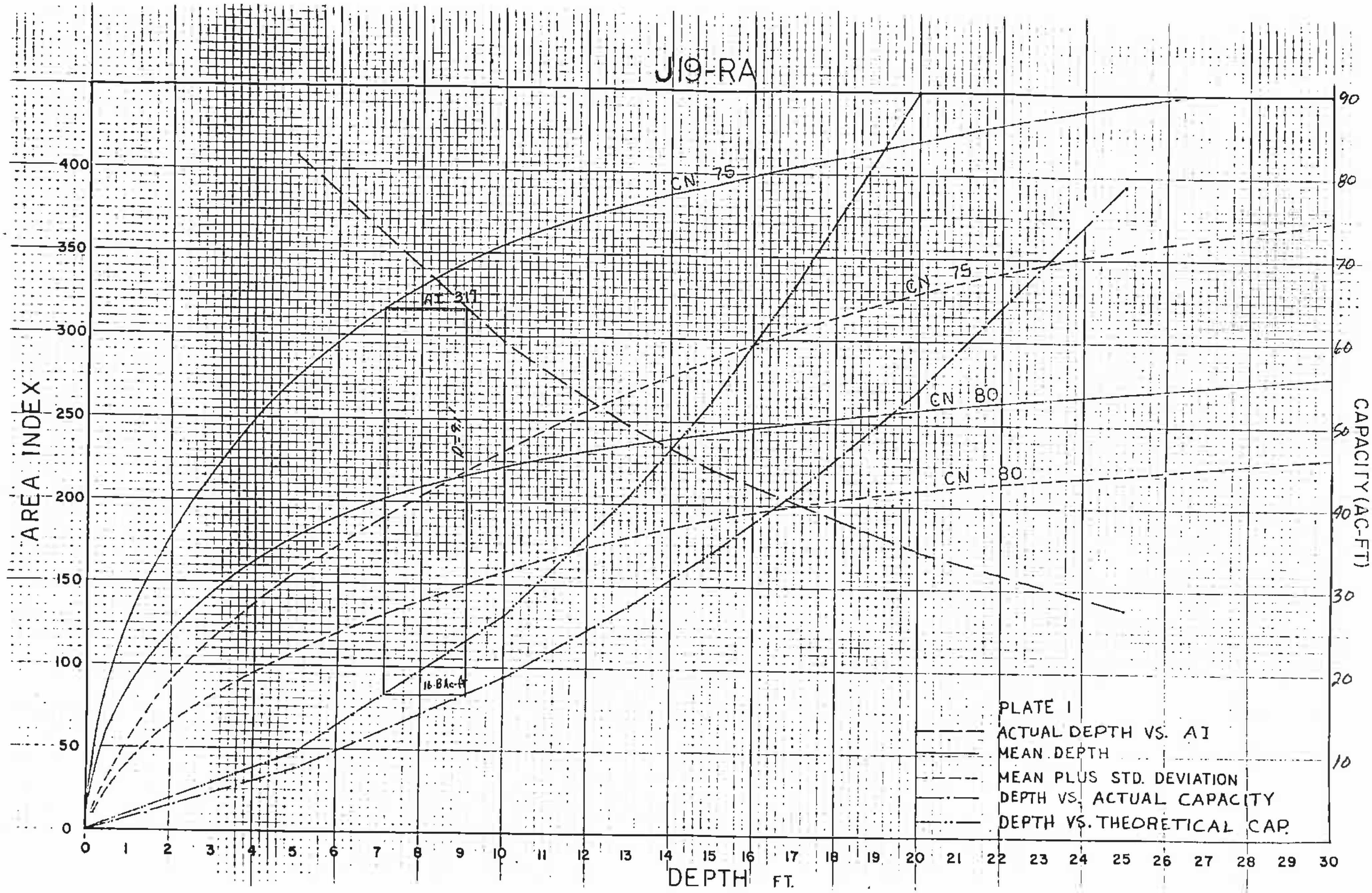
AI: Area Index = A_B/A_P

Notes: Proposed Internal Impoundment

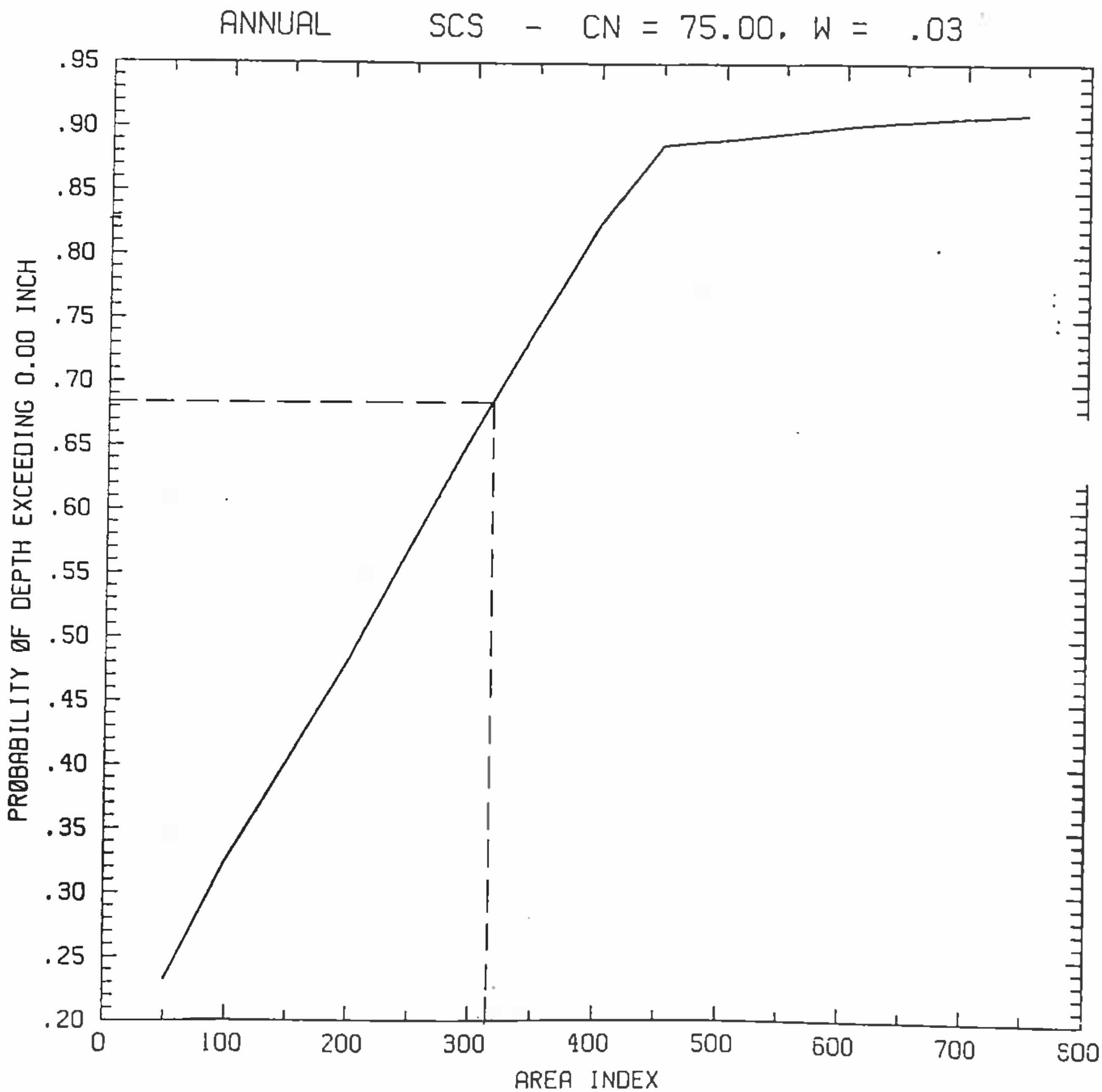
Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	N/A	1.240	780.06	0	629	0
3		1.612	779.688	4.8	484	4.3
5		1.882	779.418	9.4	414	7.8
10		2.640	778.66	26.4	295	19.0
13		3.150	778.15	41.0	247	27.6
15		3.513	777.787	52.7	221	34.2
17		3.894	777.406	66.2	200	41.5
20		4.500	776.80	90.0	173	54.0
25		5.602	775.698	140.0	138	79.0

Results: Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	9.1 ft	--
	Minimum Depth (MIN)	--	3.0 ft
	Actual Capacity	16.8 Ac-ft	4.6 Ac-ft
	AI	317	484
Plate 2 or 3:	Probability	68%	85%

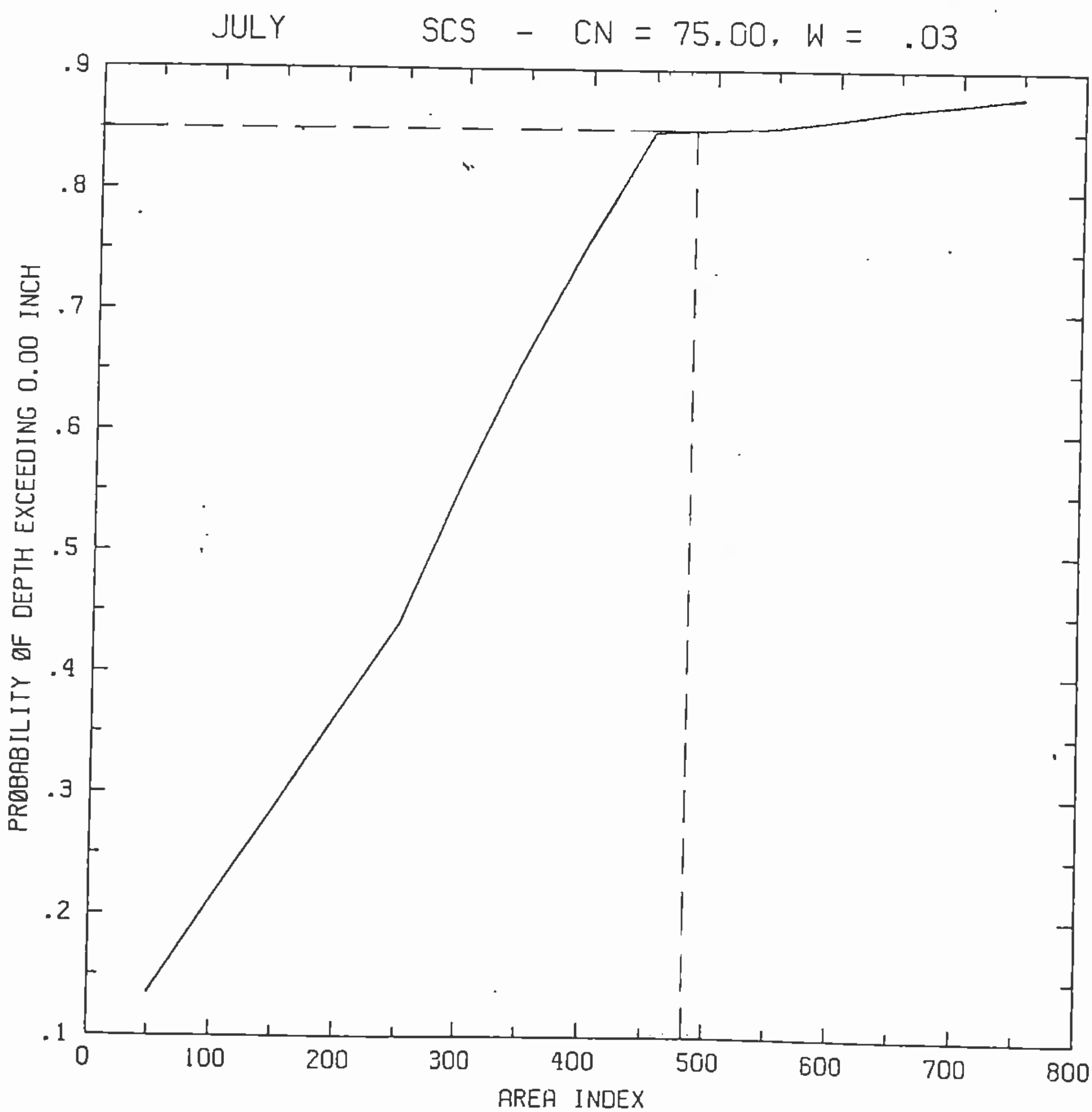

J19-RA
AREA INDEX
0
50
100
150
200
250
300
350
400
CAPACITY (AC-FT)
10
20
30
40
50
60
70
80
90
DEPTH FT.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
CN 75
CN 75
CN 80
CN 80
AI 317
16.8Ac-ft
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

J19-RA



Annual Mean Depth
Plate 2

J19-RA



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

J19-RB

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J19-RB

A_D: 815.1 Acres

Depth: From Bottom Elevation

A_B: Watershed Area = $A_D - A_P$

A_D: Total Drainage Area

Theoretical Capacity: A_P x Depth

A_P: Surface Area of Pond

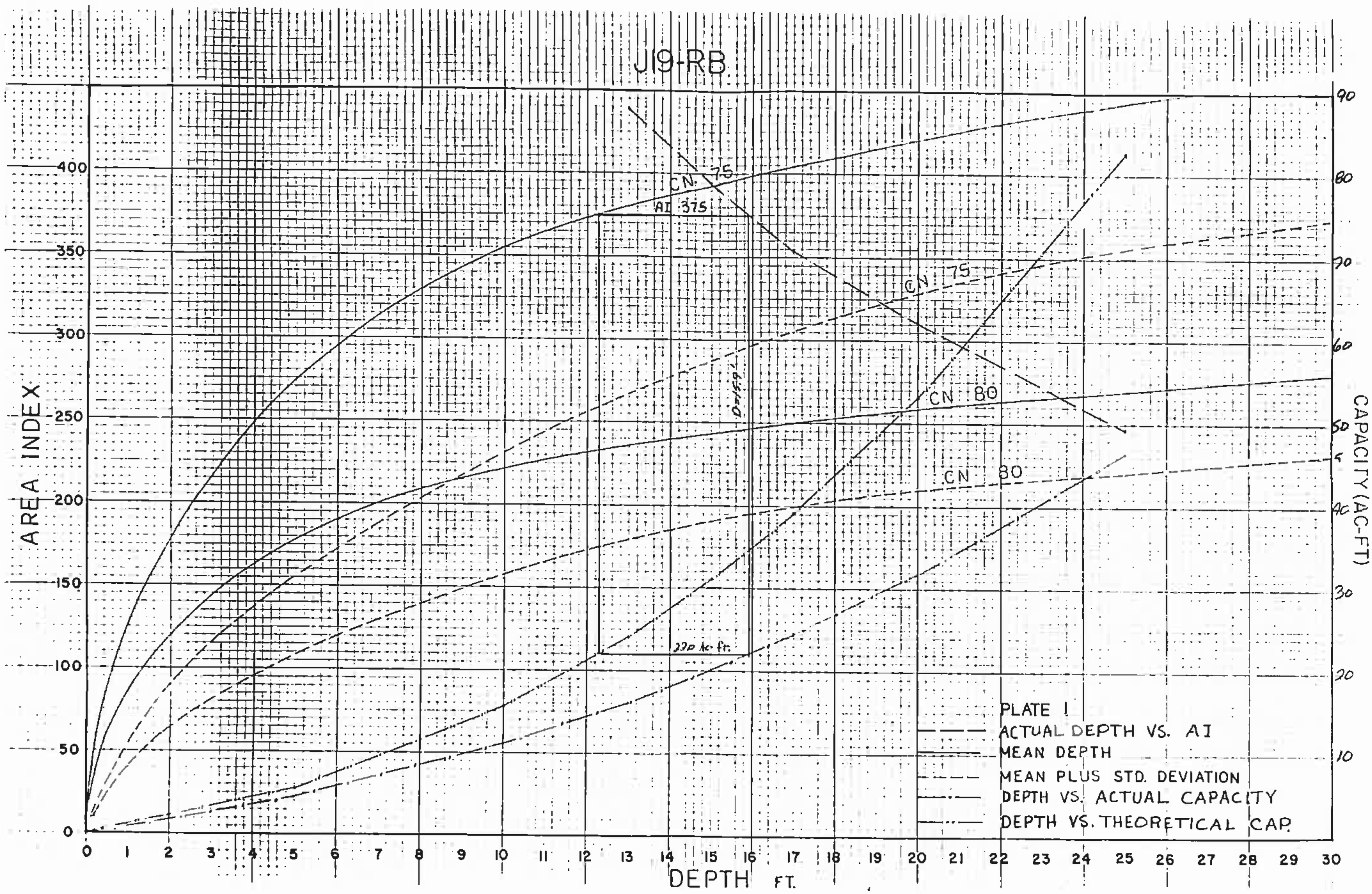
AI: Area Index = A_B/A_P

Notes: Proposed Internal Impoundment

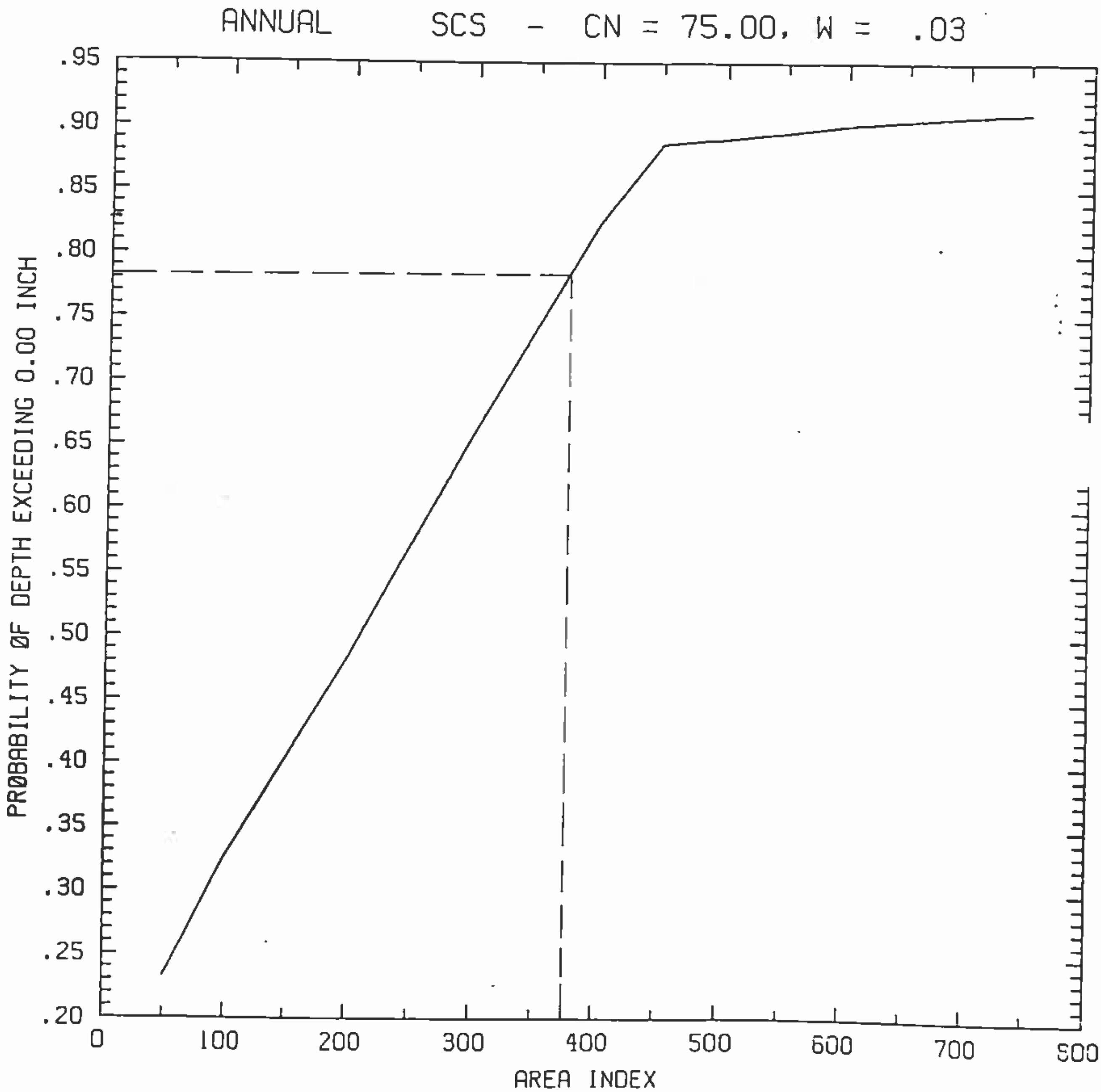
Depth (ft)	Elevation (MSL)	A_P (AC)	A_B (AC)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	N/A	0.723	814.277	0.0	1126	0.0
3		0.941	814.159	2.8	866	2.5
5		1.102	813.898	5.5	739	4.6
10		1.550	813.45	15.5	525	11.1
13		1.851	813.149	24.1	439	16.2
15		2.066	812.934	31.0	393	20.0
17		2.292	812.708	39.0	354	24.4
20		2.652	812.35	53.0	306	31.7
25		3.306	811.69	82.6	246	46.5

Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	15.9 ft	--
	Minimum Depth (MIN)	--	3.0 ft
	Actual Capacity	22.0 Ac-ft	2.5 Ac-ft
	AI	375	866
Plate 2 or 3:	Probability	78%	88+%

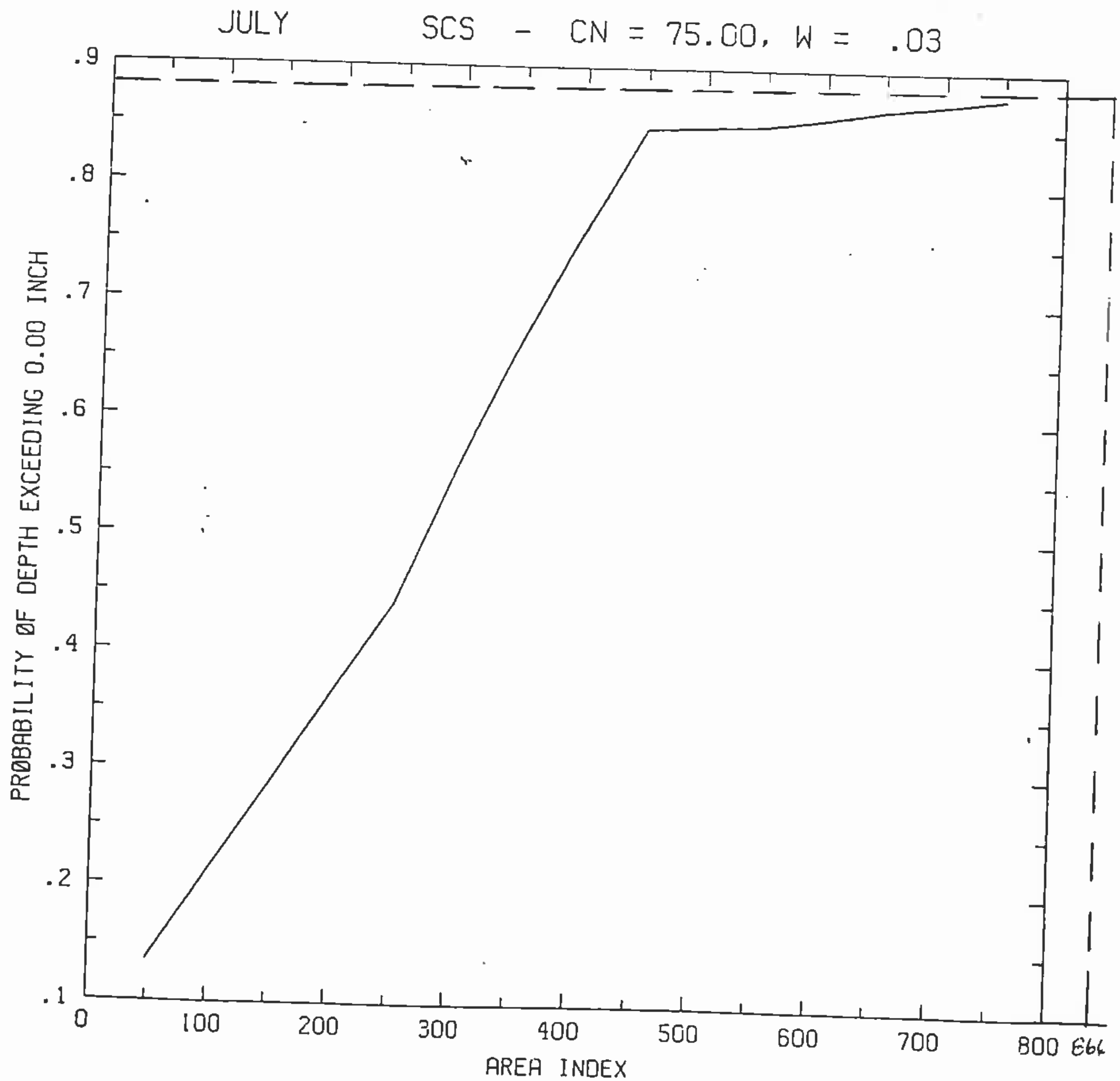

J19-RB
AREA INDEX
CAPACITY (AC-FT)
DEPTH FT.
CN 75
AI 375
CN 75
CN 80
CN 80
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

J19-RB



Annual Mean Depth
Plate 2

J19-RB



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

J21-A

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J21-A

A_D: 544.0 Acres

Depth: From Bottom Elevation

A_B: Watershed Area = A_D - A_P

A_D: Total Drainage Area

Theoretical Capacity: A_P x Depth

A_P: Surface Area of Pond

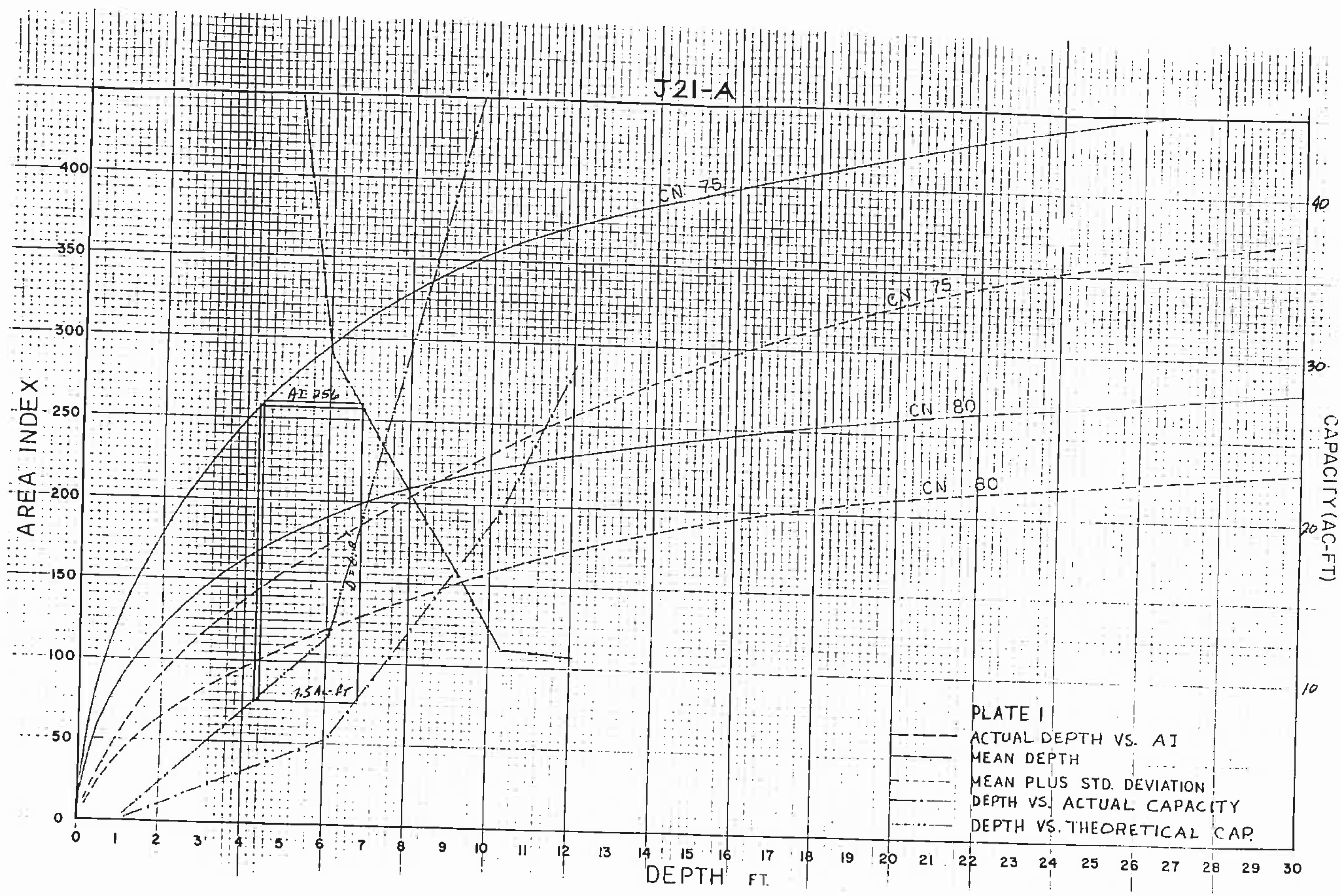
AI: Area Index = A_B/A_P

Notes: Proposed Impoundment

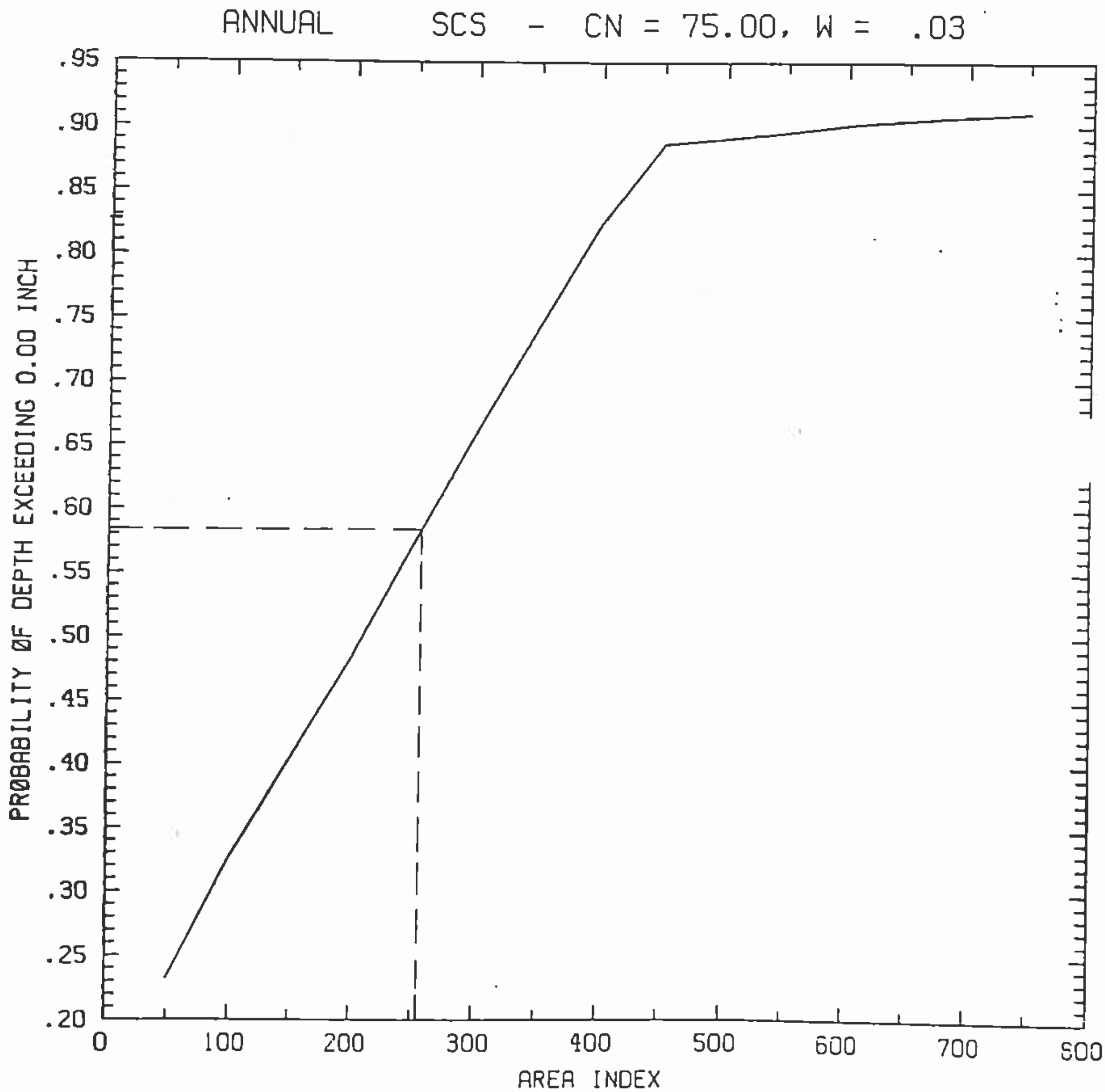
Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6924	0.001	543.999	0	543999	0.0
1	6925	0.178	543.822	0.2	3055	0.1
3	6927	0.688	543.312	2.1	790	2.1
6	6930	1.898	542.102	11.4	286	5.3
10.2	6934.2	4.921	539.079	50.2	110	19.6
12	6936.0	5.035	538.965	60.4	107	28.6

Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	6.8 ft	--
	Minimum Depth (MIN)	--	3.0 ft
	Actual Capacity	7.5 Ac-ft	2.6 Ac-ft
	AI	256	790
Plate 2 or 3:	Probability	58%	88%

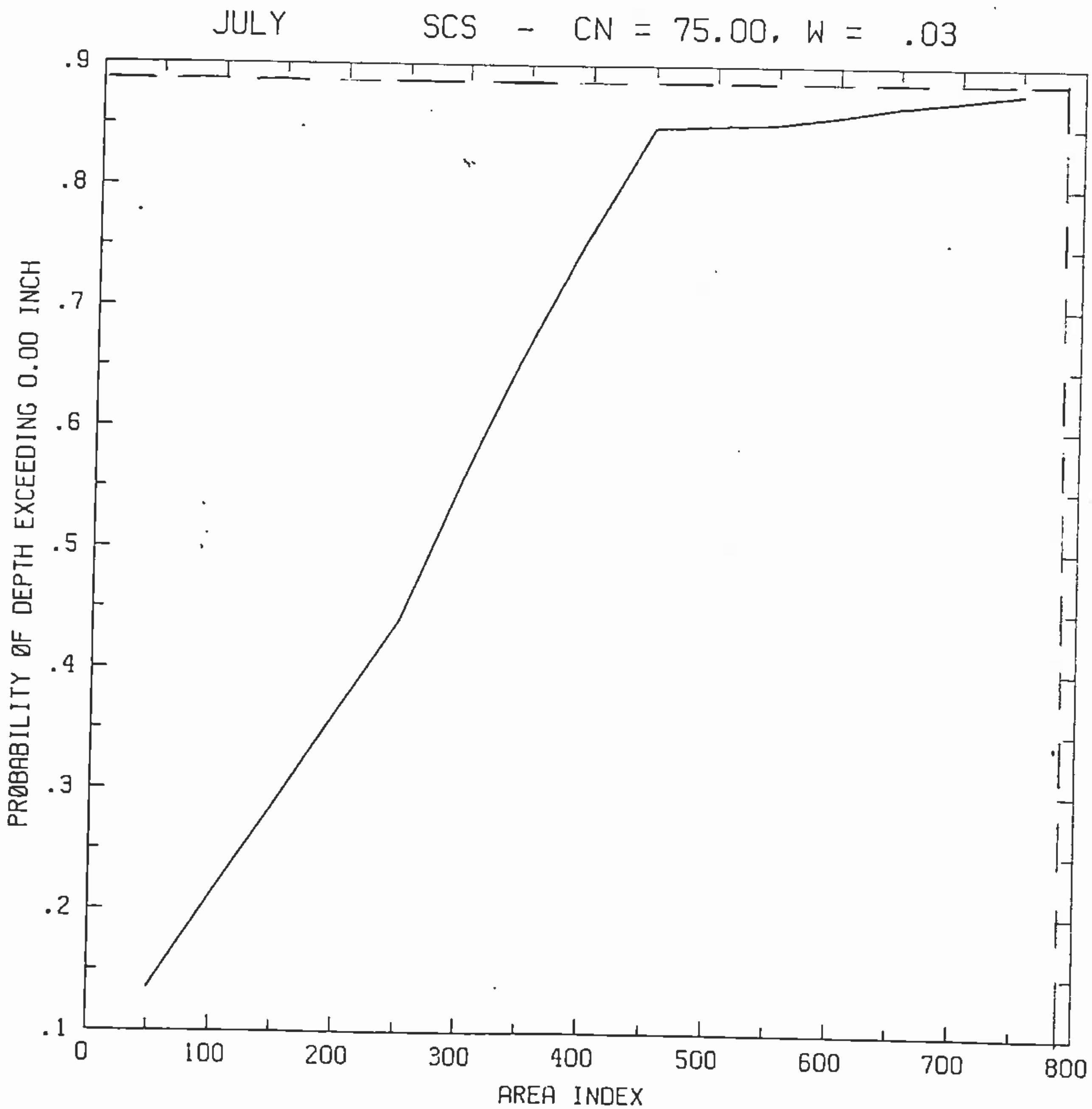

J21-A
AREA INDEX
0
50
100
150
200
250
300
350
400
DEPTH FT.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
CAPACITY (AC-FT)
10
20
30
40
CN 75
CN 75
CN 80
CN 80
AI 256
7.5 Ac-ft
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

J21-A



Annual Mean Depth
Plate 2

J21-A



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

J21-C

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J21-C

A_D: 780.3 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

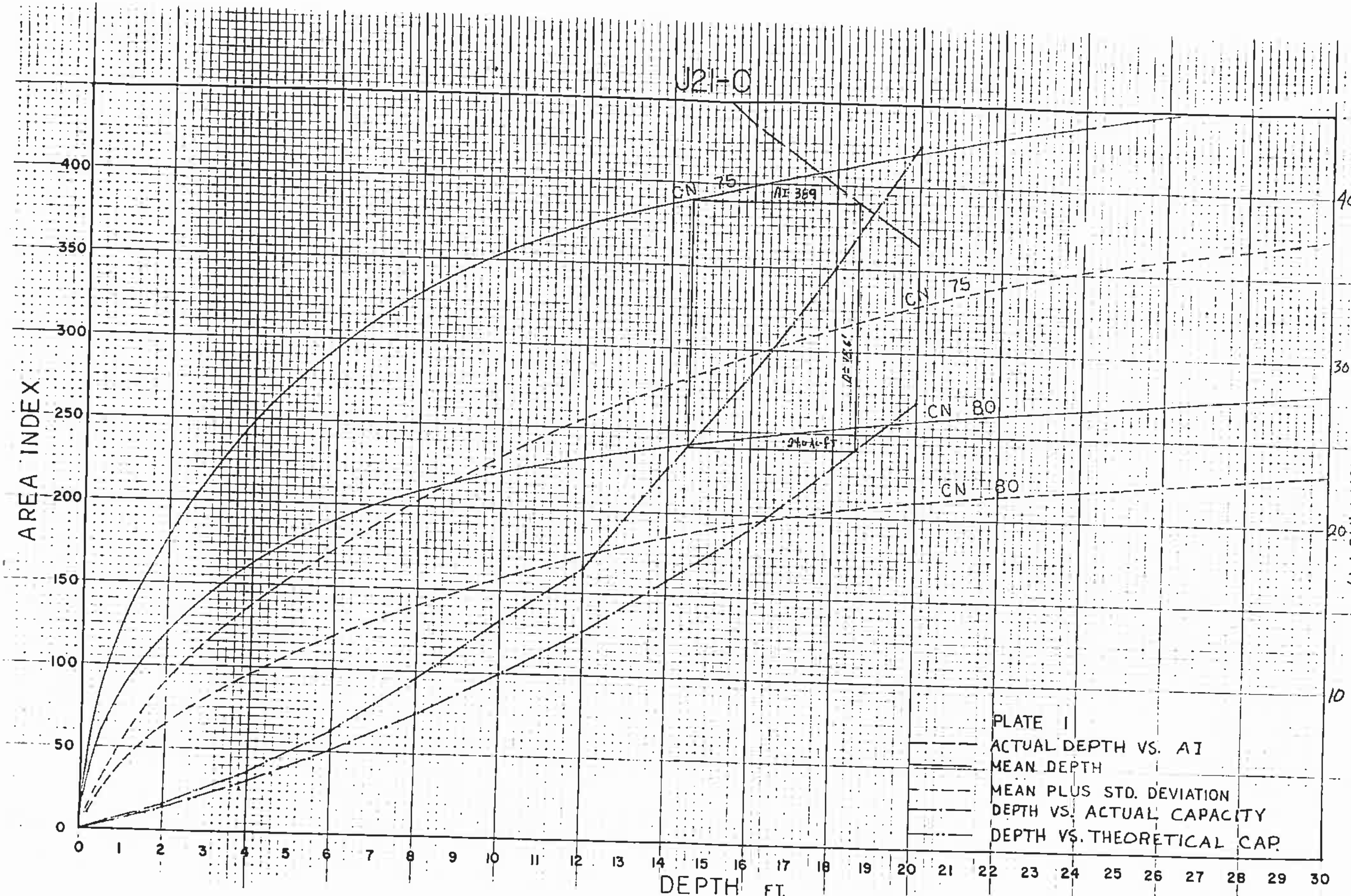
AI: Area Index = A_B/A_P

Notes: Proposed Impoundment

Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	N/A	0.689	779.611	0	1132	0
2		0.802	779.5	1.6	972	1.5
4		0.922	779.4	3.7	845	3.2
6		1.049	779.3	6.3	743	5.2
8		1.182	779.1	9.5	659	7.4
10		1.322	778.978	13.2	589	9.9
12		1.469	778.831	17.6	530	12.7
14		1.622	778.7	22.7	480	15.8
16		1.782	778.5	28.5	437	19.2
18		1.948	778.4	35.1	400	22.9
20		2.121	778.2	42.4	367	27.0

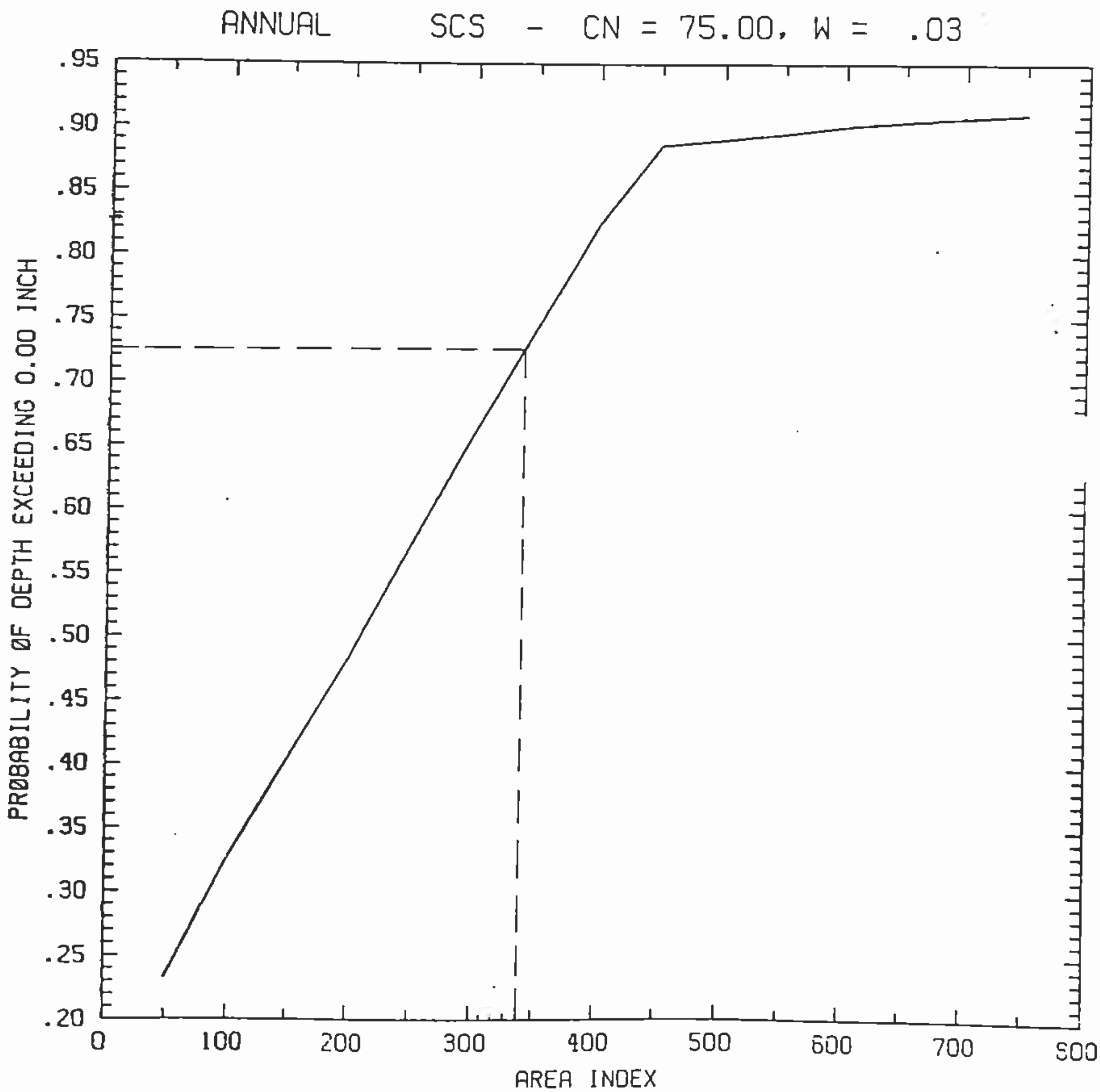
Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	18.6 ft	--
	Minimum Depth (MIN)	--	3.0 ft
	Actual Capacity	24.0 Ac-ft	2.3 Ac-ft
	AI	389	905
Plate 2 or 3:	Probability	73%	88+%



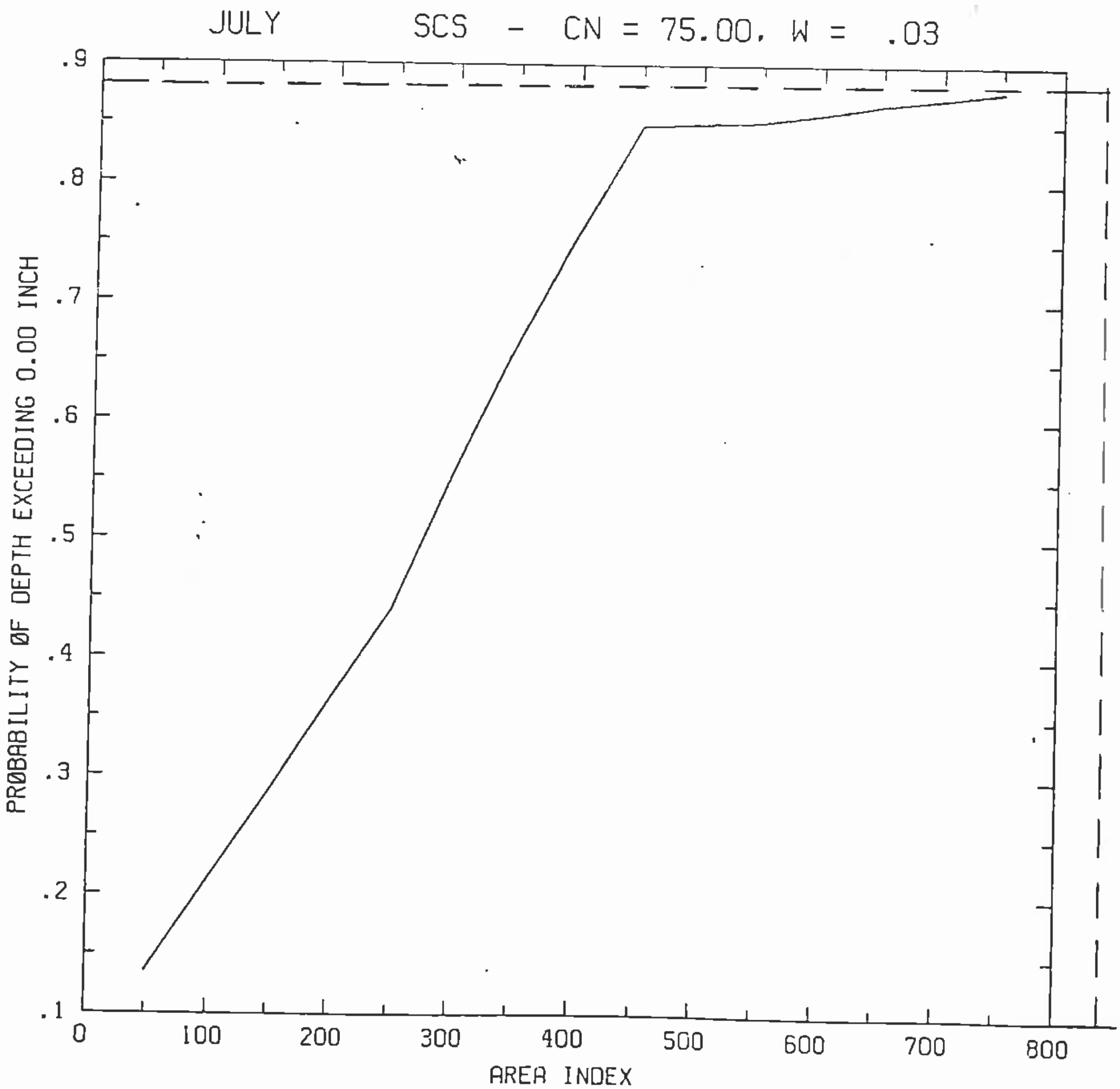
U21-O
AREA INDEX
0
50
100
150
200
250
300
350
400
DEPTH FT.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
CAPACITY (AC-FT)
10
20
30
40
CN 75
CN 75
CN 80
CN 80
AI 389
240 Ac-Ft
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

J21-C



Annual Mean Depth
Plate 2

J21-C



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

J21-I

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: J21-I

A_D: 780.4 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

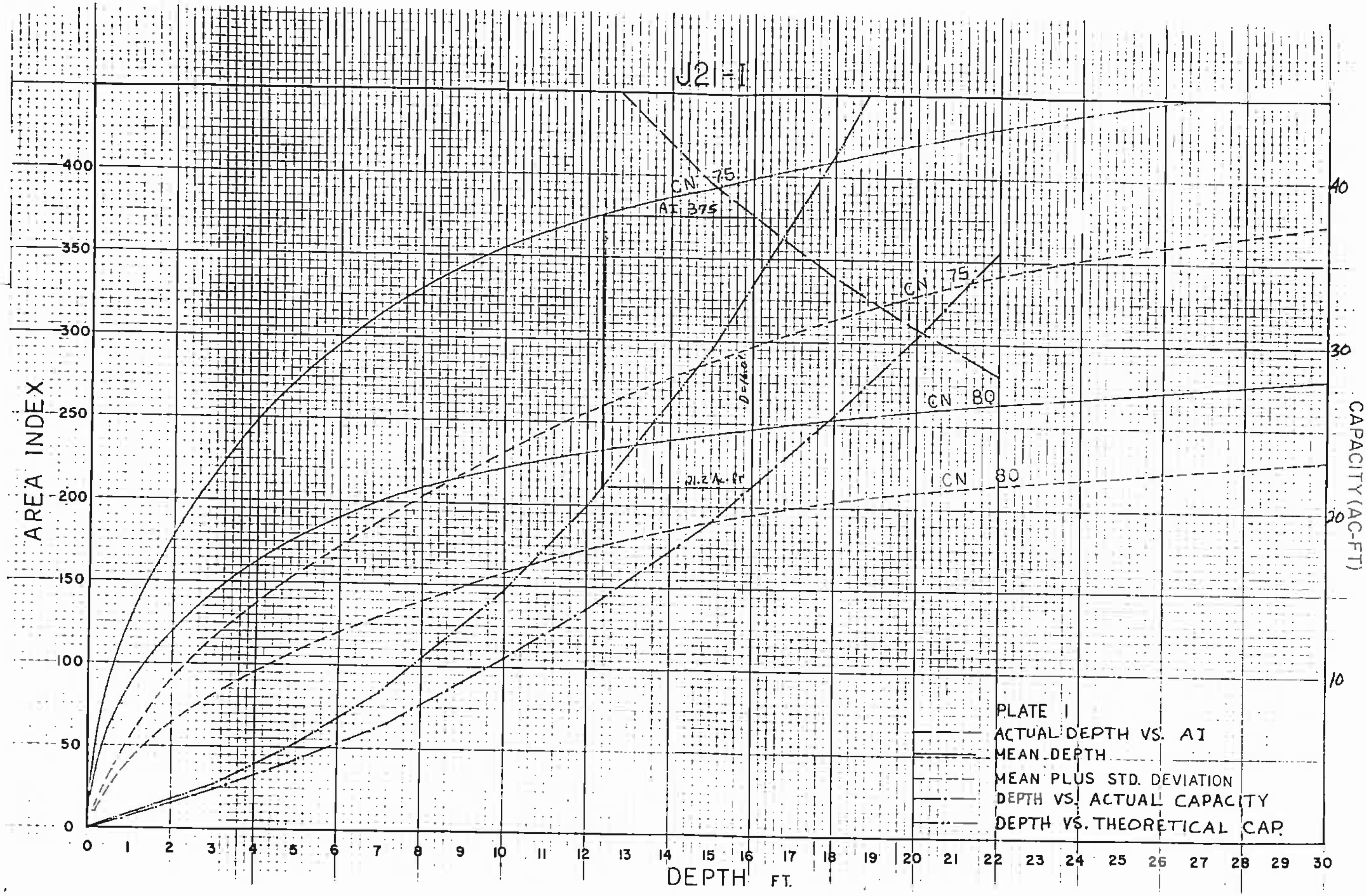
AI: Area Index = A_B/A_P

Notes: Proposed Impoundment

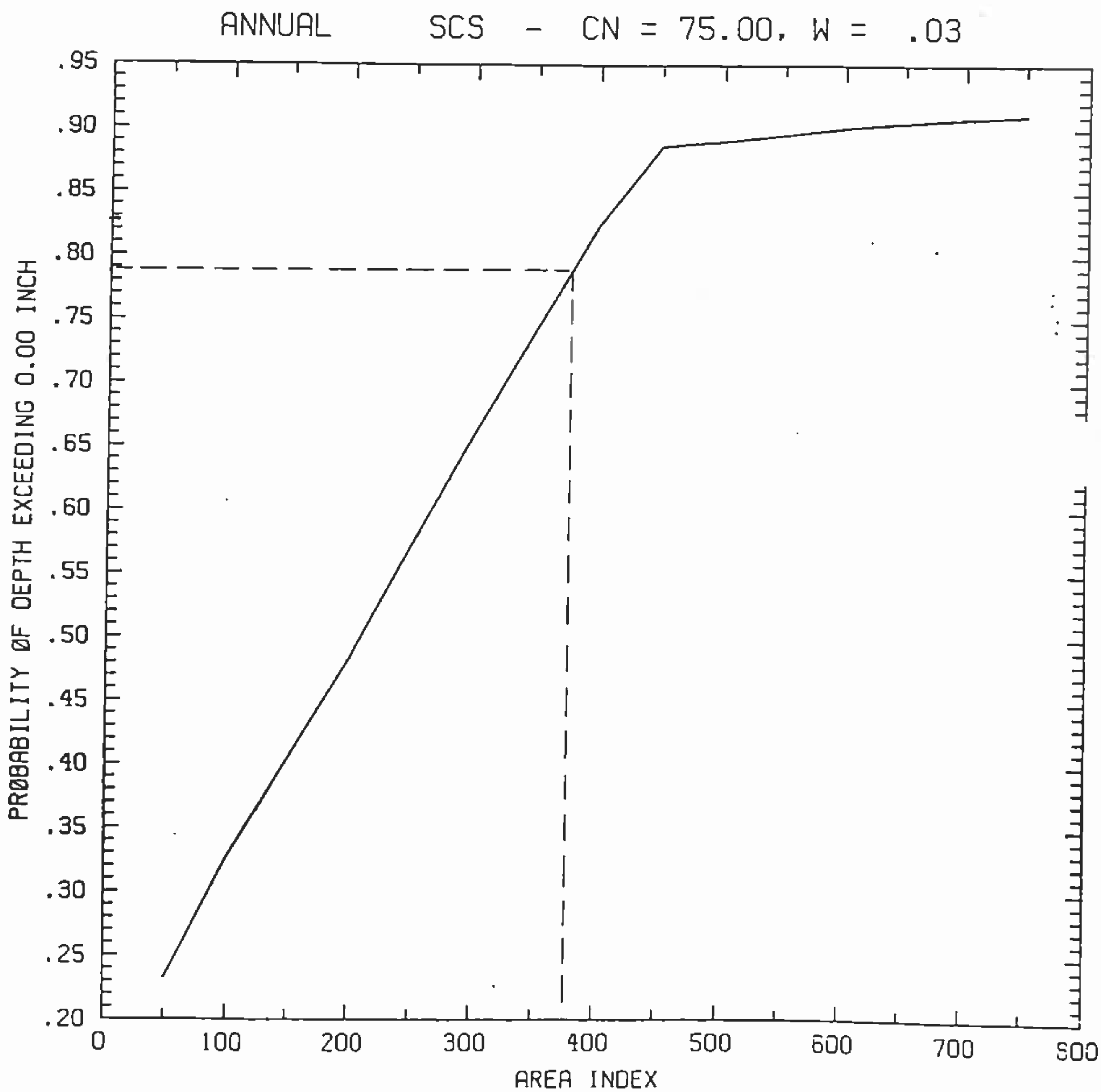
Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	N/A	0.689	779.711	0	1132	0
3		0.894	779.506	2.7	872	2.4
5		1.045	779.355	5.3	746	4.3
7		1.206	779.194	8.4	646	6.6
10		1.469	778.931	14.7	530	10.6
12		1.658	778.742	19.9	470	13.7
15		1.963	778.437	29.4	397	19.1
18		2.292	778.108	41.2	339	25.5
20		2.525	777.875	50.5	308	30.3
22		2.770	777.630	60.9	281	35.6

Results: Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	16.0 ft	--
	Minimum Depth (MIN)	--	3.0 ft
	Actual Capacity	21.2 ac-ft	2.4 ac-ft
	AI	375	872
Plate 2 or 3:	Probability	79%	88+%

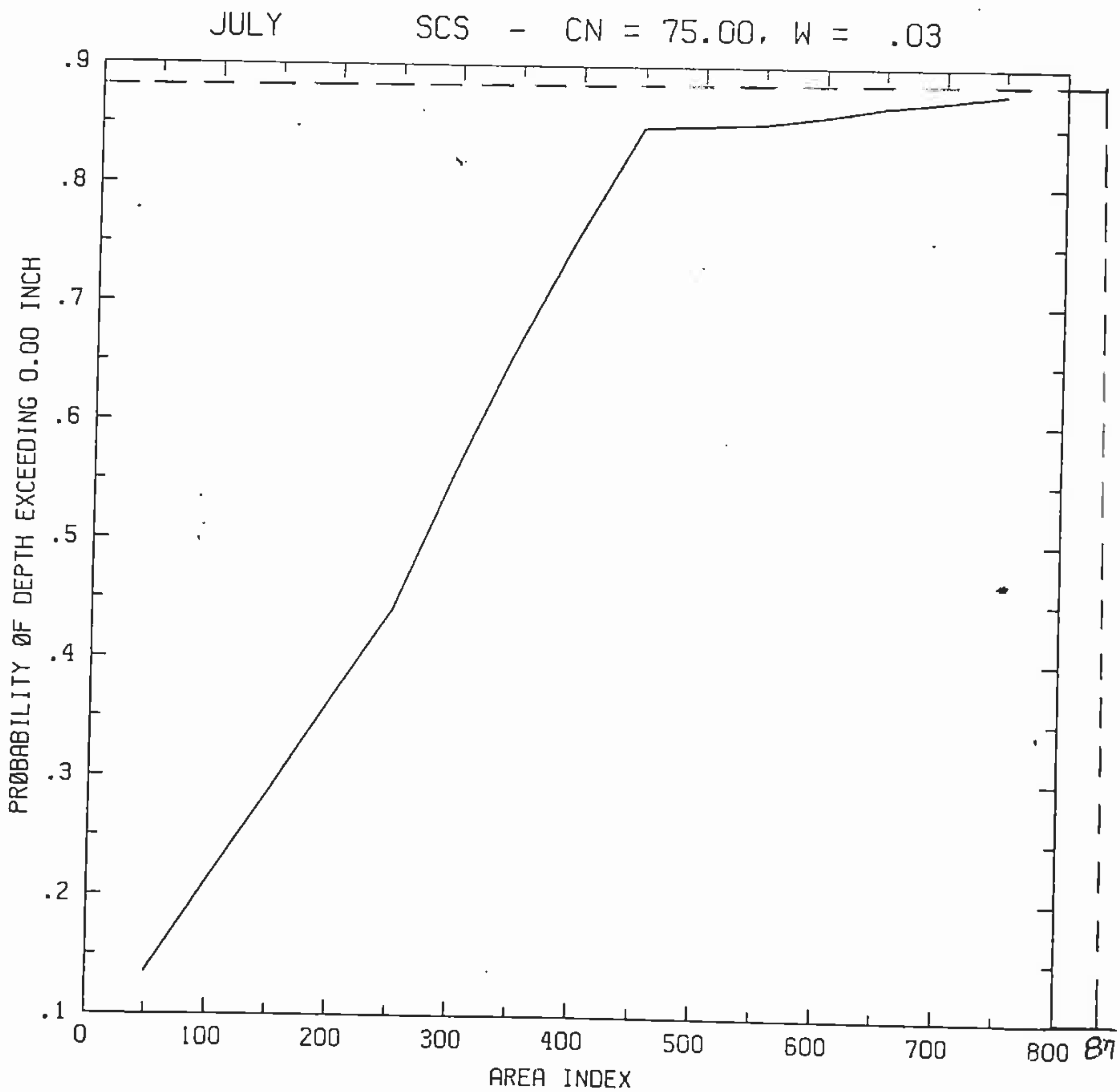

J21-I
AREA INDEX
CAPACITY (AC-FT)
DEPTH FT.
CN 75
AI 375
CN 75
CN 80
CN 80
D=16.0'
21.2 Ac-Ft
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

J21-I



Annual Mean Depth
Plate 2

J21-I



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

N5-A

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: N5-A

A_D: 547.3 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

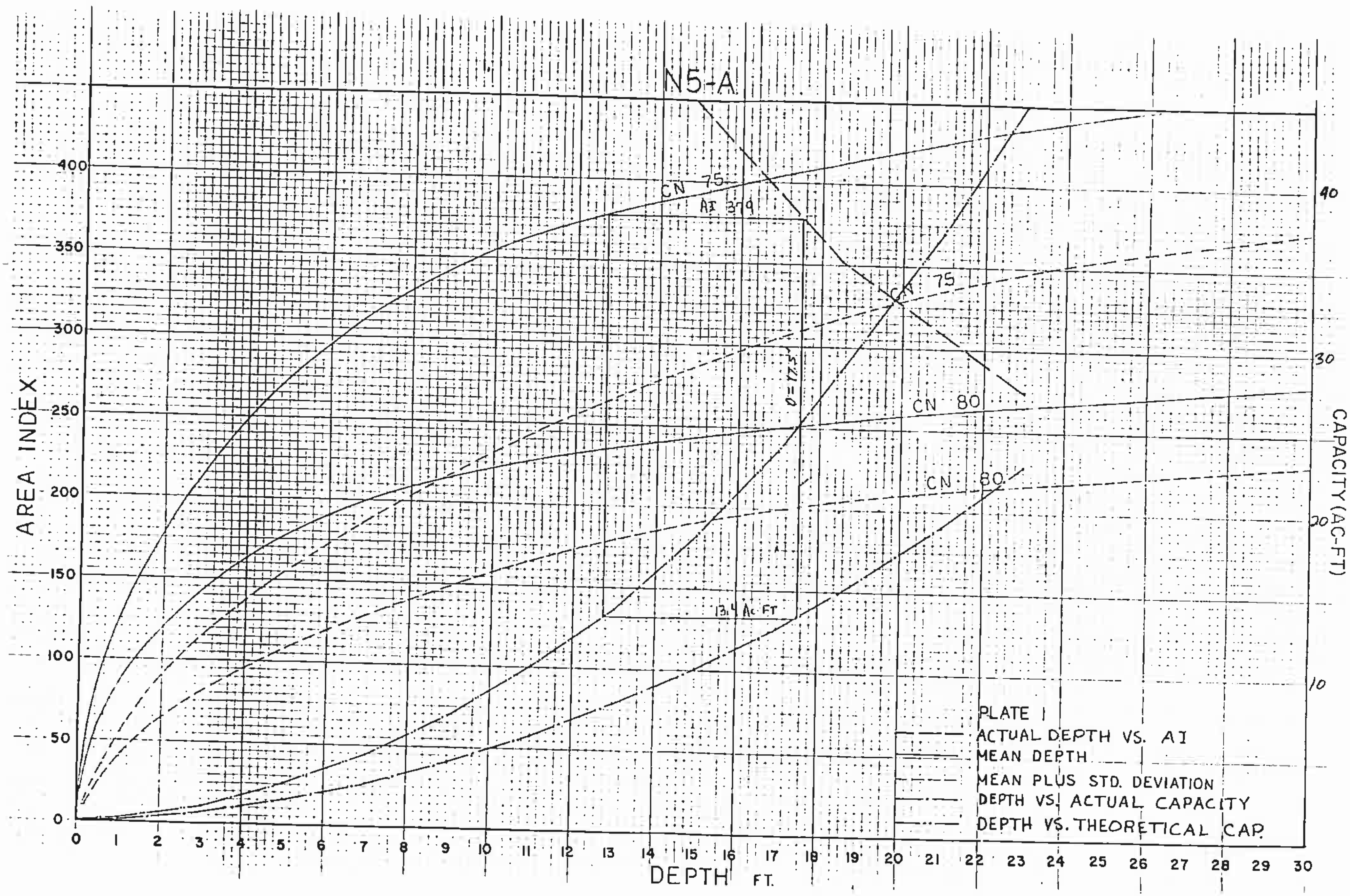
AI: Area Index = A_B/A_P

Notes: Existing Impoundment

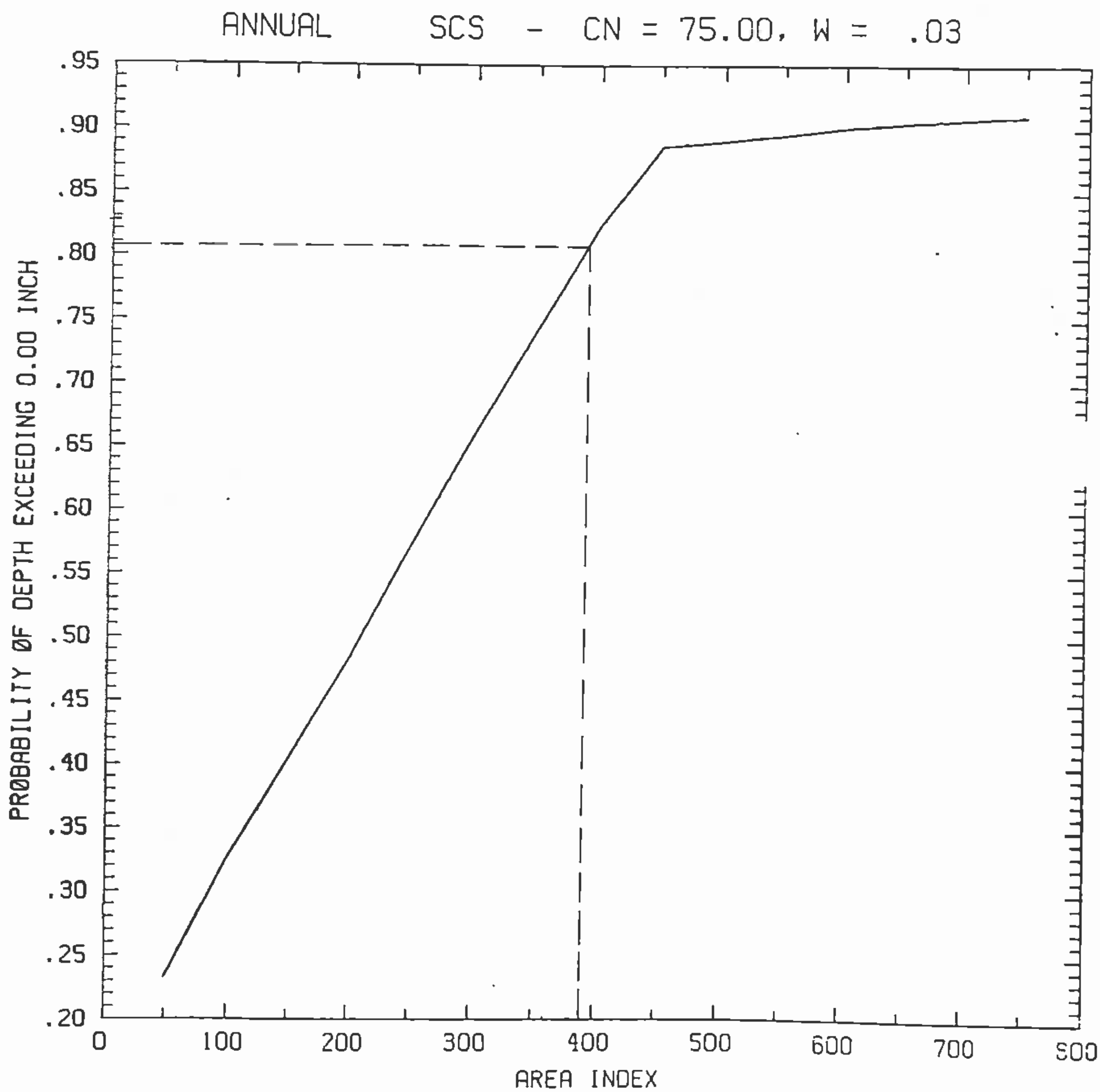
Depth (ft)	Elevation (MSL)	A_P (AC)	A_B (AC)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6443	0.023	547.277	0.0	23795	0
1	6444	0.195	547.105	0.2	2805	0.1
3	6446	0.370	546.930	1.1	1478	0.7
5	6448	0.520	546.780	2.6	1052	1.6
7	6450	0.635	546.665	4.4	861	2.7
9	6452	0.777	546.523	7.0	703	4.1
11	6454	0.926	546.374	10.2	590	5.8
13	6456	1.056	546.244	13.7	517	7.8
15	6458	1.222	546.078	18.3	447	10.1
17	6460	1.388	545.912	23.6	393	12.7
18.5	6461.5	1.544	545.756	28.6	354	14.9
21	6464	1.768	545.532	37.1	309	19.0
23	6466	1.990	545.310	45.8	274	22.8

Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	17.5 ft	--
	Minimum Depth (MIN)	--	5.8 ft
	Actual Capacity	13.4 ac-ft	2.0 ac-ft
	AI	379	947
Plate 2 or 3:	Probability	81%	88+%

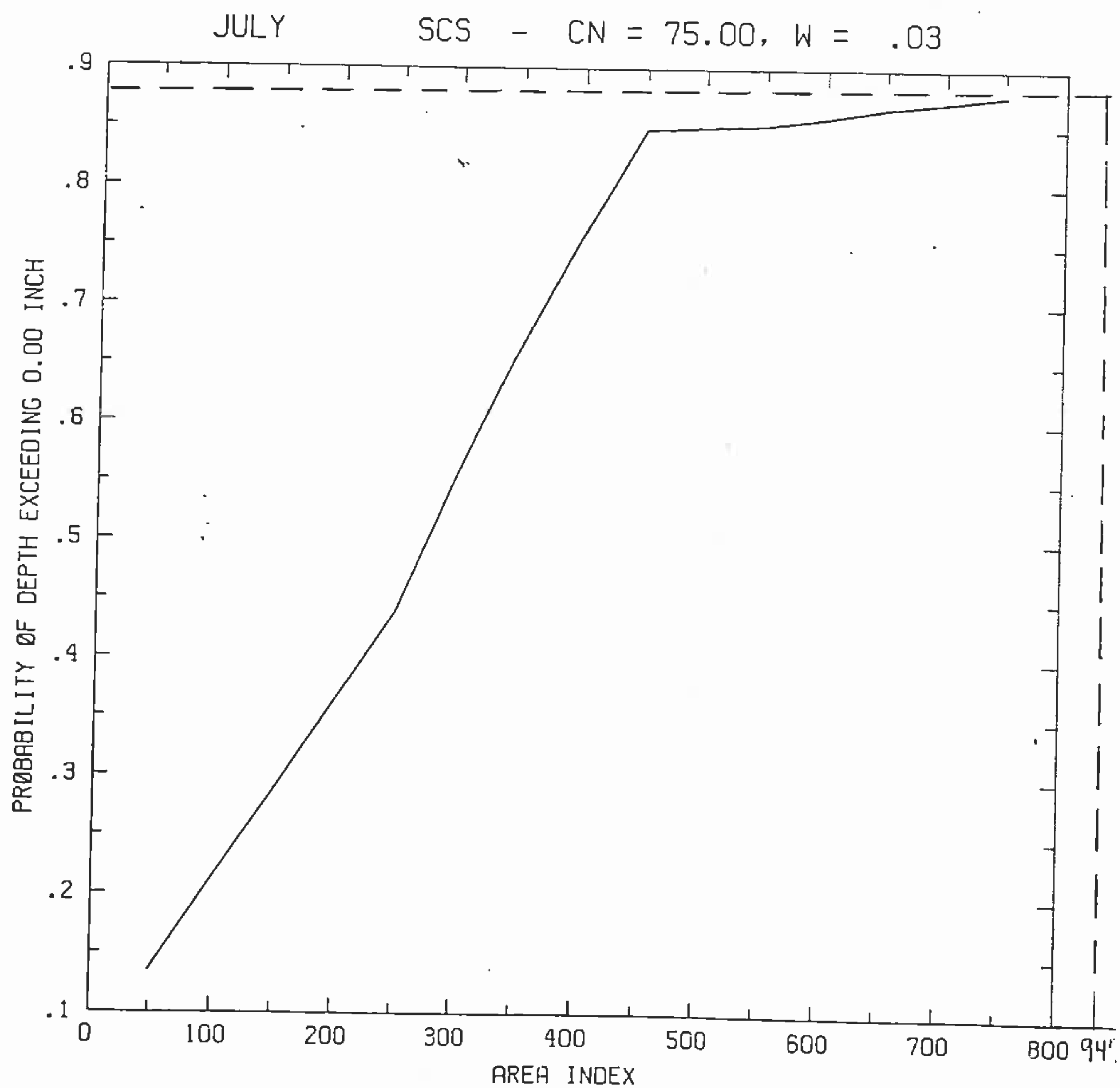

N5-A
CN 75
AI 379
CN 75
CN 80
CN 80
Q=17.5
13.4 Ac Ft
AREA INDEX
0
50
100
150
200
250
300
350
400
DEPTH FT.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
CAPACITY (AC-FT)
10
20
30
40
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

N5-A



Annual Mean Depth
Plate 2

N5-A



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

N6-K

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: N6-K

A_D: 443.6 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

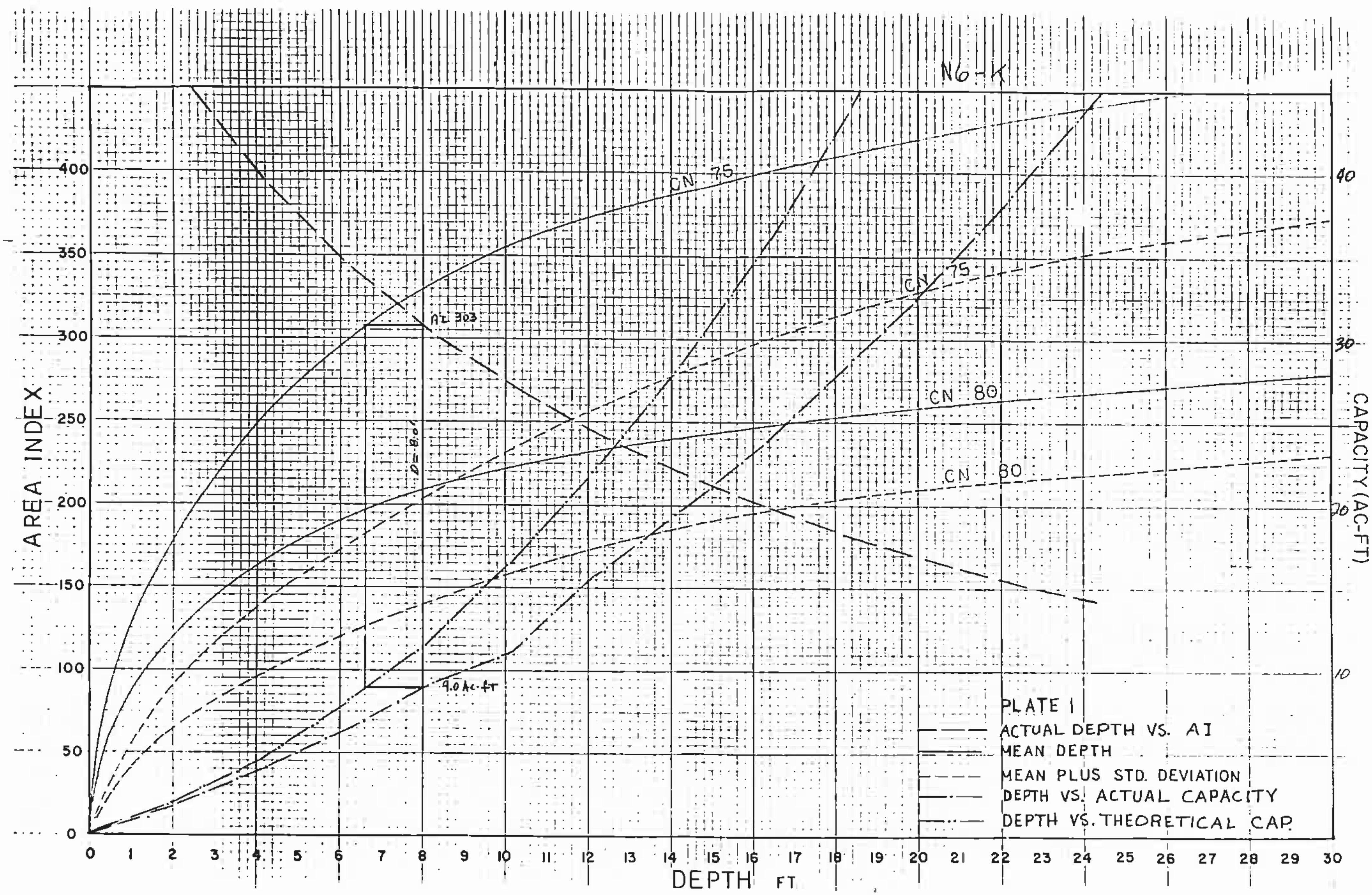
AI: Area Index = A_B/A_P

Notes: Proposed Impoundment

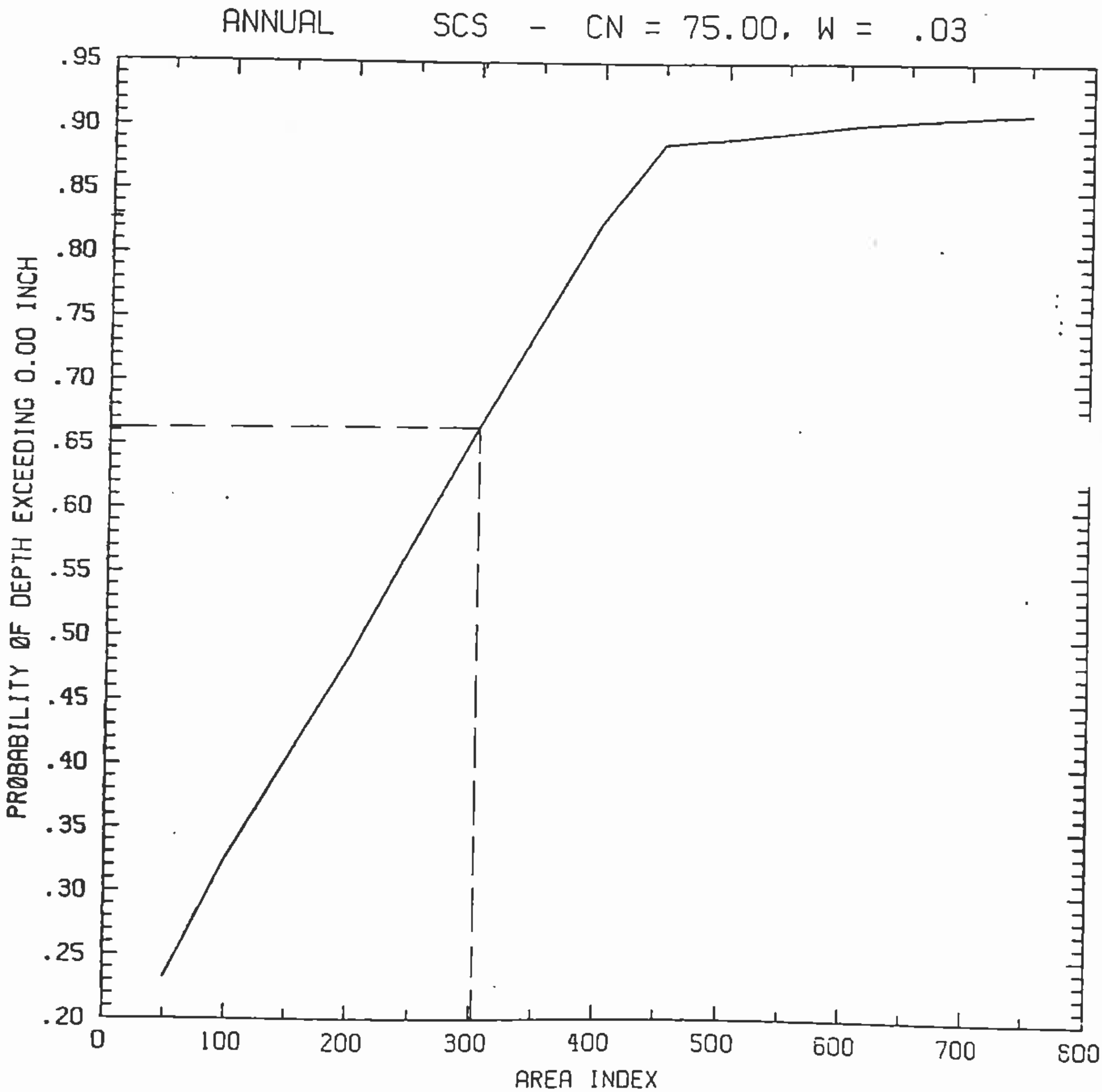
Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	N/A	0.826	442.774	0	536	0
2		0.976	442.624	2.0	454	1.8
4		1.132	442.5	4.5	391	3.9
6		1.294	442.3	7.8	342	6.3
8		1.463	442.1	11.7	302	9.1
10		1.639	441.961	16.4	270	12.2
12		1.822	441.8	21.9	243	15.7
14		2.011	441.6	28.2	220	19.5
16		2.206	441.4	35.3	200	23.7
18		2.408	441.2	43.3	183	28.3
20		2.617	440.983	52.3	169	33.3
22		2.833	440.767	62.3	156	38.8
24		3.055	440.545	73.3	144	44.7

Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	8.0 ft	--
	Minimum Depth (MIN)	--	3.0 ft
	Actual Capacity	9.0 ac-ft	2.8 ac-ft
	AI	303	421
Plate 2 or 3:	Probability	66%	80%

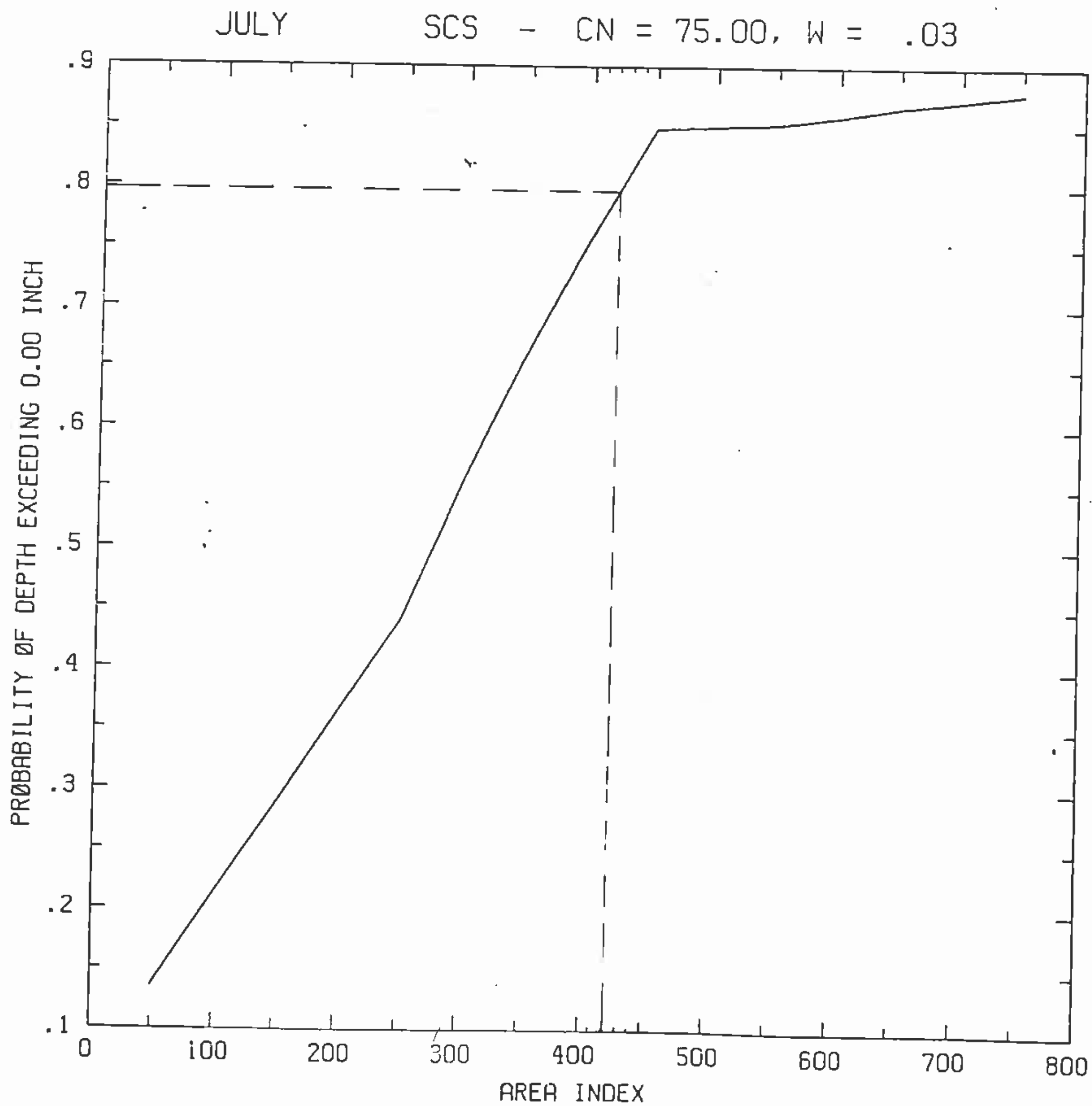

N6-K
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.
CN 75
CN 75
CN 80
CN 80
AI 303
D = 8.0'
9.0 Ac-ft
AREA INDEX
DEPTH FT
CAPACITY (AC-FT)
0
50
100
150
200
250
300
350
400
10
20
30
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

N6-K



Annual Mean Depth
Plate 2

N6-K



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

N7-D

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: N7-D

A_D: 778.6 Acres

Depth: From Bottom Elevation

A_B: Watershed Area = $A_D - A_P$

A_D: Total Drainage Area

Theoretical Capacity: A_P x Depth

A_P: Surface Area of Pond

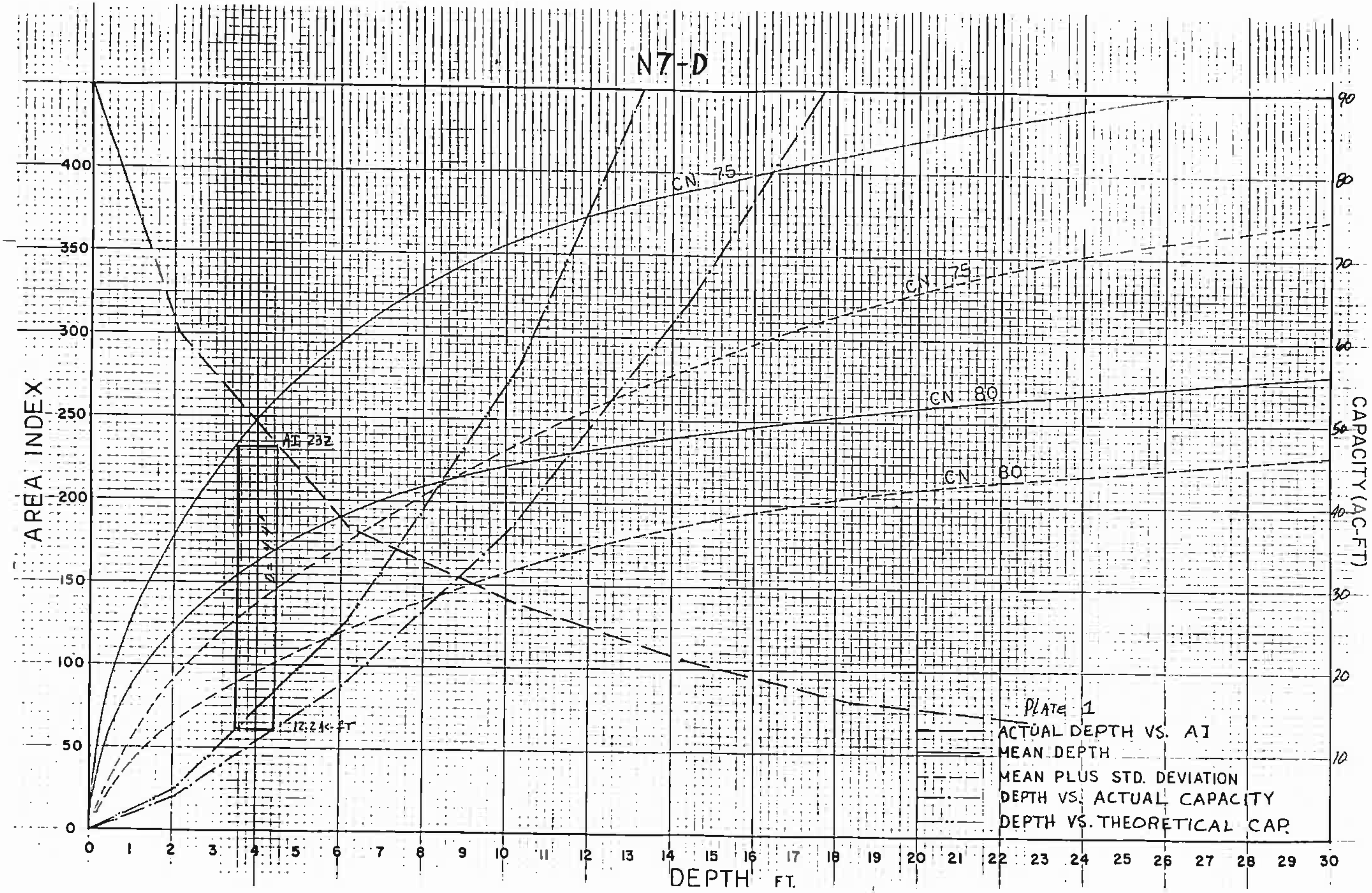
AI: Area Index = A_B/A_P

Notes: Existing Impoundment

Depth (ft)	Elevation (MSL)	A_P (AC)	A_B (AC)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6556	1.751	776.849	0	444	0.0
2	6558	2.616	775.984	5.2	230	4.4
6	6562	4.223	774.377	25.3	183	18.0
10	6566	5.575	773.025	55.8	139	37.6
14	6570	7.221	771.379	101.1	107	63.2
18	6574	8.895	769.705	160.1	87	95.5
22	6578	10.495	768.105	230.9	73	134.2
26	6582	12.175	766.425	316.6	63	179.6
30	6586	13.815	764.785	414.5	53	231.6

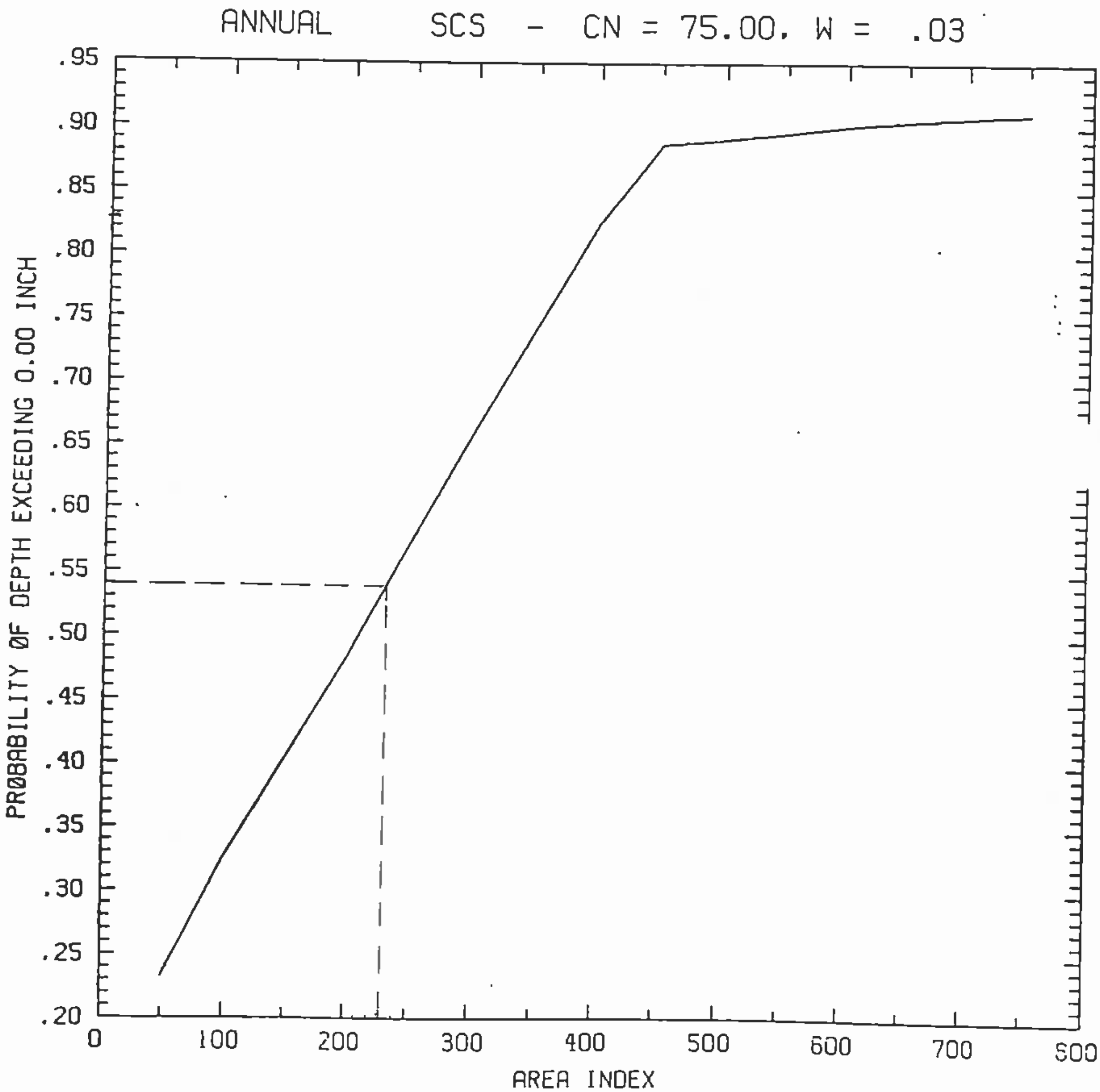
Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	4.4 ft.	--
	Minimum Depth (MIN)	--	3.0 ft.
	Actual Capacity	12.2 ac-ft.	7.8 ac-ft.
	AI	232	268
Plate 2 or 3:	Probability	54%	48%



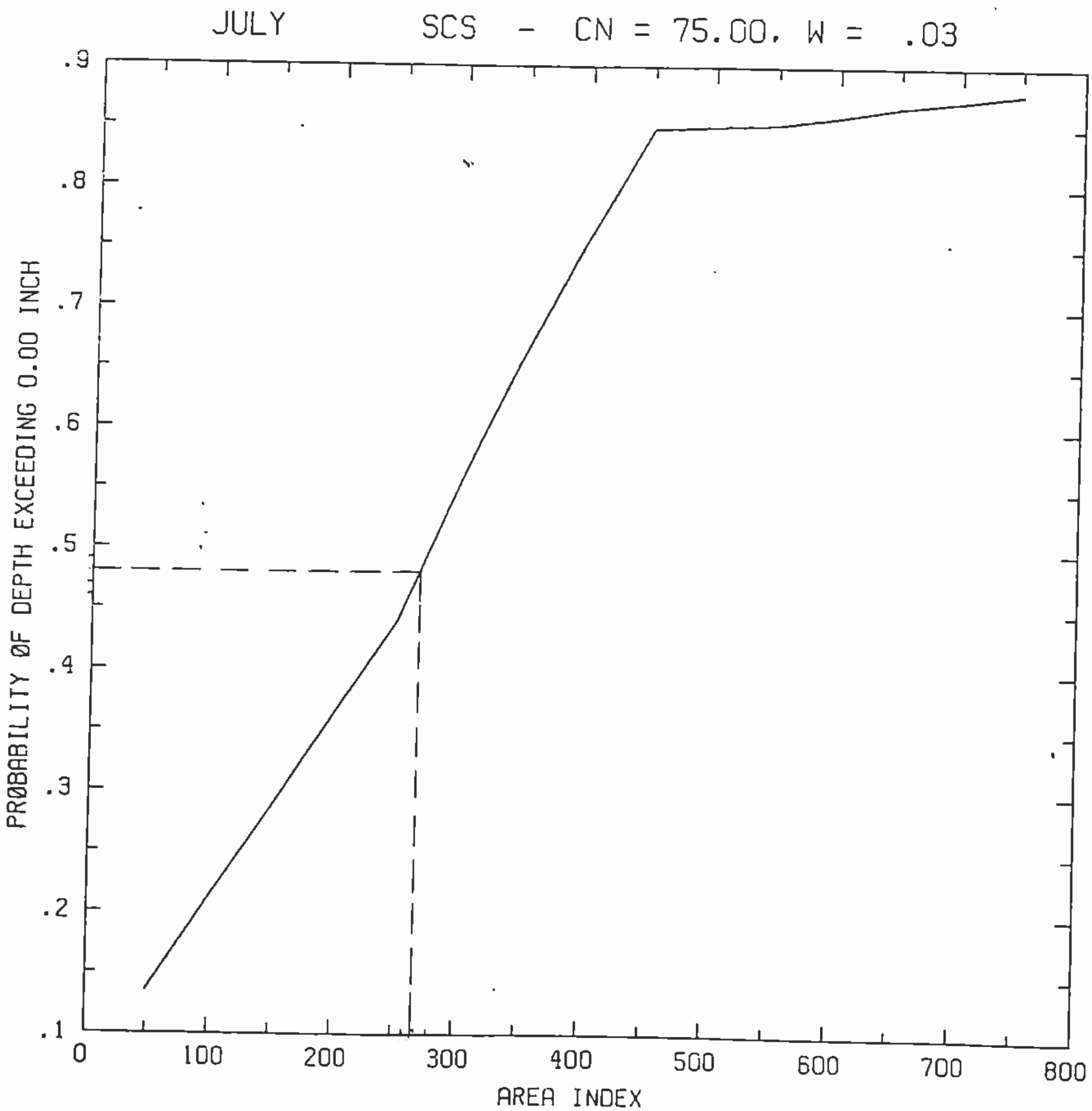
N7-D
AREA INDEX
CAPACITY (AC-FT)
DEPTH FT.
CN 75
CN 75
CN 80
CN 80
AI 232
12.2 AC-FT
PLATE 1
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

N7-D



Annual Mean Depth
Plate 2

N7-D



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

N7-E

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: N7-E

A_D: 238.7 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

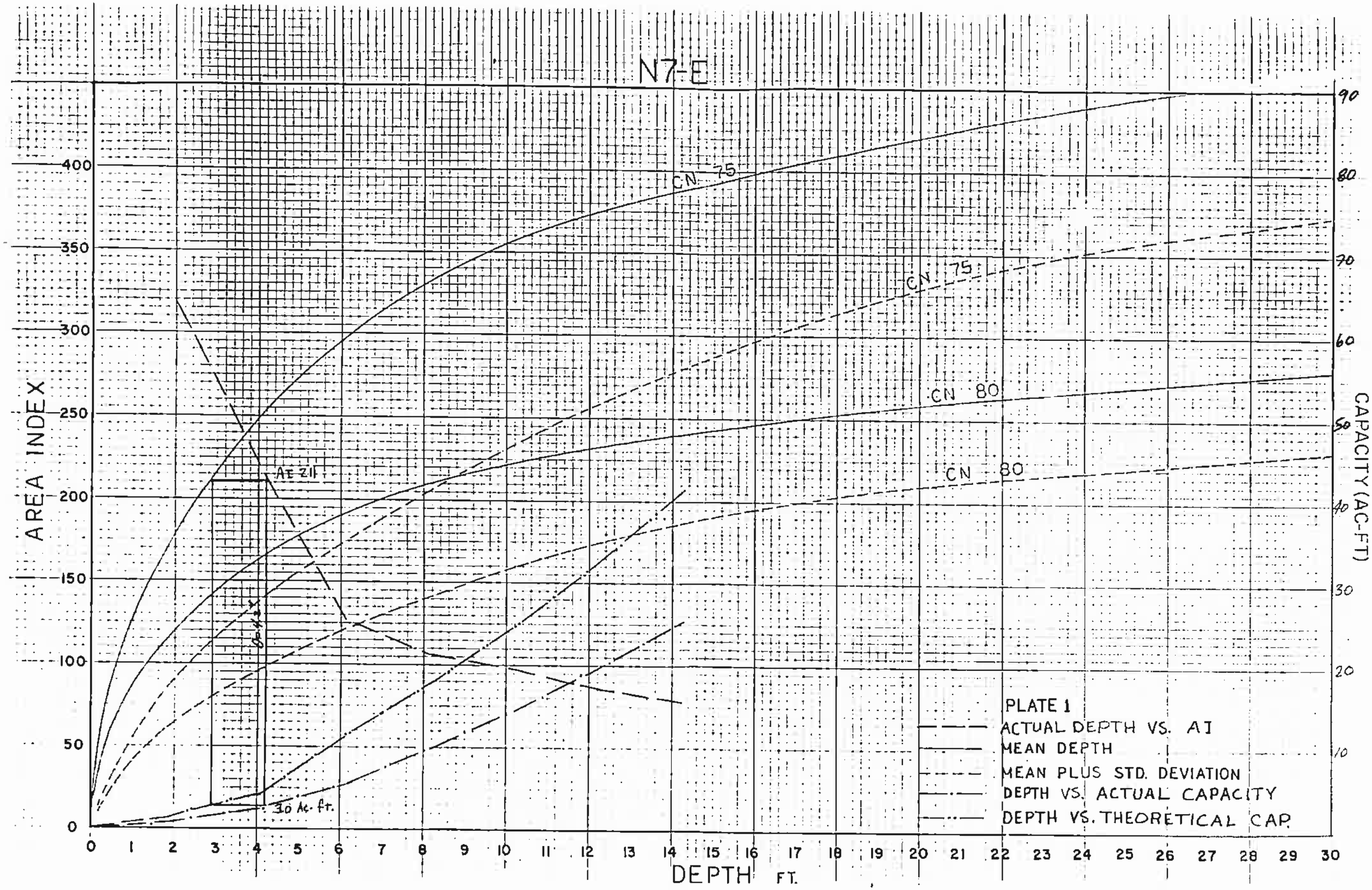
AI: Area Index = A_B/A_P

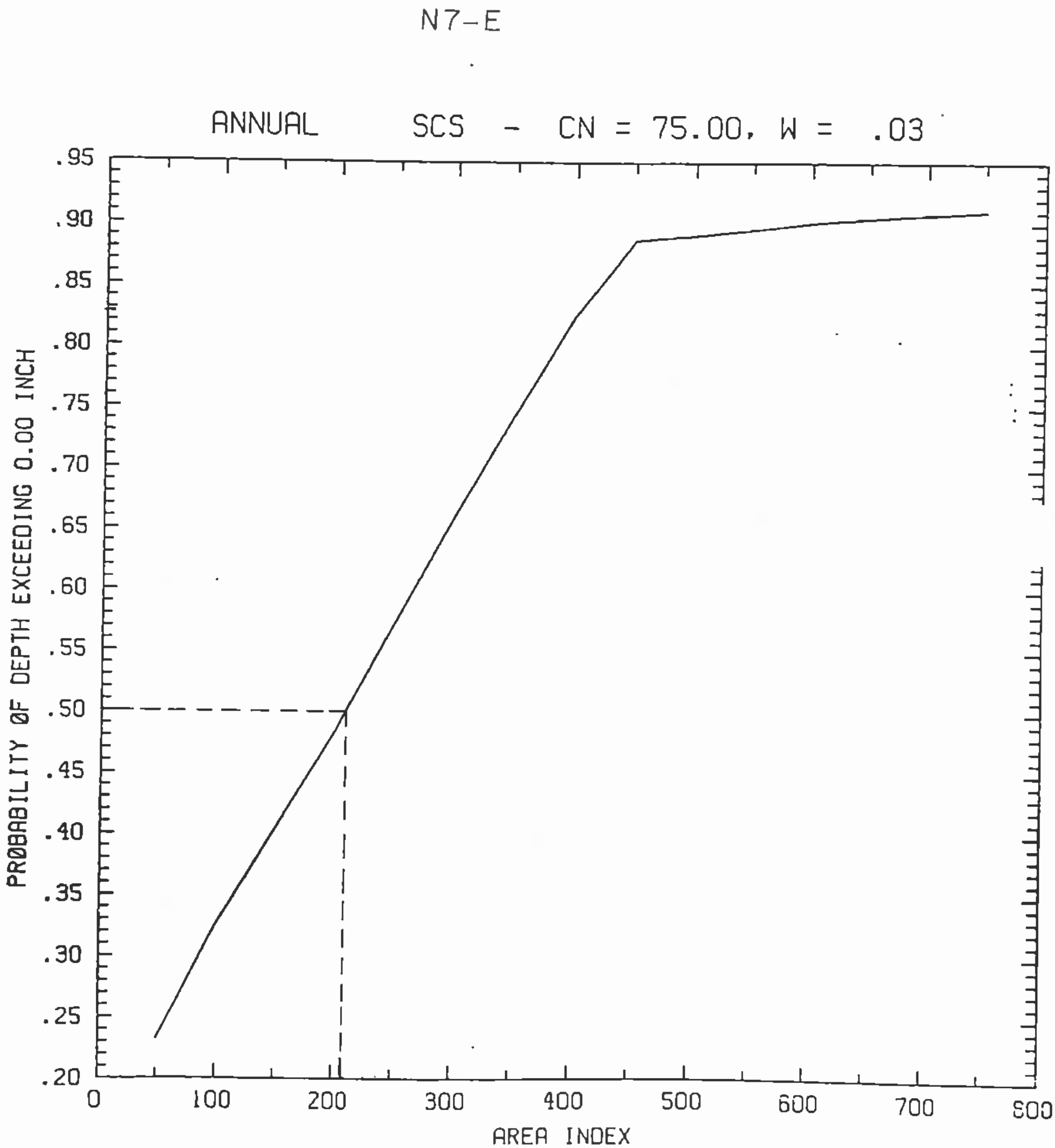
Notes: Existing Impoundment

Depth (ft)	Elevation (MSL)	A_P (AC)	A_B (AC)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6551	0.25	238.45	0	954	0
2	6553	0.76	237.94	1.5	313	1.0
4	6555	1.10	237.60	4.4	216	2.9
6	6557	1.89	236.81	11.3	126	5.9
8	6559	2.23	236.47	17.8	106	10.0
10	6561	2.47	236.23	24.7	96	14.7
11.5	6562.5	2.66	236.04	30.6	89	18.5
12	6563	2.72	235.98	32.6	88	19.9
14	6567	2.96	235.74	41.4	80	25.6

Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

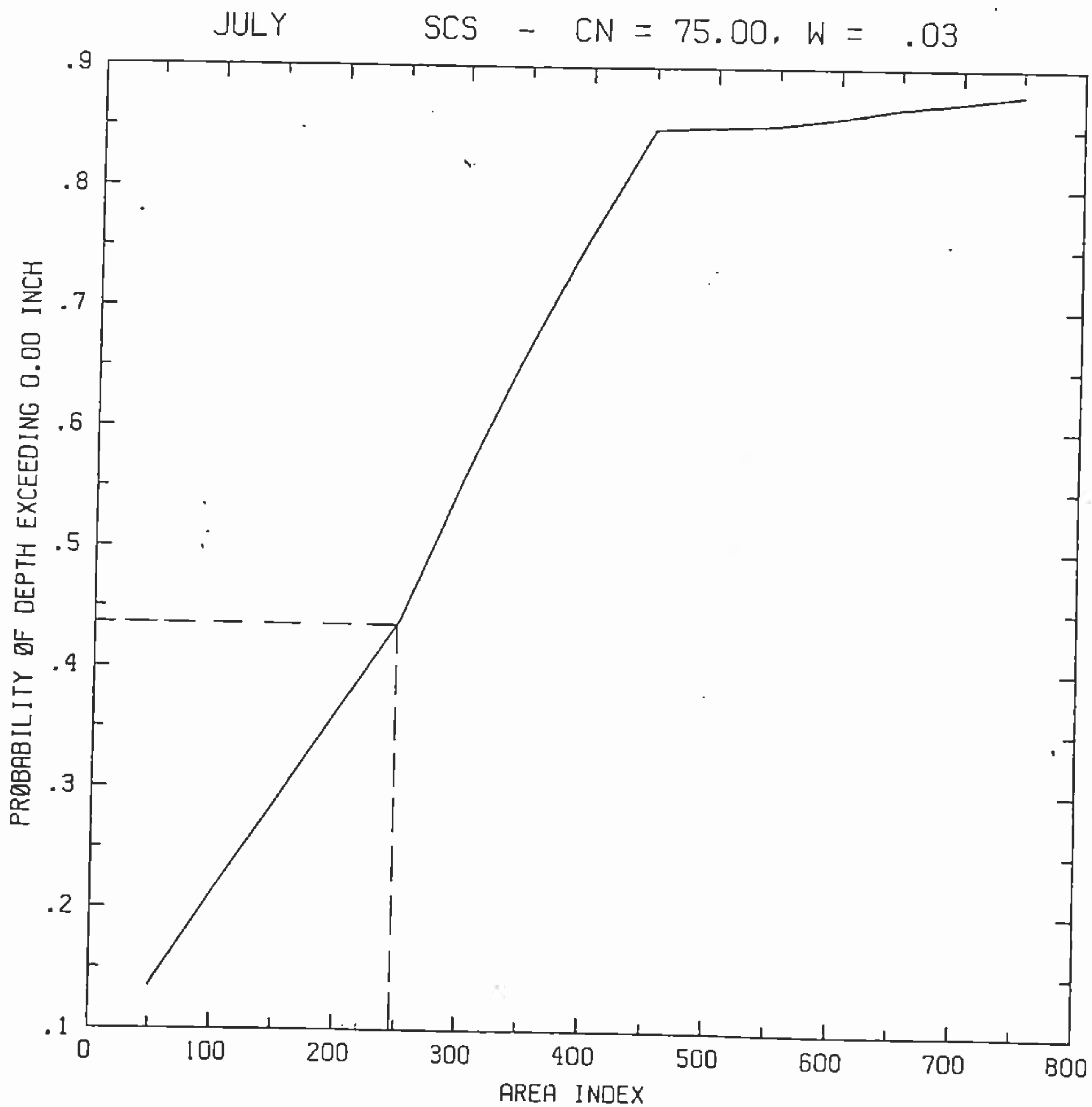
Plate 1:	Annual Mean Depth (AMD)	4.2 ft	--
	Minimum Depth (MIN)	--	3.2 ft
	Actual Capacity	3.0 ac-ft	2.0 ac-ft
	AI	211	246
Plate 2 or 3:	Probability	50%	44%


N7-E
AREA INDEX
CAPACITY (AC-FT)
DEPTH FT.
CN 75
CN 75
CN 80
CN 80
A = 211
30 Ac. ft.
PLATE 1
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.



Annual Mean Depth
Plate 2

N7-E



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

N10-A1

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: N10-A1

A_D: 701.8 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

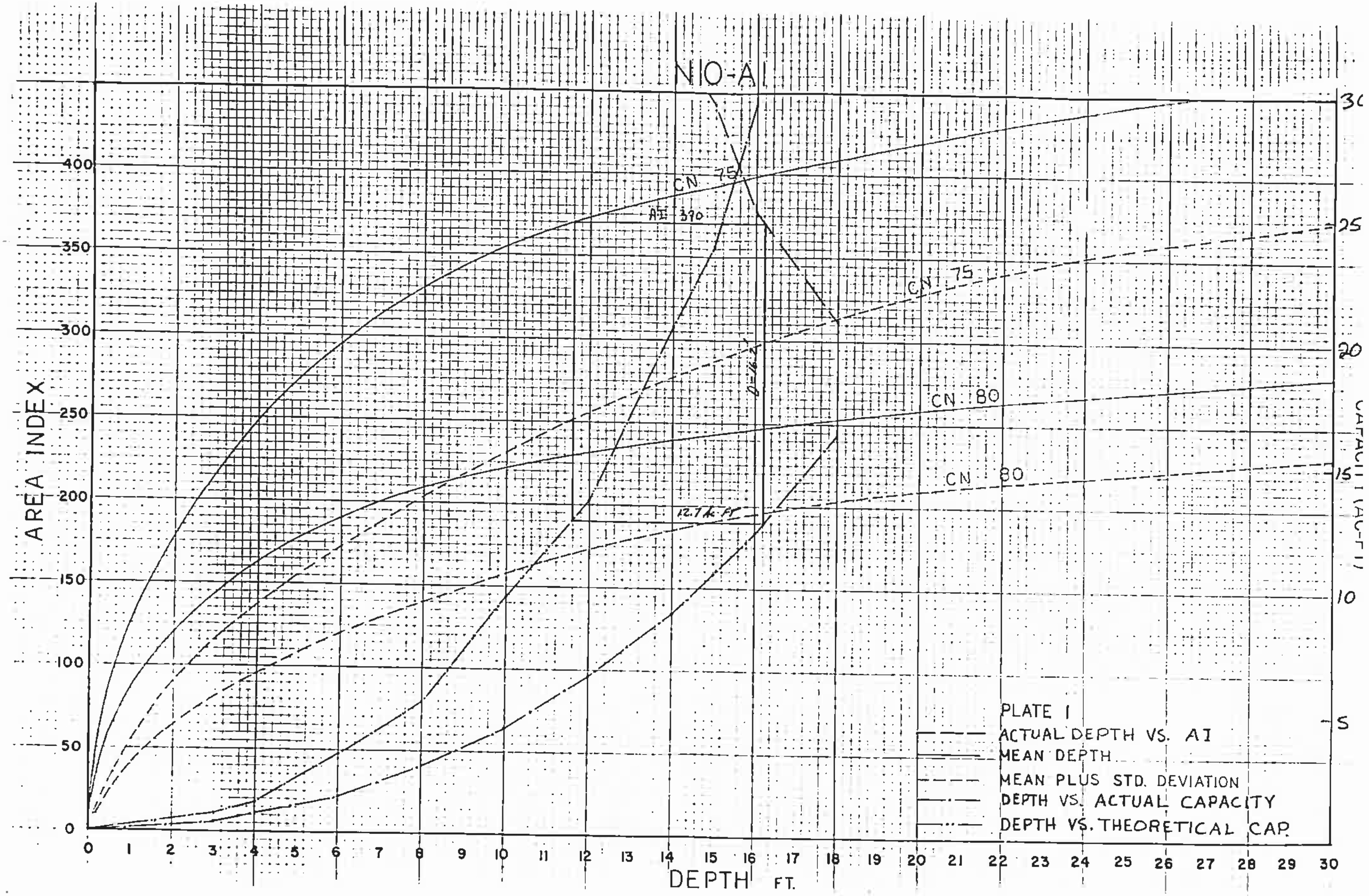
AI: Area Index = A_B/A_P

Notes: Existing Impoundment

Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6612	0.001	701.799	0	701,800	0.0
3	6615	0.252	701.548	0.8	2781	0.4
4	6616	0.308	701.492	1.2	2280	0.7
6	6618	0.512	701.288	3.1	1369	1.5
8	6620	0.668	701.132	5.3	1050	2.7
10	6622	0.962	700.838	9.6	728	4.3
12	6624	1.128	700.672	13.5	621	6.4
14	6626	1.462	700.338	20.5	479	9.0
15	6627	1.578	700.222	23.7	444	10.5
16	6628	1.843	699.957	29.5	380	12.2
18	6630	2.247	699.553	40.5	311	16.3

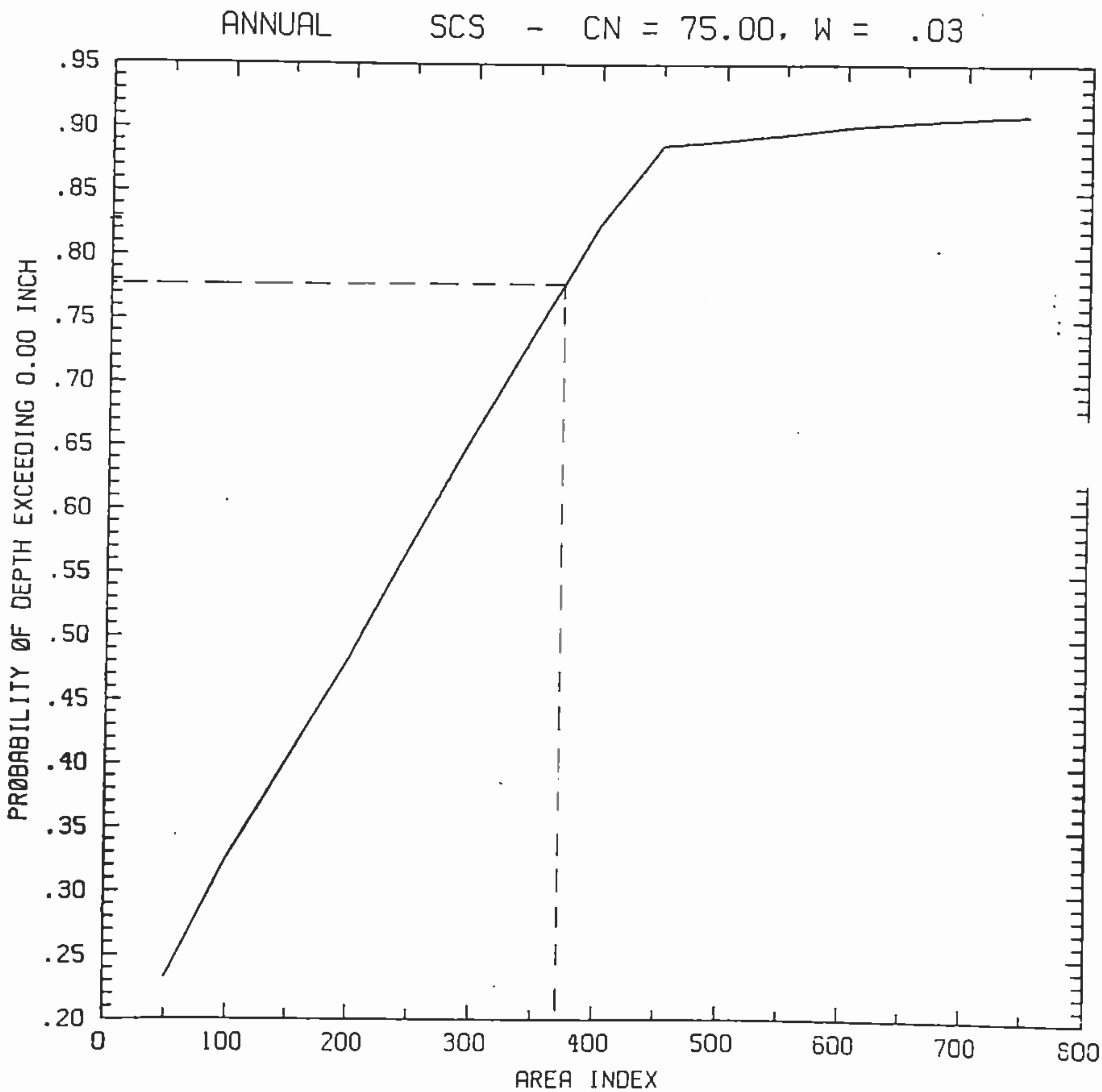
Results: Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	16.2 ft.	--
	Minimum Depth (MIN)	--	6.8 ft.
	Actual Capacity	12.7 ac-ft.	2.0 ac-ft.
	AI	370	1221
Plate 2 or 3:	Probability	78%	88+%



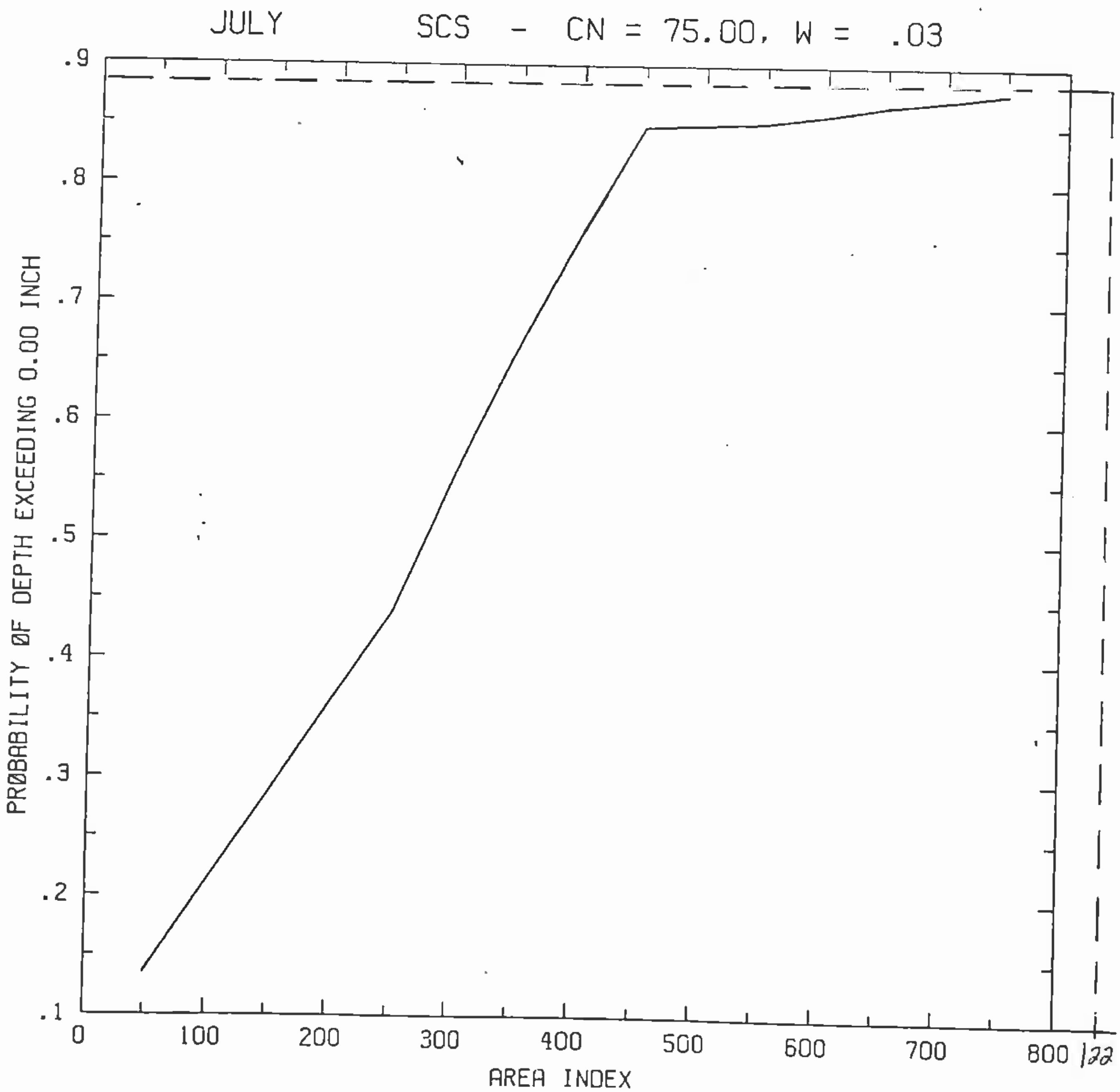
N10-A
CN 75
AI 370
CN 75
D=16.2
CN 80
CN 80
12.7 Ac-Ft
AREA INDEX
CAPACITY (AC-FT)
DEPTH FT.
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

N10-A1



Annual Mean Depth
Plate 2

NIO-AI



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

N10-D

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: N10-D

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_D: 286.8 Acres

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

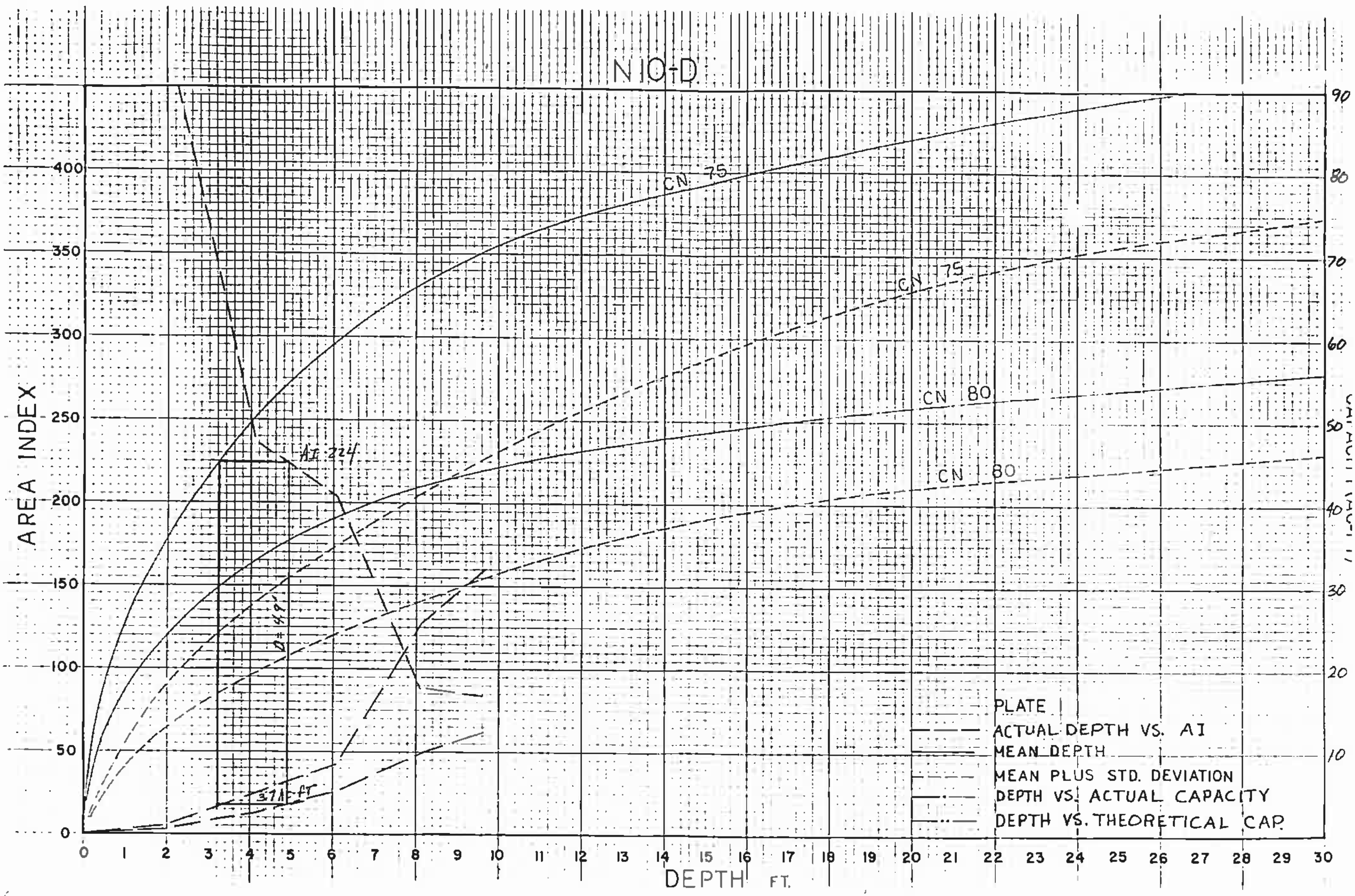
AI: Area Index = A_B/A_P

Notes: Existing Impoundment

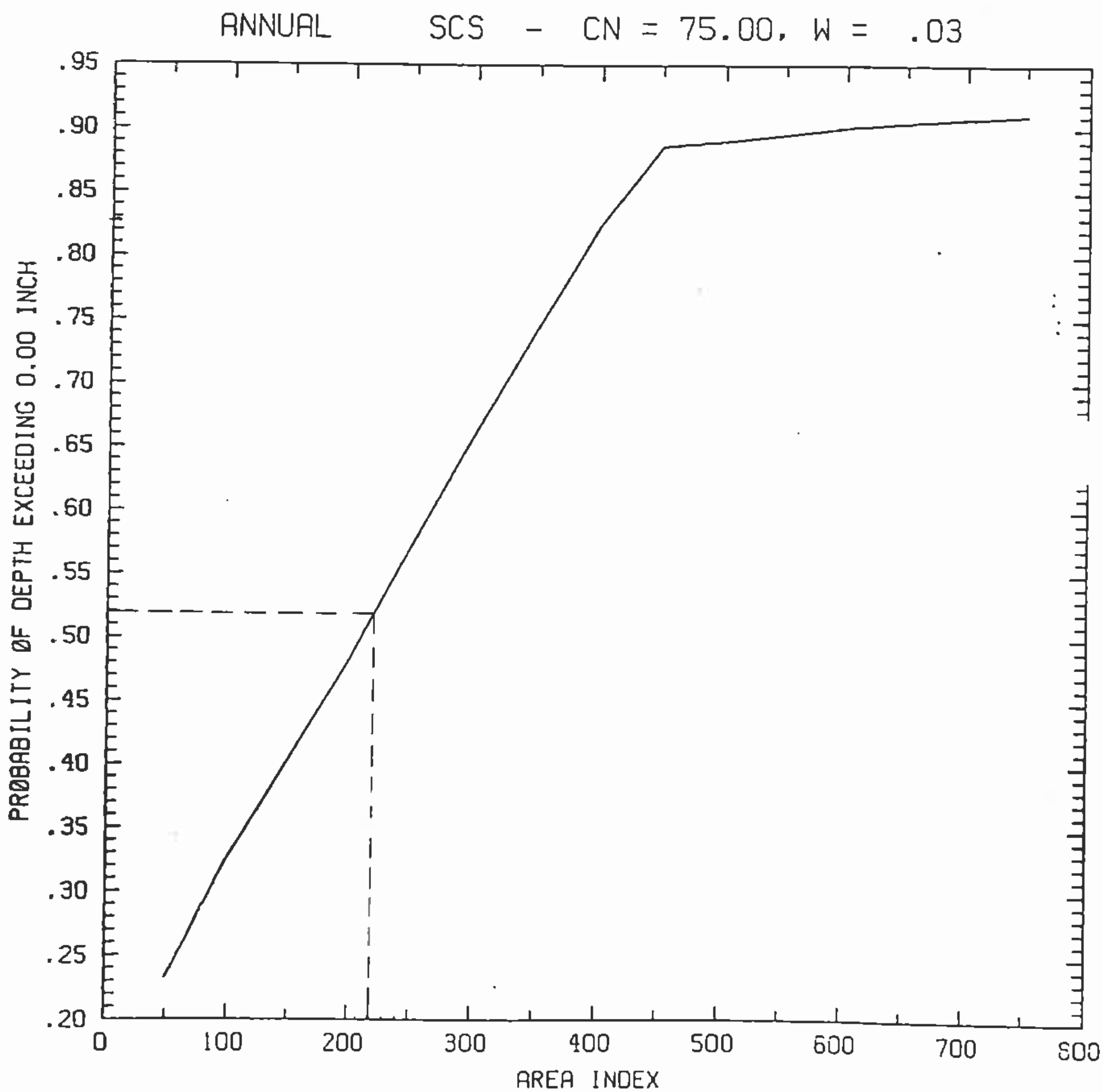
Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6572	0.100	286.70	0	2867	0.0
2	6574	0.620	286.18	1.2	462	0.7
4	6576	1.220	285.6	4.9	234	2.6
6	6578	1.420	285.4	8.5	201	5.2
8	6580	3.180	283.6	25.4	89	9.8
9.5	6581.5	3.353	283.4	31.9	85	12.3

Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD) Minimum Depth (MIN) Actual Capacity AI	4.9 ft. -- 3.7 ac-ft. 224	-- 3.4 ft. 2.0 ac-ft. 300
Plate 2 or 3:	Probability	52%	56%

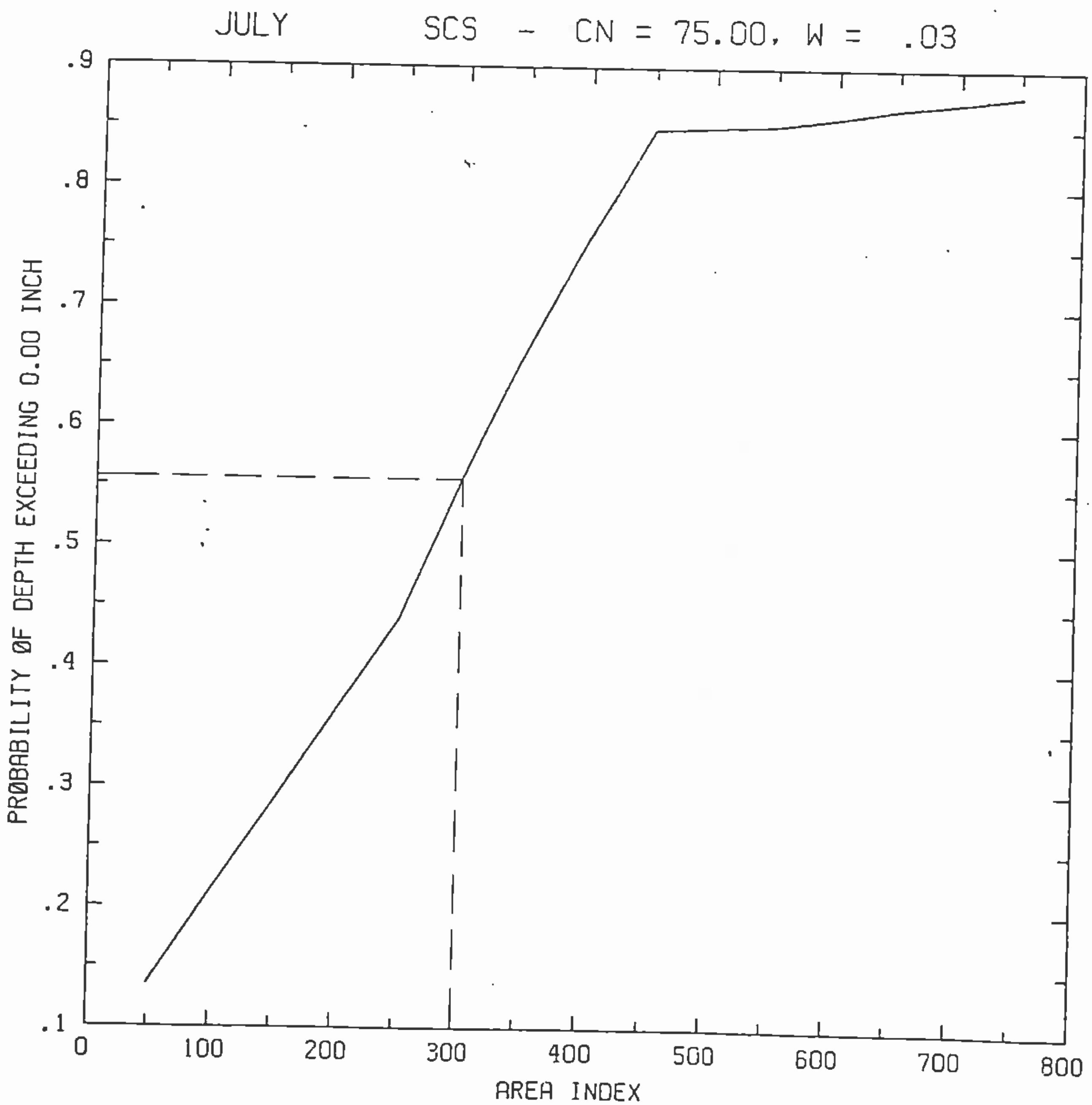

N10-D
AREA INDEX
DEPTH FT.
CN 75
CN 75
CN 80
CN 80
AI 224
D=4.9'
37.1 AF
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

NIO-D



Annual Mean Depth
Plate 2

NIO-D



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

N10-G

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: N10-G

A_D: 467.0 Acres

Depth: From Bottom Elevation

A_B: Watershed Area = $A_D - A_P$

A_D: Total Drainage Area

Theoretical Capacity: A_P x Depth

A_P: Surface Area of Pond

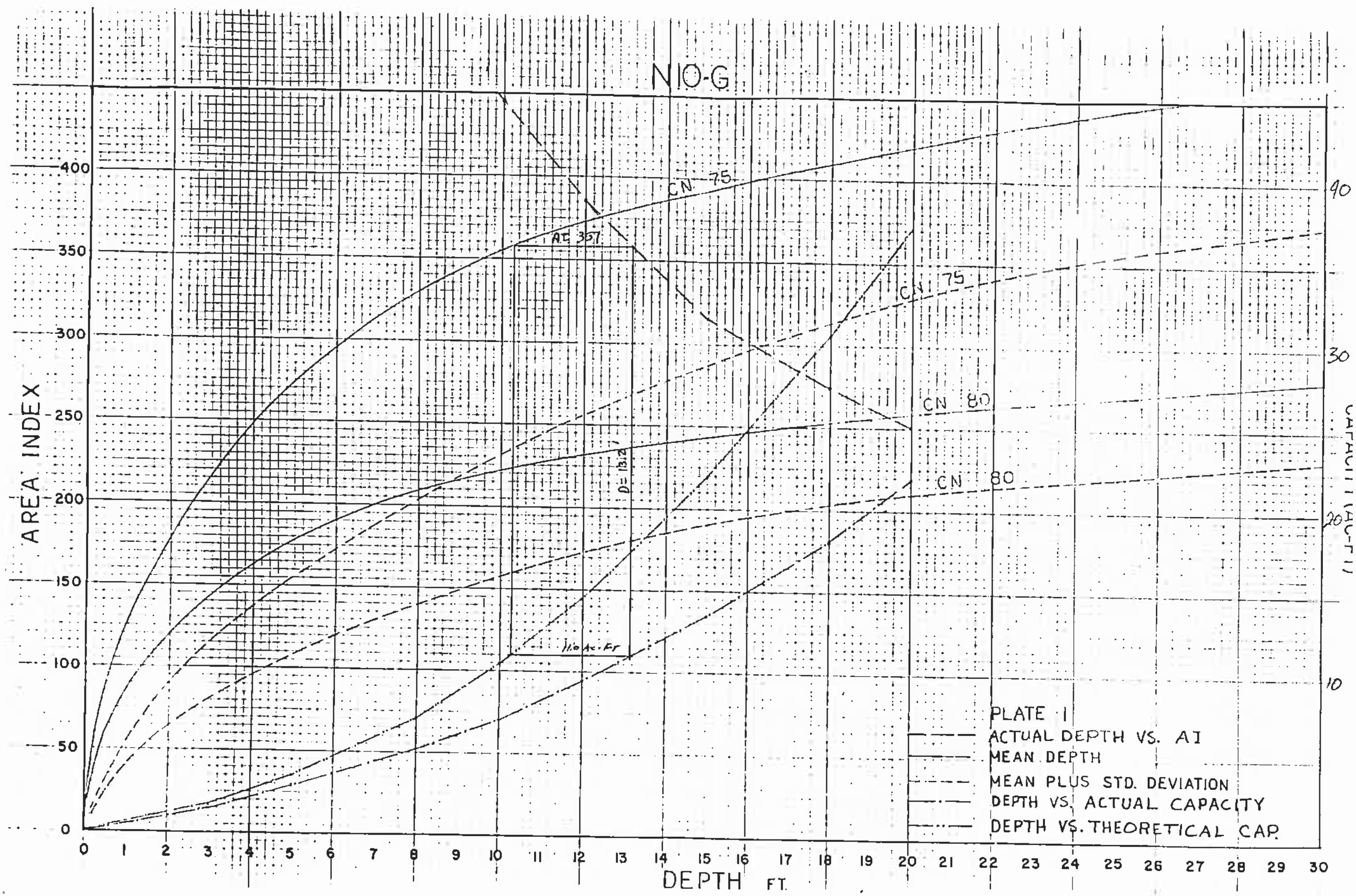
AI: Area Index = A_B/A_P

Notes: Proposed Impoundment

Depth (ft)	Elevation (MSL)	A_P (AC)	A_B (AC)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	N/A	0.402	466.598	0	1161	0
3		0.566	466.434	1.7	824	1.5
5		0.689	466.311	3.4	677	2.8
8		0.894	466.106	7.2	521	5.2
10		1.045	465.955	10.5	446	7.1
12		1.206	465.794	14.5	386	9.4
15		1.469	465.531	22.0	317	13.4
18		1.698	465.302	30.6	274	18.2
20		1.860	465.140	37.2	250	21.8

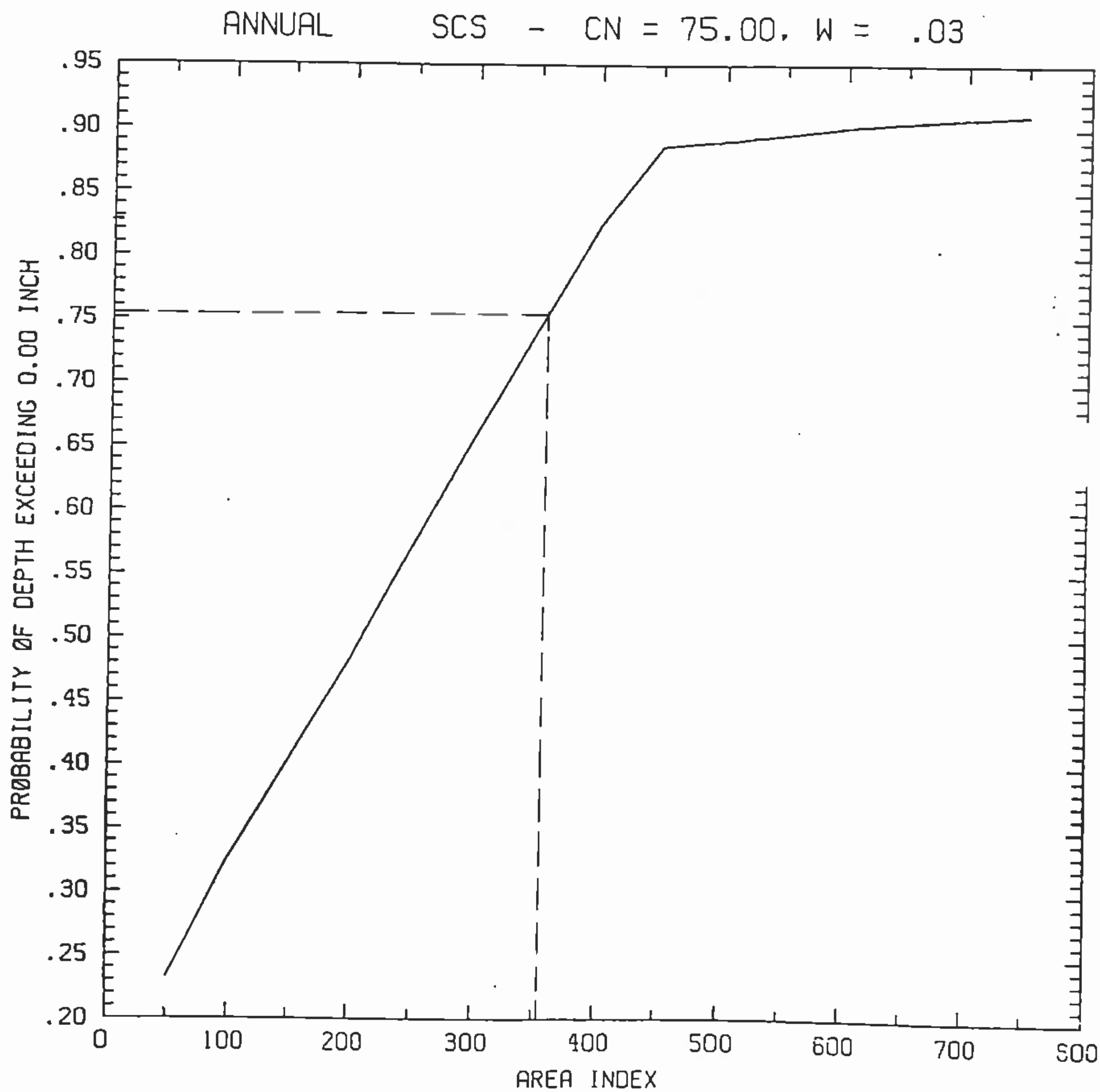
Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	13.2 ft.	--
	Minimum Depth (MIN)	--	3.8 ft.
	Actual Capacity	11.0 ac-ft.	2.0 ac-ft.
	AI	357	765
Plate 2 or 3:	Probability	75%	88%



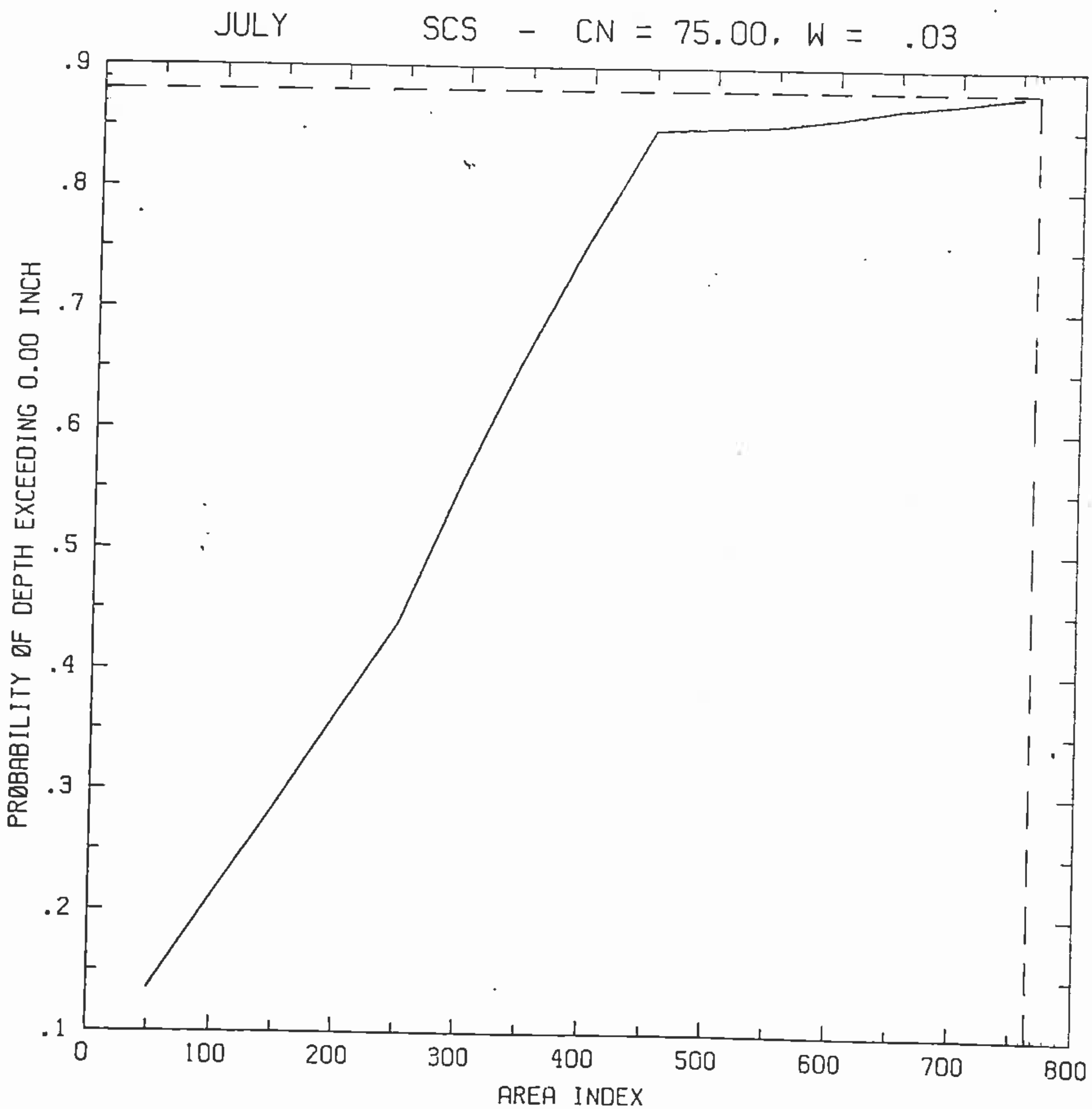
N10-G
AREA INDEX
DEPTH FT.
CAPACITY (AC-FT)
CN 75
CN 75
CN 80
CN 80
AI= 357
D= 13.2
1.10 Ac-Ft
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

NIO-G



Annual Mean Depth
Plate 2

NIO-G



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

N11-A

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: N11-A

A_D: 495.4 Acres

Depth: From Bottom Elevation

A_B: Watershed Area = $A_D - A_P$

A_D: Total Drainage Area

Theoretical Capacity: A_P x Depth

A_P: Surface Area of Pond

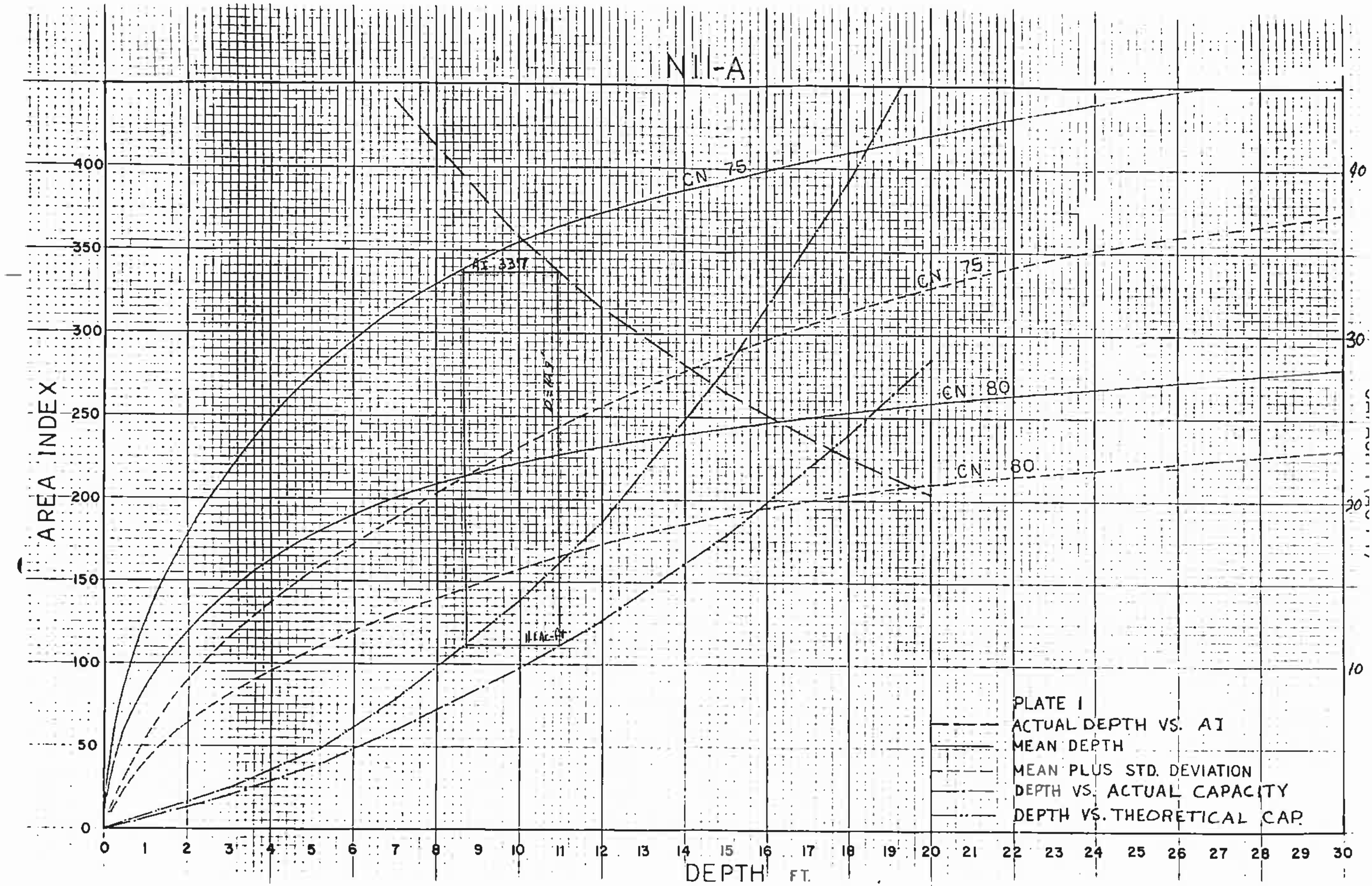
AI: Area Index = A_B/A_P

Notes: Proposed Impoundment

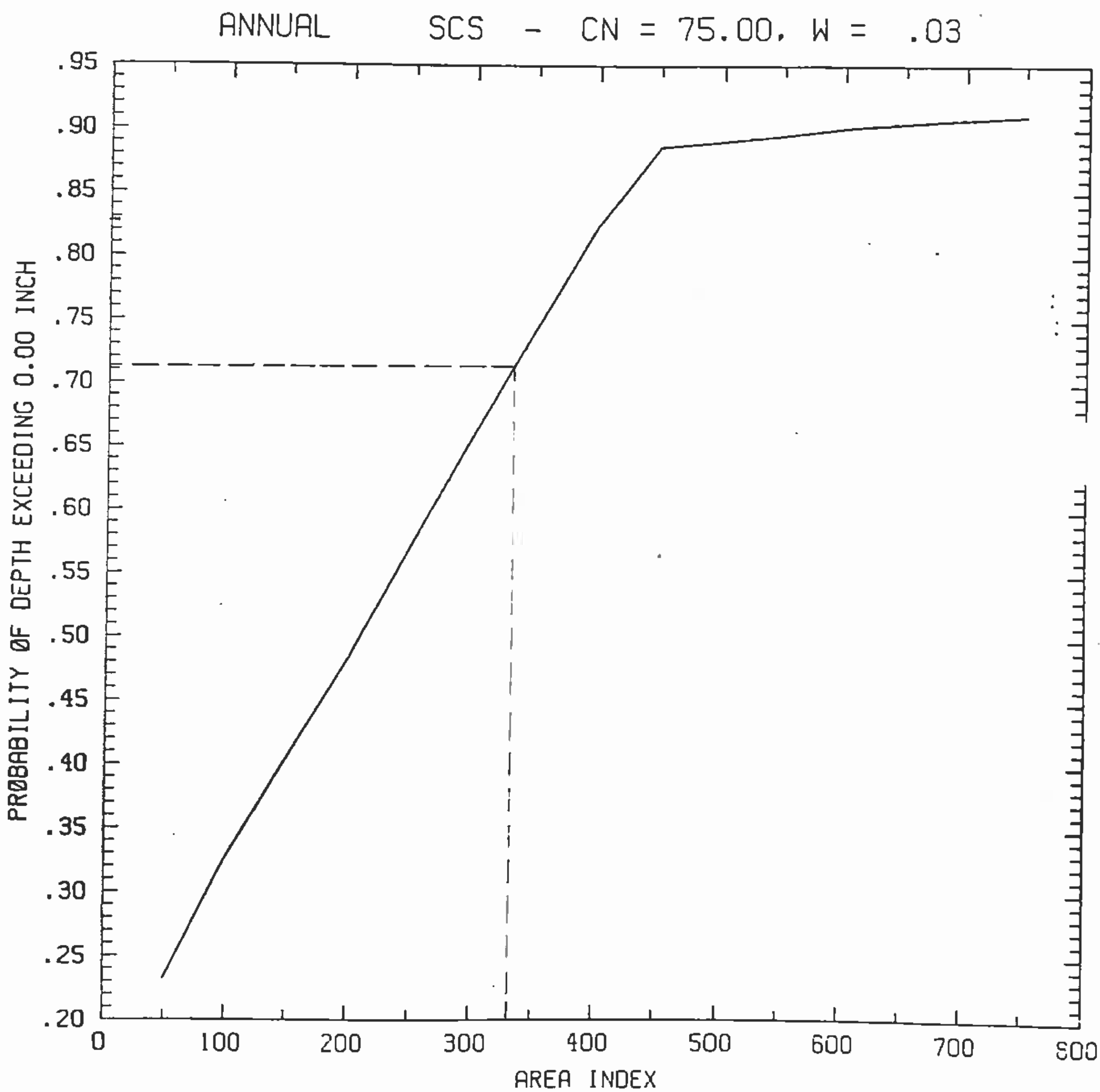
Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	N/A	0.620	494.78	0	798	0
3		0.818	494.582	2.5	605	2.2
5		0.964	494.436	4.8	513	3.9
7		1.121	494.279	7.8	441	6.0
10		1.377	494.023	13.8	359	9.8
12		1.562	493.838	18.7	316	12.7
15		1.860	493.540	27.9	265	17.8
18		2.182	493.218	39.3	226	23.9
20		2.411	492.989	48.2	204	28.5

Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	10.9 ft.	--
	Minimum Depth (MIN)	--	3.0 ft.
	Actual Capacity	11.1 ac-ft.	2.2 ac-ft.
	AI	337	605
Plate 2 or 3:	Probability	71%	86%

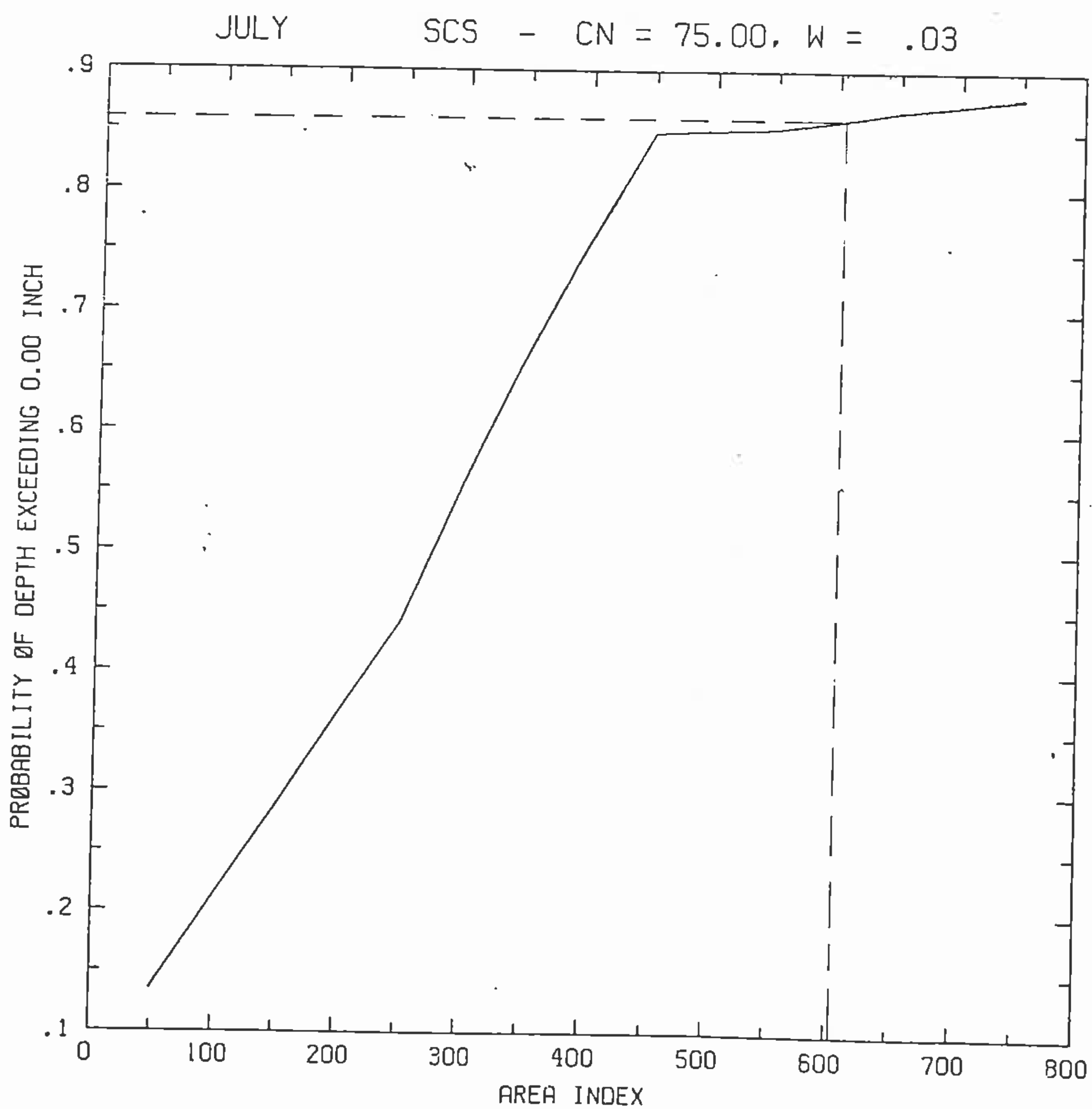

N11-A
CN 75
CN 75
CN 80
CN 80
AI 337
AREA INDEX
DEPTH FT.
CAPACITY (AC FT)
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

N II-A



Annual Mean Depth
Plate 2

NII-A



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

N11-G

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: N11-G

A_D: 881.2 Acres

Depth: From Bottom Elevation

A_B: Watershed Area = $A_D - A_P$

A_D: Total Drainage Area

Theoretical Capacity: A_P x Depth

A_P: Surface Area of Pond

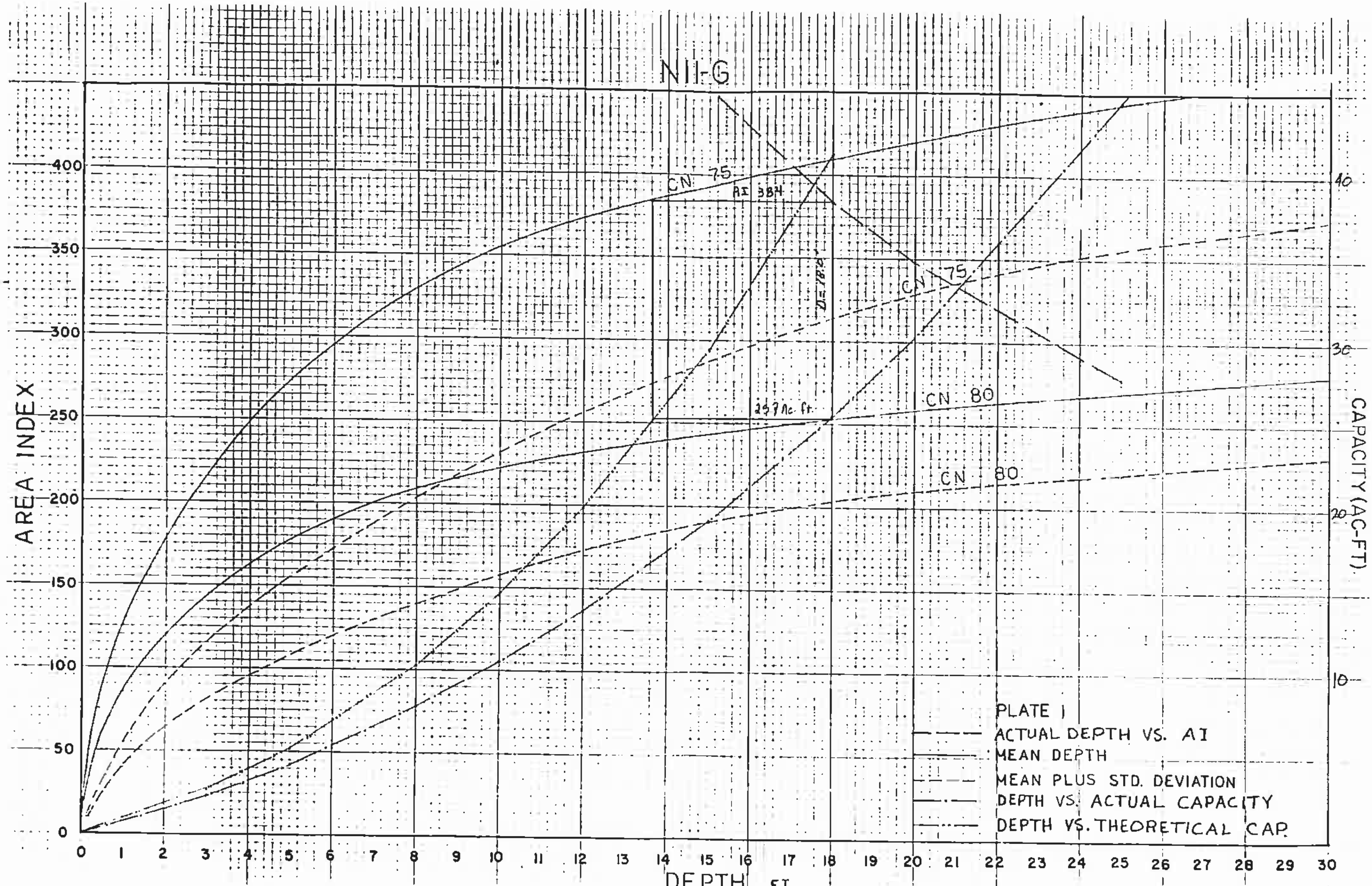
AI: Area Index = A_B/A_P

Notes: Proposed Impoundment

Depth (ft)	Elevation (MSL)	A_P (AC)	A_B (AC)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	N/A	0.689	880.511	0.0	1278	0.0
3	N/A	0.894	880.306	2.7	985	2.4
5	N/A	1.045	880.155	5.2	842	4.3
8	N/A	1.291	879.909	10.3	682	7.8
10	N/A	1.469	879.731	14.7	599	10.6
12	N/A	1.658	879.542	19.9	530	13.7
15	N/A	1.963	879.237	29.4	448	19.1
18	N/A	2.292	878.908	41.3	384	25.5
20	N/A	2.525	878.675	50.5	348	30.3
25	N/A	3.157	878.043	78.9	278	44.5

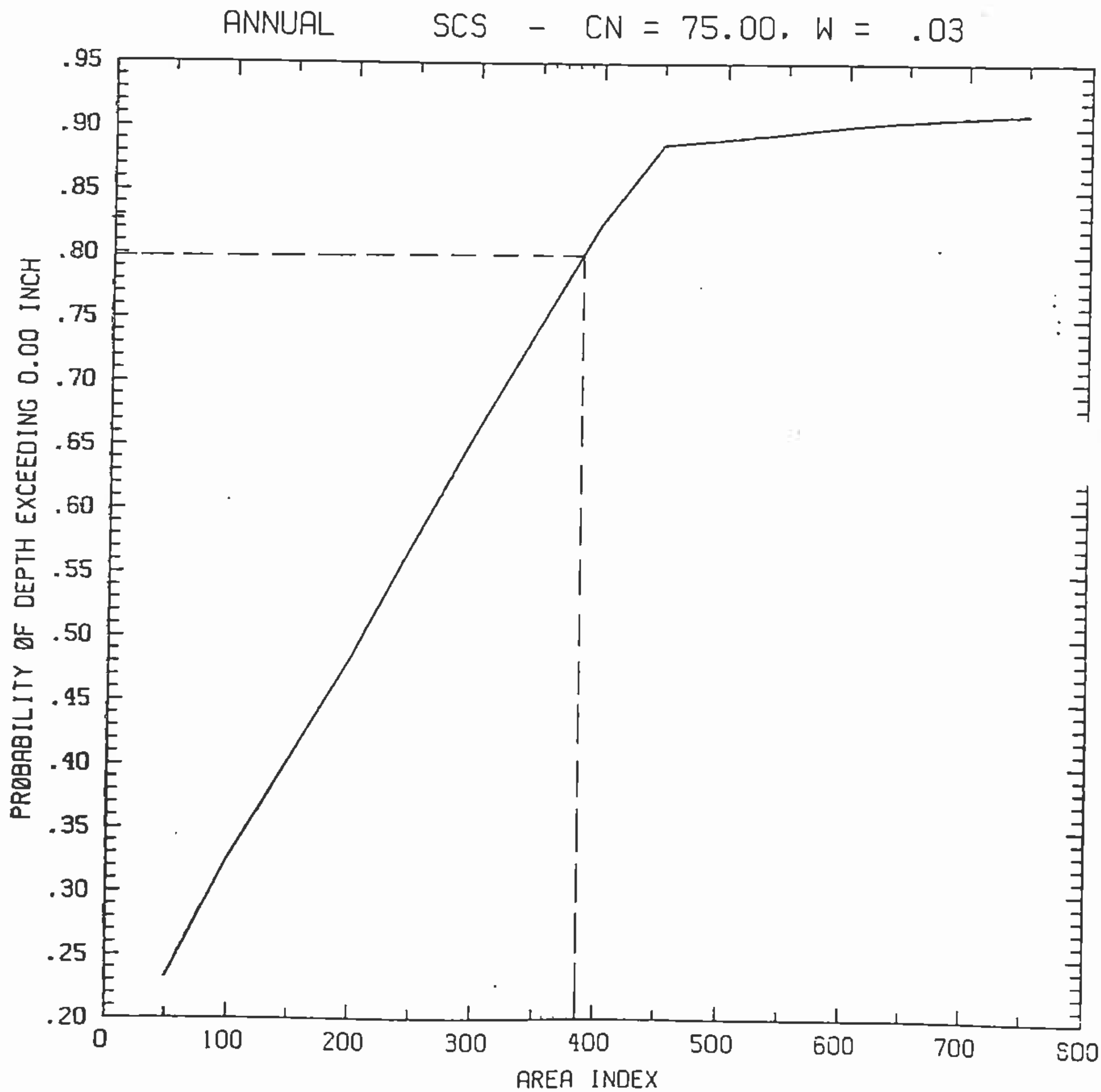
Results: Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	18.0 ft.	--
	Minimum Depth (MIN)	--	3.0 ft.
	Actual Capacity	25.7 ac-ft.	2.4 ac-ft.
	AI	384	985
Plate 2 or 3:	Probability	80%	88+%



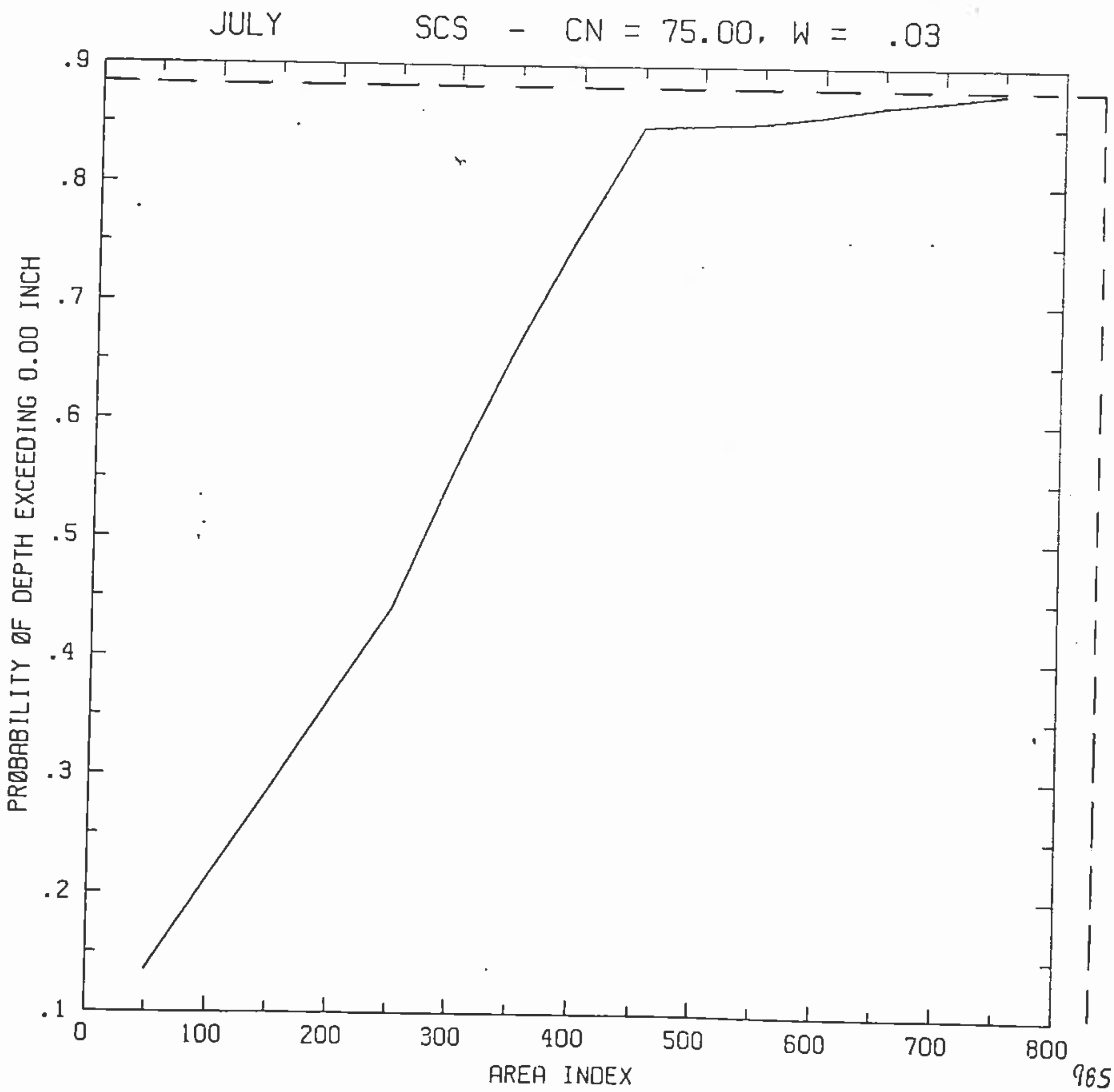
NII-G
AREA INDEX
CAPACITY (AC-FT)
DEPTH FT.
CN 75
AI 384
D=18.0
257 Ac. Ft.
CN 80
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

NII-G



Annual Mean Depth
Plate 2

NII-G



965

Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

N12-C

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: N12-C

A_D: 850.1 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = A_D - A_P

Theoretical Capacity: A_P x Depth

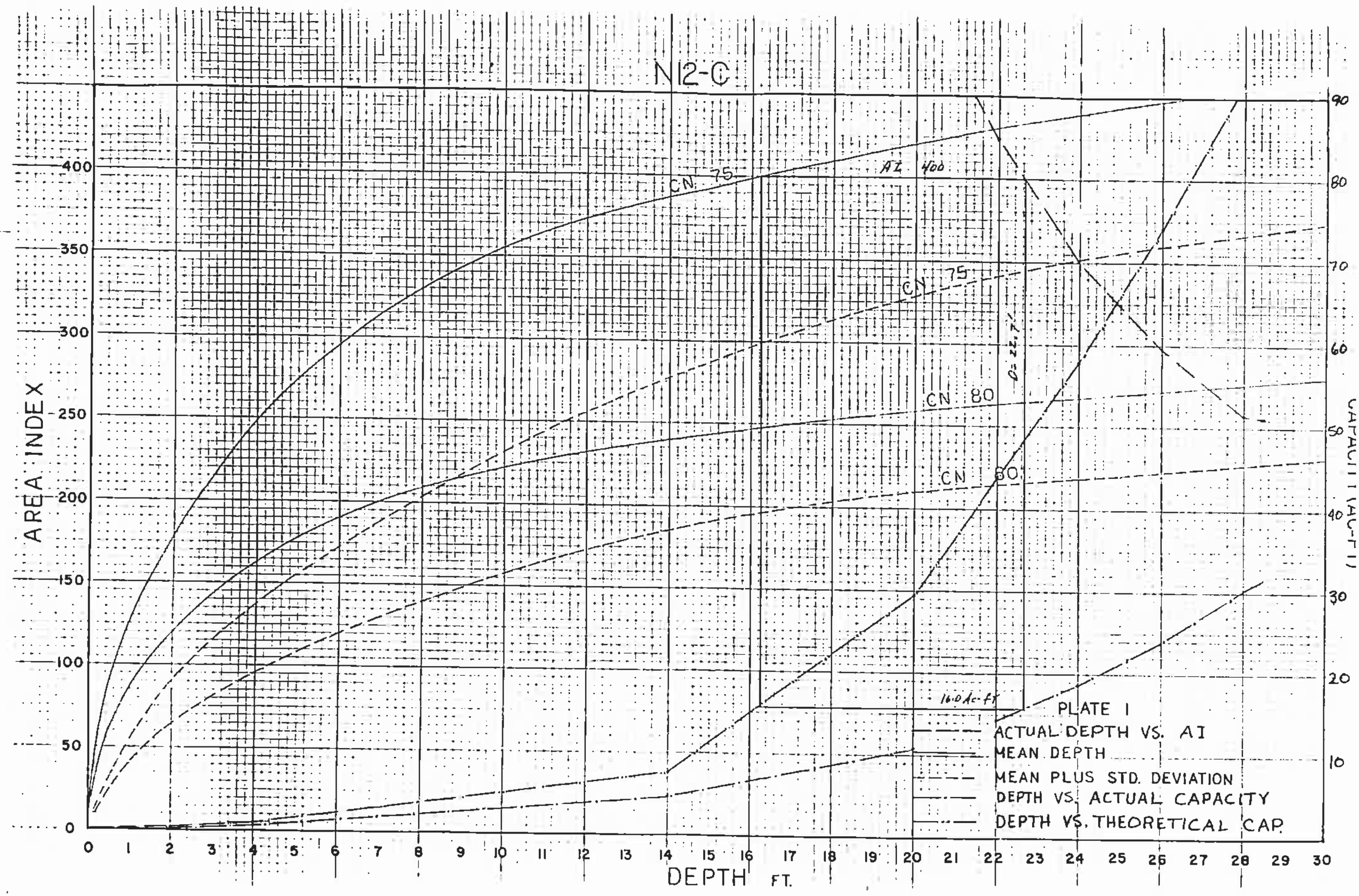
AI: Area Index = A_B/A_P

Notes: Existing Impoundment

Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6556	0.103	849.997	0.0	8228	0.0
2	6658	0.186	849.914	0.4	4557	0.3
4	6560	0.253	849.848	1.0	3365	0.7
8	6564	0.370	849.730	3.0	2297	2.0
14	6570	0.545	849.555	7.6	1558	4.7
20	6576	1.467	848.633	29.3	578	10.8
22	6578	1.996	848.104	43.9	423	14.2
24	6580	2.410	847.690	57.9	352	18.6
26	6582	2.847	847.253	74.0	298	23.9
28	6584	3.283	846.817	91.9	258	30.0
28.5	6584.5	3.312	846.788	94.4	256	31.7

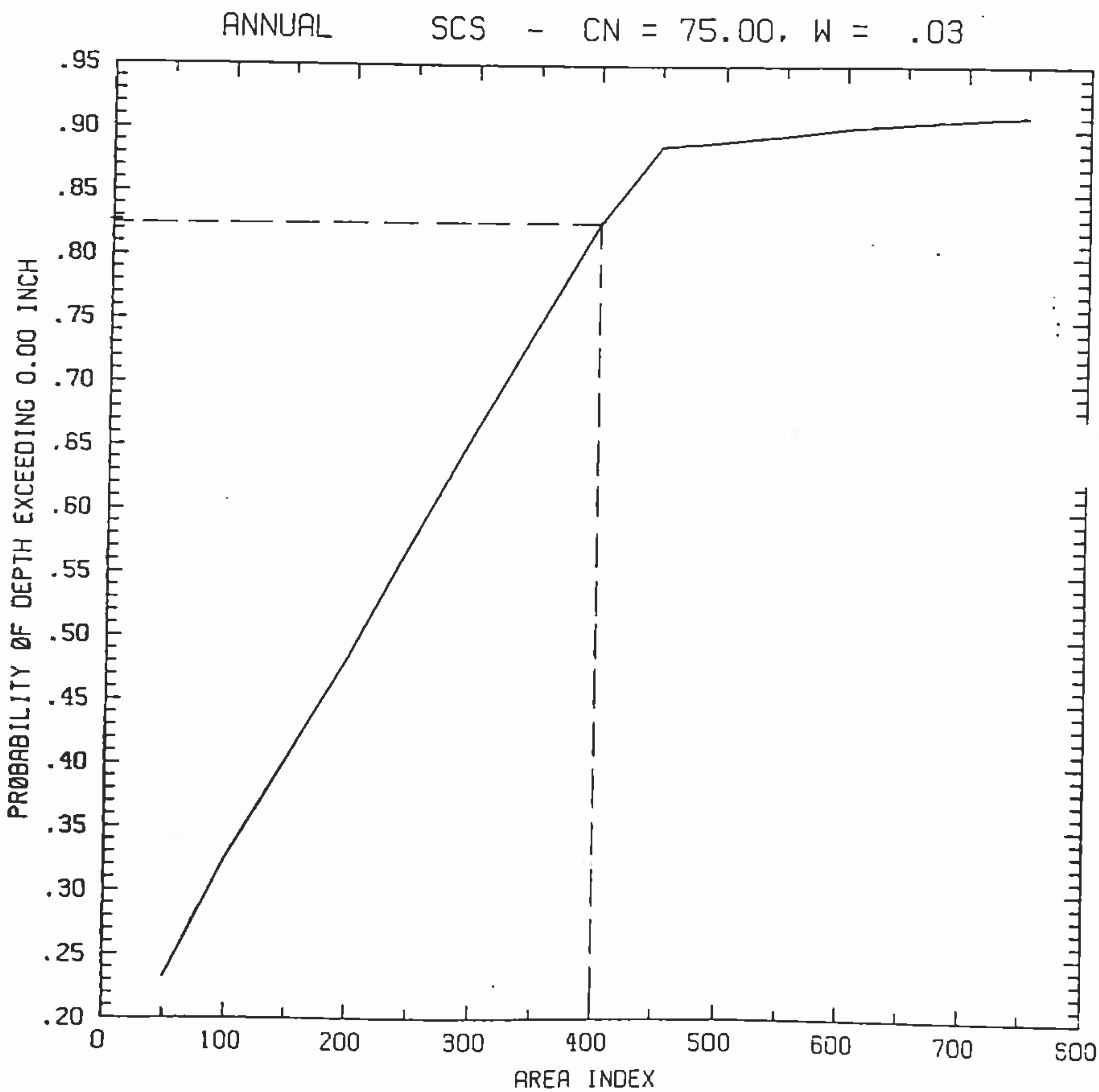
Results   Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	22.7 ft.	---
	Minimum Depth (MIN)	---	8.0 ft.
	Actual Capacity	16.0 ac-ft.	2.0 ac-ft.
	AI	400	2297
Plate 2 or 3:	Probability	83%	88+%



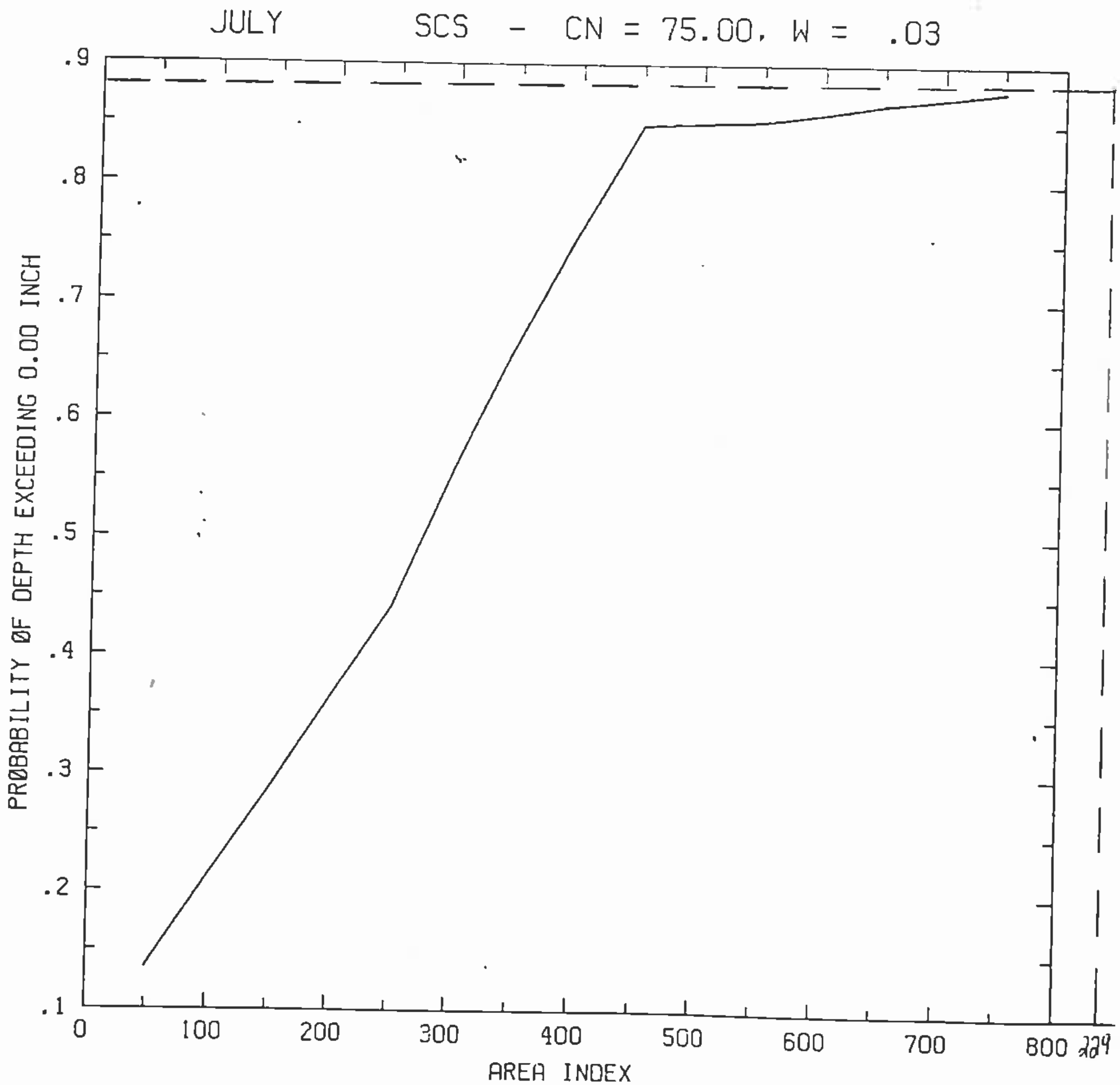
N12-C
AREA INDEX
DEPTH FT.
CAPACITY (AC-FT)
CN 75
CN 80
AI 400
D=22.7'
160 Ac-Ft
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

N12-C



Annual Mean Depth
Plate 2

N12-C



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

N14-D

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: N14-D

A_D: 1836.0 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

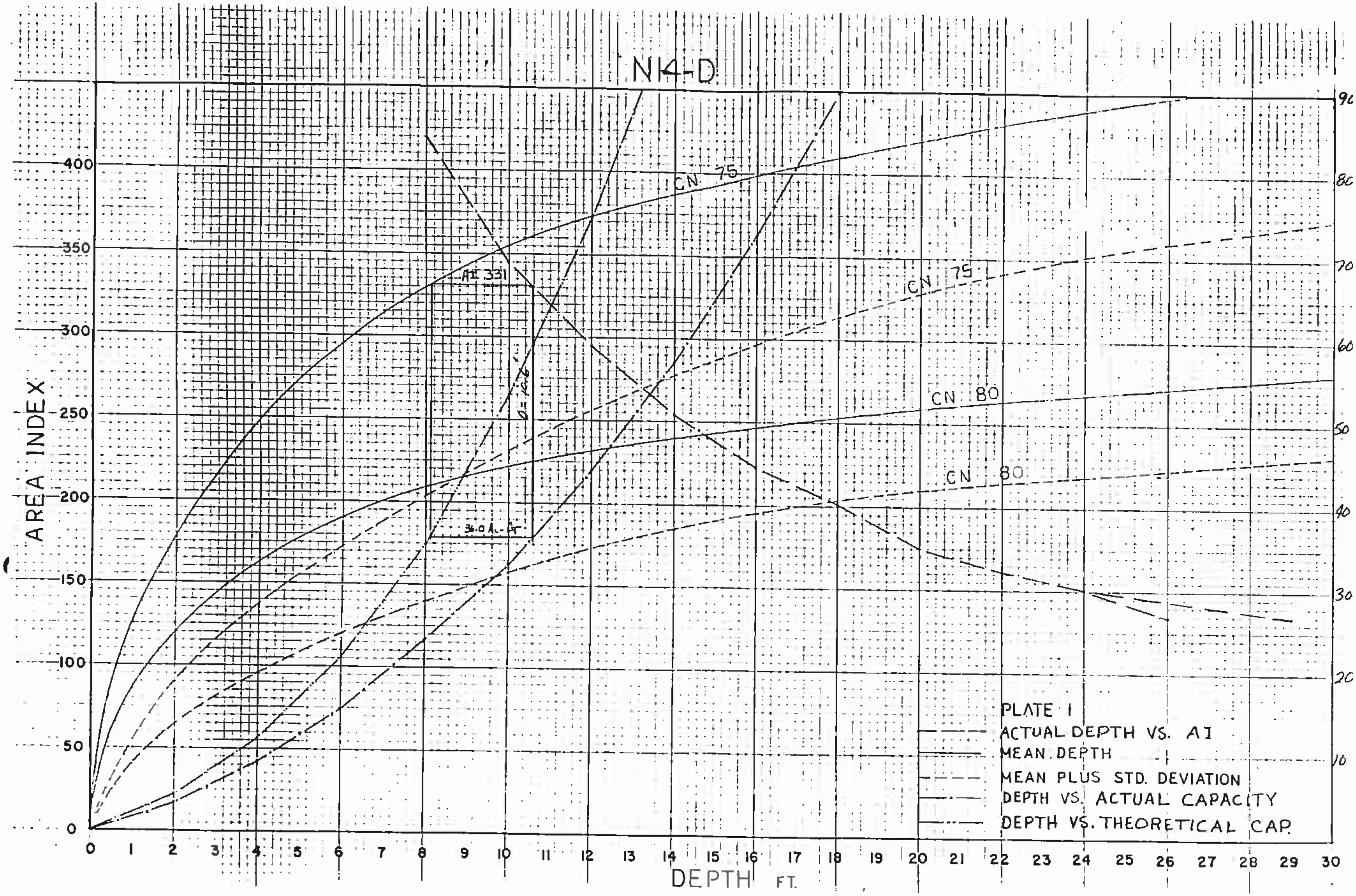
AI: Area Index = A_B/A_P

Notes: MSHA Impoundment

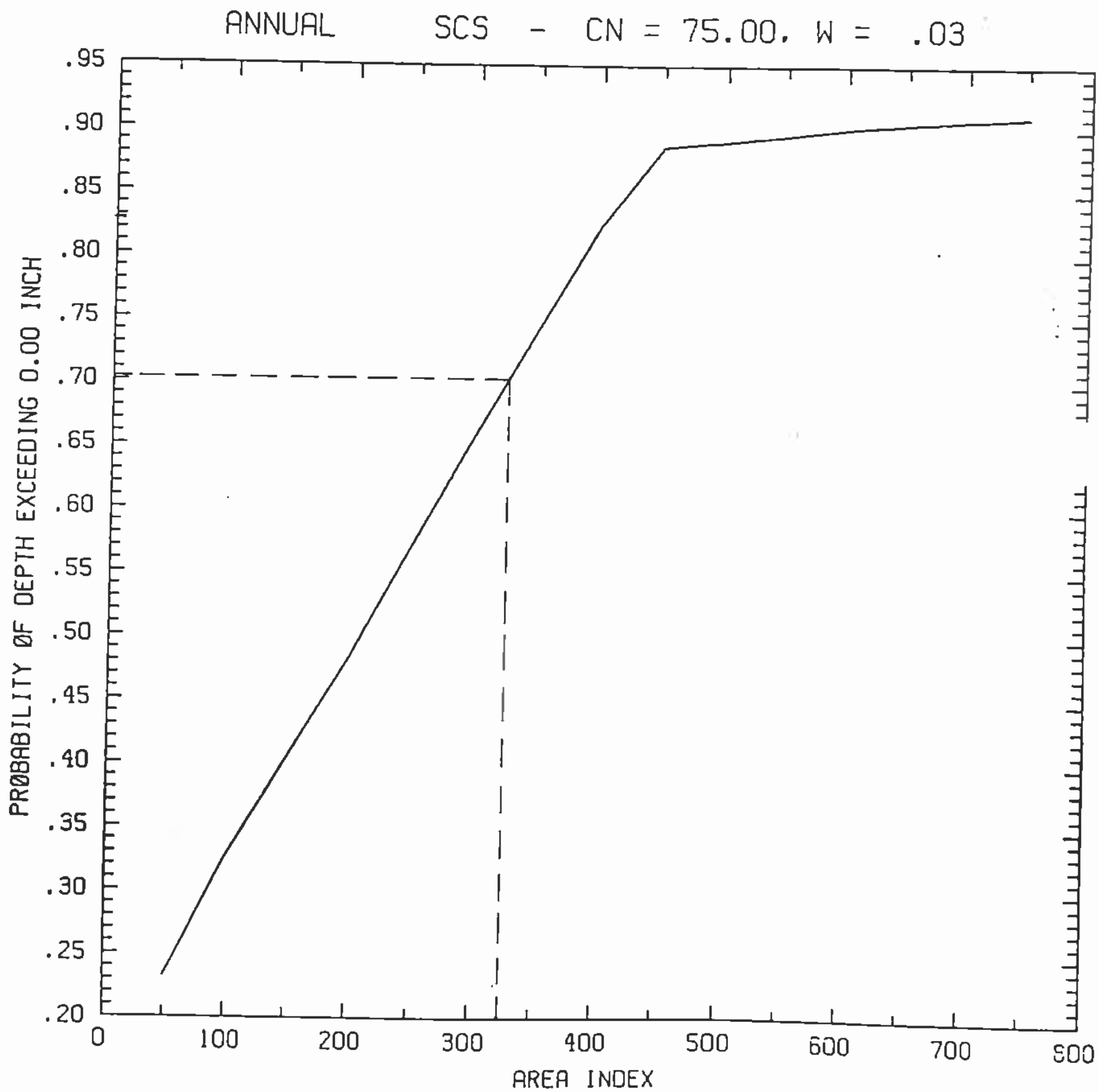
Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6606	1.307	1834.693	0	1404	0
2	6608	2.144	1833.856	4.3	855	3.5
4	6610	2.831	1833.169	11.3	648	8.4
6	6612	3.557	1832.443	21.3	515	14.8
8	6614	4.365	1831.635	34.9	420	22.7
10	6616	5.299	1830.701	53.0	346	32.4
12	6618	6.202	1829.798	74.4	295	43.9
14	6620	7.175	1828.825	100.5	255	57.3
16	6622	8.168	1827.833	130.7	224	72.6
18	6624	9.036	1826.964	162.6	202	89.8
20	6626	10.391	1825.609	207.8	176	109.3
22	6628	11.211	1824.789	246.6	163	130.8
24	6630	12.034	1823.966	288.8	152	154.0
29	6635	13.598	1822.402	394.3	134	218.1
34	6640	16.045	1819.955	545.5	113	292.2

Results: Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	10.6 ft.	--
	Minimum Depth (MIN)	--	3.0 ft.
	Actual Capacity	36.0 ac-ft.	6.0 ac-ft.
	AI	331	737
Plate 2 or 3:	Probability	70%	88%

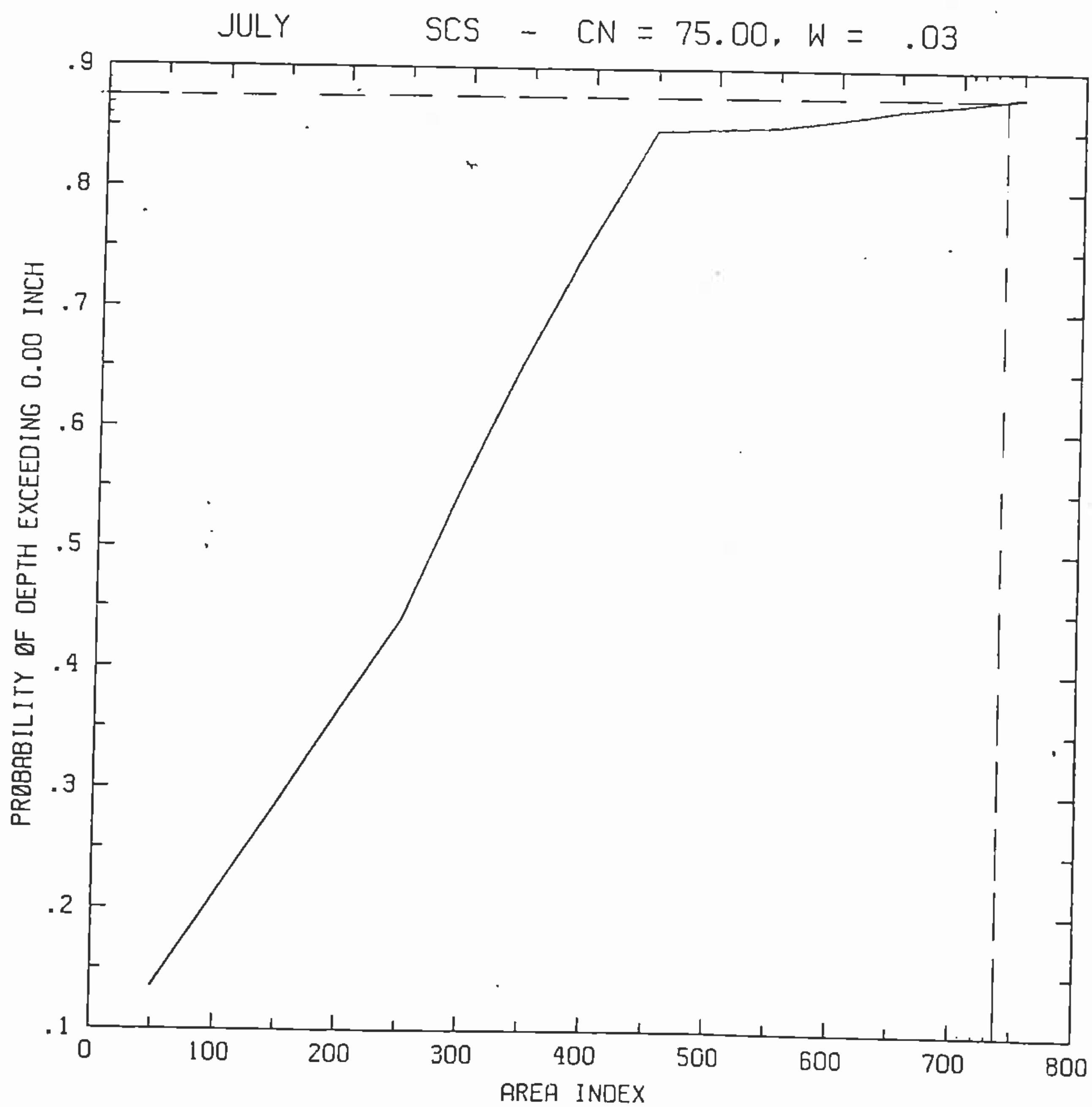

N14-D
AREA INDEX
DEPTH FT.
CN 75
CN 75
CN 80
CN 80
AI 331
D = 10.6
34.0 A.-F.
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

N14-D



Annual Mean Depth
Plate 2

N14-D



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

N14-F

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: N14-F

A_D: 376.0 Acres

Depth: From Bottom Elevation

A_B: Watershed Area = $A_D - A_P$

A_D: Total Drainage Area

Theoretical Capacity: A_P x Depth

A_P: Surface Area of Pond

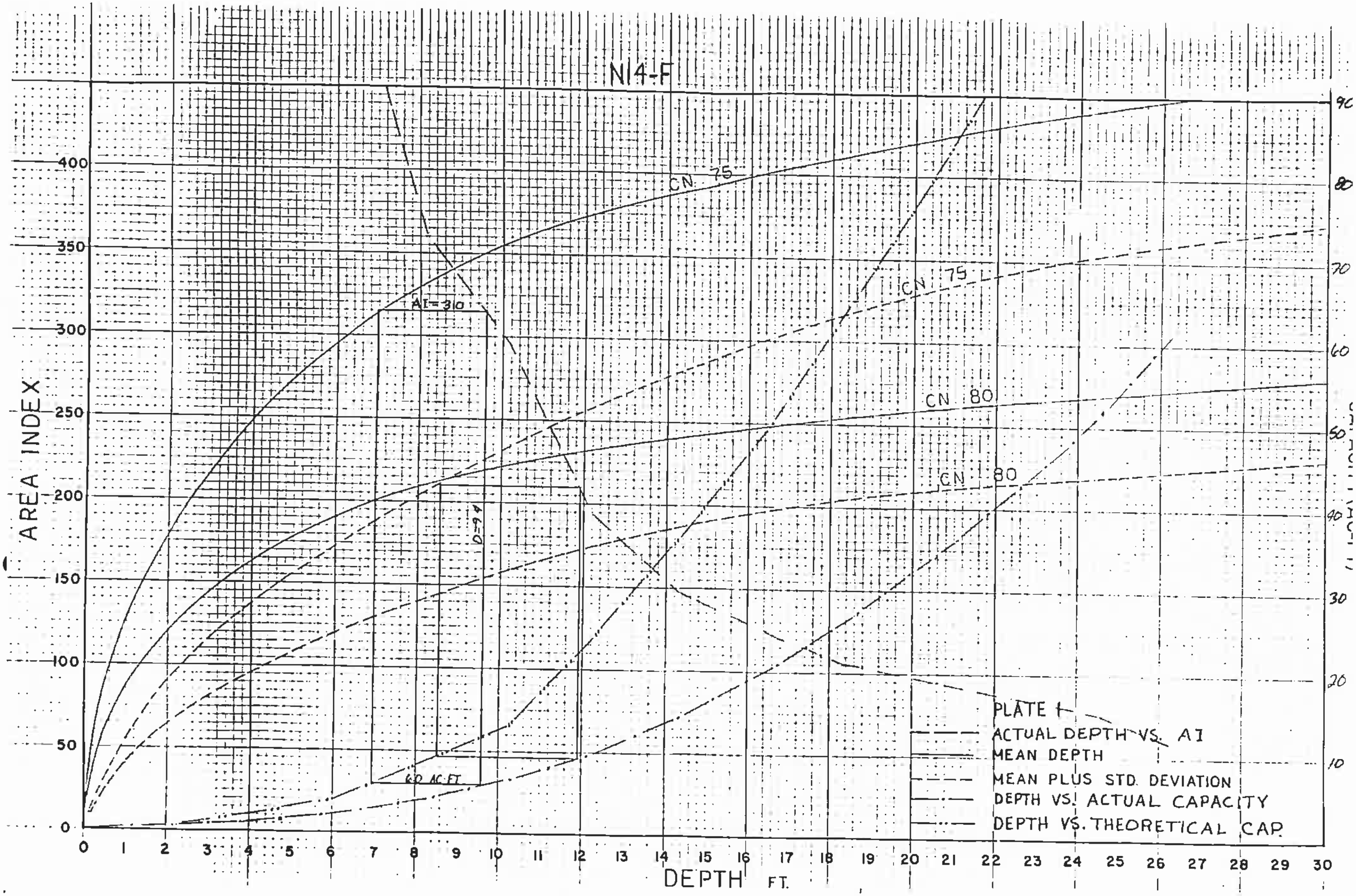
AI: Area Index = A_B/A_P

Notes: MSHA Impoundment

Depth (ft)	Elevation (MSL)	A_P (AC)	A_B (AC)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6634	0.136	375.9	0	2764	0
2	6636	0.264	375.7	0.5	1423	0.4
4	6638	0.490	375.5	2.0	766	1.2
6	6640	0.699	375.3	4.2	537	2.3
8	6642	1.054	374.9	8.4	356	4.1
10	6644	1.292	374.7	12.9	290	6.4
12	6646	1.951	374.0	23.4	192	9.7
14	6648	2.527	373.5	35.4	148	14.2
16	6650	3.000	373.0	48.0	124	19.7
18	6652	3.519	372.5	63.3	106	26.2
20	6654	3.950	372.1	79.0	94	33.7
22	6656	4.367	371.6	96.1	85	42.0
24	6658	4.876	371.1	117.0	76	51.2
25.7	6659.7	6.299	369.7	161.9	59	60.7

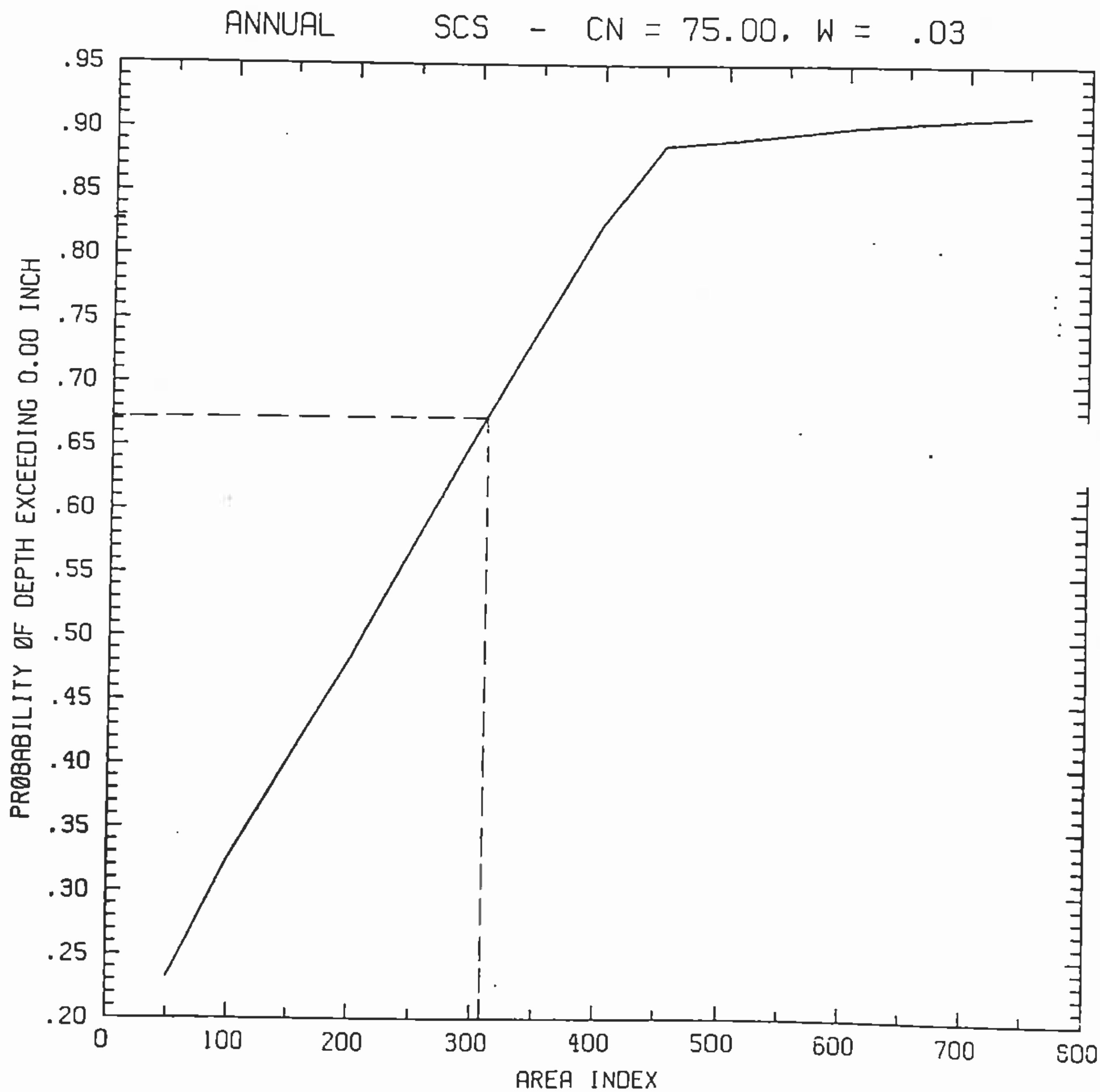
Results: Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	9.4 ft	--
	Minimum Depth (MIN)	--	6.0 ft
	Actual Capacity	6.0 ac-ft	2.3 ac-ft
	AI	310	537
Plate 2 or 3:	Probability	67%	85%



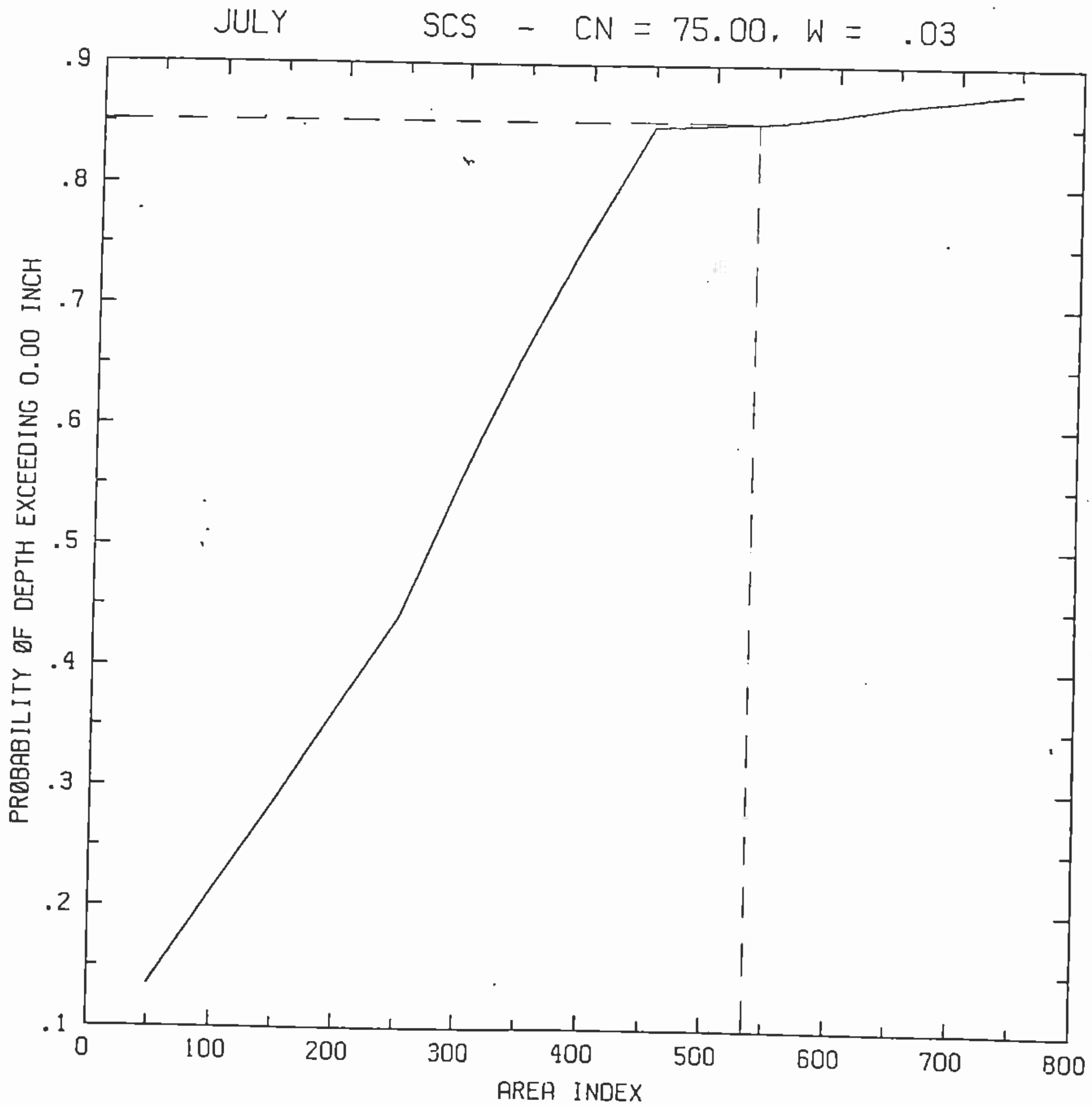
N14-F
PLATE 1
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.
CN 75
CN 75
CN 80
CN 80
AI=310
D=9.4
60 AC FT
AREA INDEX
DEPTH FT.
CAPACITY (AC-FT)
0
50
100
150
200
250
300
350
400
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
10
20
30
40
50
60
70
80
90

NI4-F



Annual Mean Depth
Plate 2

N14-F



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

N14-G

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: N14-G

A_D: 1479.0 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = $A_D - A_P$

Theoretical Capacity: A_P x Depth

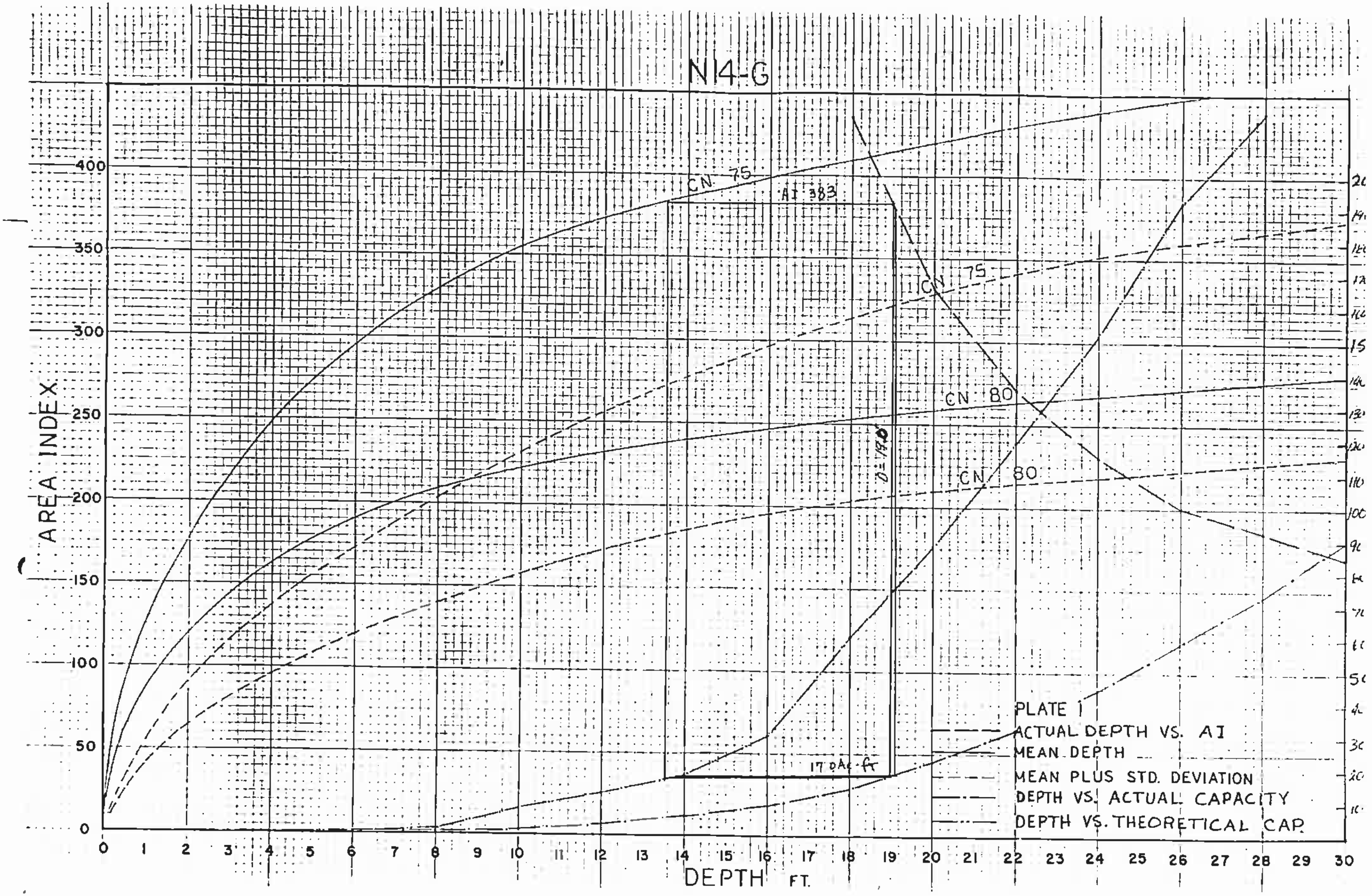
AI: Area Index = A_B/A_P

Notes: MSHA Impoundment

Depth (ft)	Elevation (MSL)	A_P (AC)	A_B (AC)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6622	0.007	1478.993	0	211285	0.0
2	6624	0.039	1478.961	0.1	37922	0.0
4	6626	0.115	1478.885	0.5	12860	0.2
6	6628	0.188	1478.812	1.1	7866	0.5
8	6630	0.273	1478.727	2.2	5417	1.0
10	6632	0.801	1478.199	8.0	1845	2.0
12	6634	1.068	1477.932	12.8	1384	3.9
14	6636	1.306	1477.694	18.3	1132	6.3
16	6638	1.974	1477.026	31.6	748	9.6
18	6640	3.388	1475.612	61.0	436	14.9
20	6642	4.426	1474.574	88.5	333	22.7
22	6644	5.445	1473.555	119.8	271	32.6
24	6646	6.357	1472.643	152.6	232	44.4
26	6648	7.385	1741.615	192.0	199	58.3
28	6650	7.879	1471.121	220.6	187	73.4
30	6652	8.639	1470.461	259.2	170	89.9

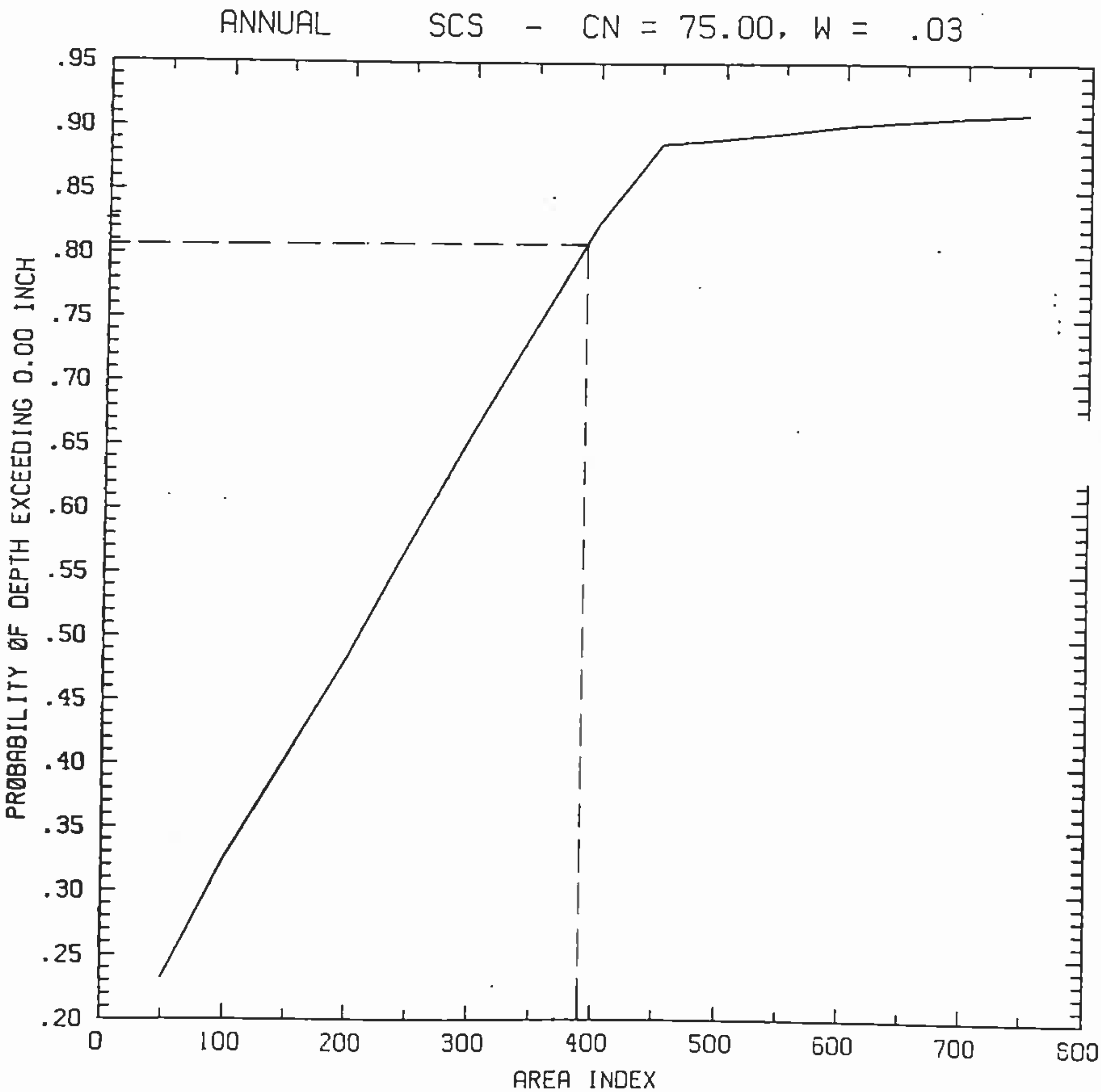
Results: Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	19.0 ft.	--
	Minimum Depth (MIN)	--	10.0 ft.
	Actual Capacity	12.0 ac-ft.	2.0 ac-ft.
	AI	383	1845
Plate 2 or 3:	Probability	81%	88+%



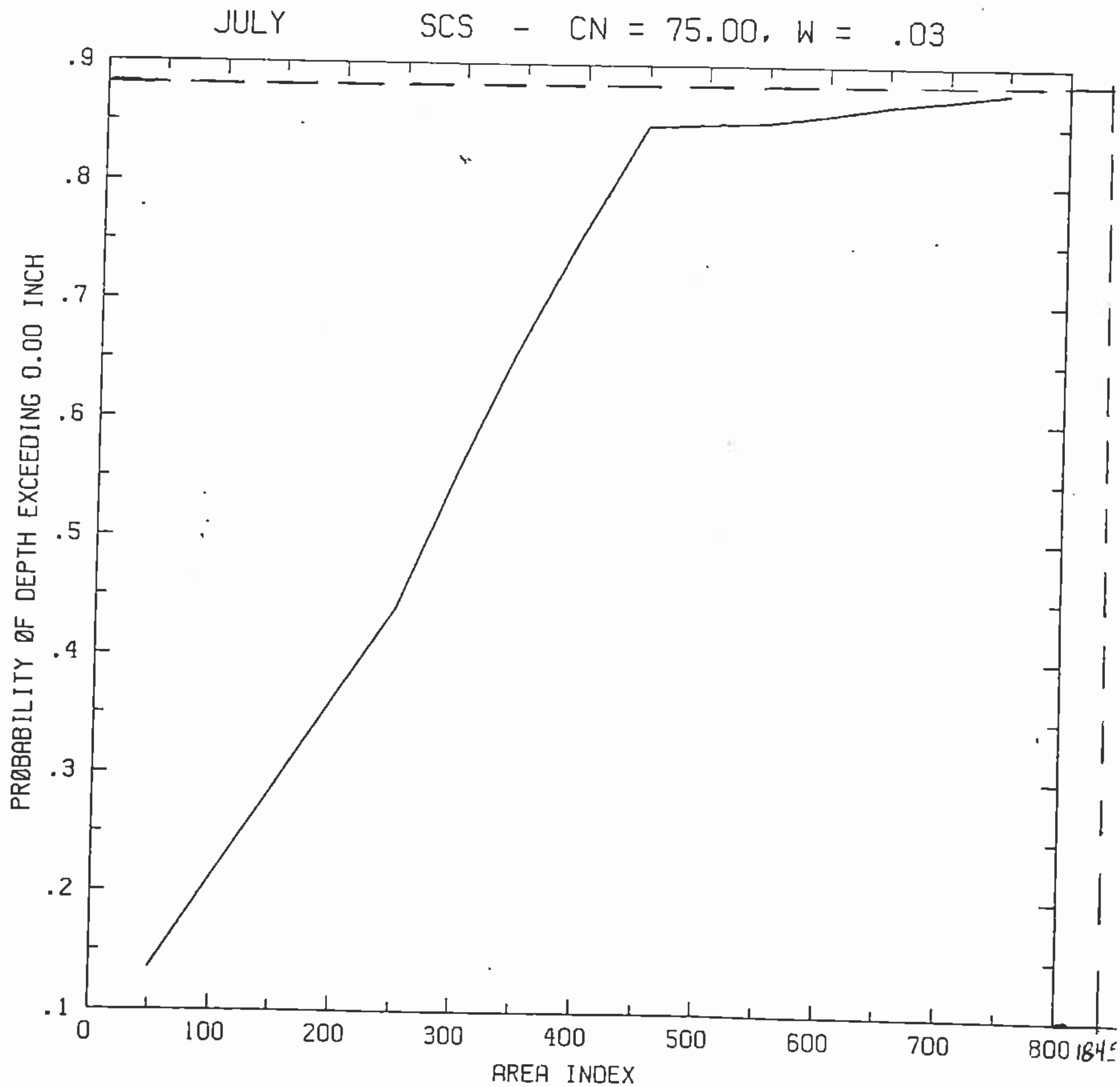
N14-G
AREA INDEX
DEPTH FT.
CN 75
AI 383
CN 75
CN 80
CN 80
17 DAC Ft
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

NI4-G



Annual Mean Depth
Plate 2

N14-G



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

N14-H

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: N14-H

A_D: 1615.0 Acres

Depth: From Bottom Elevation

A_B: Watershed Area = $A_D - A_P$

A_D: Total Drainage Area

Theoretical Capacity: A_P x Depth

A_P: Surface Area of Pond

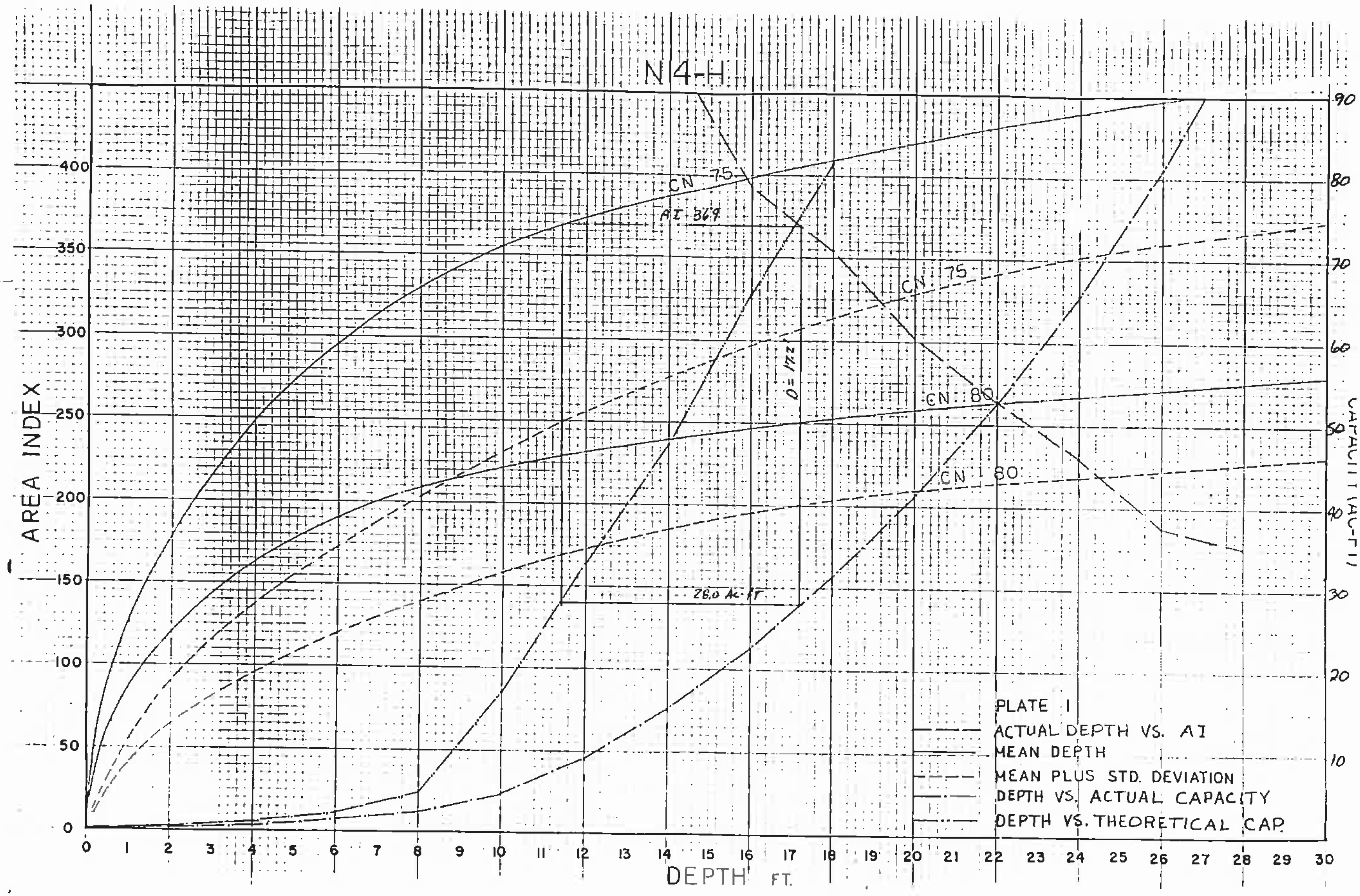
AI: Area Index = A_B/A_P

Notes: MSHA Impoundment

Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6680	0.101	1614.90	0	15989	0
2	6682	0.178	1614.82	0.4	9072	0.3
4	6684	0.270	1614.73	1.1	5981	0.7
6	6686	0.389	1614.6	2.3	4151	1.4
8	6688	0.597	1614.4	4.8	2704	2.4
10	6690	1.703	1613.297	17.0	947	4.7
12	6692	2.731	1612.269	32.8	590	9.1
14	6694	3.379	1611.621	47.3	477	15.2
16	6696	4.093	1610.907	65.5	394	22.7
18	6698	4.539	1610.5	81.7	355	31.3
20	6700	5.302	1609.698	106.0	304	41.2
22	6702	6.082	1608.918	133.8	265	52.6
24	6704	6.949	1608.051	166.8	231	65.6
26	6706	8.531	1606.469	221.8	188	81.1
28	6708	9.070	1605.93	254.0	177	98.7
30	6710	10.080	1604.92	302.4	159	117.8

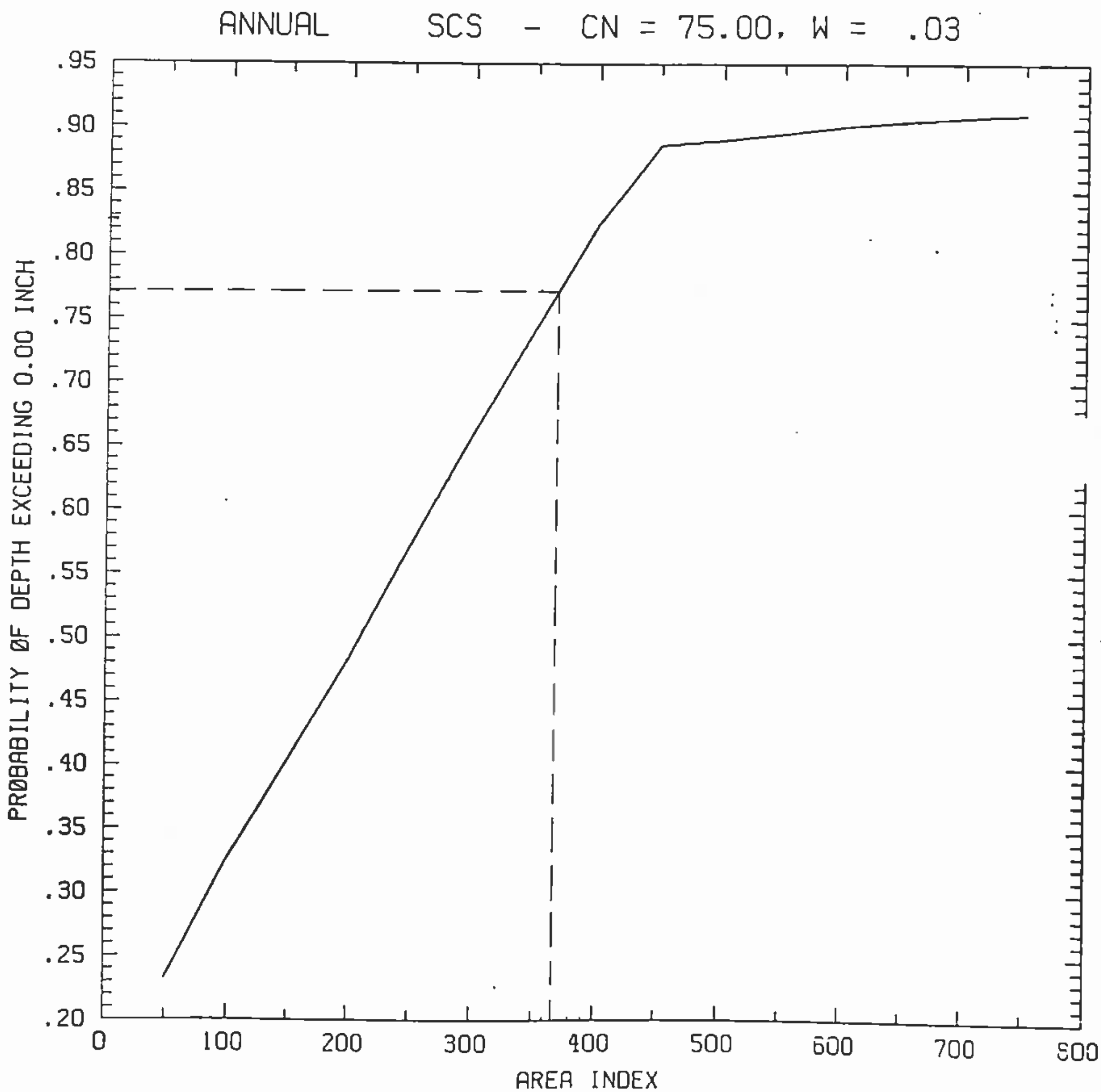
<u>Results</u> Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	17.2 ft.	--
	Minimum Depth (MIN)	--	8.0 ft.
	Actual Capacity	28 ac-ft.	2.4 ac-ft.
	AI	369	2704
Plate 2 or 3:	Probability	77%	88+%



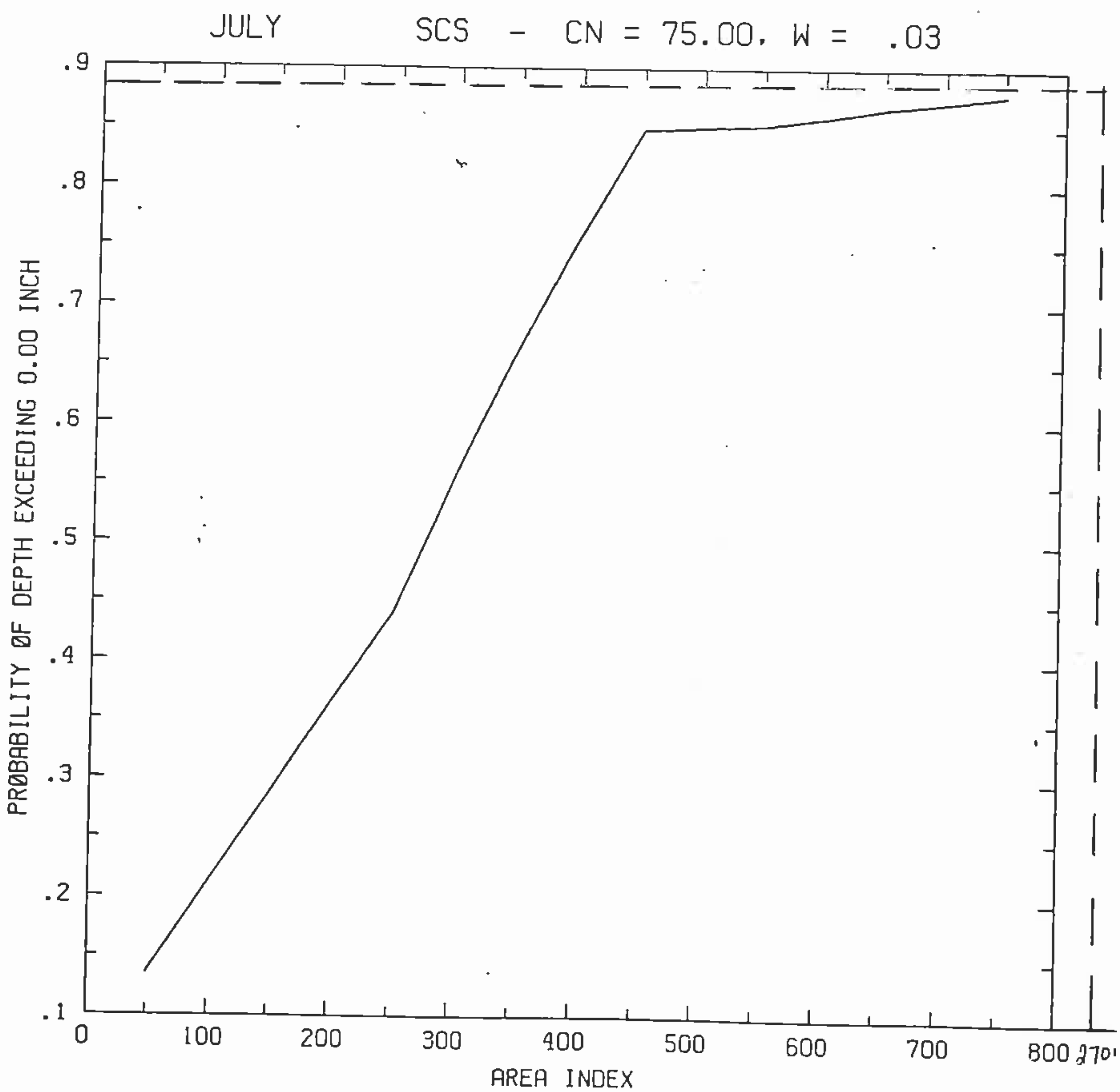
N 4-H
AREA INDEX
0
50
100
150
200
250
300
350
400
DEPTH FT.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
CAPACITY (AC-FT)
10 20 30 40 50 60 70 80 90
CN 75
CN 75
CN 80
CN 80
AI 369
Q = 172
28.0 Ac-Ft
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

N14-H



Annual Mean Depth
Plate 2

N14-H



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

TPF-A

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: TPF-A

A_D: 219.4 Acres

Depth: From Bottom Elevation

A_B: Watershed Area = $A_D - A_P$

A_D: Total Drainage Area

Theoretical Capacity: A_P x Depth

A_P: Surface Area of Pond

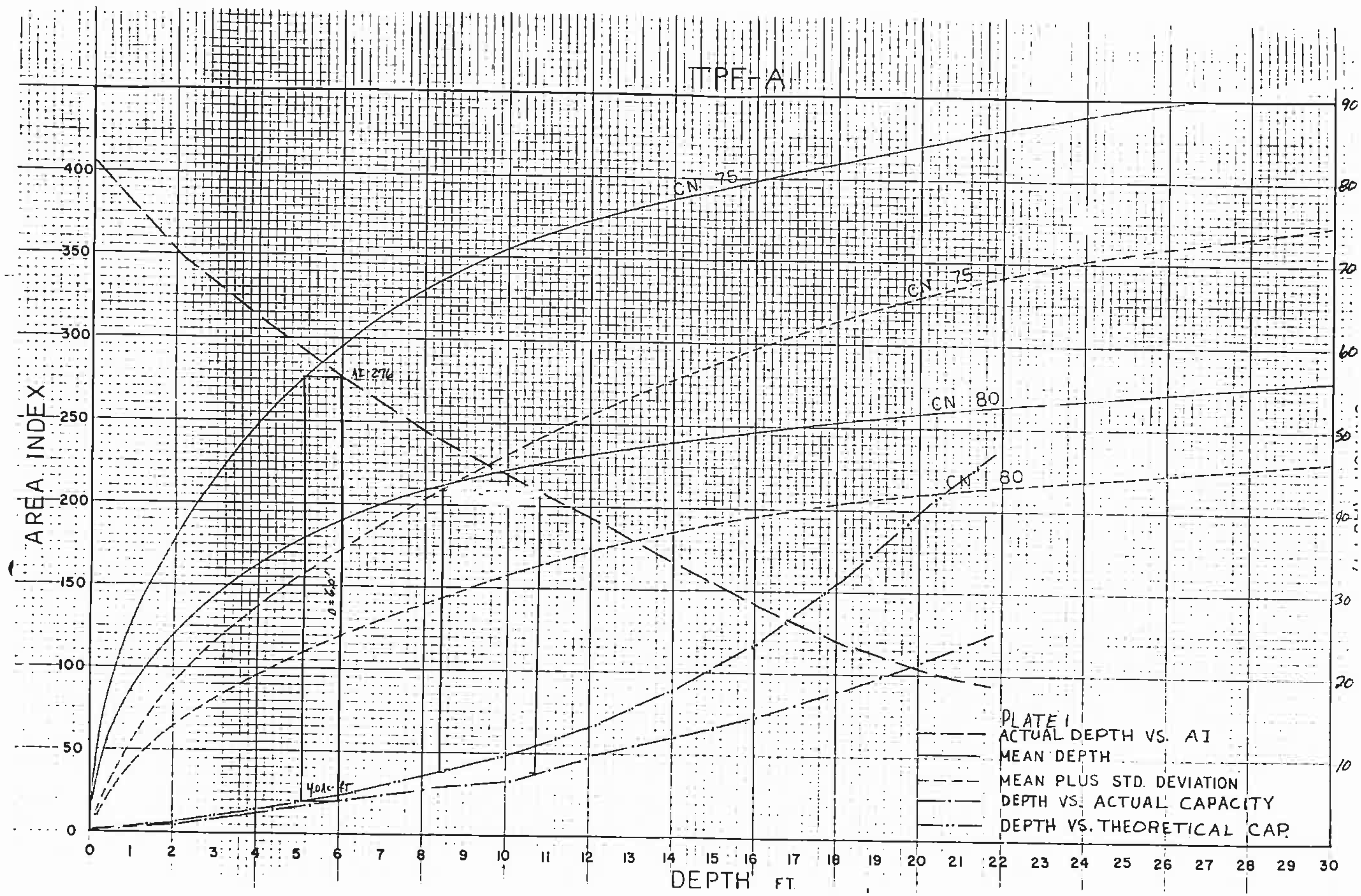
AI: Area Index = A_B/A_P

Notes: Existing Impoundment

Depth (ft)	Elevation (MSL)	A_P (AC)	A_B (AC)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6580	0.553	218.847	0.0	396	0.0
2	6582	0.637	218.763	1.3	343	1.2
4	6584	0.715	218.685	2.9	306	2.6
6	6586	0.807	218.593	4.8	271	4.1
8	6588	0.911	218.489	7.3	240	5.8
10	6590	1.014	218.386	10.1	215	7.7
12	6592	1.145	218.255	13.7	191	9.9
14	6594	1.307	218.093	18.3	167	12.4
16	6596	1.531	217.869	24.5	142	15.2
18	6598	1.779	217.621	32.0	122	18.5
20	6600	2.065	217.335	41.3	105	22.3
21.5	6601.5	2.200	217.200	47.3	99	26.6

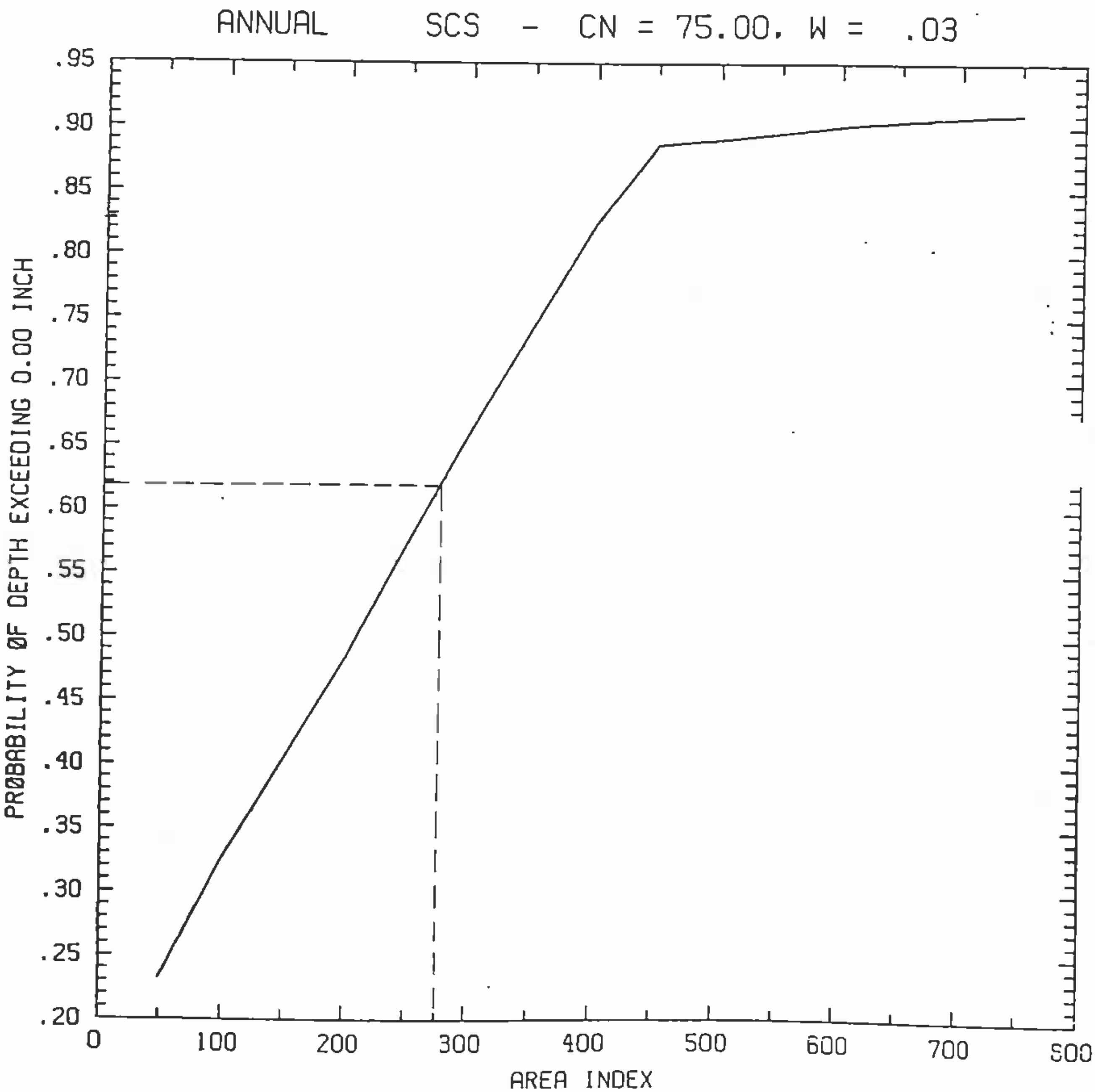
Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	6.0 ft.	--
	Minimum Depth (MIN)	--	3.4 ft.
	Actual Capacity	4.0 ac-ft.	2.0 ac-ft.
	AI	276	316
Plate 2 or 3:	Probability	62%	59%



TPF-A
AREA INDEX
DEPTH FT
CN 75
CN 75
CN 80
CN 80
AI 276
40 Ac-Ft
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

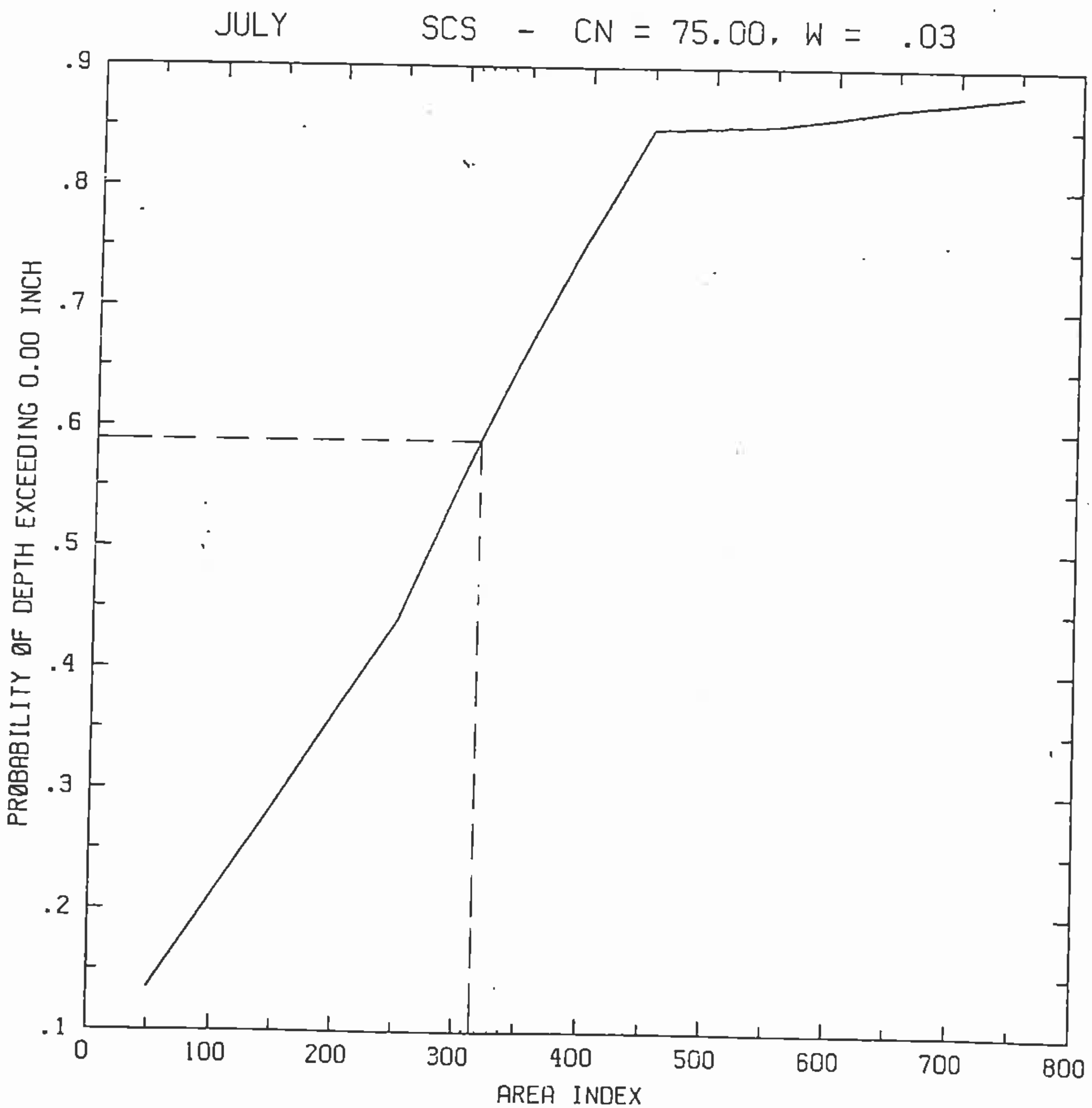
TPF-A



Annual Mean Depth

Plate 2

TPF-A



Minimum Depth
Plate 3

PERMANENT IMPOUNDMENT

TPF-D

WATER PERSISTENCE WORKSHEET

WATER PERSISTENCE WORKSHEET

Pond ID: TPF-D

A_D: 330.6 Acres

Depth: From Bottom Elevation

A_D: Total Drainage Area

A_P: Surface Area of Pond

A_B: Watershed Area = A_D - A_P

Theoretical Capacity: A_P x Depth

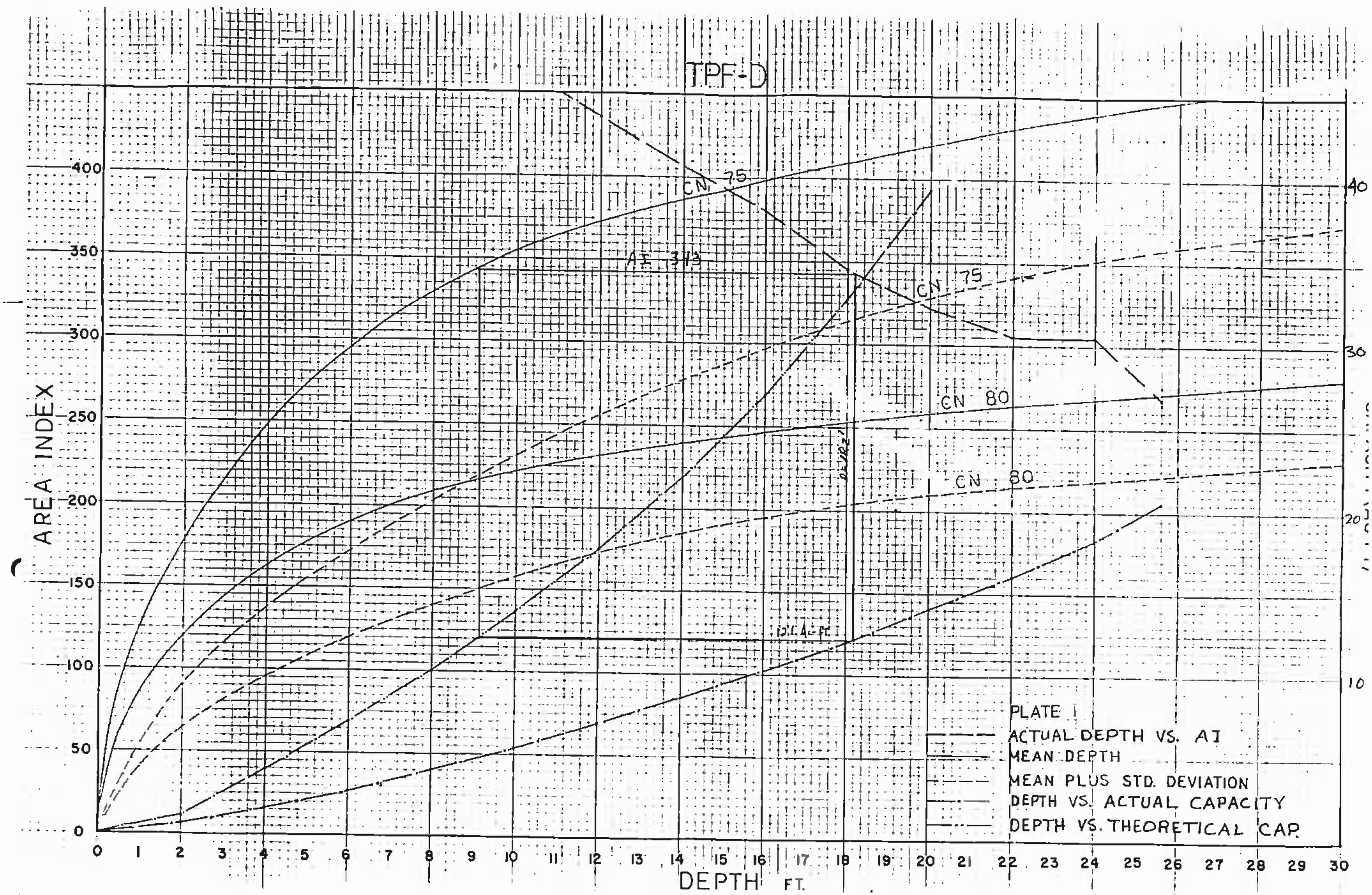
AI: Area Index = A_B/A_P

Notes: Existing Impoundment

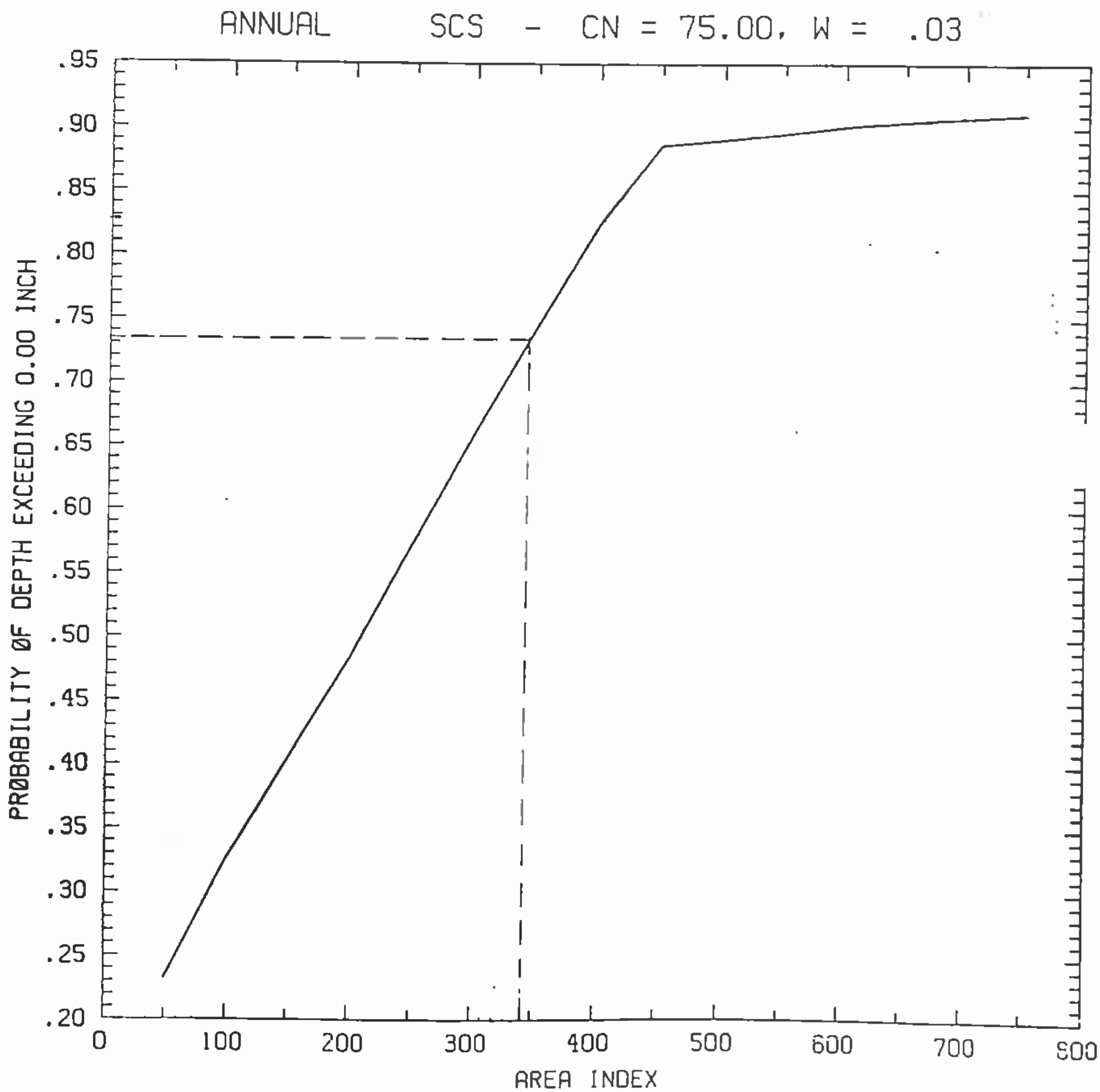
Depth (ft)	Elevation (MSL)	A_P (Ac)	A_B (Ac)	Theoretical Capacity (ac-ft)	AI	Actual Capacity (ac-ft)
0	6694	0.157	330.443	0	2105	0
2	6696	0.420	330.180	1.2	786	0.6
4	6698	0.545	330.055	3.9	606	1.6
6	6700	0.610	329.990	6.9	541	2.7
8	6702	0.660	329.940	10.1	500	4.0
10	6704	0.709	329.891	13.7	465	5.4
12	6706	0.757	329.843	17.6	436	6.9
14	6708	0.809	329.791	21.9	408	8.5
16	6710	0.864	329.736	26.8	382	10.2
18	6712	0.952	329.648	32.7	346	12.0
20	6714	1.019	329.581	39.4	323	14.0
22	6716	1.078	329.522	46.1	306	16.1
24	6718	1.079	329.521	51.8	305	18.3
25.6	6719.6	1.230	329.370	59.1	268	20.6

Results Assume CN = 75 and minimum depth (greater of) 3.0 feet or depth at 2.0 ac-ft.

Plate 1:	Annual Mean Depth (AMD)	18.2 ft	--
	Minimum Depth (MIN)	--	4.8 ft
	Actual Capacity	12.1 ac-ft	2.0 ac-ft
	AI	343	578
Plate 2 or 3:	Probability	73%	86%

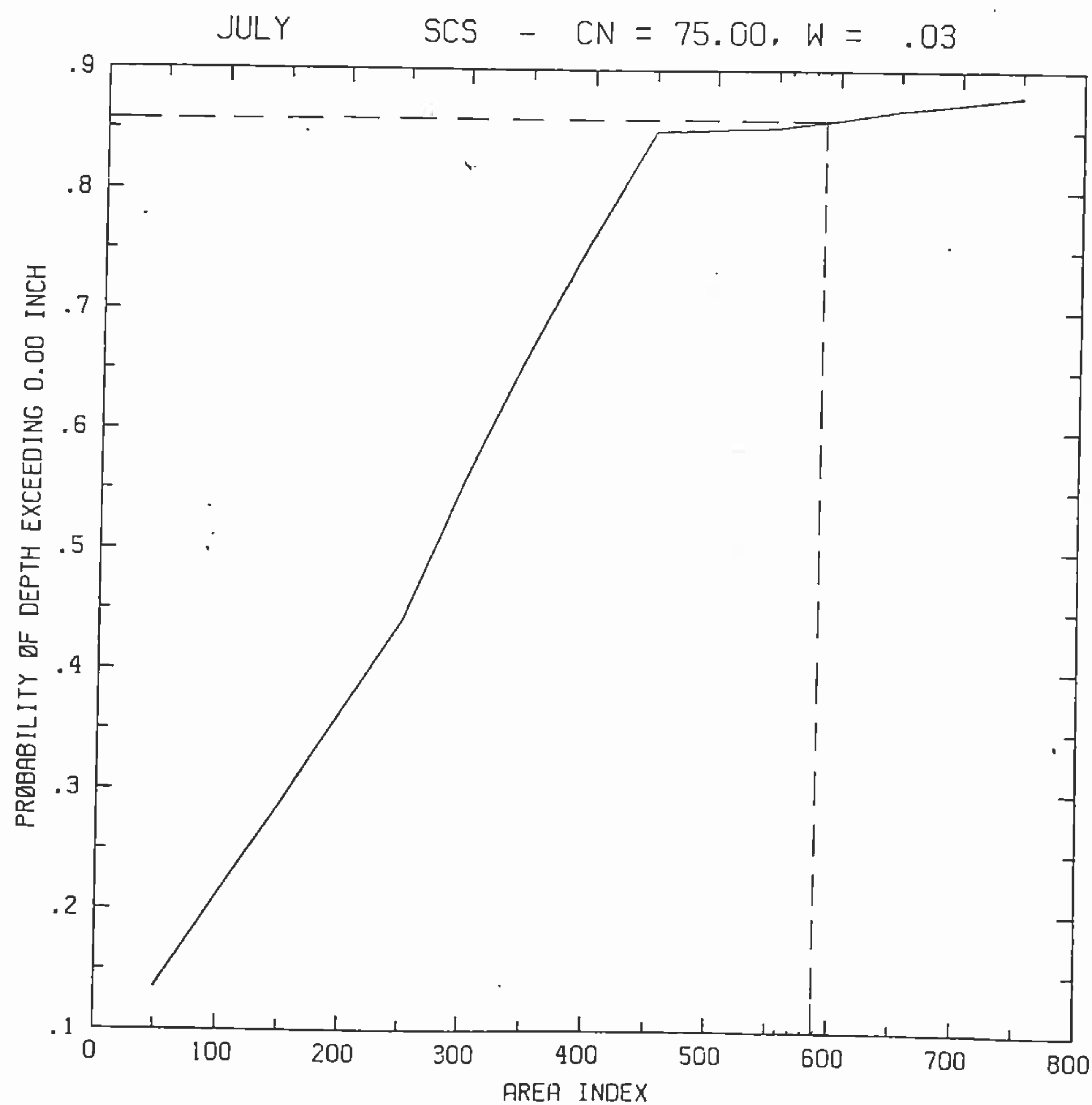

TPF-D
AREA INDEX
DEPTH FT.
CAPACITY (AC FT)
CN 75
CN 75
CN 80
CN 80
AI 343
PLATE I
ACTUAL DEPTH VS. AI
MEAN DEPTH
MEAN PLUS STD. DEVIATION
DEPTH VS. ACTUAL CAPACITY
DEPTH VS. THEORETICAL CAP.

TPF-D



Annual Mean Depth
Plate 2

TPF-D



Minimum Depth
Plate 3

CHAPTER 6

ATTACHMENT V

Primary Roads As-Built Certified Report

Revised May 10, 2002

Primary Roads As-Built Certified Report

Pursuant to 30 CFR, 816.151(a), once construction, or significant reconstruction is completed and adequate time has occurred to collect the "as-built" data, a Registered Professional Engineer will submit a certified report indicating construction or reconstruction has been performed in accordance with the approved plan. Typically, PWCC's Primary Roads As-Built Certified Report is the submittal of the Drawing No. 85400, "Drainage Area and Facilities Maps". Since July 6,1990 until May 10, 2002, all PWCC primary roads have been constructed or reconstructed as designed and in accordance with the approved plans, including the typical details included in this permit. Continuing in the future, PWCC's Primary Roads As-Built Certified Report is the submittal of the Drawing No. 85400, "Drainage Area and Facilities Maps". In addition, certified "as-built" drawings are kept on file at the mine site and are available for inspection.

CERTIFICATE 16782 JAMES SCHLENVOGT ARIZONA, U.S.A.

Engineer

MAY 10 2002

Date

ATTACHMENT W

Impoundments Hazard Map

Drawing No. 85408

Resident List

Revised 05/19/95

IMPOUNDMENTS HAZARD MAP DRAWING NO. 85408
RESIDENT LIST

SITE NO.	NAME	PWCC EASTING	PWCC NORTHING
1.0	ALBERT , ALTA R.	18163.00	-10886.00
1.1	ALBERT , ALTA R.	14561.00	-14862.00
2.0	ALBERT , EARLENE	17322.00	-11246.00
118.0	ALBERT , OLIVER	17909.95	-10989.98
3.0	ANDERSON , WOODY	44900.00	-21378.00
117.0	AUSTIN , BILLY	31857.56	10818.36
4.0	AUSTIN SR. , BILLY	31600.00	8800.00
301.0	B.M. BIBLE CHURCH	21035.18	-16355.32
5.0	BAHE , JOHN	36749.00	-15670.00
6.2	BECENTI , IRENE/KEEVIN	20356.00	-16059.00
6.0	BECENTI , IRENE/KEEVIN	21870.34	-14806.50
6.1	BECENTI , IRENE/KEEVIN	21901.31	-14879.08
7.2	BEGAY , BAH	77936.00	-38947.00
7.1	BEGAY , BAH	77550.00	-40394.00
7.0	BEGAY , BAH	77300.00	-40380.00
8.3	BEGAY , BESSIE	36343.23	-23479.45
8.0	BEGAY , BESSIE	36343.23	-23479.45
8.1	BEGAY , BESSIE	36215.65	-23368.40
8.2	BEGAY , BESSIE	36215.65	-23368.40
8.4	BEGAY , BESSIE	32122.00	-24673.00
9.1	BEGAY , BILTA	73147.00	-52302.00
9.4	BEGAY , BILTA	73100.00	-52300.00
9.2	BEGAY , BILTA	72950.00	-52300.00
9.3	BEGAY , BILTA	55399.00	-52434.00
9.0	BEGAY , BILTA	55431.00	-52299.00
10.1	BEGAY , DANNY	73217.00	-52396.00
10.0	BEGAY , DANNY	73212.00	-53065.00
11.1	BEGAY , EDITH	44832.24	-21484.31
11.0	BEGAY , EDITH	44856.14	-21441.58
133.0	BEGAY , EDWARD	43835.30	-8651.67
14.0	BEGAY , ELSIE	29129.00	-33838.00
12.0	BEGAY , GEORGE/LENA	37837.00	-11453.00
7.1	BEGAY , HARVEY	77960.00	-34868.00
7.0	BEGAY , HARVEY	78023.09	-34779.59
130.0	BEGAY , JOHN D.	77455.60	-39421.11
116.0	BEGAY , KEE Z.	20031.00	-55229.00
127.0	BEGAY , LENORA	69786.00	-44063.00
13.0	BEGAY , LEO	72887.00	-52078.00
15.0	BEGAY , PHILLIP	72826.00	-52120.00
16.0	BEGAY , RAYMOND	78043.00	-38612.00
131.0	BEGAY , RAYTHANIEL	78926.03	-38850.23
17.0	BEGAY , TEDDY	21521.00	-52016.00
17.3	BEGAY , TEDDY	29900.00	-62800.00
17.4	BEGAY , TEDDY	29880.00	-62850.00
17.2	BEGAY , TEDDY	29900.00	-62875.00

OCT 2002 APPROVED

REVISED 01/25/2002

IMPOUNDMENTS HAZARD MAP DRAWING NO. 85408
RESIDENT LIST

SITE NO.	NAME	PWCC EASTING	PWCC NORTHING
41.2	CRANK , SIMON	60682.00	-16278.00
41.1	CRANK , SIMON	60881.00	-16136.00
42.0	CRANK , THOMAS	60792.00	-15680.00
43.0	CRANK JR. , SIMON/TABBY	61578.00	-15164.00
44.0	CRANK. , BEN	53675.00	-13908.00
120.0	EDSITTY, LAURA	19197.00	-25326.00
45.2	ETSITTY , CALVIN	38102.00	-10416.00
45.1	ETSITTY , CALVIN	38063.97	-11031.72
45.0	ETSITTY , CALVIN	30200.06	-27906.92
46.0	ETSITTY , LAURA	22247.00	-33065.00
47.2	ETSITTY , LESLIE	30148.29	-27958.00
47.0	ETSITTY , LESLIE	30216.38	-27922.25
47.1	ETSITTY , LESLIE	37259.65	-10233.72
48.0	ETSITTY , PHILLIP	37666.00	-11343.00
48.1	ETSITTY , PHILLIP	37704.00	-11297.00
49.0	ETSITTY , STEVEN/IRENE	20657.00	-15658.00
49.1	ETSITTY , STEVEN/IRENE	38364.71	-9702.62
50.0	FARLEY , CORNELIUS/GRACE	20756.00	-15657.00
51.0	FREEMAN , IRENE	9125.00	-24125.00
51.1	FREEMAN , IRENE	11480.00	-17868.00
51.2	FREEMAN , IRENE	12336.00	-21247.00
52.1	GILMORE , MARY	66639.76	-50390.78
52.0	GILMORE , MARY	55000.00	-56000.00
121.0	HARVEY , LEMAN/JEAN	16397.02	14470.62
53.1	HERRERA , ANNIE	18802.00	-10533.00
53.0	HERRERA , ANNIE	21229.00	-15083.00
53.4	HERRERA , ANNIE	18521.00	-10092.00
53.2	HERRERA , ANNIE	18521.00	-10092.00
53.3	HERRERA , ANNIE	18719.10	-10290.10
54.0	HONIE , LEONARD/MARIE	71004.00	-43493.00
54.1	HONIE , LEONARD/MARIE	77408.00	-39264.00
[illegible]3.0	JAMES , JOE	20789.83	-50758.48
55.0	JIM , MABEL/BENNIE	62235.23	-15923.03
29.0	JOHNSON , BERT	53098.45	-14195.55
56.0	JOHNSON , GRACE	59358.38	-14608.51
57.0	JOHNSON , MILTON/LILY	20638.00	-15918.00
57.1	JOHNSON , MILTON/LILY	52975.47	-14110.78
58.1	JOHNSON , PAUL/THELMA	60187.00	-15464.00
58.0	JOHNSON , PAUL/THELMA	62189.58	-15980.38
58.2	JOHNSON , PAUL/THELMA	59857.89	-11128.89
59.1	JOHNSON , SPENCER	60721.00	-15011.00
59.0	JOHNSON , SPENCER	60762.78	-15145.43
122.0	JOHNSON JR., PAUL	60309.28	-15592.00
60.0	KEE , CHARIE/SARAH	66658.00	-25391.00
61.0	KELLY , SADIE/PRESTON	67362.00	-26023.00

IMPOUNDMENTS HAZARD MAP DRAWING NO. 85408
RESIDENT LIST

SITE NO.	NAME	PWCC EASTING	PWCC NORTHING
88.1	PULINOS , GEORGE/MAE	55144.00	-49446.00
88.0	PULINOS , GEORGE/MAE	61595.99	-52035.15
89.0	RUSSEL , JERRY	55340.00	-52545.00
90.0	RUSSELL , KEE/JULIA	55418.00	-52613.00
91.0	RUSSELL , KEITH/PAULETTA	60066.00	-15310.00
91.1	RUSSELL , KEITH/PAULETTA	60147.00	-14977.00
92.0	SAVAGE , LINDA	36254.00	-33426.00
93.0	SAVAGE , SARAH	35519.22	-32618.11
94.0	SCHMITT , HENRY	39208.00	-51331.00
95.0	SEATON , EVELYN	20814.00	-15319.00
95.1	SEATON , EVELYN	53764.00	-14702.16
124.0	SEGAY, LAVONNE	36411.06	-46581.80
96.0	SHERLOCK , TOM/JULIA	55981.00	-49459.00
97.0	SMITH , AMBROSE	19085.00	-36257.00
98.0	SMITH , BESSIE	19498.00	-36976.00
99.0	SMITH , FRED	17101.00	-32252.00
99.2	SMITH , FRED	17181.00	-32658.00
99.1	SMITH , FRED	17302.00	-32618.00
100.0	SNEDDY , LOCITA	50324.00	2300.00
101.0	TALLMAN , FANAE/STANLEY	20401.00	-16321.00
102.1	TSO , ROY/ALICE	44927.00	-21578.00
102.0	TSO , ROY/ALICE	44745.00	-21570.00
102.2	TSO , ROY/ALICE	45000.00	-21470.00
103.0	TSOSIE , STANLEY/CONNIE	16438.73	6750.67
300.0	UNKNOWN ,	30000.00	-63200.00
300.0	UNKNOWN ,	29960.00	-63210.00
300.0	UNKNOWN ,	29890.00	-63240.00
300.0	UNKNOWN ,	29940.00	-63400.00
104.0	VANDEVER , ELSIE	36542.23	-23295.53
104.1	VANDEVER , ELSIE	36673.03	-23320.83
105.0	VANDEVER , LORRAINE	36876.00	-46180.00
106.0	WILLIAMS , GEORGE/LETA	15757.00	7012.00
107.3	YAZZIE , ALICE	54941.00	-49982.00
107.2	YAZZIE , ALICE	29465.00	10017.00
107.1	YAZZIE , ALICE	28579.00	6491.00
107.0	YAZZIE , ALICE	28650.00	6429.00
107.4	YAZZIE , ALICE	22989.00	4195.00
108.0	YAZZIE , ARLENE	21500.00	-51800.00
109.0	YAZZIE , JAMES	18712.00	-10743.00
109.1	YAZZIE , JAMES	28980.00	7615.00
110.0	YAZZIE , LINDA	22387.00	-32954.00
111.0	YAZZIE , MARILYN	66045.00	-25408.00
111.1	YAZZIE , PRISCILLA	65880.00	-25559.00
112.5	YAZZIE , ROSE	60433.00	-13457.00

REVISED 01/25/2002

Resident List

Site No.	Last Name	First Name	Easting	Northing
1.10	BEGAY	BILTA	73,147.0	-52,302.0
1.20	BEGAY	BILTA	73,100.0	-52,300.0
1.30	BEGAY	BILTA	72,950.0	-52,300.0
2.00	BEGAY	DANNY	73,217.0	-52,396.0
3.00	BEGAY	DANNY	73,212.0	-53,065.0
4.00	KESCOLI	JOHN/HELEN	56,972.0	-52,497.0
5.00	KESCOLI	JOHN/HELEN	57,025.0	-52,381.0
6.00	KESCOLI	MAXINE	58,003.0	-52,045.0
7.00	LITTLE	JIMMIE/TERESA	57,058.0	-52,478.0
8.00	BEGAY	BILTA	55,399.0	-52,434.0
9.00	BEGAY	BILTA	55,431.0	-52,299.0
10.00	RUSSELL	JERRY	55,340.0	-52,545.0
11.00	RUSSELL	KEE/JULIA	55,418.0	-52,613.0
14.00	PULINOS	GEORGE/MAE	55,144.0	-49,446.0
15.00	SHERLOCK	TOM/JULIA	55,981.0	-49,459.0
18.00	YAZZIE	ALICE	54,941.0	-49,982.0
21.00	GILMORE	MARY	64,051.0	-45,273.0
22.00	GILMORE	MARY	64,154.0	-45,301.0
23.00	KESCOLI	MAXINE	64,162.0	-45,122.0
[illegible].00	KESCOLI	MAXINE	64,240.0	-45,096.0
[illegible].00	BEGAY	KEE JOHN	64,302.0	-45,028.0
[illegible].00	LAKE	ATED	54,171.0	-42,132.0
29.00	LAKE	ATED	54,181.0	-42,078.0
33.00	LAKE	ESTHER	58,136.0	-39,177.0
39.00	WHITEHAIR	OSCAR/ZONNIE	66,698.0	-41,050.0
40.00	CHARLEY	KATIE	77,707.0	-31,802.0
41.00	CHARLEY	KATIE	77,717.0	-31,751.0
44.00	KELLY	SADIE/PRESTON	67,362.0	-26,023.0
45.00	YAZZIE	PRISCILLA	65,880.0	-25,559.0
46.00	YAZZIE	PRISCILLA	66,045.0	-25,408.0
47.00	TSO	ROY/ALICE	44,927.0	-21,578.0
48.00	TSO	ROY/ALICE	44,745.0	-21,570.0
49.00	CHIEF	BILL/SALLY	60,453.0	-15,514.0
50.00	CHIEF	BILL/SALLY	60,557.0	-15,478.0
51.00	JIM	MABEL/BENNIE	62,217.0	-15,943.0
52.00	JOHNSON	SPENCER	60,721.0	-15,011.0
53.00	RUSSELL	KEITH/PAULETTA	60,066.0	-15,310.0
54.00	RUSSELL	KEITH/PAULETTA	60,147.0	-14,977.0
55.00	YAZZIE	ROSE	60,433.0	-13,457.0
56.00	YAZZIE	ROSE	60,519.0	-13,375.0
57.00	YAZZIE	ROSE	60,522.0	-13,570.0
61.10	CRANK	LILLY	52,827.0	-14,605.0
61.20	CRANK	LILLY	52,827.0	-14,705.0
62.00	CODY SR	JAMES	50,224.0	2,295.0
[illegible]3.00	YAZZIE	ALICE	29,465.0	10,017.0
[illegible].00	YAZZIE	ALICE	28,579.0	6,491.0

Resident List

Site No.	Last Name	First Name	Easting	Northing
121.00	BENALLY	DANIEL/MABEL	29,025.0	-33,950.0
122.00	BENALLY	DANIEL/MABEL	29,068.0	-33,962.0
123.00	LAKE	DZANH	36,126.0	-33,616.0
124.00	SAVAGE	LINDA	36,254.0	-33,426.0
125.00	LAKE	SAM	37,077.0	-31,358.0
126.00	BENALLY	DANIEL/MABEL	28,133.0	-38,685.0
127.00	LAKE	ATED	31,271.0	-39,701.0
129.00	KESCOLI	EARL/ANCITA	37,338.0	-45,389.0
132.00	LAKE	MARY	36,314.0	-46,098.0
133.00	LAKE	MARY	36,495.0	-46,170.0
134.00	LAKE	MILTON	36,443.0	-46,276.0
137.00	BOYD	MARY	21,568.0	-48,444.0
139.00	LITTLE	BEN/IDA	32,238.0	-54,407.0
140.00	LITTLE	SAM/ELLA	32,223.0	-54,464.0
141.00	BOYD	MARY	33,931.0	-55,862.0
143.00	SAVAGE	SARAH	35,497.0	-32,632.0
144.00	LAKE	CINDY	35,572.0	-32,541.0
145.00	SCHMITT	HENRY	39,208.0	-51,331.0
147.00	LEONARD	EUGENE	20,928.0	-49,507.0
148.00	LEONARD	EUGENE	20,933.0	-49,463.0
[illegible].00	KEE	CHARLIE/SARAH	66,658.0	-25,391.0
[illegible]00	BAHE	JOHN	36,749.0	-15,670.0
[illegible].00	HERRERA	ANNIE	18,521.0	-10,092.0
152.00	YAZZIE	JAMES	18,712.0	-10,743.0
153.00	LUNA	BESSIE	18,448.0	-11,590.0
154.10	VANDEVER	GARY/ELSIE	36,510.0	-23,299.0
154.20	VANDEVER	GARY/ELSIE	36,600.0	-23,300.0
155.00	BEGAY	BESSIE	36,310.0	-23,480.0
156.00	BEGAY	EDITH	44,841.0	-21,483.0
157.00	TSO	ROY/ALICE	45,000.0	-21,470.0
159.00	LAKE	MOLITA	38,221.0	-31,437.0
162.00	HONIE	LEONARD/MARIE	71,004.0	-43,493.0
164.00	SMITH	AMBROSE	19,085.0	-36,257.0
165.00	JOHNSON	MILTON/LILY	52,985.0	-14,137.0
166.00	CRANK	HARRISON	53,070.0	-14,631.0
168.00	LITTLE	AMY	60,515.0	-13,905.0
169.00	YAZZIE	ROSE	60,665.0	-14,310.0
170.10	CRANK	ROBERT/LINDA	60,749.0	-15,959.0
170.20	CRANK	ROBERT/LINDA	60,755.0	-15,960.0
171.00	CRANK	THOMAS	60,792.0	-15,680.0
173.00	KESCOLI	MAXINE	67,341.0	-48,813.0
174.00	LUFKIN	WAYNE/MARTHA	72,803.0	-52,019.0
175.00	BEGAY	PHILLIP	72,826.0	-52,120.0
176.00	BEGAY	LEO	72,887.0	-52,078.0
178.00	VANDEVER	LORRAINE	36,876.0	-46,180.0
[illegible].10	LAKE	CLARENCE	36,686.0	-46,367.0
[illegible].20	LAKE	CLARENCE	36,710.0	-46,380.0

Resident List

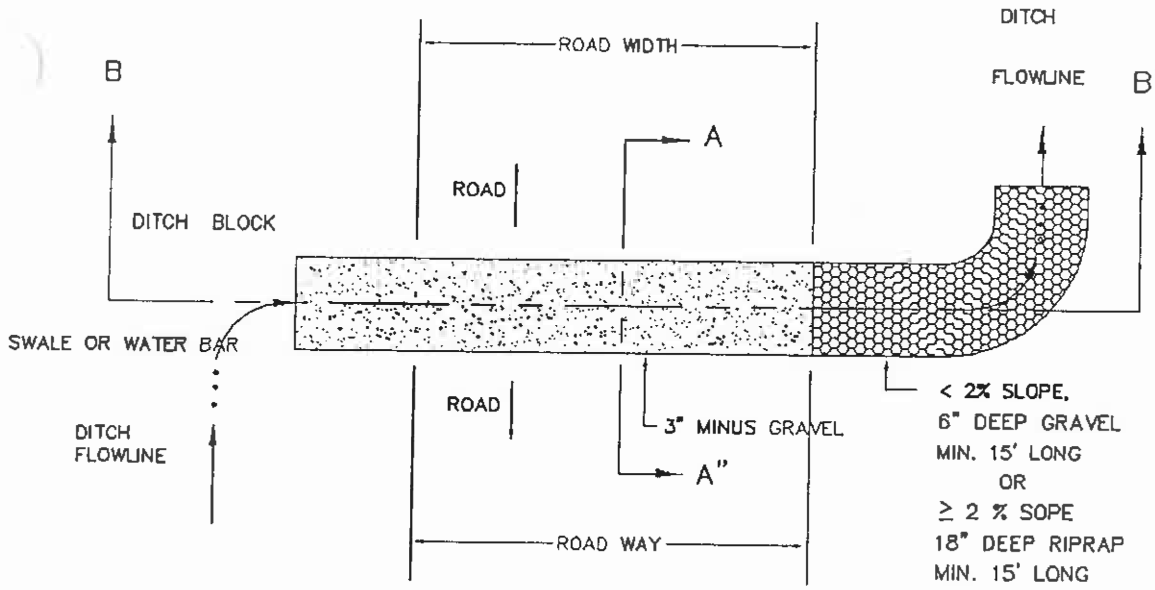
Site No.	Last Name	First Name	Easting	Northing
325.00	BEGAY	TEDDY	29,900.0	-62,875.0
326.00	BEGAY	TEDDY	30,050.0	-63,200.0
327.00	UNKNOWN	UNKNOWN	30,000.0	-63,200.0
328.00	UNKNOWN	UNKNOWN	29,960.0	-63,210.0
329.00	UNKNOWN	UNKNOWN	29,890.0	-63,240.0
330.00	UNKNOWN	UNKNOWN	29,940.0	-63,400.0

ATTACHMENT X

Typical Water Bar and Road Swale Detail

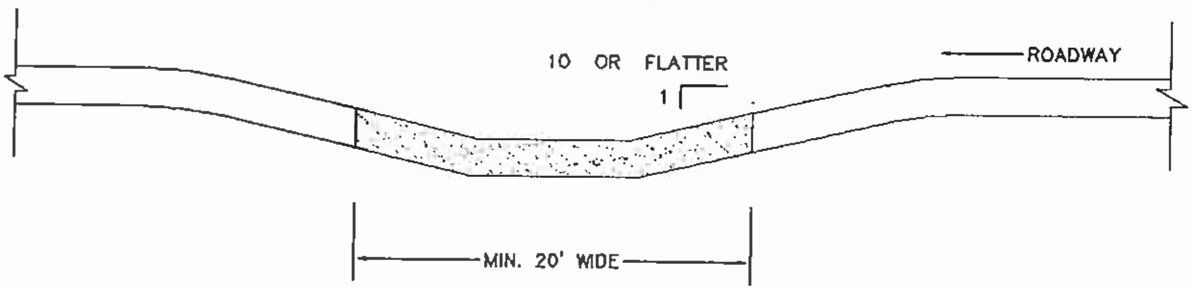
PLAN VIEW

WATER BAR (FOR EPHEMERAL CHANNEL ONLY)



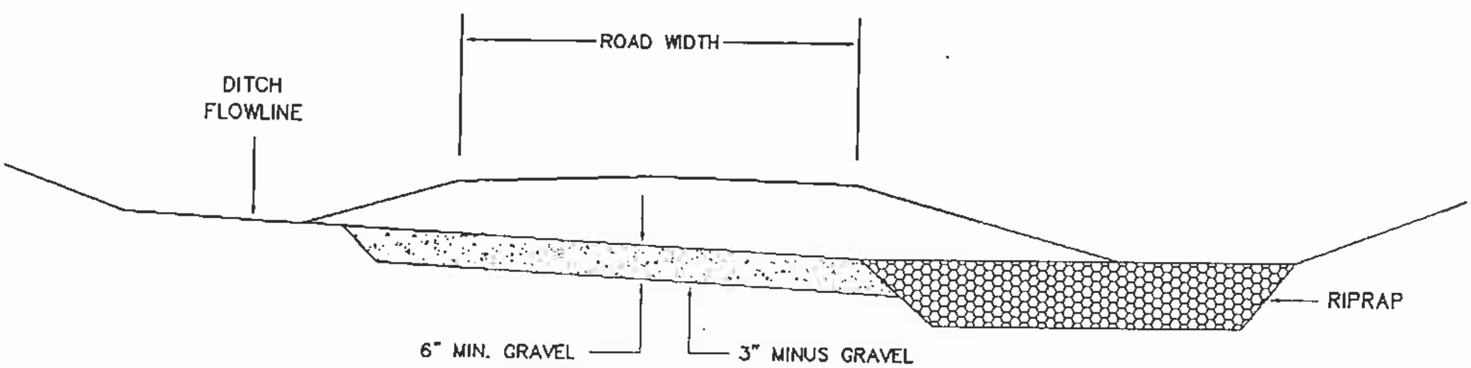
TYPICAL CROSS-SECTION

SECTION A-A'



TYPICAL PROFILE

SECTION B - B'



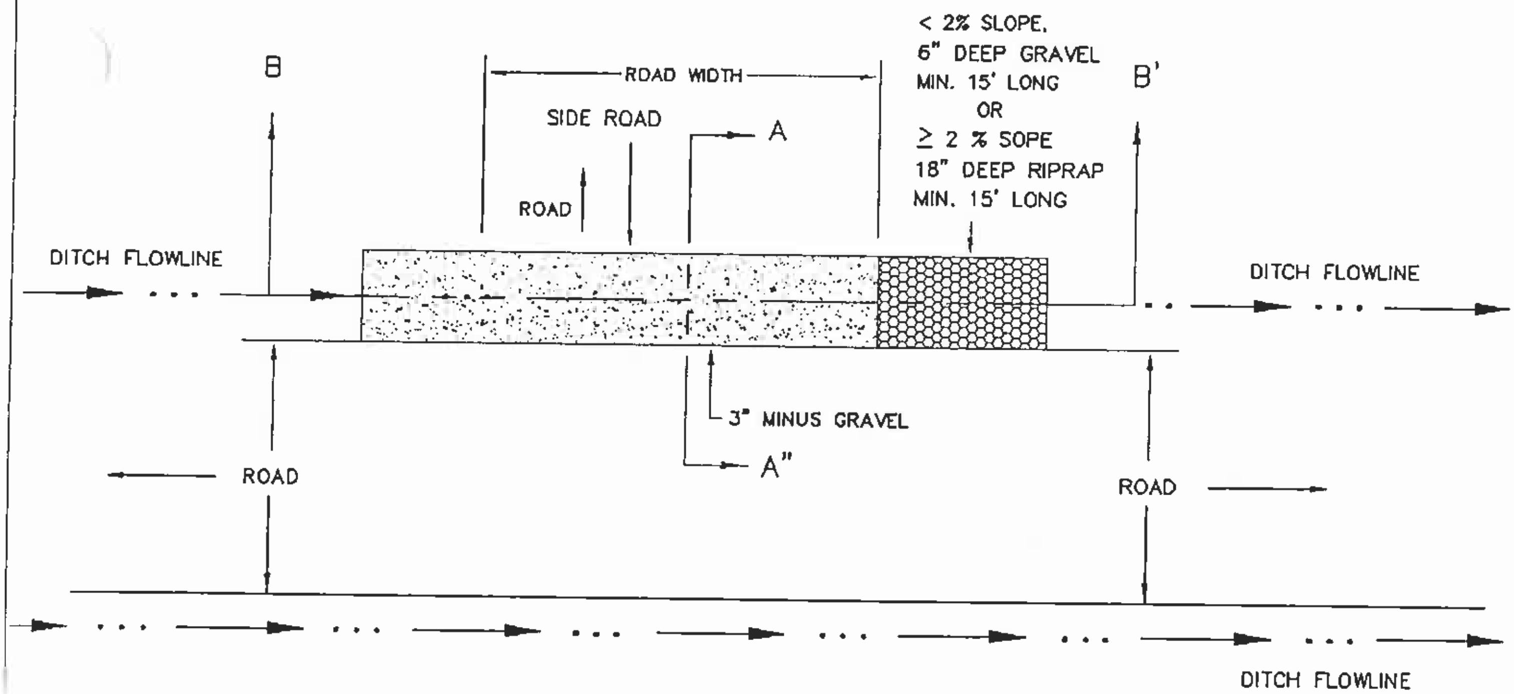
NOT TO SCALE

PEABODY WESTERN COAL COMPANY
BLACK MESA COMPLEX
PLATE 1
TYPICAL WATER BAR

DESIGNED BY: JGS	SCALE: NO SCALE
DRAWN BY: PWCC	DRAWING DATE: 6-28-96
CHECKED BY: JGS	PHOTO DATE:
CONTOUR INTERVAL:	DWG FILE: WATER BAR

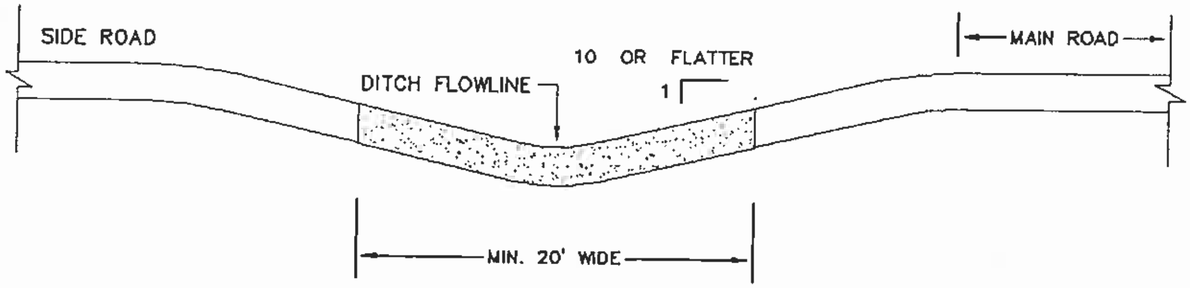
PLAN VIEW

ROAD SWALE (FOR EPHEMERAL CHANNEL ONLY)



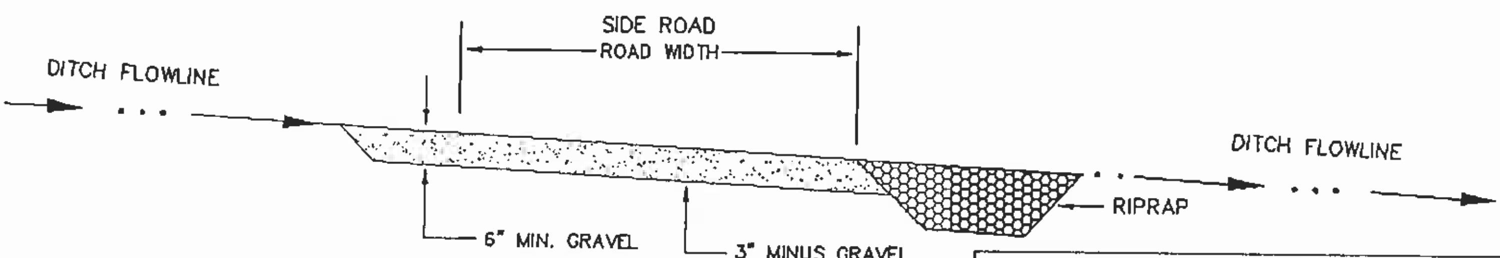
TYPICAL CROSS-SECTION

SECTION A-A'



TYPICAL PROFILE

SECTION B - B'



NOT TO SCALE

PEABODY WESTERN COAL COMPANY
BLACK MESA COMPLEX

PLATE 2

TYPICAL ROAD SWALE

DESIGNED BY: JGS	SCALE: NO SCALE
DRAWN BY: PWCC	DRAWING DATE: 6-28-96
CHECKED BY: JGS	PHOTO DATE:
CONTOUR INTERVAL:	DWG FILE: RDSWALE

ATTACHMENT Y

Temporary Sedimentation Pond N14-T

Permit Information

DESIGN REPORT

Temporary Sedimentation Structure
N-14T
Kayenta Mine
Navajo County, Arizona

PEABODY WESTERN COAL COMPANY

Registered Professional Engineer (Civil)
CERTIFICATE NO.
18782
JAMES GARY
SCHLENVOGT
Date Signed
ARIZONA, U.S.A.
OCT 01 1996

Revised 10/01/96

TABLE OF CONTENTS

Introduction

Sedimentation Structure N14-T will be insized with a small earthen embankment, designed, and to be constructed upon approval by OSMRE in 1996, by Peabody Western Coal Company as a temporary sedimentation structure to control runoff and sediment from a reclaimed stockpile (No. N14-14) located at the Kayenta Mine. The location of Structure N14-T is shown on Plate 1, Site Plan, Drawing No. 85400 (Sheet M-8) and Drawing No. 85405. The pond will be required to control sediment and runoff from the disturbance associated with this revegetated stockpile.

This design report contains information specific to Structure N14-T. Regional site information is presented in the "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona for Peabody Western Coal Company", December 1985 (PAP), Chapter 6, Attachment D, Volume 2 along with the methods and results of analyses used for slope stability, hydrology, and hydraulics.

Inspection

The proposed site of Structure N14-T was inspected by a senior engineer from Peabody Western Coal Company in June, 1996 to ensure that the site is suitable and no adverse conditions exist to prevent the successful construction of the structure. A detailed geotechnical investigation was not performed, rather, the information in Chapter 6, Attachment D will be utilized for embankment design during construction.

Site Description

Land Use. Structure N14-T has a 2.1-acre tributary drainage area. The watershed is classified as a 100 percent reclaimed area.

Embankment. A homogeneous earthen embankment, a minimum of ten feet wide, was assumed for the hydraulic analysis and to develop the stage-capacity chart shown on Plate 2. An upstream slope of 2:1 (horizontal to vertical) and downstream slopes of 3H:1V were used.

Design Analysis

General. Structure N14-T was designed by a senior engineer from Peabody Western Coal Company. The design was performed in accordance with applicable 30 CFR 715 regulations of the United States Department of Interior, Office of Surface Mining (OSM) and included a review of available project files. The most current information contained in the Peabody Western Coal Company files includes topographic maps developed from aerial photography flown in 1985 for Peabody Western Coal Company and was used in the analyses of the structure.

Stability. The slopes of Structure N14-T will be chosen based on the stability analyses performed for existing structures in the General Report. The design assumes "worst case" embankment material (see Attachment D). The embankment fill materials and the type of foundation will be identified in the field during construction and stable slopes will be chosen based on the category classification of the structure.

Hydrology. The hydrologic analysis was completed using Civil Software Design's computer program SEDCAD+ (see Appendix A, B, and C). Structure N14-T is not in series with any other structure nor does the structure fall under the guidelines of the 30 CFR Section 77.216 for MSHA size structures. Therefore, the spillway was analyzed using the 25-year, 24-hour storm. The storage capacity of Structure N14-T was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course Length, L	0.133 mi
2.	Elevation Difference, H	12 ft
3.	Time of Concentration, T_c	0.097 hr
4.	SCS Curve Number	87
5.	Rainfall Depth, 10-year, 24-hour storm	2.1 in
	25-year, 24-hour storm	2.5 in
6.	Drainage Area	2.1 acres

Hydraulics. The SEDCAD+ program was used to evaluate inflow to the planned sedimentation structure, outflow from the structure, and the resulting water surface elevations. The initial conditions and results of the analysis are summarized in the following table.

N14-T Hydraulics

	Units	10-Yr 24-Hr Storm	25-Yr, 24-Hr Storm
Initial Reservoir Volume Condition		Empty	Full to principal spillway elevation
Inflow			
Peak Flow	cfs	2.2	2.84
Volume	ac-ft	0.17	0.23
Storage			
Peak Stage	ft	6603.0	6603.6
Principal Spillway Elevation	ft	6603.0	6603.0
Emergency Spillway Elevation	ft	6604.0	6604.0
Peak Storage	ac-ft	0.17	0.28
Storage Capacity	ac-ft	0.24	0.49
Available Sediment Storage	ac-ft	.07	-
Sediment Inflow Rate	ac-ft/yr	.0089	-
Sediment Storage Life	years	8	-
Outflow			
Peak Flow	cfs	0	2.11
Embankment Crest			
Elevation	ft	6606.0	6606.0
Peak Stage	ft	6603.0	6603.6
Freeboard	ft	3.0	2.4

Principal Spillway Channel. The principal spillway for N14-T will be a minimum of one foot lower than the emergency spillway and be a trapezoidal channel with the following dimensions.

Channel depth	1.0 ft.
Channel bottom width	2.0 ft.
Channel length	10 ft.
Side slopes (horizontal to vertical)	0.1:1 or flatter
Average exit slope	0.5 percent
Inlet elevation	6603.0

The outflow channel will not require protection against erosion (see Appendix A). However, the spillway will be lined with a three-inch minus gravel.

Emergency Spillway Channel. The emergency spillway for N14-T will be a trapezoidal channel with the following dimensions.

Channel depth	1.0 ft
Channel bottom width	5 ft
Channel length	10 ft
Side slopes (horizontal to vertical)	3:1 or flatter
Average exit slope	0.5 percent
Inlet elevation	6604.0

The outflow channel will not require protection against erosion. However, the spillway will be lined with a three-inch minus gravel.

Storage Capacity. The impoundment volume-elevation curve is based on the most current topographic maps available in developing Plate 2, Volume-Elevation Curve, N14-T.

The calculations for the sediment load entering Structure N14-T were made utilizing the Revised Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R	40
2. Soil Erodibility Factor, K	0.42
3. Slope Length Factor, LS	2.234
4. Cover Factor, C	0.240
5. Erosion Control Factor, P	1.0

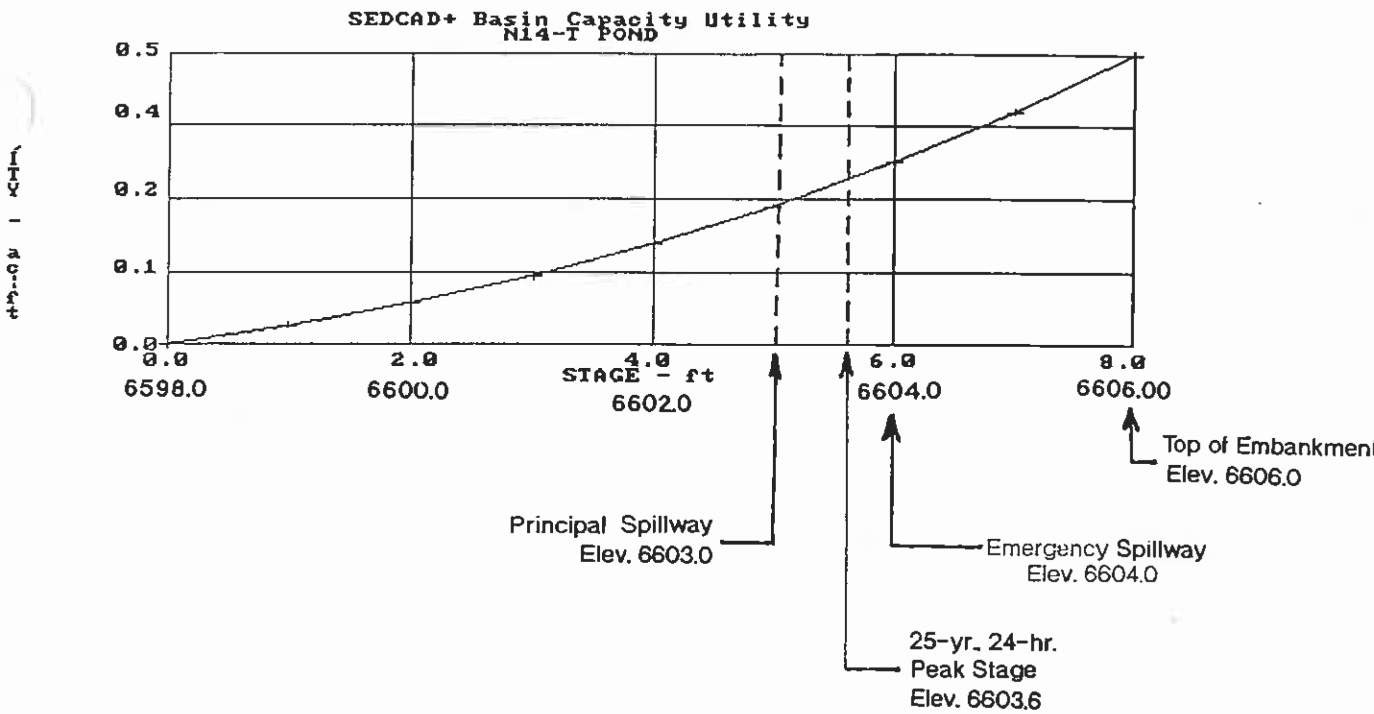
The hydrologic analysis gives the storage volume required to contain the 10-year, 24-hour storm, and the remaining storage volume available for storing sediment. The proposed storage capacity of N14-T and the results of the sediment inflow analysis are summarized in the following table.

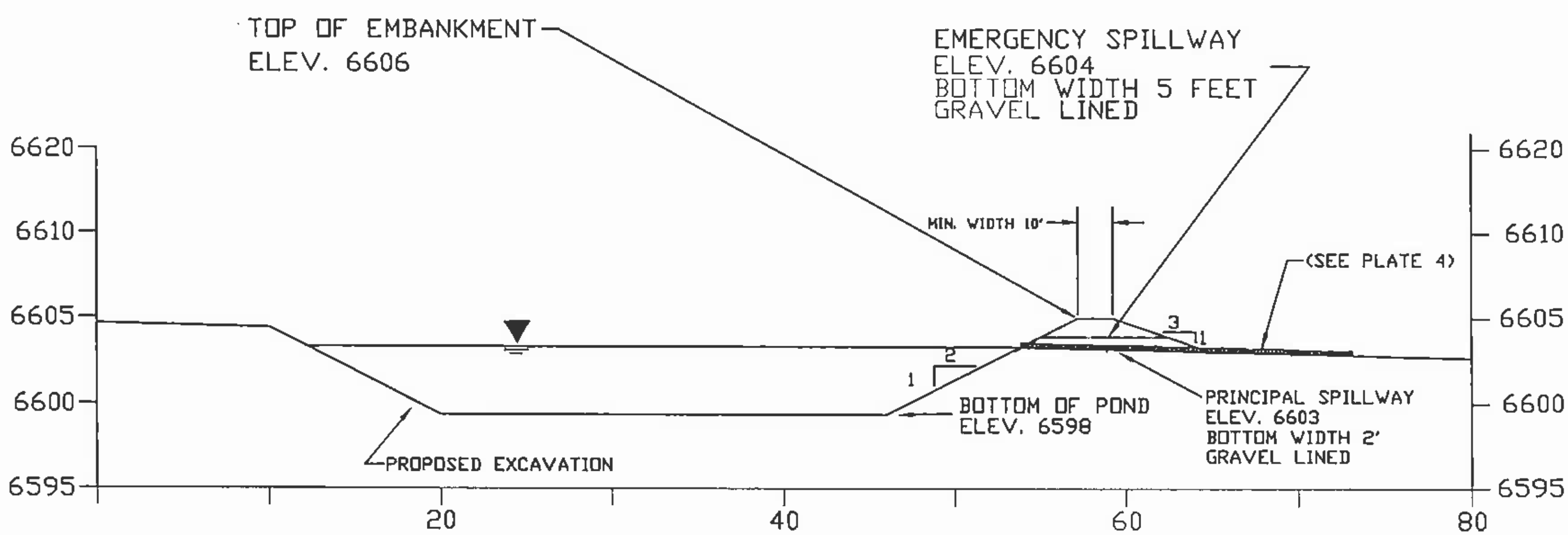
N14-T Storage

Total Storage Capacity	0.24 acre-ft
10-year, 24-hour Storm Inflow	0.17 acre-ft
Available Sediment Storage Capacity	0.07 acre-ft
Sediment Inflow Rate	.0088 ac-ft/yr
Sediment Storage Life	8 yrs

The following plates and appendices are attached and complete this design report.

Plate 1 -	Site Plan N14-T
Plate 2 -	Stage-Capacity Chart
Plate 3 -	Cross-Section A-A'
Plate 4-	Emergency Spillway Typical Cross Section
Appendix A -	Hydrology, Hydraulic, and Sedimentology Calculations
Appendix B -	SEDCAD+ (Input and Output) 10-year, 24-hour Storm
Appendix C -	SEDCAD+ (Input and Output) 25-year, 24-hour Storm

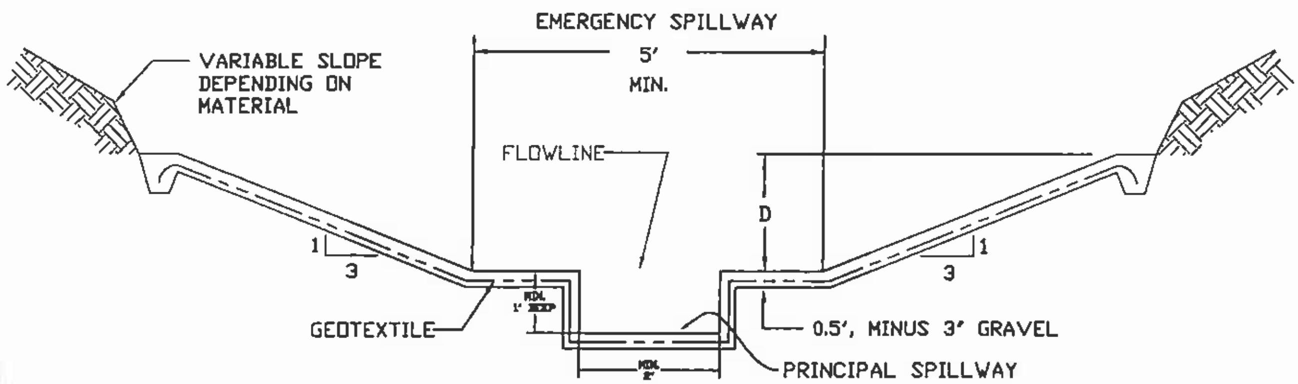

SEDCAD+ Basin Capacity Utility
N14-T POND
0.5
0.4
0.2
0.1
0.0
0.0
2.0
4.0
6.0
8.0
STAGE - ft
6598.0
6600.0
6602.0
6604.0
6606.00
Top of Embankment
Elev. 6606.0
Principal Spillway
Elev. 6603.0
Emergency Spillway
Elev. 6604.0
25-yr. 24-hr.
Peak Stage
Elev. 6603.6



CROSS-SECTION A-A'

PEABODY WESTERN COAL COMPANY
KAYENTA MINE
PLATE 3 CROSS-SECTION A-A'

DESIGNED BY: TMI	SCALE: 1' = 10'
DRAWN BY: TMI	DRAWING DATE: 9-23-96
CHECKED BY: JGS	PHOTO DATE:
C.I.	DWG FILE: N14TXS.DWG



POND N14-T

EMERGENCY SPILLWAY

OUTFLOW CHANNEL

TYPICAL CROSS-SECTION

EMERGENCY SPILLWAY CHANNEL

D = 1.5'

LENGTH = 10'

FLOWLINE ELEV. = 6604

OUTFLOW CHANNEL

D = 1.5'

PRINCIPAL SPILLWAY CHANNEL

LENGTH = 10'

FLOWLINE ELEV. = 6603

PEABODY WESTERN COAL COMPANY KAYENTA MINE PLATE 4 EMERGENCY SPILLWAY: TYPICAL CROSS-SECTION	
DESIGNED BY: TMI	SCALE: NOT TO SCALE
DRAWN BY: TMI	DRAWING DATE: 9-23-96
CHECKED BY: JGS	PHOTO DATE:
C.I.	DWG FILE: N14TDIT.DWG

APPENDIX A

HYDROLOGY, HYDRAULIC, AND SEDIMENTOLOGY CALCULATIONS

N14-T

Time of Concentration

Elevation Difference = DH = 12

Water Course Length = L = $\frac{700}{5280}$ = .133

$$T_c = \left[\frac{11.9\ (L)^3}{H}\right]^{0.385} = \left[\frac{11.9\ (.133)^3}{12}\right]^{0.385} = .097$$

SCS Curve Number

Cover Type	Hydrologic Condition	Soil Type	CN	Area (Acres)	CN x Area
Reclaim	Pre-law	C	87	2.1	

SEDIMENT YIELD CALCULATIONS
for Pond N14T

Project Name:	PEABODY COAL
Project Number:	808-0100
Calculated by:	*TEL*
Checked by:	

Description	Value
Surface Slope	20.0%
Annual Rainfall Factor	40.000
Soil Erodibility Factor	0.42
Slope Length	50 ft
m	0.6
Slope Angle	0.197 Rad
Slope Factor	2.795
Length Slope Factor	2.234
Control Practice Factor	0.240
Annual Sediment Yield	9.009 (tons/acre/year)
Annual Sediment Yield	0.0044 (ac-ft/acre/year)
SDR	95%
Annual Sediment Yield	0.0042 (ac-ft/acre/year)
Area	2.1 ac
Annual Sediment Yield	0.0088 (ac-ft/year)
Total Avalable Storage	0.07 ac-ft
Total Years	8.0 years

20-Jun-96

TRAPEZOIDAL CHANNEL ANALYSIS
CRITICAL DEPTH COMPUTATION

October 1, 1996
N14-T PRINCIPAL SPILLWAY
25-YEAR, 24-HOUR STORM

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	2.1
Manning's Roughness Coefficient (n-value)	0.0220
Channel Side Slope - Left Side (horizontal/vertical)	0.10
Channel Side Slope - Right Side (horizontal/vertical)	0.10
Channel Bottom Width (feet)	2.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Critical Depth (feet)	0.32
Critical Slope (feet per foot)	0.0144
Flow Velocity (feet per second)	3.20
Froude Number	1.000
Velocity Head (feet)	0.16
Energy Head (feet)	0.48
Cross-Sectional Area of Flow (square feet)	0.66
Top Width of Flow (feet)	2.06

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

October 1, 1996
N14-T PRINCIPAL SPILLWAY
25-YEAR, 24-HOUR STORM

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second).......................	2.1
Channel Bottom Slope (feet per foot)....................	0.0050
Manning's Roughness Coefficient (n-value)...............	0.0220
Channel Side Slope - Left Side (horizontal/vertical)....	0.10
Channel Side Slope - Right Side (horizontal/vertical)...	0.10
Channel Bottom Width (feet).............................	2.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....................................	0.46
Flow Velocity (feet per second).........................	2.24
Froude Number (Flow is Sub-Critical)....................	0.590
Velocity Head (feet)....................................	0.08
Energy Head (feet)......................................	0.54
Cross-Sectional Area of Flow (square feet)..............	0.94
Top Width of Flow (feet)................................	2.09

APPENDIX B

SEDCAD+ (Input and Output)
10-Year, 24-Hour Storm

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

PEABODY COAL KAYENTA MINE: POND N14-T

by

Name: TEL

Company Name: ACZ, INC.
File Name: C:\808\N14T

Date: 06-19-1996

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: ACZ, INC.
Filename: C:\808\N14T User: TEL
Date: 06-19-1996 Time: 12:32:38
PEABODY COAL KAYENTA MINE: POND N14-T
Storm: 2.10 inches, 10 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	2.10	87	F	0.097	0.000	0.000	0.0	0.17	2.18
		Type: Pond			Label: POND N14-T					
111	Structure	2.10							0.17	
111	Total IN	2.10							0.17	2.18
111	Total OUT								0.17	2.03

APPENDIX C

SEDCAD+ (Input and Output)
25-Year, 24-Hour Storm

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

POND N14-T, 25-YEAR, 24-HOUR STORM

by

Name: JGS

Company Name: PEABODY WESTERN COAL COMPANY

File Name: C:\SEDCAD3\K-MINE\N14T25

Date: 10-01-1996

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: PEABODY WESTERN COAL COMPANY
Filename: C:\SEDCAD3\K-MINE\N14T25 User: JGS
Date: 10-01-1996 Time: 09:10:39
POND N14-T, 25-YEAR, 24-HOUR STORM
Storm: 2.50 inches, 25 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	2.10	87	F	0.097	0.000	0.000	0.0	0.23	2.84
		Type: Pond			Label: N14-T POND					
111	Structure	2.10							0.23	
111	Total IN	2.10							0.23	2.84
111	Total OUT								0.23	2.11

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: PEABODY WESTERN COAL COMPANY
Filename: C:\SEDCAD3\K-MINE\N14T25 User: JGS
Date: 10-01-1996 Time: 09:10:39
POND N14-T, 25-YEAR, 24-HOUR STORM
Storm: 2.50 inches, 25 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

POND INPUT/OUTPUT TABLE

J1, B1, S1
N14-T POND

Drainage Area from J1, B1, S1, SWS(s)1: 2.1 acres
Total Contributing Drainage Area: 2.1 acres

DISCHARGE OPTIONS:

	Emergency Spillway	Emergency Spillway
Riser Diameter (in)	----	----
Riser Height (ft)	----	----
Barrel Diameter (in)	----	----
Barrel Length (ft)	----	----
Barrel Slope (%)	----	----
Manning's n of Pipe	----	----
...illway Elevation	----	----
...est Elevation of Holes	----	----
. Holes/Elevation	----	----
Entrance Loss Coefficient	----	----
Tailwater Depth (ft)	----	----
Notch Angle (degrees)	----	----
Weir Width (ft)	----	----
Siphon Crest Elevation	----	----
Siphon Tube Diameter (in)	----	----
Siphon Tube Length (ft)	----	----
Manning's n of Siphon	----	----
Siphon Inlet Elevation	----	----
Siphon Outlet Elevation	----	----
Emergency Spillway Elevation	6603.0	6604.0
Crest Length (ft)	10.0	10.0
Z:1 (Left and Right)	0.1 0.1	3.0 3.0
Bottom Width (ft)	2.0	5.0

POND RESULTS:

Permanent Pool (ac-ft)
0.2

	Runoff Volume (ac-ft)	Peak Discharge (cfs)
IN	0.23	2.84

OUT	0.23	2.11

Peak Elevation	Hydrograph Detention Time (hrs)
6603.6	0.04

****

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: PEABODY WESTERN COAL COMPANY

Filename: C:\SEDCAD3\K-MINE\N14T25 User: JGS

Date: 10-01-1996 Time: 09:10:39

POND N14-T, 25-YEAR, 24-HOUR STORM

Storm: 2.50 inches, 25 year-24 hour, SCS Type II

Hydrograph Convolution Interval: 0.1 hr

ELEVATION-DISCHARGE TABLE

J1, B1, S1

N14-T POND

Drainage Area from J1, B1, S1, SWS(s)1: 2.1 acres

Total Contributing Drainage Area: 2.1 acres

Elevation	Emergency Spillway (cfs)	Emergency Spillway (cfs)	Total Discharge (cfs)
6598.00	0.0	0.0	0.0
6599.00	0.0	0.0	0.0
6600.00	0.0	0.0	0.0
6601.00	0.0	0.0	0.0
6602.00	0.0	0.0	0.0
6603.00	0.0	0.0	0.0
603.60	2.2	0.0	2.2
03.70	2.9	0.0	2.9
03.80	3.6	0.0	3.6
03.90	4.5	0.0	4.5
6604.00	5.2	0.0	5.2
6604.50	10.7	5.3	16.0
6604.60	12.0	6.4	18.4
6604.70	13.3	8.7	22.0
6604.80	14.6	11.4	26.0
6604.90	15.9	14.4	30.3
6605.00	17.2	17.4	34.6
6605.50	24.8	40.7	65.5
6606.00	33.5	73.1	106.6

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: PEABODY WESTERN COAL COMPANY
Filename: C:\SEDCAD3\K-MINE\N14T25 User: JGS
Date: 10-01-1996 Time: 09:10:39
POND N14-T, 25-YEAR, 24-HOUR STORM
Storm: 2.50 inches, 25 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

ELEVATION-AREA-CAPACITY-DISCHARGE TABLE

J1, B1, S1
N14-T POND

Drainage Area from J1, B1, S1, SWS(s)1: 2.1 acres
Total Contributing Drainage Area: 2.1 acres

SW#1: Emergency Spillway
SW#2: Emergency Spillway

Elev	Stage (ft)	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	
6598.00	0.00	0.03	0.00	0.00	
6599.00	1.00	0.03	0.03	0.00	
6600.00	2.00	0.04	0.07	0.00	
6601.00	3.00	0.05	0.12	0.00	
6602.00	4.00	0.06	0.17	0.00	
6603.00	5.00	0.07	0.24	0.00	Stage of SW#1
6603.59	5.59	0.08	0.28	2.11	Peak Stage
6603.60	5.60	0.08	0.28	2.15	
6603.70	5.70	0.08	0.29	2.85	
6603.80	5.80	0.08	0.29	3.62	
6603.90	5.90	0.08	0.30	4.45	
6604.00	6.00	0.08	0.31	5.25	Stage of SW#2
6604.50	6.50	0.09	0.35	16.02	
6604.60	6.60	0.09	0.36	18.38	
6604.70	6.70	0.09	0.37	22.01	
6604.80	6.80	0.09	0.38	25.99	
6604.90	6.90	0.09	0.39	30.31	
6605.00	7.00	0.09	0.40	34.63	
6605.50	7.50	0.10	0.44	65.49	
6606.00	8.00	0.10	0.49	106.60	

****

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: ACZ, INC.
Filename: C:\808\N14T User: TEL
Date: 06-19-1996 Time: 12:52:02
PEABODY COAL KAYENTA MINE: POND N14-T
Storm: 1.90 inches, 25 year- 6 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

ELEVATION-AREA-CAPACITY-DISCHARGE TABLE

J1, B1, S1
POND N14-T

Drainage Area from J1, B1, S1, SWS(s)1: 2.1 acres
Total Contributing Drainage Area: 2.1 acres

SW#1: Emergency Spillway

Elev	Stage (ft)	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	
6598.00	0.00	0.03	0.00	0.00	
6599.00	1.00	0.03	0.03	0.00	
6600.00	2.00	0.04	0.07	0.00	
6601.00	3.00	0.05	0.11	0.00	
2.00	4.00	0.06	0.17	0.00	
.00	5.00	0.07	0.24	0.00	Stage of SW#1
.23	5.23	0.07	0.25	2.48	Peak Stage
6603.60	5.60	0.08	0.28	6.36	
6603.70	5.70	0.08	0.29	8.70	
6603.80	5.80	0.08	0.29	11.38	
6603.90	5.90	0.08	0.30	14.40	
6604.00	6.00	0.08	0.31	17.41	

****

Z

ATTACHMENT Z

Black Mesa Haul Road Ephemeral
Channel Diversion Design Report
(See Drawing No. 85400, Sheet K-9)

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

BLACK MESA HAUL ROAD, EPHEMERAL CHANNEL DIV., 10-YR., 6-HR. STORM

by

Name: JGS

Company Name: PEABODY WESTERN COAL COMPANY

File Name: C:\SEDCAD3\BMRDDIV

Date: 03-13-1997

Black Mesa Haul Road Ephemeral
Channel Diversion Design Summary

Purpose: To divert runoff from approximately 79.6 acres of natural ephemeral channel watershed area along the west side of the Black Mesa haul road (see Drawing No. 85400, Sheet K-9 for location) at PWCC coordinates N -31,000; E 27,500.

Temporary Diversion Design: (Trapezoidal Channel)

10-year, 6-hour precipitation	=	1.60 inches
Area	=	79.6 ac.
CN	=	85
Time of concentration	=	0.124 hrs.
Peak discharge	=	68.82 cfs
Critical slope	=	1.4 %
Minimum design width	=	3 ft.
Minimum design depth w/freeboard	=	3.0 ft.
Side slopes	=	3:1 or flatter

To allow construction of a diversion ditch which will safely handle the flow over the existing topography, two alternative trapezoidal ditch designs (i.e., Design A or Design B) are recommended:

Design A: Earth-lined trapezoidal ditch (subcritical flow, 0.5% to 1.4% slope)

Average slope	=	0.5 %
n	=	0.03
d_n(min)	=	3.00 ft.
Velocity	=	3.85 fps

Design B: Riprap-lined or bedrock-lined trapezoidal ditch (supercritical flow, 1.4% to 10.0% slope)

Average slope	=	10 %
n	=	0.047
d_n(min)	=	2.3 ft.
Velocity	=	8.37 fps
Riprap D_{max}	=	7.5 in
Riprap D_{50}	=	6.0 in

Note:
- Design selection will be field-fitted based on the slope of the constructed channel.
- If bedrock is encountered during excavation, Design B will not require the installation of riprap.
- Minimum 20 ft. length of riprapped ditch as a transitional channel between the two alternative designs.
- See Chapter 26 for construction specifications.
- The above two alternative ditch designs will be able to handle the design storm at slopes from 0.5% to 10% while still being stable.

Revised 03/24/97

Black Mesa Haul Road
Ephemeral Channel Diversion

Time of Concentration:

Elev. Difference = 6577 - 6365 = 212 ft.

Watercourse Length = 3500 ft. = 0.663 mi.

T_c = [11.9(W.L.)^3/(E.D.)]^0.385 = 0.205 hr.

SCS Curve Number

Cover Type	Hydro Cond.	Soil Type	CN	Area (ac)	CN*Area
S-G	Poor	D	85	79.6	6766

Weighted CN = Use 85

Drainage Basin Area

79.6 Acres   0.124 sq. miles

SEDCAD+ RIPRAP CHANNEL DESIGN

BLACK MESA HAUL ROAD DIV.

INPUT VALUES:

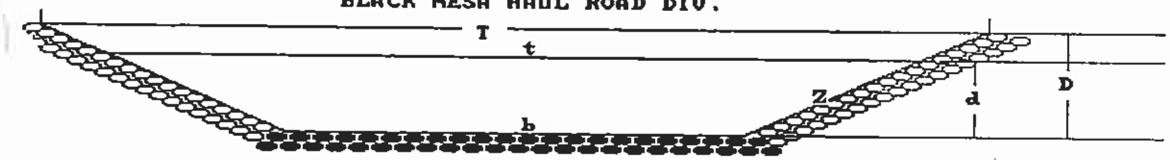
Shape	TRAPEZOIDAL	
Discharge	68.82 cfs	
Slope	10.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	3.00 feet	
Freeboard	1 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	1.23 ft
with Freeboard	2.23 ft
Top Width	10.38 ft
with Freeboard	16.38 ft
Velocity	8.37 fps
Cross Sectional Area	8.22 sq ft
Hydraulic Radius	0.76 ft
Manning's n	0.047
Froude Number	1.66
Dmax	0.625 ft (7.50 in)
D50	0.500 ft (6.00 in)
D10	0.167 ft (2.00 in)

SEDCAD+ CHANNEL DESIGN
BLACK MESA HAUL ROAD DIV.



Riprap - Steep Slope Design - PADER Method

Discharge	= 68.82 cfs	Depth (d)	= 1.23 (D = 2.23) ft
Bottom (b)	= 3.00 ft	Top width (t)	= 10.38 (T = 16.38) ft
Side slopes (Z)	= 3.0:1(L) 3.0:1(R)	Velocity	= 8.37 fps
Bed Slope	= 10.00 %	Hydraulic Radius	= 0.76 ft
Manning's n	= 0.047	Froude number	= 1.66

w/ Freeboard: (D = 2.23) ft, (T = 16.38) ft

Dmax = 0.63 ft (7.50 in)
D50 = 0.50 ft (6.00 in)
D10 = 0.17 ft (2.00 in)

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: PEABODY WESTERN COAL COMPANY

Filename: C:\SEDCAD3\BMRDDIV User: JGS

Date: 03-13-1997 Time: 19:15:32

BLACK MESA HAUL ROAD,EPHEMERAL CHANNEL DIV., 10-YR., 6-HR. STORM

Storm: 1.60 inches, 10 year- 6 hour, SCS Type II

Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	79.60	85	F	0.124	0.000	0.000	0.0	3.43	68.82
		Type: Null			Label: BM HAUL RD. DIV.					
111	Structure	79.60							3.43	
111	Total IN/OUT	79.60							3.43	68.82

TRAPEZOIDAL CHANNEL ANALYSIS
CRITICAL DEPTH COMPUTATION

March 13, 1997
BLACK MESA HAUL ROAD DIV.
10-YR., 6-HR. STORM

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	68.8
Manning's Roughness Coefficient (n-value)...............	0.0300
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	3.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Critical Depth (feet)..................................	1.58
Critical Slope (feet per foot).........................	0.0139
Flow Velocity (feet per second)........................	5.62
Froude Number...	1.000
Velocity Head (feet)...................................	0.49
Energy Head (feet).....................................	2.07
Cross-Sectional Area of Flow (square feet).............	12.25
Top Width of Flow (feet)...............................	12.49

SEDCAD+ NONERODIBLE CHANNEL DESIGN

BLACK MESA HAUL ROAD DIV.

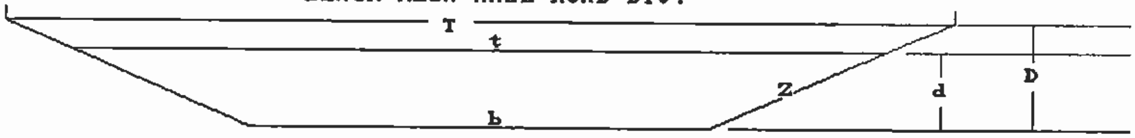
INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	68.82 cfs	
Slope	0.50 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	3.00 ft	
Manning's n	0.030	
Material	OTHER	
Freeboard	1 ft	

RESULTS:

Depth	1.99 ft
with Freeboard	2.99 ft
Top Width	14.96 ft
with Freeboard	20.96 ft
Velocity	3.85 fps
Cross Sectional Area	17.89 sq ft
Hydraulic Radius	1.15 ft
Froude Number	0.62

SEDCAD+ CHANNEL DESIGN
BLACK MESA HAUL ROAD DIV.



MATERIAL: OTHER

Discharge	= 68.82 cfs	Depth (d)	= 1.99	(D = 2.99) ft
Bottom (b)	= 3.00 ft	Top width (t)	= 14.96	(T = 20.96) ft
Side slopes (Z)	= 3.0:1(L) 3.0:1(R)	Velocity	= 3.85 fps	
Bed Slope	= 0.50 %	Hydraulic Radius	= 1.15 ft	
Manning's n	= 0.030	Froude number	= 0.62	

w/ Freeboard:

ATTACHMENT AA

N-14 East
Ephemeral Reclaimed Channel
Diversion Design Report
(See Drawing No. 85352, Sheets M-7 and M-8)

Revised 05/15/97

N-14 East - Ephemeral Reclaimed
Channel Design Summary

Purpose: To divert runoff from approximately 1440.4 acres of natural undisturbed watershed and 47.2 acres of reclaimed watershed area through and around the east side of the N-14 East mining area (see Drawing No. 85352, Sheets M-7 and M-8 for location) directly upstream of the N14-H Dam.

<u>Permanent Reclaimed Channel Design</u>: (Trapezoidal Channel)

100-year, 6-hour precipitation	=	2.40 inches
Area	=	1487.6 ac.
CN	=	78 to 81
Time of concentration	=	(see SEDCAD printout)
Peak discharge	=	531.1 cfs
Critical slope	=	1.1 %
Minimum design width	=	40 ft.
Minimum design depth w/freeboard	=	3.2 ft.
Side slopes	=	3:1 or flatter

To allow construction of a reclaimed channel which will safely handle the flow over the reclaimed topography, two alternative trapezoidal channel designs (i.e., Design A or Design B) are recommended:

Design A: Earth-lined trapezoidal channel (subcritical flow, apply this design to channel reaches which have a 0.5% to 1.1% slope)

Average slope	=	0.5 %
n	=	0.03
d_n(min) w/ freeboard	=	3.2 ft.
Velocity	=	5.3 fps

Design B: Riprap-lined or bedrock-lined trapezoidal channel (supercritical flow, apply this design to channel reaches which have a 1.1% to 12.0% slope)

Average slope	=	12 %
n	=	0.056
d_n(min) w/ freeboard	=	2.3 ft.
Velocity	=	9.9 fps

Revised 05/15/97

Riprap D_{max} = 11.25 in

Riprap D_{50} = 9.0 in

Note:
- Design selection will be field-fitted based on the slope of the constructed channel.
- If bedrock is encountered during excavation, Design B will not require the installation of riprap.
- Minimum 20 ft. length of riprapped channel as a transitional channel between the two alternative designs.
- See Chapter 26 for construction specifications.
- The above two alternative channel designs will be able to handle the design storm at slopes from 0.5% to 12% while still being stable.

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

N-14 EAST RECLAIMED DRAINAGE CHANNEL, 100-YR.,6-HR. STORM

by

Name: JGS

Company Name: PEABODY WESTERN COAL COMPANY
File Name: C:\SEDCAD3\KMINE\N14E

Date: 05-18-1997

APPROVED

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: PEABODY WESTERN COAL COMPANY
Filename: C:\SEDCAD3\KMINE\N14E User: JGS
Date: 05-18-1997 Time: 13:49:23
N-14 EAST RECLAIMED DRAINAGE CHANNEL, 100-YR.,6-HR. STORM
Storm: 2.40 inches, 100 year- 6 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	1360.00	78	M	0.944	0.000	0.000	0.0	82.04	483.24
			Type: Null		Label: N14-E1					
111	Structure	1360.00							82.04	
111	Total IN/OUT	1360.00							82.04	483.24
112	1	80.40	78	M	0.200	0.000	0.000	0.0	4.85	65.06
112	2	47.20	81	F	0.378	0.000	0.000	0.0	3.43	43.26
			Type: Null		Label: N14-E2					
112	Structure	127.60							90.31	
112	Total IN/OUT	1487.60							90.31	531.11
111 to 112	Routing					0.000	0.000			

APPROVED

PEABODY WESTERN COAL COMPANY
CALCULATED HYDROLOGIC DATA

PROJECT: N14-E1 Watershed

TIME OF CONCENTRATION:

Start Elevation (ft) =	7160
End Elevation (ft) =	6775
Elevation Difference, E (ft) =	385
Watercourse Length (ft) =	16000
Watercourse Length, L (mi) =	3.030

Tc = (11.9L^3/E)^0.385 = 0.944 hours

ROUTING PARAMETERS:

Between structure routing parameters were calculated using the SCS Upland Method in SEDCAD+. Input and output parameters are shown on the SEDCAD+ printouts in Appendices B and C.

SCS CURVE NUMBER:

Cover Type	Soil Group	Curve Number	Area (acres)	CN*Area
Undisturbed	C	78	1360.0	106080
TOTAL:			1360	106080

Weighted CN = Total CN*Area/ Total Area = 78

DRAINAGE BASIN AREA:

1360.0 Acres

PEABODY WESTERN COAL COMPANY
CALCULATED HYDROLOGIC DATA

PROJECT: N14-E2 Watershed

TIME OF CONCENTRATION:

Start Elevation (ft) =	6990
End Elevation (ft) =	6715
Elevation Difference, E (ft) =	275
Watercourse Length (ft) =	3730
Watercourse Length, L (mi) =	0.706

Tc = (11.9L^3/E)^0.385 = 0.200 hours

ROUTING PARAMETERS:

Between structure routing parameters were calculated using the SCS Upland Method in SEDCAD+. Input and output parameters are shown on the SEDCAD+ printouts in Appendices B and C.

SCS CURVE NUMBER:

Cover Type	Soil Group	Curve Number	Area (acres)	CN*Area
Undisturbed	C	78	80.4	6271.2
TOTAL:			80.4	6271.2

Weighted CN = Total CN*Area/ Total Area = 78

DRAINAGE BASIN AREA:

80.4 Acres

PEABODY WESTERN COAL COMPANY
CALCULATED HYDROLOGIC DATA

PROJECT: N14-E3 Watershed

TIME OF CONCENTRATION:

Start Elevation (ft) =	6885
End Elevation (ft) =	6715
Elevation Difference, E (ft) =	170
Watercourse Length (ft) =	5520
Watercourse Length, L (mi) =	1.045

Tc = (11.9L^3/E)^0.385 = 0.378 hours

ROUTING PARAMETERS:

Between structure routing parameters were calculated using the SCS Upland Method in SEDCAD+. Input and output parameters are shown on the SEDCAD+ printouts in Appendices B and C.

SCS CURVE NUMBER:

Cover Type	Soil Group	Curve Number	Area (acres)	CN*Area
Reclaimed	C	81	47.2	3823.2
TOTAL:			47.2	3823.2

Weighted CN = Total CN*Area/ Total Area = 81

DRAINAGE BASIN AREA:

47.2 Acres

TRAPEZOIDAL CHANNEL ANALYSIS
CRITICAL DEPTH COMPUTATION

May 18, 1997
N-14 EAST RECLAIMED DRAINAGE CHANNEL
100-YR., 6-HR. STORM
PWCC

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	531.1
Manning`s Roughness Coefficient (n-value)..............	0.0300
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	40.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Critical Depth (feet)..................................	1.69
Critical Slope (feet per foot).........................	0.0116
Flow Velocity (feet per second)........................	6.99
Froude Number..	1.000
Velocity Head (feet)...................................	0.76
Energy Head (feet).....................................	2.44
Cross-Sectional Area of Flow (square feet).............	76.01
Top Width of Flow (feet)...............................	50.12

SEDCAD+ NONERODIBLE CHANNEL DESIGN

N-14 EAST RECLAIMED DRAINAGE CHANNEL

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	531.11 cfs	
Slope	0.50 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	40.00 ft	
Manning's n	0.030	
Material	OTHER	
Freeboard	1 ft	

RESULTS:

Depth	2.15 ft
with Freeboard	3.15 ft
Top Width	52.90 ft
with Freeboard	58.90 ft
Velocity	5.32 fps
Cross Sectional Area	99.87 sq ft
Hydraulic Radius	1.86 ft
Froude Number	0.68

SEDCAD+ RIPRAP CHANNEL DESIGN

N-14 EAST RECLAIMED DRAINAGE CHANNEL

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	531.11 cfs	
Slope	12.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	40.00 feet	
Freeboard	1 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	1.22 ft
with Freeboard	2.22 ft
Top Width	47.34 ft
with Freeboard	53.34 ft
Velocity	9.94 fps
Cross Sectional Area	53.45 sq ft
Hydraulic Radius	1.12 ft
Manning's n	0.056
Froude Number	1.65
Dmax	0.938 ft (11.25 in)
D50	0.750 ft (9.00 in)
D10	0.250 ft (3.00 in)

ATTACHMENT AA

N-14 East
Ephemeral Reclaimed Channel
Diversion Design Report
(See Drawing No. 85352, Sheets M-7 and M-8)

Revised 05/15/97

N-14 East - Ephemeral Reclaimed
Channel Design Summary

Purpose: To divert runoff from approximately 1440.4 acres of natural undisturbed watershed and 47.2 acres of reclaimed watershed area through and around the east side of the N-14 East mining area (see Drawing No. 85352, Sheets M-7 and M-8 for location) directly upstream of the N14-H Dam.

Permanent Reclaimed Channel Design: (Trapezoidal Channel)

100-year, 6-hour precipitation	=	2.40 inches
Area	=	1487.6 ac.
CN	=	78 to 81
Time of concentration	=	(see SEDCAD printout)
Peak discharge	=	531.1 cfs
Critical slope	=	1.1 %
Minimum design width	=	40 ft.
Minimum design depth w/freeboard	=	3.2 ft.
Side slopes	=	3:1 or flatter

To allow construction of a reclaimed channel which will safely handle the flow over the reclaimed topography, two alternative trapezoidal channel designs (i.e., Design A or Design B) are recommended:

Design A: Earth-lined trapezoidal channel (subcritical flow, apply this design to channel reaches which have a 0.5% to 1.1% slope)

Average slope	=	0.5 %
n	=	0.03
d_n(min) w/ freeboard	=	3.2 ft.
Velocity	=	5.3 fps

Design B: Riprap-lined or bedrock-lined trapezoidal channel (supercritical flow, apply this design to channel reaches which have a 1.1% to 12.0% slope)

Average slope	=	12 %
n	=	0.056
d_n(min) w/ freeboard	=	2.3 ft.
Velocity	=	9.9 fps

Revised 05/15/97

Riprap D_{max} = 11.25 in

Riprap D_{50} = 9.0 in

Note:
- Design selection will be field-fitted based on the slope of the constructed channel.
- If bedrock is encountered during excavation, Design B will not require the installation of riprap.
- Minimum 20 ft. length of riprapped channel as a transitional channel between the two alternative designs.
- See Chapter 26 for construction specifications.
- The above two alternative channel designs will be able to handle the design storm at slopes from 0.5% to 12% while still being stable.

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

N-14 EAST RECLAIMED DRAINAGE CHANNEL, 100-YR.,6-HR. STORM

by

Name: JGS

Company Name: PEABODY WESTERN COAL COMPANY
File Name: C:\SEDCAD3\KMINE\N14E

Date: 05-18-1997

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: PEABODY WESTERN COAL COMPANY
Filename: C:\SEDCAD3\KMINE\N14E User: JGS
Date: 05-18-1997 Time: 13:49:23
N-14 EAST RECLAIMED DRAINAGE CHANNEL, 100-YR.,6-HR. STORM
Storm: 2.40 inches, 100 year- 6 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	1360.00	78	M	0.944	0.000	0.000	0.0	82.04	483.24
			Type: Null		Label: N14-E1					
111	Structure	1360.00							82.04	
111	Total IN/OUT	1360.00							82.04	483.24
112	1	80.40	78	M	0.200	0.000	0.000	0.0	4.85	65.06
112	2	47.20	81	F	0.378	0.000	0.000	0.0	3.43	43.26
			Type: Null		Label: N14-E2					
1[illegible]	Structure	127.60							90.31	
11[illegible]	Total IN/OUT	1487.60							90.31	531.11
111 to 112	Routing					0.000	0.000			

PEABODY WESTERN COAL COMPANY
CALCULATED HYDROLOGIC DATA

PROJECT: N14-E1 Watershed

TIME OF CONCENTRATION:

Start Elevation (ft) =	7160
End Elevation (ft) =	6775
Elevation Difference, E (ft) =	385
Watercourse Length (ft) =	16000
Watercourse Length, L (mi) =	3.030

Tc = (11.9L^3/E)^0.385 = 0.944 hours

ROUTING PARAMETERS:

Between structure routing parameters were calculated using the SCS Upland Method in SEDCAD+. Input and output parameters are shown on the SEDCAD+ printouts in Appendices B and C.

SCS CURVE NUMBER:

Cover Type	Soil Group	Curve Number	Area (acres)	CN*Area
Undisturbed	C	78	1360.0	106080
TOTAL:			1360	106080

Weighted CN = Total CN*Area/ Total Area = 78

DRAINAGE BASIN AREA:

1360.0 Acres

PEABODY WESTERN COAL COMPANY
CALCULATED HYDROLOGIC DATA

PROJECT: N14-E2 Watershed

TIME OF CONCENTRATION:

Start Elevation (ft) =	6990
End Elevation (ft) =	6715
Elevation Difference, E (ft) =	275
Watercourse Length (ft) =	3730
Watercourse Length, L (mi) =	0.706

Tc = (11.9L^3/E)^0.385 = 0.200 hours

ROUTING PARAMETERS:

Between structure routing parameters were calculated using the SCS Upland Method in SEDCAD+. Input and output parameters are shown on the SEDCAD+ printouts in Appendices B and C.

SCS CURVE NUMBER:

Cover Type	Soil Group	Curve Number	Area (acres)	CN*Area
Undisturbed	C	78	80.4	6271.2
TOTAL:			80.4	6271.2

Weighted CN = Total CN*Area/ Total Area = 78

DRAINAGE BASIN AREA:

80.4 Acres

PEABODY WESTERN COAL COMPANY
CALCULATED HYDROLOGIC DATA

PROJECT: N14-E3 Watershed

TIME OF CONCENTRATION:

Start Elevation (ft) =	6885
End Elevation (ft) =	6715
Elevation Difference, E (ft) =	170
Watercourse Length (ft) =	5520
Watercourse Length, L (mi) =	1.045

Tc = (11.9L^3/E)^0.385 = 0.378 hours

ROUTING PARAMETERS:

Between structure routing parameters were calculated using the SCS Upland Method in SEDCAD+. Input and output parameters are shown on the SEDCAD+ printouts in Appendices B and C.

SCS CURVE NUMBER:

Cover Type	Soil Group	Curve Number	Area (acres)	CN*Area
Reclaimed	C	81	47.2	3823.2
TOTAL:			47.2	3823.2

Weighted CN = Total CN*Area/ Total Area = 81

DRAINAGE BASIN AREA:

47.2 Acres

TRAPEZOIDAL CHANNEL ANALYSIS
CRITICAL DEPTH COMPUTATION

May 18, 1997
N-14 EAST RECLAIMED DRAINAGE CHANNEL
100-YR., 6-HR. STORM
PWCC

==

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	531.1
Manning`s Roughness Coefficient (n-value)..............	0.0300
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	40.0

==

PROGRAM RESULTS:

DESCRIPTION	VALUE
Critical Depth (feet)..................................	1.69
Critical Slope (feet per foot).........................	0.0116
Flow Velocity (feet per second)........................	6.99
Froude Number..	1.000
Velocity Head (feet)...................................	0.76
Energy Head (feet).....................................	2.44
Cross-Sectional Area of Flow (square feet).............	76.01
Top Width of Flow (feet)...............................	50.12

==

SEDCAD+ NONERODIBLE CHANNEL DESIGN

N-14 EAST RECLAIMED DRAINAGE CHANNEL

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	531.11 cfs	
Slope	0.50 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	40.00 ft	
Manning's n	0.030	
Material	OTHER	
Freeboard	1 ft	

RESULTS:

Depth	2.15 ft
with Freeboard	3.15 ft
Top Width	52.90 ft
with Freeboard	58.90 ft
Velocity	5.32 fps
Cross Sectional Area	99.87 sq ft
Hydraulic Radius	1.86 ft
Froude Number	0.68

SEDCAD+ RIPRAP CHANNEL DESIGN

N-14 EAST RECLAIMED DRAINAGE CHANNEL

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	531.11 cfs	
Slope	12.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	40.00 feet	
Freeboard	1 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	1.22 ft
with Freeboard	2.22 ft
Top Width	47.34 ft
with Freeboard	53.34 ft
Velocity	9.94 fps
Cross Sectional Area	53.45 sq ft
Hydraulic Radius	1.12 ft
Manning's n	0.056
Froude Number	1.65
Dmax	0.938 ft (11.25 in)
D50	0.750 ft (9.00 in)
D10	0.250 ft (3.00 in)

ATTACHMENT AE

J21-J TEMPORARY DIVERSION

(See Drawing No. 85400, Sheet M-10)

Revised 01/07/98

J21-J TEMPORARY DIVERSION
DESIGN SUMMARY

Purpose: To divert runoff from the J-19 highwall affected lands to the J21-J Pond until construction can be completed on Ponds J21-K and J21-K1 (see Drawing No. 85210, Sheet 4 of 4 and 85400, Sheet M-10). The watershed area is relatively small and a typical gradient terrace design (see Chapter 26, Attachment B, Figure 7) can be utilized to control runoff from potential affected lands.

Temporary Diversion Design (V-ditch Channel)

10-year, 6-hour precipitation	=	1.60 inches
Area	=	41 ac.
CN	=	91
Time of concentration	=	0.268 hrs
Peak discharge	=	41.14 cfs
Critical slope	=	1.5%
Minimum design depth/w freeboard	=	3.5 feet
Side slopes	=	2:1 or flatter

To allow construction of a diversion ditch which will safely handle the flow over the existing topography, two alternative V-ditch designs (i.e., Design A or Design B) are recommended:

Design A: Earth-lined V-ditch (subscritical flow, 0.5% to 1.5% slope)

Minimum Slope	=	0.5%
n	=	0.025
d_n(min) (w/freeboard)	=	3.5 ft
Velocity	=	4.19 fps

Design B: Riprap-lined or bedrock-lined V-ditch (supercritical flow, 1.5% to 13.0% slope)

Maximum slope	=	13%
n	=	0.045
d_n(min) (w/freeboard)	=	2.5 ft
Velocity	=	9.15 fps
Riprap D_{max}	=	11.25 in
Riprap D_{50}	=	9.0 in

Note:

- Design selection will be field-fitted based on the slope of the constructed channel.
- If bedrock is encountered during excavation, Design B will not require the installation of riprap.
- Minimum 20 ft. length of riprapped ditch as a transitional channel between the two alternative designs.
- See Chapter 26 for construction specifications.
- The above two alternative ditch designs will be able to handle the design storm at slopes from 0.5% to 13% while still being stable.

Time of Concentration:

Elevation Difference	=	7006-6925	=	81 ft.
Watercourse Length	=	3200 ft	=	0.606 mi
t_c = [11.9 (W.L.)^3/(E.D.)]^0.385			=	0.268 hr

SCS Curve Number

Cover Type	Hydro Cond.	Soil Type	CN	Area (ac)	CN Area
Graded Area	--	C	91	41.0	3731

Weighted CN = Use 91

Drainage Basin Area

41 Acres 0.064 sq. miles

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

J21-J DIVERSION, 10-YEAR, 6-HOUR STORM

by

Name: JGS

Company Name: PEABODY WESTERN COAL COMPANY
File Name: C:\SEDCAD3\BMC\J21JDIV

Date: 01-05-1998

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: PEABODY WESTERN COAL COMPANY
Filename: C:\SEDCAD3\BMC\J21JDIV User: JGS
Date: 01-05-1998 Time: 19:15:27
J21-J DIVERSION, 10-YEAR, 6-HOUR STORM
Storm: 1.60 inches, 10 year- 6 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	41.00	91	F	0.268	0.000	0.000	0.0	2.81	41.14
		Type: Null		Label: J21-J DIVERSION						
111	Structure	41.00							2.81	
111	Total IN/OUT	41.00							2.81	41.14

TRAPEZOIDAL CHANNEL ANALYSIS
CRITICAL DEPTH COMPUTATION

January 6, 1998
J21-J DIVERSION
10-YR., 6-HR. STORM

==

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second).......................	41.1
Manning's Roughness Coefficient (n-value)...............	0.0300
Channel Side Slope - Left Side (horizontal/vertical)....	2.00
Channel Side Slope - Right Side (horizontal/vertical)...	2.00
Channel Bottom Width (feet).............................	0.0

==

PROGRAM RESULTS:

DESCRIPTION	VALUE
Critical Depth (feet)...................................	1.92
Critical Slope (feet per foot)..........................	0.0154
Flow Velocity (feet per second).........................	5.56
Froude Number...	1.000
Velocity Head (feet)....................................	0.48
Energy Head (feet)......................................	2.40
Cross-Sectional Area of Flow (square feet)..............	7.39
Top Width of Flow (feet)................................	7.69

==

SEDCAD+ ERODIBLE CHANNEL DESIGN

J21-J DIVERSION

Limiting Velocity Technique
Sediment-laden Water

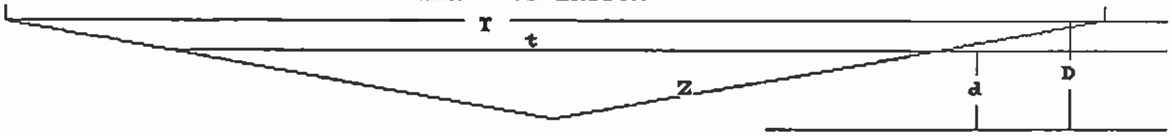
INPUT VALUES:

Shape	TRIANGULAR	
Discharge	41.14 cfs	
Slope	0.50 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	6.00 fps	
Material	SHALES AND HARDPANS	
Freeboard	1 ft	

RESULTS:

Actual Discharge	41.14 cfs
Depth	2.22 ft
with Freeboard	3.22 ft
Top Width	8.86 ft
with Freeboard	12.86 ft
Velocity	4.19 fps
Cross Sectional Area	9.82 sq ft
Hydraulic Radius	0.99 ft
Froude Number	0.70

SEDCAD+ CHANNEL DESIGN
J21-J DIVERSION



MATERIAL: SHALES AND HARDPANS
Limiting Variable: Velocity = 6.000 fps
Sediment-laden Water

					w/ Freeboard:
Discharge	= 41.14 cfs		Depth (d)	= 2.22	(D = 3.22) ft
Side slopes (Z)	= 2.0:1(L)	2.0:1(R)	Top width (t)	= 8.86	(T = 12.86) ft
Bed Slope	= 0.50 %		Velocity	= 4.19 fps	
Manning's n	= 0.025		Hydraulic Radius	= 0.99 ft	
			Froude number	= 0.70	

SEDCAD+ RIPRAP CHANNEL DESIGN

J21-J DIVERSION

INPUT VALUES:

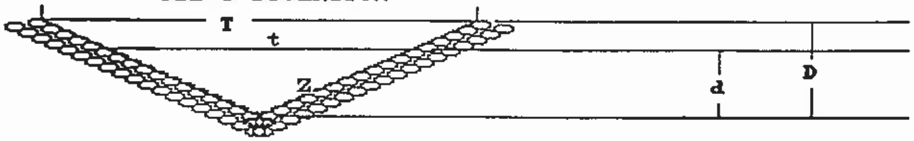
Shape	TRIANGULAR	
Discharge	41.14 cfs	
Slope	13.00 %	
Sideslopes (L and R)	2.00:1	2.00:1
Freeboard	1 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	1.50 ft
with Freeboard	2.50 ft
Top Width	6.00 ft
with Freeboard	10.00 ft
Velocity	9.15 fps
Cross Sectional Area	4.50 sq ft
Hydraulic Radius	0.67 ft
Manning's n	0.045
Froude Number	1.86
Dmax	0.938 ft (11.25 in)
D50	0.750 ft (9.00 in)
D10	0.250 ft (3.00 in)

SEDCAD+ CHANNEL DESIGN
J21-J DIVERSION



Riprap - Steep Slope Design - PADER Method

					w/ Freeboard:
Discharge	= 41.14 cfs	Depth (d)	=	1.50	(D = 2.50) ft
		Top width (t)	=	6.00	(T = 10.00) ft
Side slopes (Z)	= 2.0:1(L) 2.0:1(R)	Velocity	=	9.15 fps	
Bed Slope	= 13.00 %	Hydraulic Radius	=	0.67 ft	
Manning's n	= 0.045	Froude number	=	1.61	

Dmax = 0.94 ft (11.25 in)
D50 = 0.75 ft (9.00 in)
D10 = 0.25 ft (3.00 in)

ATTACHMENT AF

IMPOUNDMENT SPILLWAY DESIGN EVALUATION REPORT

Revised 12/31/98

ATTACHMENT AF

IMPOUNDMENT SPILLWAY DESIGN EVALUATION REPORT

Temporary Impoundment Structures

Black Mesa/Kayenta Mines

Navajo County, Arizona

For

PEABODY WESTERN COAL COMPANY

Registered Professional Engineer (Civil)
CERTIFICATE NO.
18782
JAMES GARY
SCHLENVOGT
Date Signed ....
ARIZONA, U.S.A.

DEC 31 1998

Revised 12/31/98

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APPENDICES

Revised January 29, 1999

1.0 INTRODUCTION

This report responds to OSM's concerns regarding existing ponds that utilize single culverts for principal and emergency spillways. According to 30 CFR 816.49(a)(9), an impoundment can have a single spillway only if it is an open channel spillway not a culvert; however, 30 CFR 816.49(c)(2) allows approval of structures that relies primarily on storage to control the runoff from the design precipitation event. All of Peabody's impoundment structures are considered temporary structures until approximately two years prior to Peabody requesting Bond or Reclamation Liability Release. At that time and in consultation with the Tribal agencies and local entities, Peabody will determine which impoundment structures will be permitted as permanent impoundment structures. When this future permit request is submitted for approval, the structure's design will include either removing the existing culverts for a spillway and constructing an open channel spillway, or designing and constructing an additional open channel with the culvert(s) for the impoundment's spillway or exploring other available options with the regulatory agency at this future date.

Nine existing impoundments that utilize only a single culvert spillway were evaluated and includes the following structures: BM-FWP, BM-TW, J7-I, J7-J, J7-M, KM-B, N12-C, J7-Dam, and KM-FWP (see Drawing No. 85406 – "Design Spillway Type" and Chapter 6, Volume 1). All of these existing impoundment structures have been previously submitted to OSM in the AZ-0001 and/or AZ-0001D Permits. In addition to this evaluation, following is the location in the AZ-0001D Permit or in pending permit revisions where additional design information can be found:

-BM-FWP (Pending Permit Revision, Attachment H, Volume 2)

-BM-TW (Pending Permit Revision, Attachment H, Volume 2)

-J7-I (Attachment H, Volume 3)

-J7-J (Attachment H, Volume 3)

-J7-M (Attachment H, Volume 3)

-KM-B (Attachment H, Volume 4)

-N12-C (Attachment H, Volume 6a)

-KM-FWP(Chapter6:MSHA-Size Structures,Vol. 1)

-J-7 Dam (Chapter 6: MSHA-Size Structures, Volume 1)

In addition, the following Impoundments: J7-O, J7-P and J27-B Ponds have only culverts for spillways; however, all three of these structures have pending OSM permit revisions or approved permit revisions to reclaim these structures. Evaluations of these three impoundments are not included in this report and all three of these structures are assumed to be reclaimed in 1999. The locations of all of the above structures are shown on Drawing No. 85405.

For all nine of the existing impoundments evaluated, Peabody is proposing to provide "control primarily through storage" by establishing a maximum operating elevation in the ponding area. Peabody will dewater each of these structures below the maximum operating elevation in accordance with Peabody's approved OSM dewatering plan and Peabody's NPDES Permit. Therefore, the design event will be safely controlled and the water in the ponding area will be safely removed using current prudent engineering practices. In December 1998 Peabody contacted Mr. Chuck Nixon supervisor of the Bureau of Indian Affairs (BIA) -- Navajo Area Office, Dam Safety Program to discuss the hazard classification of ponds and dams on the Navajo Indian Reservation. Mr. Nixon was supplied with a copy of the NRCS TR-60 dam classification criteria to review. BIA utilizes the Bureau of Reclamation and USCOE dam classification; however, Mr. Nixon stated the hazard classification criteria appeared to be similar between the above agencies. Mr. Nixon also stated, the BIA equivalent of the NRCS Class (a) dam classification criteria only includes roads that are dirt or gravel and a downstream road will have to have enough traffic volume or jurisdiction classification to be required to be a paved road before the impounding structure will be classified equivalent to a Class (b) or Class (c) structure. Therefore, based on Mr. Nixon's discussion; the following NRCS TR-60 dam classification criteria; and the lack of any Class (b) or Class (c) structures, facilities or situation immediately downstream in the floodplain area, all Non-MSHA and all MSHA size structures within the Black Mesa permit area are classified as Class (a) structures:

Class (a) - - Dams located in rural or agricultural areas where failure may damage farm buildings, agricultural land, or township and country roads.

In conclusion, all of the impoundment structures within the Black Mesa permit area are not located where failure would be expected to cause loss of life or serious property damage nor do the impoundment structures meet the NRCS TR-60 Class (b) or (c) criteria. Based on this evaluation, the appropriate design storage event was evaluated for each structure.

2.0 NON-MSHA IMPOUNDMENT SPILLWAY DESIGN EVALUATION

Structures BM-FWP, BM-TW, J7-I, J7-J, J7-M, KM-B and N12-C are classified as low-hazard Class (a) structures (see Drawing No. 85408). In addition, the mine area is sparsely populated, with no one living in the downstream floodplains of these structures. The structures impound less than 20 acre-feet and are less than 20 vertical feet in height from the upstream toe of the embankment of the natural stream elevation to the spillway invert elevation.

To replace the existing spillways with an open channel spillway will not be practical because the existing spillway culverts are installed under existing access or haul roads. In order to comply with the applicable OSM regulations while reflecting the practical site-specific considerations, PWCC proposes to maintain adequate storage in these impoundments to contain the storm runoff from the 25-year, 6-hour storm event while maintaining a minimum of one foot of freeboard. For ponds in-series with upstream ponds and the combined storage volume is greater than 20 acre-feet (see the design report), the 100-year, 6-hour storm event was utilized. Required containment volumes have been determined assuming the culverts do not exist. Using this methodology demonstrates that the ponds have the capacity to contain the 25-year, 6-hour or 100-year, 6-hour storm event, as required, and do not require an emergency spillway. The existing culverts are, therefore, not required for the ponds to function adequately and in compliance with the law. If however, the culverts remain, they will function to dewater the ponds after any major storm event and thus will provide an added measure of safety. The required storage volumes for each pond are shown in Table 1. The calculations to determine the required storage volumes are found in the individual design reports for each pond. The pond design reports are included in Appendices A to G. To assure that adequate design stormwater storage capacity is available; the maximum operating water levels in the impoundments will be maintained at or below the elevations shown on Table 1. As required, the existing culverts or pumping will control water levels. During the fall of 1998, this design methodology and resulting compliance with applicable regulatory requirements were verified through discussions with OSM's personnel.

Table 1 REQUIRED STORAGE CAPACITY				
Pond	Runoff Volume 25-yr, 6-hr (ac-ft) (2)	Peak Stage (ft) (1)	Maximum Operating Water Level (ft)	Ponding Area Design Storage Volume (ac-ft)
KM-B	1.35	6504.8	6502.9	1.35
J7-M	5.07	6381.5	6378.5	5.07
J7-J	0.81	6362.2	6459.5	0.81
J7-I*	10.54	6346.6	6343.4	10.54
N12-C*	34.20	6595.9	6589.1	34.20
BM-TW	0.49	6490.1	6486.5	0.49
BM-FWP	0.28	6611.2	6611.0	0.28
Notes: 1. Peak stage is one foot below the embankment crest. *2. The runoff volume for J7-I is for the 100-year, 6-hour event because the pond is in series with pond J7-H. The runoff volume was determined assuming J7-H was reclaimed. The runoff volume for N12-C is for the 100-year, 6-hour event because the pond is in series with pond N12-C1 and N12-C2. The runoff volume was determined assuming N12-C1 and N12-C2 were reclaimed.				

3.0 MSHA IMPOUNDMENT SPILLWAY DESIGN EVALUATION

3.1 POND KM-FWP

Impoundment KM-FWP is used to store water as part of Peabody's water system. The embankment is classified as an MSHA structure based on its capacity. The impoundment is located in an area which is sparsely populated, with no one living in the downstream floodplain, therefore, in accordance with NCRS (formerly SCS) TR-60, the embankment is classified as a Class (a) embankment structure.

The watershed for KM-FWP consists of the pond and a small area surrounding the pond (4.3 acres). The pond capacity at the invert of the principal spillway is 21.7 ac-ft. The pond receives and stores water from nearby Navajo aquifer wells. Well water discharges to the pond through buried pipelines, which empty into the impoundment through a riser. Any overflow water from KM-FWP will discharge through the principal spillway to Pond KM-E downstream. The invert elevation of the principal spillway is 6615.6.

Pond KM-FWP does not incorporate an emergency spillway, instead the peak runoff from the 100-year, 6-hour event will be contained. The total runoff from the 100-year, 6-hour event is 0.86 ac-ft. The runoff volume was determined using SEDCAD4. All inputs and results are shown on the SEDCAD4 computer printouts contained in Appendix I. The top of the embankment is approximately 6620.0; therefore, the peak stage is 6619.0. To maintain adequate capacity to contain the 100-year, 6-hour event and a minimum of one foot of freeboard, the maximum operational water elevation will be maintained at or below elevation 6618.6. As required, the existing culvert and pumping will control the operational water level.

3.2 POND J-7 DAM

Pond J-7 Dam is an MSHA-size impoundment that collects runoff from a 9,157-acre watershed. The watershed is predominately undisturbed. The pond is used for sediment control, to store water for dust suppression on the existing mine haul roads and as a backup water supply. The pond has existing capacity of 448.52 ac-ft at the invert of the spillway. The embankment is classified as an MSHA structure based on its height and capacity. The impoundment is located in an area which is sparsely populated, with no one living in the downstream floodplain, therefore, in accordance with NCRS (formerly SCS) TR-60, the embankment is classified as a Class (a) embankment structure.

The total runoff from the 100-year, 6-hour event is 517.7 ac-ft. The runoff volume was determined utilizing SEDCAD4. All inputs and results are shown on the SEDCAD4 computer printouts contained in Appendix H. The top of the embankment is at approximately elevation 6375.4; therefore, the peak stage is 6374.4. To maintain adequate capacity to contain the 100-year, 6-hour event and a minimum of one foot of freeboard, the maximum operational water elevation will be maintained at or below elevation 6364.7. As required, the existing culverts and pumping will control the operation water level.

The following appendices are attached and complete this evaluation report:

Appendix A	Design Reports for BM-FWP
Appendix B	Design Reports for BM-TW
Appendix C	Design Reports for J7-I
Appendix D	Design Reports for J7-J
Appendix E	Design Reports for J7-M
Appendix F	Design Reports for KM-B
Appendix G	Design Reports for N12-C
Appendix H	100-Year, 6-Hour SEDCAD4 Runs for J-7 Dam
Appendix I	100-Year, 6-Hour SEDCAD4 Runs for KM-FWP

Appendix A

Design Report for BM-FWP

(See Chapter 6, Attachment H, Volume 2 for the Complete Certified Report and Drawings)

DESIGN REPORT

Temporary Impoundment Structure

BM-FWP

Black Mesa Mine

Navajo County, Arizona

For

PEABODY WESTERN COAL COMPANY

Registered Professional Engineer (Civil)
CERTIFICATE NO.
18732
JAMES GARY
SCHLENVOGT
Date Signed
ARIZONA, U.S.A.

MAY 01 1998

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INTRODUCTION

Impoundment Structure BM-FWP is an incised impoundment, designed and constructed by Peabody Western Coal Company as a temporary impoundment structure to contain clean water for use by the Black Mesa plant. BM-FWP was constructed to store clean water pumped from the upstream pipeline and wells WW-5 and 6. Clean water is gravity fed from the impoundment to the Black Mesa plant via a 14-inch underground waterline. The location of Structure BM-FWP is shown on Drawing No. 85400 (Sheet L-9) and Drawing No. 85405. The site-specific general construction plans are shown on the attached Exhibit 1.

This design report contains information specific to Structure BM-FWP. Mine-wide design, construction, and reclamation information is presented in the "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona, for Peabody Western Coal Company", December, 1985 (PAP), Chapter 6, Attachment D, Volume 2, along with the methods and results of analyses used for slope stability, hydrology, and hydraulics, and in Chapter 6, Pages 11 to 42, "Sediment and Water Control Facility Plan".

INSPECTION

The construction site of the Structure BM-FWP was inspected in February, 1998 by a Registered Professional Engineer from Peabody Western Coal Company to assure that the site is suitable and no adverse conditions exist for this structure. A detailed geotechnical investigation was not performed; rather, the information in Chapter 6, Attachment D was utilized for incised slope design.

SITE DESCRIPTION

LAND USE

The tributary area for structure BM-FWP is limited to the pond surface, basin, and crest. The total tributary area is 2.3 acres.

DESIGN ANALYSES

GENERAL

Structure BM-FWP was designed under the supervision of a Registered Professional Engineer from Peabody Western Coal Company. The design was performed in accordance with applicable 30 CFR 780 and 816 regulations of the United States Department of Interior, Office of Surface Mining (OSM) and included a review of available project files. The most current information contained in the Peabody Western Coal Company files includes topographic maps developed from aerial photography flown in 1990 for Peabody Western Coal Company and was used in the analyses of the structure.

STABILITY

Structure BM-FWP is completely incised impoundment. The incised slopes are approximately 5.5:1 (horizontal to vertical). Based on the total pond depth of approximately 10 feet, these slopes are equal to or flatter than the recommended "worst case" embankment/foundation condition slopes in Table 3-6, Attachment D, Chapter 6; therefore, the basin slopes will be stable.

HYDROLOGY

The hydrologic analysis was completed using the computer program SEDCAD+ (see Appendices A and B). Structure BM-FWP is classified as a low hazard structure (see Drawing No. 85408). In addition, the mine area is sparsely populated with no one living in the downstream floodplain. The structure will impound less than 20 acre-feet and be less than 20 vertical feet in depth. The impoundment does not contain a spillway. Adequate storage will be maintained in the impoundment above the normal operating level to contain the storm run-off from the 25-year storm event. To assure that adequate storm water storage volume is available, the operating water level in the impoundment will be maintained at or below elevation 6611.0. Water level management and stormwater de-watering will be accomplished through control of process water feed rates to the plant with discharge through the existing outlet structure (two 8-inch steel pipes). This design methodology and compliance with applicable regulatory requirements were verified through discussions with OSM personnel.

The following parameters were used in the hydrologic analysis:

		25yr-6hr Storm	
1.	Water Course length, L	0.015	mi.
2.	Elevation Difference, H	2	ft
3.	Time of Concentration, T_c	0.016	hr
4.	SCS Curve Number	96	
5.	Rainfall Depth, 25-year, 6-hour storm	1.9	in
6.	Drainage Area	2.3	acres

The SEDCAD+ computer program was used to evaluate inflow to the impoundment structure. The initial conditions and results of the analysis are summarized in the following table (supporting calculations are presented in Appendices A and B).

BM-FWP POND HYDROLOGY TABLE

	Units	25-Yr, 6-Hr Storm
Initial Reservoir Volume Condition		Full to emergency spillway
Inflow		
Peak Flow	cfs	4.4
Volume	ac-ft	0.28
Storage		
Peak Stage	msl	6611.2
Operational Elev.	msl	6611.0
Peak Storage	ac-ft	8.21
Storage Capacity	ac-ft	7.94
Top of Impoundment	msl	6612.2
Freeboard	ft	1.0

Notes: The Storage Capacity figure reflects available pond storage up to the defined Operational Elevation. The Peak Storage figure reflects available pond storage up to the Peak Stage elevation and includes Storage Capacity plus stormwater inflow volume (7.93 + 0.28).

INLET AND OUTLET STRUCTURES

The inlet structures consist of two, 8-inch steel pipes at elevations 6612.4 and 6612.8, which are fed from the upstream pipeline and wells WW-5 and 6. The outlet structure consists of two, 8-inch steel pipe at elevation 6602.5 and are connected to a 14-inch underground steel pipe that transfers discharge to the Black Mesa plant. The alignment and dimensions are shown on Exhibit 1.

* * *

The following appendices and drawing are attached and complete this design report.

APPENDIX A	Hydrology Calculations
APPENDIX B	SEDCAD+ (Input and Output) 25-Year, 6-Hour Storm Event
Exhibit # 1	BM-FWP Temporary Impoundment Design

Appendix B

Design Report for BM-TW

(See Chapter 6, Attachment H, Volume 2 for the Complete Certified Report and Drawings)

DESIGN REPORT

Temporary Impoundment Structure

BM-TW

Black Mesa Mine

Navajo County, Arizona

For

PEABODY WESTERN COAL COMPANY

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INTRODUCTION

Impoundment Structure BM-TW is an earthen embankment, designed and constructed by Peabody Western Coal Company as a temporary impoundment structure to collect runoff from portions of the facilities area at the Black Mesa Mine. BM-TW was constructed to collect runoff and wash water from the truck wash area as secondary control after the truck wash sump. BM-TW is not designed as a sediment control structure. The sediment control for the BM-TW watershed is incorporated into the designs for downstream sediment structure BM-SS assuming BM-TW is non-existent. The location of Structure BM-TW and its watershed boundary are shown on Drawing No. 85400 (Sheet K-10) and Drawing No. 85405. The site-specific general construction plans are shown on the attached Exhibit 1.

This design report contains information specific to Structure BM-TW. Mine-wide design, construction, and reclamation information is presented in the "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona, for Peabody Western Coal Company", December, 1985 (PAP), Chapter 6, Attachment D, Volume 2, along with the methods and results of analyses used for slope stability, hydrology, and hydraulics, and in Chapter 6, Pages 11 to 42, "Sediment and Water Control Facility Plan".

INSPECTION

The construction site of the Structure BM-TW was inspected in February, 1998 by a Registered Professional Engineer from Peabody Western Coal Company, to assure that the site is suitable and no adverse conditions exist for this structure. A detailed geotechnical investigation was not performed, rather, the information in Chapter 6, Attachment D was utilized for embankment design.

SITE DESCRIPTION

LAND USE

Structure BM-TW has a 5.5-acre tributary area and is located upstream of sediment structure BM-SS. The watershed is classified as 100% disturbed.

DESIGN ANALYSES

GENERAL

Structure BM-TW was designed under the supervision of a Registered Professional Engineer from Peabody Western Coal Company. The design was performed in accordance with applicable 30 CFR 780 and 816 regulations of the United States Department of Interior, Office of Surface Mining (OSM) and included a review of available project files. The most current information contained in the Peabody Western Coal Company files includes topographic maps developed from aerial photography flown in 1990 for Peabody Western Coal Company and was used in the analyses of the structure.

STABILITY

Structure BM-TW is a Category A-5 embankment. A homogeneous earthen embankment, compacted in lifts to design specifications, and approximately 10 feet wide on top was constructed. An upstream slope of a minimum 1.75:1 (horizontal to vertical) and a downstream slope of 3.25:1 was utilized. Based on the total embankment height of approximately 13 feet, these slopes are equal to or flatter than the recommended "worst case" embankment/foundation condition slopes in Table 3-6, Attachment D, Chapter 6; therefore, the embankment will be stable.

HYDROLOGY

The hydrologic analysis was completed using the computer program SEDCAD+ (see Appendices A and B). Structure BM-TW is classified as a low hazard structure (see Drawing No. 85408). In addition, the mine area is sparsely populated with no one living in the downstream floodplain. The structure will impound less than 20 acre-feet and be less than 20 vertical feet in height from the upstream toe of the embankment of the natural stream elevation to the spillway invert elevation.

BM-TW has an 18-inch diameter culvert spillway. Adequate storage capacity, however, will be maintained in the impoundment above the normal operating level and below the spillway invert to contain the storm runoff from the 25-year, 6-hour storm event with no discharge through the spillway. To assure that adequate storm water storage capacity is available, the operating water level in the impoundment will be maintained at or below elevation 6486.5. Water level will be controlled and excess stormwater runoff accumulations will be removed by pumping (see Chapter 6 dewatering discussion), as required. This design methodology and compliance with applicable regulatory requirements were verified through discussions with OSM personnel.

The following parameters were used in the hydrologic analysis:

		25-yr,6-hr Storm	
1.	Water Course length, L	0.171	mi.
2.	Elevation Difference, H	37	ft
3.	Time of Concentration, T_c	0.084	hr
4.	SCS Curve Number	91	
5.	Rainfall Depth, 25-year, 6-hour storm	1.9	in
6.	Drainage Area	5.5	acres

HYDRAULICS

The SEDCAD+ computer program was used to evaluate inflow to the impoundment structure. The initial conditions and results of the analysis are summarized in the following table (supporting calculations are presented in Appendices A and B).

BM-TW POND HYDRAULICS TABLE

	Units	25-Yr, 6-Hr Storm
Initial Reservoir Volume Condition		Full to emergency spillway
Inflow		
Peak Flow	cfs	8.75
Volume	ac-ft	0.49
Storage		
Spillway Invert	msl	6488.0
Peak Stage	msl	6488.0
Operational Elev.	msl	6486.5
Peak Storage	ac-ft	2.38
Storage Capacity	ac-ft	1.89
Top of Impoundment	msl	6491.1
Freeboard	ft	3.1

Notes: The Storage Capacity figure reflects available pond storage up to the defined Operational Elevation.

The Peak Storage figure reflects available pond storage up to the Peak Stage elevation and includes Storage Capacity plus stormwater inflow volume (1.89 + 0.49).

SPILLWAY

The existing spillway for BM-TW is a corrugated metal pipe with dimensions listed below. The alignment and dimensions are shown on Exhibit 1. As designed, operating water levels will be maintained at or below 6486.5 elevation such that peak stage for the 25-year, 6-hour storm is at or below the spillway invert.

Pipe Diameter	(Spillway)	1.5	ft
Pipe Length	(Spillway)	40	ft
Average Slope	(Spillway)	0.1	%
Spillway Elevation		6488	ft

* * *

The following appendices and drawing are attached and complete this design report.

Appendix A - Hydrology Calculations

Appendix B - SEDCAD+ (Input and Output) 100-Year, 6-Hour Storm Event

Exhibit # 1 - BM-TW Temporary Impoundment Design

Appendix C

Design Report for J7-I

(See Chapter 6, Attachment H, Volume 3 for the Complete Certified Report and Drawings)

INSPECTION REPORT

Sedimentation Structure

J7-I

Black Mesa Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure J7-I is an earthen embankment, designed and constructed in 1983 by Peabody Coal Company as a temporary sedimentation structure to control runoff and sediment from the disturbed mining areas of the Black Mesa Mine. The location of Structure J7-I is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure J7-I. Regional site information is presented in the "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona for Peabody Coal Company," along with the methods and results of analyses used for slope stability, hydrology and hydraulics.

INSPECTION

Structure J7-I was inspected on September 2, 1985 by an interdisciplinary team of engineers from Dames & Moore. The purpose of the inspection was to assess the safety and general condition of the structure with respect to United States Department of Interior, Office of Surface Mining (OSM) regulations.

Dames & Moore's inspection was performed in accordance with applicable 30 CFR 780 and 816 regulations and included a review of the J7-I project files and a field inspection of the structure. The most current information contained in the Peabody Coal Company files includes the 1984 and current survey data and inspections performed in 1984 and 1985 by

Peabody Coal Company. The survey data developed in August 1984 was used in the analyses of the structure. Results of the field inspection are included in this report as Appendix A.

SITE DESCRIPTION

LAND USE

Structure J7-I has a 117.1-acre tributary drainage area and is located near Yucca Flats Wash at the Black Mesa Mine. The watershed is classified as 66% disturbed, 31% Sagebrush, and 3% reclaimed.

EMBANKMENT

Structure J7-I is a homogeneous earthen embankment classified as a roadway embankment. Physical characteristics of the embankment are listed in the following table:

Structure J7-I

Embankment	Residual Sandstone/Shale Soils
Foundation	Sandstone
Right Abutment	Residual Shale Soils
Left Abutment	Residual Shale Soils
Height	13.7 ft
Crest Width	30 ft
Upstream Slope	3.75 H : 1 V
Downstream Slope	3.75 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section J7-I, A-A'. Grass provides erosion protection on the upstream and downstream slopes of the embankment.

ANALYSES

STABILITY

Structure J7-I is a category A-5 embankment. A standard category A-5 embankment has static and seismic factors of safety of 1.5 and 1.2, respectively, under the following conditions:

1. Maximum height = 30 ft
2. Maximum upstream slope = 2.0 H : 1 V
3. Maximum downstream slope = 4.25 H : 1 V
4. Normal pool with steady seepage saturation conditions

The upstream slope is lower in height and has a flatter slope than the category standard. The downstream slope is steeper than the category standard; therefore, the embankment has factors of safety less than the design minimum.

HYDROLOGY

The hydrologic analysis was completed using the U.S. Army Corps of Engineers generalized computer program HEC-1, Flood Hydrograph Package. Structure J7-I is located downstream from Structure J7-H. The two structures have a combined storage capacity that is greater than 20 acre-feet. Therefore, the spillway for J7-I was analyzed using the 100-year, 6-hour storm. The storage capacity of Structure J7-I was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.473	mi
2.	Elevation Difference, H	135	ft
3.	Time of Concentration in hours, T_c . . .	0.166	h
4.	Lag time, $0.6T_c$	0.099	h
5.	SCS Curve Number	85	
6.	Rainfall Depth, 10-year, 24-hour storm .	2.1	in.
	100-year, 6-hour storm .	2.4	in.
7.	Drainage Area, 10-year, 24-hour storm .	117.1	acres
	100-year, 6-hour storm . .	150.1	acres

HYDRAULICS

The HEC-1 program was utilized to evaluate inflow, reservoir response and outflow from the sedimentation structure. The initial conditions and results of the analysis are summarized in the following table.

J7-I HYDRAULICS

	Units	10-year 24-hour Storm	100-year 6-hour Storm	
Initial Reservoir Volume Condition		Empty	Full to the spillway elevation	
Inflow				
Peak Flow	cfs	162	362	
Volume	acre-ft	8.59	10.54	
Storage				
Peak Stage	ft	6335.76	6343.19	
Spillway Elevation . .	ft	6340.00	—	
Peak Storage	acre-ft	8.57	—	
Storage Capacity . . .	acre-ft	16.8	—	
Outflow				
Peak Flow	cfs	0	80	
Embankment Crest Elevation	ft	—	6347.60	
Peak Storage	ft	—	6343.19	
Freeboard	ft	—	3.19	
Spillway				
Pipe Exit Velocity . .	fps	—	10.3	
Mannings "n"		—	0.024	
Outflow Channel			Section I	Section II
Slope	%	—	14	5
Normal Velocity. . . .	fps	—	8.7	6.2
Normal Depth	ft	—	0.74	0.55
Manning's "n"		—	0.040	0.040

Spillway

The existing spillway for J7-I consists of two corrugated metal pipes (CMP) with the following dimensions:

Pipe Diameter	36	in.
Pipe length	89	ft
Upstream invert elevation	6340.0	ft
Approximate slope	3.9	percent

Outflow Channel

The existing outflow channel for J7-I has a trapezoidal channel with the following dimensions:

Channel depth	2	ft
Channel width	15	ft
Channel length	100	ft
Side slopes (horizontal to vertical)	2:1	
Average exit slope	10	percent

The first 50 feet of the channel is riprapped with rock.

STORAGE CAPACITY

The impoundment volume-elevation curve is based on site specific surveys conducted for Peabody Coal Company's August 1984 inspection, and 1985 resurveys, where available. Additionally, the most current topographic maps available were used in developing Plate 3, Volume-Elevation Curve, J7-I.

The calculations for the sediment load entering Structure J7-I were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.192
3. Slope Factor, LS 1.0
4. Cover Factor, C 0.673
5. Erosion Control Factor, P 1.0

The hydrologic analysis gives the storage volume required to contain the 10-year, 24-hour storm, and the remaining storage volume available for storing sediment. The existing storage capacity of J7-I is shown on Plate 3, Volume-Elevation Curve, J7-I, and the results of the analysis are summarized in the following table.

J7-I STORAGE

Total Storage Capacity	16.8	acre-ft
10-year, 24-hour Storm Inflow	8.59	acre-ft
Available Sediment Storage Capacity . .	8.23	acre-ft
Sediment Inflow Rate	0.27	acre-ft/yr
Sediment Storage Life	30	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure J7-I indicated that the geotechnical problems consist of rill erosion on the upstream slopes; a large gully on downstream slope; heavy erosion at the downstream toe of the embankment and gullys on the right abutment; and a steep downstream slope. Correction of erosion is considered a periodic maintenance task and does not require remedial action. The downstream slope should be flattened to 4.25 horizontal to 1 vertical to meet stability requirements. Evidence of seepage was noted below the downstream toe of embankment through the sandstone bedrock. Remedial action for this condition is not required at the present time, however, future inspections should check for changes.

HYDRAULICS

The storage capacity and spillway capacity of Structure J7-I are adequate; however, the spillway does not have an adequate outflow channel or adequate erosion protection. A trapezoidal outflow channel and a stilling basin should be constructed along the alignment B-B' shown in Plate 1. The channel and stilling basin profile is shown in Plate 4 and the required dimensions are shown in Plate 5 and Plate 6. The outflow channel, and stilling basin should be protected against erosion using geotextile and riprap as shown in Plate 5. A trashrack should be installed on the inlet of the CMP to prevent clogging of the spillway.

*   *   *

The following plates and appendix are attached and complete this inspection report.

Plate 1 - Site Plan J7-I

Plate 2 - Existing Maximum Cross Section J7-I, A-A'

Plate 3 - Volume-Elevation Curve J7-I

Plate 4 - Channel Profile J7-I, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section J7-I

Plate 6 - Spillway Stilling Basin Plan J7-I

Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations

Appendix D

Design Report for J7-J

(See Chapter 6, Attachment H, Volume 3 for the Complete Certified Report and Drawings)

AUG 1999
APPROVED

INSPECTION REPORT

Sedimentation Structure

J7-J

Black Mesa Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Registered Professional Engineer (Civil)
CERTIFICATE NO.
13376
LUTZ
KUNZE
Date Signed 11-22-85
ARIZONA, U.S.A.

AUG 1999
APPROVED

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure J7-J is an earthen embankment, designed and constructed in 1983 by Peabody Coal Company as a temporary sedimentation structure to control runoff and sediment from the disturbed mining areas of the Black Mesa Mine. The location of Structure J7-J is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure J7-J. Regional site information is presented in the "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona for Peabody Coal Company," along with the methods and results of analyses used for slope stability, hydrology and hydraulics.

INSPECTION

Structure J7-J was inspected on August 31, 1985 by an interdisciplinary team of engineers from Dames & Moore. The purpose of the inspection was to assess the safety and general condition of the structure with respect to United States Department of Interior, Office of Surface Mining (OSM) regulations.

Dames & Moore's inspection was performed in accordance with applicable 30 CFR 780 and 816 regulations and included a review of the J7-J project files and a field inspection of the structure. The most current information contained in the Peabody Coal Company files includes the 1984 and current survey data and inspections performed in 1984 and 1985 by

Peabody Coal Company. The survey data developed in August 1984 was used in the analyses of the structure. Results of the field inspection are included in this report as Appendix A.

SITE DESCRIPTION

LAND USE

Structure J7-J has a 9.14-acre tributary drainage area and is located near Yucca Flats Wash at the Black Mesa Mine. The watershed is classified as 100% disturbed.

EMBANKMENT

Structure J7-J is a homogeneous earthen embankment classified as a roadway embankment. Physical characteristics of the embankment are listed in the following table:

Structure J7-J

Embankment	Residual Shale Soils
Foundation	Sandstone
Right Abutment	Residual Shale Soils
Left Abutment	Residual Shale Soils
Height	10.8 ft
Crest Width	30 ft
Upstream Slope	3.3 H : 1 V
Downstream Slope . . .	2.9 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section J7-J, A-A'. Grass provides erosion protection on the upstream and downstream slopes of the embankment.

ANALYSES

STABILITY

Structure J7-J is a category B-5 embankment. A standard category B-5 embankment has static and seismic factors of safety of 1.5 and 1.2, respectively, under the following conditions:

1. Maximum height = 15 ft
2. Maximum upstream slope = 1.75 H : 1 V
3. Maximum downstream slope = 2.5 H : 1 V
4. Normal pool with steady seepage saturation conditions

The J7-J embankment is lower in height and has flatter slopes than the category standard; therefore, the embankment has factors of safety greater than the design minimum.

HYDROLOGY

The hydrologic analysis was completed using the U.S. Army Corps of Engineers generalized computer program HEC-1, Flood Hydrograph Package. Structure J7-J is not in series with any other structure and therefore the spillway was analyzed using the 25-year, 6-hour storm. The storage capacity of Structure J7-J was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1. Water Course length, L . . . . 0.142 mi
2. Elevation Difference, H . . . . 62 ft
3. Time of Concentration in hours, T_c . . . 0.0556 h
4. Lag time, $0.6T_c$ . . . . 0.0333 h
5. SCS Curve Number 91
6. Rainfall Depth, 10-year, 24-hour storm . 2.1 in.
   25-year, 6-hour storm. . 1.9 in.
7. Drainage Area . . . . 9.14 acres

HYDRAULICS

The HEC-1 program was used to evaluate inflow to the sedimentation structure, outflow from the structure and the resulting water surface elevations. The initial conditions and results of the analysis are summarized in the following table.

J7-J HYDRAULICS

	Units	10-year 24-hour Storm	25-year 6-hour Storm	
Initial Reservoir Volume Condition		Empty	Full to the spillway elevation	
Inflow				
Peak Flow	cfs	24	30	
Volume	acre-ft	0.96	0.81	
Storage				
Peak Stage	ft	6357.16	6361.73	
Spillway Elevation . .	ft	6360.31	—	
Peak Storage	acre-ft	0.94	—	
Storage Capacity . . .	acre-ft	1.72	—	
Outflow				
Peak Flow	cfs	0	8	
Embankment Crest Elevation	ft	—	6363.20	
Peak Stage	ft	—	6361.73	
Freeboard	ft	—	1.47	
Spillway				
Pipe Exit Velocity . .	fps	—	7.7	
Mannings "n"		—	0.024	
Outflow Channel			Section I	Section II
Slope	%	—	8	35
Normal Velocity. . . .	fps	—	3.2	5.0
Normal Depth	ft	—	0.17	0.11
Manning's "n"		—	0.040	0.040

Spillway

The existing spillway for J7-J is a corrugated metal pipe (CMP) with the following dimensions:

Pipe diameter	24	in.
Pipe length	108	ft
Upstream invert elevation	6360.31	ft
Downstream invert elevation	6356.11	ft
Slope	5.2	percent

Outflow Channel

The structure presently has no outflow channel.

STORAGE CAPACITY

The impoundment volume-elevation curve is based on site specific surveys conducted for Peabody Coal Company's August 1984 inspection, and 1985 resurveys, where available. Additionally, the most current topographic maps available were used in developing Plate 3, Volume-Elevation Curve, J7-J.

The calculations for the sediment load entering Structure J7-J were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.21
3. Slope Factor, LS 2.77
4. Cover Factor, C 1.0
5. Erosion Control Factor, P 1.0

The hydrologic analysis gives the storage volume required to contain the 10-year, 24-hour storm, and the remaining storage volume available for storing sediment. The existing storage capacity of J7-J is shown on Plate 3, Volume-Elevation Curve, J7-J, and the results of the analysis are summarized in the following table.

J7-J STORAGE

Total Storage Capacity	1.72	acre-ft
10-year, 24-hour Storm Inflow	0.96	acre-ft
Available Sediment Storage Capacity . .	0.78	acre-ft
Sediment Inflow Rate	0.099	acre-ft/yr
Sediment Storage Life	8	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure J7-J indicated that the only geotechnical problem is rill erosion on the upstream and downstream slopes; and a steep downstream slope. Correction of erosion is considered a periodic maintenance task and does not require remedial action.

HYDRAULICS

The storage capacity and spillway capacity of Structure J7-J are adequate; however, the spillway does not have an outflow channel. A trapezoidal outflow channel should be constructed along the alignment B-B' shown in Plate 1. The channel profile is shown in Plate 4 and the required dimensions are shown in Plate 5. The outflow channel should be protected against erosion using geotextile and riprap as shown in Plate 5. A trash-rack should be installed on the inlet of the CMP to prevent clogging of the spillway.

* * *

The following plates and appendix are attached and complete this inspection report.

Plate 1 - Site Plan J7-J

Plate 2 - Existing Maximum Cross Section J7-J, A-A'

Plate 3 - Volume-Elevation Curve J7-J

Plate 4 - Channel Profile J7-J, B-B'

Plate 5 - Outflow Channel Cross Section J7-J

Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations

Appendix E

Design Report for J7-M

(See Chapter 6, Attachment H, Volume 3 for the Complete Certified Report and Drawings)

INSPECTION REPORT

Sedimentation Structure

J7-M

Black Mesa Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure J7-M is an earthen embankment, designed and constructed in 1983 by Peabody Coal Company as a temporary sedimentation structure to control runoff and sediment from the disturbed mining areas of the Black Mesa Mine. The location of Structure J7-M is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure J7-M. Regional site information is presented in the "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona for Peabody Coal Company," along with the methods and results of analyses used for slope stability, hydrology and hydraulics.

INSPECTION

Structure J7-M was inspected on August 31, 1985 by an inter-disciplinary team of engineers from Dames & Moore. The purpose of the inspection was to assess the safety and general condition of the structure with respect to United States Department of Interior, Office of Surface Mining (OSM) regulations.

Dames & Moore's inspection was performed in accordance with applicable 30 CFR 780 and 816 regulations and included a review of the J7-M project files and a field inspection of the structure. The most current information contained in the Peabody Coal Company files includes the 1984 and current survey data and inspections performed in 1984 and 1985 by

Peabody Coal Company. The survey data developed in August 1984 was used in the analyses of the structure. Results of the field inspection are included in this report as Appendix A.

SITE DESCRIPTION

LAND USE

Structure J7-M has a 52.0-acre tributary drainage area and is located near Sagebrush Wash at the Black Mesa Mine. The watershed is classified as 100% disturbed.

EMBANKMENT

Structure J7-M is a homogeneous earthen embankment classified as a roadway embankment. Physical characteristics of the embankment are listed in the following table:

Structure J7-M

Embankment	Residual Sandstone Soils
Foundation	Residual Sandstone Soils
Right Abutment	Residual Sandstone Soils/Sandstone
Left Abutment	Residual Sandstone Soils/Sandstone
Height	13.9 ft
Crest Width	30 ft
Upstream Slope	3.3 H : 1 V
Downstream Slope . . .	2.6 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section J7-M, A-A'. Grass provides erosion protection on the upstream and downstream slopes of the embankment.

ANALYSES

STABILITY

Structure J7-M is a category A-1 embankment. A standard category A-1 embankment has static and seismic factors of safety of 1.5 and 1.2, respectively, under the following conditions:

1. Maximum height = 20 ft
2. Maximum upstream slope = 2.0 H : 1 V
3. Maximum downstream slope = 4.0 H : 1 V
4. Normal pool with steady seepage saturation conditions

The J7-M embankment is lower in height; however, the downstream slope is steeper than the category standard; therefore, the embankment has factors of safety less than the design minimum.

HYDROLOGY

The hydrologic analysis was completed using the U.S. Army Corps of Engineers generalized computer program HEC-1, Flood Hydrograph Package. Structure J7-M is located downstream from Structure J7-N. The two structures have a combined storage capacity that is less than 20 acre-feet. Therefore, the spillway for J7-M was analyzed using the 25-year, 6-hour storm. The storage capacity of Structure J7-M was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.540	mi
2.	Elevation Difference, H	98	ft
3.	Time of Concentration, T_c	0.218	h
4.	Lag time, $0.6T_c$	0.131	h
5.	SCS Curve Number	92	
6.	Rainfall Depth, 10-year, 24-hour storm .	2.1	in.
	25-year, 6-hour storm. .	1.9	in.
7.	Drainage Area	52.0	acres

HYDRAULICS

The HEC-1 program was used to evaluate inflow to the sedimentation structure, outflow from the structure and the resulting water surface elevations. Both the 10-year and 25-year storms were routed through Structure J7-N located upstream and into Structure J7-M. The initial conditions and results of the analysis are summarized in the following table.

J7-M HYDRAULICS

	Units	10-year 24-hour Storm	25-year 6-hour Storm
Initial Reservoir Volume Condition		Empty	Full to the spillway elevation
Inflow			
Peak Flow	cfs	100	127
Volume	acre-ft	5.91	5.07
Storage			
Peak Stage	ft	6373.69	—
Spillway Elevation . .	ft	6377.40	—
Peak Storage	acre-ft	5.91	--
Storage Capacity . . .	acre-ft	10.4	—
Outflow			
Peak Flow	cfs	0	49
Embankment Crest Elevation	ft	—	6382.40
Peak Stage	ft	--	6379.61
Freeboard	ft	--	2.79
Spillway			
Pipe Exit Velocity (36" CMP)	fps	--	11.8
Pipe Exit Velocity (48" CMP)	fps	—	7.2
Mannings "n"		—	0.024
Outflow Channel			
Slope	%	—	9
Normal Velocity. . . .	fps	—	6.4
Normal Depth	ft	--	0.47
Manning's "n"		--	0.040

Spillway Channel

The existing spillway for J7-M consists of two corrugated metal pipes (CMP) with the following dimensions:

Pipe diameters	36, 48 in.
Pipe lengths	60 ft
Approximate slope	1-2 percent
Upstream invert elevation	6377.40 ft

Outflow Channel

The existing outflow channel for J7-M is a U-shaped channel with the following dimensions:

Channel width	8 ft
Channel length	30 ft
Average exit slope	3 percent

Rock provides erosion protection within the channel.

STORAGE CAPACITY

The impoundment volume-elevation curve is based on site specific surveys conducted for Peabody Coal Company's August 1984 inspection, and 1985 resurveys, where available. Additionally, the most current topographic maps available were used in developing Plate 3, Volume-Elevation Curve, J7-M.

The calculations for the sediment load entering Structure J7-M were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.203
3. Slope Factor, LS 2.6
4. Cover Factor, C 1.0
5. Erosion Control Factor, P 1.0

The hydrologic analysis gives the storage volume required to contain the 10-year, 24-hour storm, and the remaining storage volume available for storing sediment. The existing storage capacity of J7-M and the results of the sediment inflow analysis are summarized in the following table.

J7-M STORAGE

Total Storage Capacity	10.4	acre-ft
10-year, 24-hour Storm Inflow	5.91	acre-ft
Available Sediment Storage Capacity . .	4.49	acre-ft
Sediment Inflow Rate	0.509	acre-ft/yr
Sediment Storage Life	9	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure J7-M indicated that the geotechnical problems consist of rills on the upstream and downstream slopes and gullys in the right and left abutments; and a steep downstream slope. Correction of erosion is considered a periodic maintenance task and does not require remedial action. The downstream slope should be flattened to 4.0 horizontal to 1 vertical to meet stability requirements.

HYDRAULICS

The storage capacity and spillway capacity of Structure J7-M are adequate; however, the spillway does not have an adequate outflow channel. A trapezoidal outflow channel should be constructed along the alignment B-B' shown in Plate 1. The channel profile is shown in Plate 4 and the required dimensions are shown in Plate 5. The outflow channel should be protected against erosion using geotextile and riprap as shown in Plate 5. A trash-rack should be installed on the inlet of the CMP to prevent clogging of the spillway.

* * *

The following plates and appendix are attached and complete this inspection report.

Plate 1 - Site Plan J7-M

Plate 2 - Existing Maximum Cross Section J7-M, A-A'

Plate 3 - Volume-Elevation Curve J7-M

Plate 4 - Channel Profile J7-M, B-B'

Plate 5 - Outflow Channel Cross Section J7-M

Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations

Appendix F

Design Report for KM-B

(See Chapter 6, Attachment H, Volume 4 for the Complete Certified Report and Drawings)

INSPECTION REPORT

Sedimentation Structure

KM-B

Kayenta Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure KM-B is an earthen embankment, designed and constructed in 1983 by Peabody Coal Company as a temporary sedimentation structure to control runoff and sediment from the disturbed mining areas of the Kayenta Mine. The location of Structure KM-B is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure KM-B. Regional site information is presented in the "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona for Peabody Coal Company," along with the methods and results of analyses used for slope stability, hydrology and hydraulics.

INSPECTION

Structure KM-B was inspected on September 5, 1985 by an interdisciplinary team of engineers from Dames & Moore. The purpose of the inspection was to assess the safety and general condition of the structure with respect to United States Department of Interior, Office of Surface Mining (OSM) regulations.

Dames & Moore's inspection was performed in accordance with applicable 30 CFR 780 and 816 regulations and included a review of the KM-B project files and a field inspection of the structure. The most current information contained in the Peabody Coal Company files includes the 1984 and current survey data and inspections performed in 1984 and 1985 by

Peabody Coal Company. The survey data developed in August 1984 was used in the analyses of the structure. Results of the field inspection are included in this report as Appendix A.

SITE DESCRIPTION

LAND USE

Structure KM-B has a 22.5-acre tributary drainage area and is located near the Yellow Water Canyon at the Kayenta Mine. The watershed is classified as 75% Pinion/Juniper and 25% disturbed.

EMBANKMENT

Structure KM-B is a homogeneous earthen embankment classified as a roadway embankment. Physical characteristics of the embankment are listed in the following table:

Structure KM-B

Embankment	Residual Shale Soils
Foundation	Alluvium
Right Abutment	Shale
Left Abutment	Shale
Height	12.4 ft
Crest Width	21 ft
Upstream Slope	1.9 H : 1 V
Downstream Slope . . .	3.3 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section KM-B, A-A'. Grass provides erosion protection on the upstream and downstream slopes of the embankment.

ANALYSES

STABILITY

Structure KM-B is a category B-3 embankment. A standard category B-3 embankment has static and seismic factors of safety of 1.5 and 1.2, respectively, under the following conditions:

1. Maximum height = 20 ft
2. Maximum upstream slope = 2.0 H : 1 V
3. Maximum downstream slope = 2.5 H : 1 V
4. Normal pool with steady seepage saturation conditions

The KM-B embankment is lower in height; however, the upstream slope is steeper than the category standard; therefore, the embankment has factors of safety less than the design minimum.

HYDROLOGY

The hydrologic analysis was completed using the U.S. Army Corps of Engineers generalized computer program HEC-1, Flood Hydrograph Package. Structure KM-B is not in series with any other structure and therefore the spillway was analyzed using the 25-year, 6-hour storm. The storage capacity of Structure KM-B was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.303	mi
2.	Elevation Difference, H	106	ft
3.	Time of Concentration, T_c	0.109	h
4.	Lag time, $0.6T_c$	0.065	h
5.	SCS Curve Number	85	
6.	Rainfall Depth, 10-year, 24-hour storm .	2.1	in.
	25-year, 6-hour storm. .	1.9	in.
7.	Drainage Area	22.5	acres

HYDRAULICS

The HEC-1 program was used to evaluate inflow to the sedimentation structure, outflow from the structure and the resulting water surface elevations. The initial conditions and results of the analysis are summarized in the following table.

KM-B HYDRAULICS

	Units	10-year 24-hour Storm	25-year 6-hour Storm	
Initial Reservoir Volume Condition		Empty	Full to the spillway elevation	
Inflow				
Peak Flow	cfs	34	44	
Volume	acre-ft	1.66	1.35	
Storage				
Peak Stage	ft	6497.58	6505.42	
Spillway Elevation . .	ft	6504.10	—	
Peak Storage	acre-ft	1.66	—	
Storage Capacity . . .	acre-ft	4.40	—	
Outflow				
Peak Flow	cfs	0	7	
Embankment Crest Elevation	ft	—	6507.10	
Peak Stage	ft	—	6505.42	
Freeboard	ft	—	1.68	
Spillway				
Pipe Exit Velocity . .	fps	—	7.3	
Mannings "n"		—	0.024	
Outflow Channel			Section I	Section II
Slope	%	—	8	43
Normal Velocity. . . .	fps	—	2.9	4.8
Normal Depth	ft	—	0.15	0.09
Manning's "n"		—	0.040	0.040

Spillway

The existing spillway for KM-B is a 24-inch corrugated metal pipe (CMP).

Pipe length	42	ft
Pipe Invert Elevation Upstream	6504.10	ft
Pipe Invert Elevation Downstream . . .	6502.00	ft
Pipe slope	5	percent

Outflow Channel

The existing outflow channel for KM-B has a U-shaped channel with the following dimensions:

Channel width	8 ft
Channel length	50 ft
Side slopes (horizontal to vertical). .	2:1
Average exit slope	5 percent

There is presently no erosion protection within the channel.

STORAGE CAPACITY

The impoundment volume-elevation curve is based on site specific surveys conducted for Peabody Coal Company's August 1984 inspection, and 1985 resurveys, where available. Additionally, the most current topographic maps available were used in developing Plate 3, Volume-Elevation Curve, KM-B.

The calculations for the sediment load entering Structure KM-B were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.16
3. Slope Factor, LS 19.42
4. Cover Factor, C 0.355
5. Erosion Control Factor, P 1.0

The hydrologic analysis gives the storage volume required to contain the 10-year, 24-hour storm, and the remaining storage volume available for storing sediment. The existing storage capacity of KM-B and the results of the sediment inflow analysis are summarized in the following table.

KM-B STORAGE

Total Storage Capacity	4.40	acre-ft
10-year, 24-hour Storm Inflow	1.66	acre-ft
Available Sediment Storage Capacity . .	2.74	acre-ft
Sediment Inflow Rate	0.46	acre-ft/yr
Sediment Storage Life	6	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure KM-B indicated that the only geotechnical problem is rill and gully erosion on the upstream and downstream slope and the right and left abutments. Correction of erosion is considered a periodic maintenance task and does not require remedial action.

The upstream slope should be flattened to 2.0 horizontal to 1 vertical to meet stability requirements.

HYDRAULICS

The storage capacity and spillway capacity of Structure KM-B are adequate; however, the spillway does not have an adequate outflow channel or adequate erosion protection. There is no suitable location for an improved outflow channel along the existing alignment. Therefore, a new pipe spillway and outflow channel should be constructed along the alignment B-B' shown in Plate 1. The existing spillway should be abandoned. The spillway and outflow channel profile is shown in Plate 4 and the required dimensions are shown in Plate 5. The outflow channel should be protected against erosion using geotextile and riprap as shown in Plate 5. A trashrack should be installed on the inlet of the CMP to prevent clogging of the spillway.

* * *

The following plates and appendix are attached and complete this inspection report.

- Plate 1 - Site Plan KM-B
- Plate 2 - Existing Maximum Cross Section KM-B, A-A'
- Plate 3 - Volume-Elevation Curve KM-B
- Plate 4 - Channel Profile KM-B, B-B'
- Plate 5 - Outflow Channel Cross Section KM-B
- Appendix A - Inspection Check List
- Appendix B - Hydrology and Hydraulic Calculations

Appendix G

Design Report for N12-C

(See Chapter 6, Attachment H, Volume 6a for the Complete Certified Report and Drawings)

INSPECTION REPORT

Sedimentation Structure

N12-C

Kayenta Mine

Navajo County, Arizona

For

PEABODY WESTERN COAL COMPANY

Registered Professional Engineer (Civil)
CERTIFICATE NO.
18782
JAMES G.
SCHLENVOGT
Date Signed
ARIZONA, U.S.A.

DEC 30 1998

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INTRODUCTION

Sedimentation Structure N12-C is a partially incised structure with an earthen embankment, designed and reconstructed in 1994 by Peabody Western Coal Company as a sedimentation structure to control runoff and sediment from portions of the disturbed mining area at the Black Mesa and Kayenta Mines. The location of Structure N12-C and its watershed boundary are shown on Drawing No. 85400 (Sheets L-7 and L-8) and Drawing No. 85405. The site-specific 1994 as-built plans are shown on the attached Exhibit 1. With this revised design evaluation, the N12-C structure will not require any field modifications.

This inspection report contains information specific to Structure N12-C, which is in series with Sedimentation Structures N12-C1 and N12-C2. Mine-wide design, construction, and reclamation information is presented in the "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona, for Peabody Western Coal Company", December, 1985 (PAP), Chapter 6, Attachment D, Volume 2, along with the methods and results of analyses used for slope stability, hydrology, and hydraulics, and in Chapter 6, Pages 11 to 42, "Sediment and Water Control Facility Plan".

INSPECTION

Existing Structure N12-C was inspected by a Registered Professional Engineer from Peabody Western Coal Company, to assure that the existing structure is stable and no adverse conditions exist. A detailed geotechnical investigation was not performed, rather, the information in Chapter 6, Attachment D was utilized for embankment design and during construction to assure that the as-built embankment configuration would be stable.

SITE DESCRIPTION

LAND USE

The N12-C, N12-C1 and N12-C2 Structures have a combined watershed of 473.0 acres and are located near Coal Mine Wash at the Kayenta Mine. The 80.5 acre watershed that contributes directly to structure N12-C is classified as, 34% pinion/juniper, 30% disturbed, and 36% sagebrush/grass.

DESIGN ANALYSES

GENERAL

Structure N12-C was designed under the supervision of a Registered Professional Engineer from Peabody Western Coal Company. The design was performed in accordance with applicable 30 CFR 780 and 816 regulations of the United States Department of Interior, Office of Surface Mining (OSM) and included a review of available project files. The most current information contained in the Peabody Western Coal Company files includes topographic maps developed from aerial photography flown in 1998 for Peabody Western Coal Company and was used in the analyses of the structure.

STABILITY

Structure N12-C is a Category A-1 embankment with a homogeneous earthen embankment, compacted in lifts to design specifications and approximately 22 feet wide on top. An upstream slope of 3:1 (horizontal to vertical) and a downstream slope of 4:1was constructed. Based on the total embankment height of approximately 19.4 feet, these slopes are equal to or flatter than the recommended "worst case" embankment/foundation condition slopes in Table 3-6, Attachment D, Chapter 6; therefore, the embankment will be stable. The embankment incorporates a 48-inch diameter corrugated metal pipe for an emergency spillway.

HYDROLOGY

The hydrologic analysis was completed using the computer program SEDCAD 4 (see Appendices A, B, and C). Structure N12-C was constructed in series with Structures N12-C1 and N12-C2. Structure N12-C is classified as a low hazard structure (see Drawing No. 85408). In addition, the mine area is sparsely populated with no one living in the downstream floodplain. The structure will impound 26.41acre-feet, however, 6.71 acre-feet are incised. The embankment is also less than 20 vertical feet in height from the upstream toe of the embankment at the natural stream elevation to the spillway invert elevation.

The N12-C structure is in series with the N12-C1 and N12-C2 structures and the combined storage capacity is greater than 20 acre-feet; therefore, the spillway was analyzed using the 100-year, 6-hour storm event assuming structures N12-C1 and N12C-2 are reclaimed. The N12-C structure contains a 48-inch culvert. According to 30 CFR 816.49(a)(9), an impoundment can have a single spillway only if it is an open channel spillway and not a culvert. To replace the existing spillway with an open channel spillway would not be practical because the spillway runs under an existing access road. In order to comply with the applicable OSM regulations including 30 CFR 816.49(c)(2) while reflecting the practical site-specific considerations, PWCC proposes to maintain adequate storage in this impoundment to contain the storm run-off from the 100-year, 6-hour storm event while maintaining a minimum of one foot of freeboard. Required containment volumes have been determined assuming the culvert does not exist. The existing culvert is, therefore, not required for the pond to function adequately and in compliance with the law. If, however, the culvert remains, it will function to dewater the pond after any major storm event and thus will provide an added measure of safety, (see Chapter 6, Attachment AF for additional discussions).

The storage capacity of structure N12-C was analyzed using the 10-year, 24-hour storm event. The combined ponds in series were verified to completely contain the 10-year, 24-hour storm event, and provide adequate sediment storage volume, without discharging.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.744 mi.
2.	Elevation Difference, H	224 ft
3.	Time of Concentration, T_c	0.229 hr
4.	SCS Curve Number	80
5.	Rainfall Depth, 10-year, 24-hour storm 100-year, 6-hour storm	2.1 in 2.4 in
6.	Drainage Area	80.5 acres

HYDRAULICS

The SEDCAD 4 and Flow Master computer programs were used to evaluate inflow to the sedimentation structure, and the resulting water surface elevations. The initial conditions and results of the analysis are summarized in the following table (supporting calculations are presented in Appendices A, B, and C).

<u>N12-C SEDIMENTATION POND HYDRAULICS TABLE</u>

	Units	10-Yr, 24-Hr Storm	100-Yr, 6-Hr Storm
Initial Reservoir Volume Condition		Empty	Full to the Spillway Elevation
Inflow			
Peak Flow	Cfs	44.8	410.5
Volume	ac-ft	3.63	34.2
Storage			
Peak Stage	Msl	N/A	6595.9
Max. Operating Elev.	Msl	N/A	6589.1
Spillway Elev.	Msl	6584.6	6584.6
Storage Capacity	ac-ft	26.4	N/A
Embankment Crest Elev.	Msl	6596.9	6596.9
Freeboard	Ft	–	1.0
Outflow			
Peak Flow	Cfs	N/A	85.9
Embankment Crest Elev.	ft	N/A	6596.9
Spillway Elevation	ft	N/A	6584.6
Peak Stage	ft	N/A	6589.4
Freeboard	ft	N/A	7.5
Spillway Pipe			
Design Headwater	Ft	N/A	4.8
Pipe Diameter	Ft	N/A	4.0
Manning's "n"		N/A	0.024
Outflow Channel			
Slope	%	N/A	27
Normal Velocity	fps	N/A	20.7
Normal Depth	ft	N/A	0.27
Manning's "n"		N/A	0.015

SPILLWAY AND OUTFLOW CHANNEL

The existing spillway for N12-C is a corrugated metal pipe with dimensions as listed below. The culvert alignment and dimensions are shown on Exhibit 1.

Pipe Diameter	4.0	ft
Pipe Length	72	ft
Average Slope	15	%
Spillway Elevation	6584.6	ft

The existing outflow channel for N12-C has a trapezoidal channel with the following dimensions:

Channel Bottom Width	15	ft
Channel Length	60	ft
Side Slopes	2:1	
Average Exit Slope	27	%

The outflow channel is protected against erosion with fabriform and was constructed beyond the toe of the

embankment as a transition into the downstream channel.

STORAGE CAPACITY

The impoundment stage-capacity table (see Exhibit 1) is based on the 1994 aerial topographic mapping conducted for Peabody Western Coal Company. Structure N12-C is designed to contain approximately 26.41acre-feet.

The calculations for the sediment load entering structure N12-C were made utilizing the Revised Universal Soil Loss Equation with the following parameters:

1.	Rainfall Factor, R	40
2.	Soil Erodibility Factor, K	0.27
3.	Slope Factor, LS	6.65

4. Cover Factor, C 0.392

5. Erosion Control Factor, P 0.941

The hydrologic analysis gives the storage volume required to contain the 10-year, 24-hour storm, and the remaining storage volume available for storing sediment. Structure N12-C has sufficient available storage capacity to contain the 10-year, 24-hour storm with adequate excess capacity to store additional flows from structures N12-C2 and N12-C1. The combined sediment storage capacity was determined for the structures in series and the results of the analysis are presented in the following table.

Combined Storage for Structures N12-C2, N12-C1 and N12-C

	N12-C2	N12-C1	N12-C	Combined
Total Storage Capacity	18.95	18.38	26.41	63.74 acre-ft
10-Year, 24-Hour Storm Inflow	20.15	2.46	3.63	26.24 acre-ft
Available Sediment Storage Capacity	--	--	--	37.50 acre-ft
Sediment Inflow Rate/Year	3.30	0.52	0.95	4.77 acre-ft
Sediment Storage Life	--	--	--	7.9 years

* * *

The following appendices and drawing are attached and complete this design report.

Appendix A - Hydrology, Hydraulic, and Sedimentation Calculations

Appendix B - SEDCAD4 (Input and Output) 10-Year, 24-Hour Storm Event

Appendix C - SEDCAD4 (Input and Output) 100-Year, 6-Hour Storm Event

Exhibit #1 - Proposed N12-C Sedimentation Pond Design

Appendix H

100-Year, 6-Hour Storm Event for J7-Dam

(See Chapter 6: MSHA-Size Structures, Volume 1 for Addition Information)

PEABODY WESTERN COAL COMPANY
CALCULATED HYDROLOGIC DATA

PROJECT: J-7 Pond (Dam #1211-AZ-9-0003)

STRUCTURE: J7

TIME OF CONCENTRATION:

Start Elevation (ft) =	7120
End Elevation (ft) =	6350
Elevation Difference, E (ft) =	770
Watercourse Length (ft) =	41500
Watercourse Length, L (mi) =	7.860

Tc = (11.9L^3/E)^0.385 = 2.173 hours

ROUTING PARAMETERS:

Between structure routing parameters were calculated using the SCS Upland Method in SEDCAD+. Input and output parameters are shown on the SEDCAD+ printouts in Appendices B and C.

SCS CURVE NUMBER:

Cover Type	Soil Group	Curve Number	Area (acres)	CN*Area
Pinyon Juniper	B	65	635.0	41275.0
Pinyon Juniper	C	78	628.8	49046.4
Pinyon Juniper	D	83	5238.0	434754.0
Sagebrush	B	60	1350.3	81018.0
Sagebrush	C	73	742.7	54217.1
Sagebrush	D	79	67.0	5293.0
Disturbed	C	87	495.3	43094.6
TOTAL:			9157.1	708698.1

Weighted CN = Total CN*Area/ Total Area = 77

DRAINAGE BASIN AREA:

9157.0 Acres

J-7 Pond

Pond Capacity Assessment

100-Year, 6-Hour Storm

KCK

Montgomery Watson Americas, Inc.
165 S. Union Blvd., Suite 460
Lakewood, CO 80228

Phone: (303)763-5140
Email: kevin.kammerzell@us.mw.com

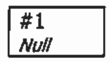
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 6 hr
Rainfall Depth:	2.400 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	J-7 Pond



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	9,157.000	9,157.000	1,564.97	517.69

Structure Detail:

Structure #1 (Null)

J-7 Pond

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	9,157.000	2.173	0.000	0.000	77.000	M	1,564.97	517.69
	Σ	**9,157.000**						**1,564.97**	**517.69**

Appendix I

100-Year, 6-Hour Storm Event for KM-FWP

(See Chapter 6: MSHA-Size Structures, Volume 1 for Addition Information)

Peabody Western Coal Co.
Impoundment KM-FWP

DGG

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 6 hr
Rainfall Depth:	2.400 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Pond KM-FWP

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	4.300	4.300	11.19	0.86

Structure Detail:

Structure #1 (Null)

Pond KM-FWP

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	4.300	0.001		0.000	100.000	F	11.19	0.86
	Σ	**4.300**						**11.19**	**0.86**

Revised 10/86

KM-FWP POND STAGE CAPACITY TABLE

Elevation (ft-msl)	Stage (ft)	Area (acres)	Capacity (ac-ft)	Total Capacity (ac-ft)	DESCRIPTION
6598	0	0.168			
6600	2	0.459	0.627	0.63	
6602	4	0.756	1.215	1.84	
6604	6	1.023	1.779	3.62	
6606	8	1.245	2.268	5.89	
6608	10	1.423	2.668	8.56	
6610	12	1.574	2.997	11.55	
6612	14	1.74	3.314	14.87	
6614	16	1.899	3.639	18.51	
6615.6	17.6	2.099	3.1984	21.71	PRINCIPAL SPILLWAY
6616	18	2.104	0.8406	22.55	
6618	20	2.239	4.343	26.89	
6619	21	2.313	2.276	29.17	
6620	22	2.387	2.35	31.52	TOP OF EMBANKMENT

Appendix J

Bureau of Indian Affairs

January 15,1999

"Dam Classification Criteria" Letter

Revised January 29, 1999

United States Department of the Interior

BUREAU OF INDIAN AFFAIRS
Navajo Area Office
P.O. Box 1060
Gallup, New Mexico 87305-1060

IN REPLY REFER TO:
Nat. Res./400

JAN 15 1999

Mr. Jim Schlenvogt
Peabody Western Coal Company
P.O. Box 625
Kayenta, AZ 86033

Dear Mr. Schlenvogt:

We have reviewed the Natural Resource Conservation Service (NRCS) Technical Release No. 60, "Dam Classification Criteria," as provided by your office. The Department of Interior (DOI) classifies dams, for safety of dams purposes, into these three categories:

1. LOW - There is no identified population at risk in the even of a dam failure, and no paved roads that would be significantly damaged.

2. SIGNIFICANT - One to five lives is at serious risk in the event of dam failure (usually means there is one home in the path of flooding) or there is a paved road that would be washed out.

3. HIGH - More than five lives are at serious risk in the event of dam failure (usually means there are two or more homes in the path of flooding).

Any dam that meets or may meet the requirements of either SIGNIFICANT or HIGH downstream hazard classification, and falls under the jurisdiction of Navajo Area, needs to be reported to the Bureau of Indian Affairs Safety of Dams program. For jurisdiction purposes, this means any dam that is located within the boundaries of the Navajo Reservation, including Navajo Partitioned Lands or dam that presents a risk of flooding to areas within the Navajo Reservation.

Enclosed is a breakdown of the standards for NRSC and the criteria for the DOI for your information. If you need further information, please contact Charles Nixon at 520/729-7357.

Sincerely,

ACTING Area Director

Enclosure

NRCS Standards and DOI Criteria

NRCS Dam Classification	**DOI Downstream Hazard Classification**
Class (a)	LOW
Class (b)	SIGNIFICANT
Class (c)	HIGH

ATTACHMENT AG

MONTHLY MSHA DAM INSPECTION JUSTIFICATION

APPROVED
JUN 1999

Revised 04/23/99

PEABODY WESTERN

Peabody Western Coal Company

February 3,1999

District Manager
Coal Mine Safety and
Health Administration - District 9
P.O. Box 25367, DFC
Denver, Colorado 80225-0367
(303) 231-5462

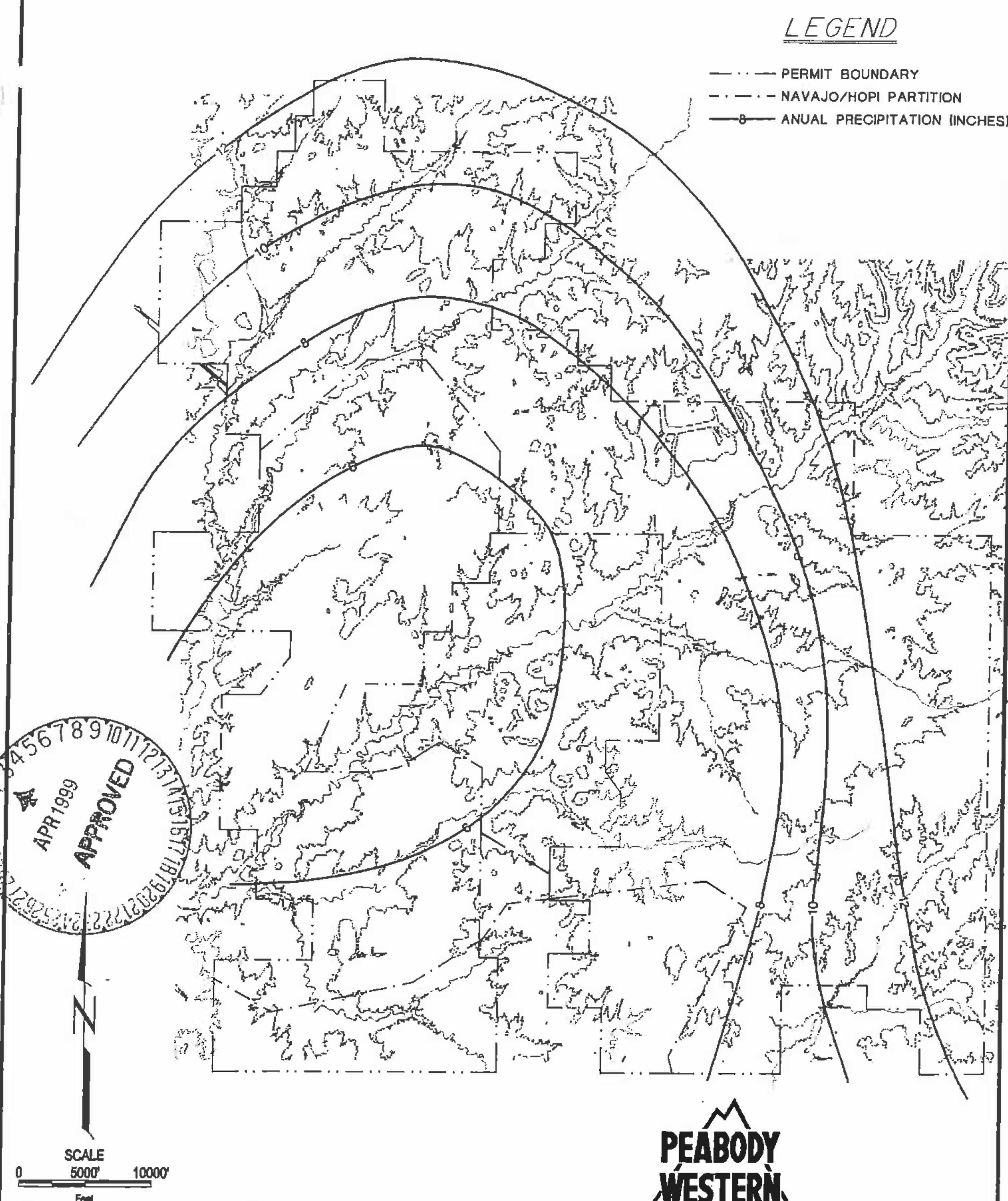
Re: Peabody Western Coal Company - Black Mesa and Kayenta Mines, Request for Reduction in MSHA Dam Inspection Frequency

Dear District Manager:

Peabody Western Coal Company (Peabody) currently maintains and operates ten surface water impoundments that are classified as MSHA Dams under applicable provisions of 30CFR77.216 in conjunction with Peabody's ongoing Kayenta/Black Mesa mining operations. Pursuant to 30CFR77.216-3(a)(3), Mandatory Inspection Frequency for MSHA Regulated Impoundments or Impounding Structures, as revised, Peabody respectfully submits this request for approval to reduce the monitoring frequency for the following MSHA Dam structures from a weekly to a monthly schedule.

Structure ID	MSHA I.D. No.	Construction Date
Black Mesa Mine		
J-2A, Wild Ram Valley Dam	1211-AZ-09-00533-02	1986
J-7 Dam	1211-AZ-09-00533-01	1973
Kayenta Mine		
J16-A Dam	1211-AZ-09-01195-07	1982
J16-L Dam	1211-AZ-09-01195-08	1984
KM - Fresh Water Pond	1211-AZ-09-01195-01	1972
N14-D Dam	1211-AZ-09-01195-02	1982
N14-E Dam	1211-AZ-09-01195-03	1982
N14-F Dam	1211-AZ-09-01195-04	1982
N14-G Dam	1211-AZ-09-01195-05	1982
N14-H Dam	1211-AZ-09-01195-06	1985

The impounding structures are located within the Peabody Black Mesa/Kayenta Mine permit areas in a rural area of the Navajo Indian Reservation in the northeastern corner of Arizona as shown by Drawing No. 85402, MSHA Dam Location Map. Flat-topped mesas and plateaus, isolated buttes, and desert valleys characterize the Black Mesa region. The climate of the permit areas is arid to semi-arid, with an average annual precipitation of only approximately ten (10) inches. The typical annual precipitation pattern for this area is illustrated by Figure 1, Annual Precipitation. Long periods with little or no precipitation are common. Much of the precipitation occurs during the summer months, in the form of afternoon thundershowers. Showers and thunderstorms are characterized by brief, intense rainfall and are often preceded by strong, gusty winds. It is common to experience widely differing amounts of precipitation over the mine area and at the various impoundments during the same period. Variations in precipitation amounts appear to be related primarily to topographic features and elevation. The "NOAA Atlas 2, Precipitation Frequency Atlas of the Western United States, Volume VIII, Arizona" indicates storm event yields of 1.6 inches of precipitation for the 10-year, 6-hour storm event and 2.1 inches for the 10 year, 24 hour event.



0	Issued for Report	1/5/99	J.James	T.Smith	J.James	
REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY	

KAYENTA AND BLACK MESA MINES

MONTGOMERY WATSON

PROJECT No: 1342081.01190100
AutoCAD FILE: PRECIP.DWG
SCALE: AS NOTED
FIGURE No: 1

ANNUAL PRECIPITATION

All of the MSHA Dams are classified as having a low hazard potential. Most of the drainage channels or washes in the mine permit areas, including those associated with the subject impoundment structures, are classified as ephemeral, with minor reaches exhibiting an intermittent flow pattern. No residences, public buildings, or other facilities are located downstream in the vicinity of the dam embankments or spillways or in the downstream floodplain. All active mine pits, spoil piles, and associated major facilities are located upstream of the dam sites. The Maximum Probable Earthquake (MPE) for the two groups of faults identified in the permit areas is projected at magnitude 6.5, with a corresponding recurrence interval of 100,000 years (Morrison et. al., 1981). The estimate is based on empirical relationships between potential surface rupture lengths and corresponding earthquake magnitudes (Slemmons, 1977). For the empirically-derived earthquake magnitude, effective peak horizontal ground accelerations of <0.05 g to 0.08 g were estimated from attenuation curves developed by Schnabel and Seed (1973). The designed pond embankments will withstand this range of ground accelerations without failure or significant permanent deformation.

All of the identified MSHA Dams have been constructed in accordance with approved designs and specifications, have been in place and operational for at least twelve years, and have a demonstrated history of safety and stability, performing as designed. All of the MSHA impoundments are equipped with principal and/or emergency spillway structures consistent with applicable design requirements. Spillways and associated outlet channels are designed to safely pass the design flows while maintaining adequate freeboard and minimizing the potential for erosion of pond embankments, discharge points, or downstream channel areas. Based on MSHA Dam Inspection Reports, as provided for the past three years in Appendix A, all spillways are functioning in accordance with the approved designs and there is no evidence of significant erosion or damage associated with spillway discharges to date.

Any design, construction, or material defects would normally have become evident during initial filling or the first few years of pond operation. In addition, initial embankment settlement has already occurred and has been minimal, with no significant changes in embankment heights or stability. Review of recent annual MSHA Dam Inspection Reports for these structures (refer to Appendix A) confirms that no defects have been identified and no significant changes in the dam embankments or problems have occurred.

The following sections provide additional specific relevant information for each of the impoundments currently classified as MSHA Dam structures

<u>J2-A Dam</u> - The J2-A embankment is located in the SE¼ NW¼ of Section 32, T36N, R18E as shown on Drawing No. 85402, MSHA Dam Location Map. Design information for the J2-A Dam was provided to OSM and MSHA in May 1985. Approval was received and the embankment was completed in 1986. J2-A impoundment has a watershed of approximately 2,761 acres and has a total storage capacity of about 182 acre-feet. The dam's primary purpose is to control runoff from mining areas. The dam is a zoned embankment extending to bedrock. More detailed information can be found in the Sergent, Hauskins and Beckwith (SHB), *Geotechnical Investigation and Design Development Report* (5/14/85) included with the 1985 design submittal.

<u>J-7 Dam</u> - The J-7 embankment is located in the E½ NW¼ of Section 22, T35N, R18E as shown on Drawing No. 85402, MSHA Dam Location Map. The J-7 Dam was constructed in 1973 and approved by MSHA in May 1980. J-7 impoundment has a watershed of approximately 9,217 acres and presently has a total storage capacity of about 448 acre-feet. The embankment is utilized as a haul road, for sediment control, to impound water for dust suppression, and as an emergency water supply for the Black Mesa Pipeline Company's coal slurry transportation system. The embankment consists of a 60-foot wide compacted clay core. More detailed design information can be found in the Sergent, Hauskins and Beckwith (SHB), *Geotechnical Investigation Report* (8/27/76) previously provided to MSHA.

<u>J16-A Dam</u> - The J16-A embankment is located in the W½ NW¼ of Section 28, T36N, R19E as shown on Drawing No. 85402, MSHA Dam Location Map. The J16-A Dam was constructed and approved by MSHA in 1982. The J16-A impoundment has a watershed of approximately 2,415 acres and total present storage capacity of about 261 acre-feet. The dam's primary purpose is to control runoff from mining areas. The dam is a zoned rock-filled embankment. More detailed design information can be found in the Sergent, Hauskins and Beckwith (SHB), *Geotechnical Investigation Report* (1982) previously provided to MSHA.

<u>J16-L Dam</u> - The J16-L embankment is located in the E½ SW¼ of Section32, T36N, R19E as shown on Drawing No. 85402, MSHA Dam Location Map. The J16-L Dam design was submitted to MSHA and approved in December of 1982. The dam was constructed in 1984 as a zoned earth embankment to control runoff from mining areas. In 1996, Peabody determined that enough silt had accumulated to require an

increase in pond capacity. A design was developed, submitted, and approved to increase the height of the spillway and the top of the embankment. J16-L impoundment currently has a watershed of approximately 7,873 acres with a total storage capacity of about 398 acre-feet. More detailed design information can be found in Rollins, Brown and Gunnell, *Reed Valley Dam, Final Design Report* (8/26/82) previously provided to MSHA.

KM Fresh Water Pond (KM-FWP) - The Kayenta Mine Fresh Water Pond is located in the SE¼ SW¼ of Section 17, T36N, R18E as shown on Drawing No. 85402, MSHA Dam Location Map. The Kayenta Mine Fresh Water Pond was constructed in 1972 as a surge pond to provide water for mine facilities, dust suppression, and to supply the Black Mesa Pipeline Company's coal slurry transportation system. The embankment was constructed using locally available materials, predominately clays, silts and clayey sand material with a PVC liner installed over the impoundment area. The pond collects runoff only from the adjacent access road (approximately 1.0-acre) and has a total storage capacity of about 21.7 acre-feet. More detailed design information can be found in the Sergent, Hauskins and Beckwith (SHB), *Geotechnical Investigation Report, Dam No. 1* (8/16/76) previously provided to MSHA.

N14-D Dam - The N14-D embankment is located in the NW¼ NW¼ of Section 29, T36N, R19E as shown on Drawing No. 85402, MSHA Dam Location Map. The N14-D Dam design was approved by MSHA on 10/15/81 and the dam was constructed in 1982 to control runoff from mining areas and as part of the Kayenta Mine Road and Peabody's overland conveyor system. The dam is a multi-zoned earth embankment. The N14-D impoundment has a watershed of approximately 1,836 acres and a total storage capacity of about 541 acre-feet. More detailed design information can be found in the Sergent, Hauskins and Beckwith (SHB), *Geotechnical Investigation Report* (6/30/1981) previously provided to MSHA.

N14-E Dam - The N14-E embankment is located in the NE¼ NW¼ and the NW¼ NE¼ of Section 29, T36N, R19E as shown on Drawing No. 85402, MSHA Dam Location Map. The N14-E Dam design was approved by MSHA on 12/8/81. The N14-E Dam is a multi-zoned earth embankment constructed in 1982 to control runoff from mining areas and as part of Peabody's overland conveyor system. The N14-E impoundment has a watershed of approximately 157 acres with a total storage capacity of about 68 acre-feet. More detailed design information can be found in the Sergent, Hauskins and Beckwith (SHB), *Geotechnical Investigation Report* (7/24/1981) previously provided to MSHA.

N14-F Dam - The N14-F embankment is located in the NW¼ SW¼ of Section 21, T36N, R19E as shown on Drawing No. 85402, MSHA Dam Location Map. The N14-F Dam design was approved by MSHA on 5/21/82 and the dam was constructed in 1982. The dam is a multi-zoned earth embankment used to control runoff from mining areas and as part of the N14 East haul road. The N14-F impoundment has a watershed of approximately 367 acres and has a current total storage capacity of about 58 acre-feet. More detailed design information can be found in the Sergent, Hauskins and Beckwith (SHB), *Geotechnical Investigation Report* (1982) previously provided to MSHA.

N14-G Dam - The N14-G embankment is located in the NE¼ SW¼ of Section 21, T36N, R19E as shown on Drawing No. 85402, MSHA Dam Location Map. The N14-G Dam design was approved by MSHA on 5/21/82. The N14-G Dam is a multi-zoned earth embankment constructed in 1982 to control runoff from mining areas and as part of N14 East haul road. The N14-G impoundment has a watershed of approximately 1,479 acres with a total storage capacity of about 181 acre-feet. More detailed design information can be found in the Sergent, Hauskins and Beckwith (SHB), *Geotechnical Investigation Report* (12/30/1981) previously provided to MSHA.

N14-H Dam - The N14-H embankment is located in the NW¼ NW¼ of Section 22, T36N, R19E as shown on Drawing No. 85402, MSHA Dam Location Map. The N14-H Dam design was approved by MSHA on 3/9/84. The N14-H Dam is a multi-zoned earth embankment constructed in 1985 to control runoff from the mining area. The N14-H impoundment has a watershed of approximately 1,615 acres with a total storage capacity of about 222 acre-feet. More detailed design information can be found in the Sergent, Hauskins and Beckwith (SHB), *Geotechnical Investigation Report* (1984) previously provided to MSHA.

Based on the information summarized above and the historical performance of the designated MSHA dam structures, as evidenced in the previous MSHA Annual Dam Inspection Reports, Peabody requests that the inspection frequency be reduced from the current weekly (7-day) schedule to a monthly (not to exceed 30-days) schedule. In conjunction with this request, Peabody proposes to conduct an immediate inspection and to temporarily resume inspections on a weekly schedule for any given pond(s) if, for the subject pond(s):

- Any unusual condition is observed or reported that could affect the stability or safety of the embankment
- A significant rainfall event occurs (i.e. a 10-year, 6-hour storm = 1.6 inches of rainfall or greater)
- A significant seismic event (magnitude greater than 4.0) occurs in or in the immediate vicinity of the mine permit area

If an unusual condition is observed or reported or if any repair or modification of the embankment is necessary as a result of the initial inspection, weekly inspections will continue for a period of at least one month following the initial inspection or completion of any necessary repair or modification. If the weekly inspections indicate no change in the embankment structure, inspection frequency will return to the monthly schedule after the fourth week. In the event of a significant rainfall or seismic event, if the initial inspection indicates no significant change in the embankment structure, weekly confirmation inspections will continue for a period of two weeks before returning to the monthly inspection schedule. In addition to the standard information provided in the MSHA Dam Inspection Reports, the reports will include an estimate of the remaining freeboard at the time of the inspection and rainfall records will continue to be collected and will be available for review by authorized MSHA personnel at the minesite.

Thank you for your consideration and prompt action on this request. If there are any questions or comments, please contact Jim Schlenvogt at (520) 677-5089.

Sincerely,

Registered Professional Engineer (Civil) CERTIFICATE NO. 18782 JAMES GARY SCHLENVOGT ARIZONA, U.S.A.

Jim Schlenvogt
Manager Compliance Engineering

FEB 03 1999

Enc.

cc: B. Bippus (PWCC)
B. Dunfee (PWCC)
G. Wendt (PWCC)

APR 1999 APPROVED

ATTACHMENT AG

MONTHLY MSHA DAM INSPECTION JUSTIFICATION

Revised 04/23/99

Peabody Western Coal Company

February 3,1999

District Manager
Coal Mine Safety and
Health Administration - District 9
P.O. Box 25367, DFC
Denver, Colorado 80225-0367
(303) 231-5462

Re: Peabody Western Coal Company - Black Mesa and Kayenta Mines, Request for Reduction in MSHA Dam Inspection Frequency

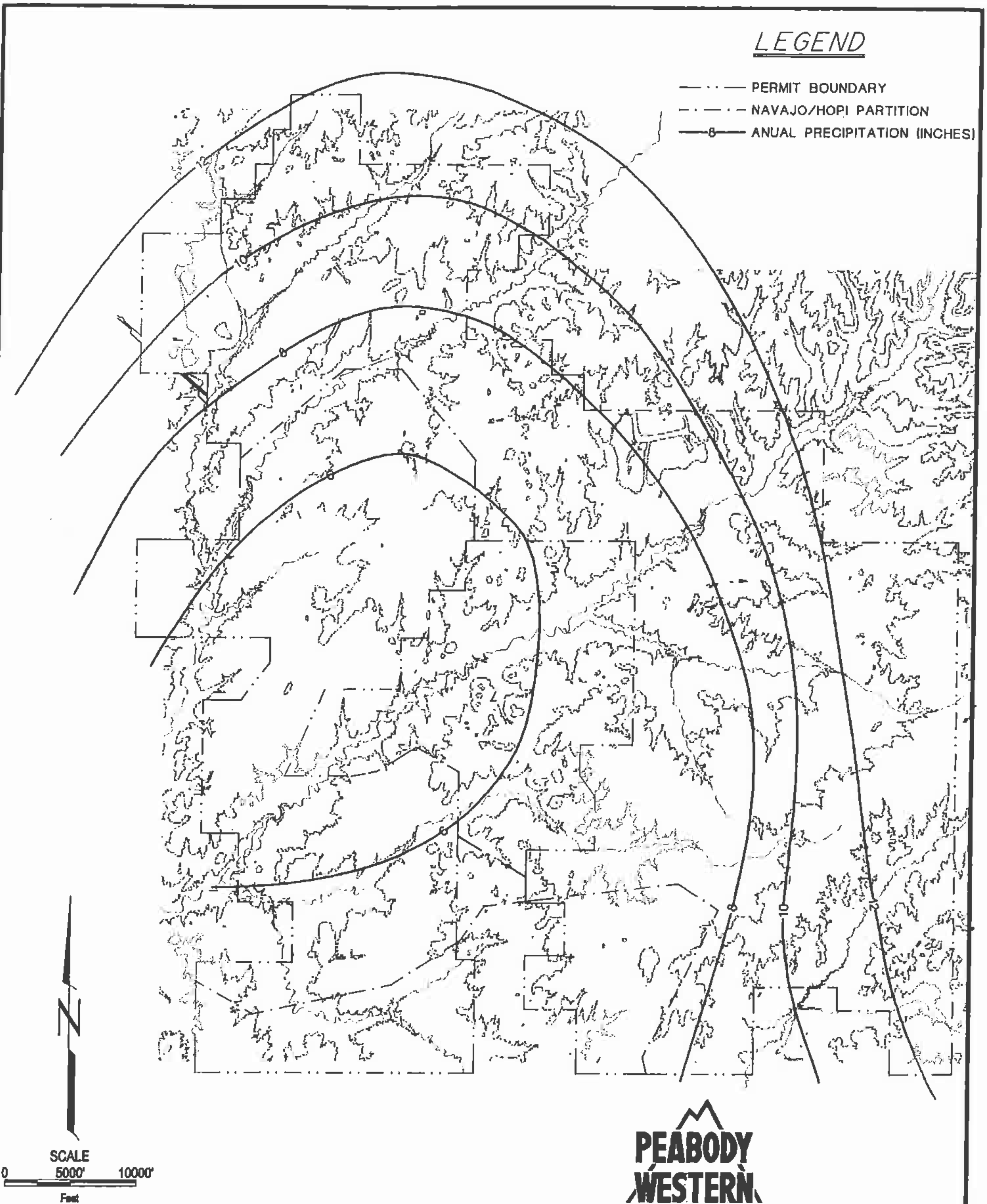
Dear District Manager:

Peabody Western Coal Company (Peabody) currently maintains and operates ten surface water impoundments that are classified as MSHA Dams under applicable provisions of 30CFR77.216 in conjunction with Peabody's ongoing Kayenta/Black Mesa mining operations. Pursuant to 30CFR77.216-3(a)(3), Mandatory Inspection Frequency for MSHA Regulated Impoundments or Impounding Structures, as revised, Peabody respectfully submits this request for approval to reduce the monitoring frequency for the following MSHA Dam structures from a weekly to a monthly schedule.

Structure ID	MSHA I.D. No.	Construction Date
Black Mesa Mine		
J-2A, Wild Ram Valley Dam	1211-AZ-09-00533-02	1986
J-7 Dam	1211-AZ-09-00533-01	1973
Kayenta Mine		
J16-A Dam	1211-AZ-09-01195-07	1982
J16-L Dam	1211-AZ-09-01195-08	1984
KM – Fresh Water Pond	1211-AZ-09-01195-01	1972
N14-D Dam	1211-AZ-09-01195-02	1982
N14-E Dam	1211-AZ-09-01195-03	1982
N14-F Dam	1211-AZ-09-01195-04	1982
N14-G Dam	1211-AZ-09-01195-05	1982
N14-H Dam	1211-AZ-09-01195-06	1985

The impounding structures are located within the Peabody Black Mesa/Kayenta Mine permit areas in a rural area of the Navajo Indian Reservation in the northeastern corner of Arizona as shown by Drawing No. 85402, MSHA Dam Location Map. Flat-topped mesas and plateaus, isolated buttes, and desert valleys characterize the Black Mesa region. The climate of the permit areas is arid to semi-arid, with an average annual precipitation of only approximately ten (10) inches. The typical annual precipitation pattern for this area is illustrated by Figure 1, Annual Precipitation. Long periods with little or no precipitation are common. Much of the precipitation occurs during the summer months, in the form of afternoon thundershowers. Showers and thunderstorms are characterized by brief, intense rainfall and are often preceded by strong, gusty winds. It is common to experience widely differing amounts of precipitation over the mine area and at the various impoundments during the same period. Variations in precipitation amounts appear to be related primarily to topographic features and elevation. The "NOAA Atlas 2, Precipitation Frequency Atlas of the Western United States, Volume VIII, Arizona" indicates storm event yields of 1.6 inches of precipitation for the 10-year, 6-hour storm event and 2.1 inches for the 10 year, 24 hour event.

Peabody Western Coal Company · P.O. Box 625 · Kayenta, Arizona 86033 · Telephone (520) 677-5072 · Fax (520) 677-5083



KAYENTA AND BLACK MESA MINES

ANNUAL PRECIPITATION

REV No.	REVISIONS	REV DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	1/6/99	J.James	T.Smith	J.James

MONTGOMERY WATSON

PROJECT No. 1342661.01190100
AutoCAD FILE PRECIP.DWG
SCALE: AS NOTED
FIGURE No. 1

All of the MSHA Dams are classified as having a low hazard potential. Most of the drainage channels or washes in the mine permit areas, including those associated with the subject impoundment structures, are classified as ephemeral, with minor reaches exhibiting an intermittent flow pattern. No residences, public buildings, or other facilities are located downstream in the vicinity of the dam embankments or spillways or in the downstream floodplain. All active mine pits, spoil piles, and associated major facilities are located upstream of the dam sites. The Maximum Probable Earthquake (MPE) for the two groups of faults identified in the permit areas is projected at magnitude 6.5, with a corresponding recurrence interval of 100,000 years (Morrison et. al., 1981). The estimate is based on empirical relationships between potential surface rupture lengths and corresponding earthquake magnitudes (Slemmons, 1977). For the empirically-derived earthquake magnitude, effective peak horizontal ground accelerations of <0.05 g to 0.08 g were estimated from attenuation curves developed by Schnabel and Seed (1973). The designed pond embankments will withstand this range of ground accelerations without failure or significant permanent deformation.

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N14-G Dam - The N14-G embankment is located in the NE¼ SW¼ of Section 21, T36N, R19E as shown on Drawing No. 85402, MSHA Dam Location Map. The N14-G Dam design was approved by MSHA on 5/21/82. The N14-G Dam is a multi-zoned earth embankment constructed in 1982 to control runoff from mining areas and as part of N14 East haul road. The N14-G impoundment has a watershed of approximately 1,479 acres with a total storage capacity of about 181 acre-feet. More detailed design information can be found in the Sergent, Hauskins and Beckwith (SHB), *Geotechnical Investigation Report* (12/30/1981) previously provided to MSHA.

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Based on the information summarized above and the historical performance of the designated MSHA dam structures, as evidenced in the previous MSHA Annual Dam Inspection Reports, Peabody requests that the inspection frequency be reduced from the current weekly (7-day) schedule to a monthly (not to exceed 30-days) schedule. In conjunction with this request, Peabody proposes to conduct an immediate inspection and to temporarily resume inspections on a weekly schedule for any given pond(s) if, for the subject pond(s):

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- A significant seismic event (magnitude greater than 4.0) occurs in or in the immediate vicinity of the mine permit area

If an unusual condition is observed or reported or if any repair or modification of the embankment is necessary as a result of the initial inspection, weekly inspections will continue for a period of at least one month following the initial inspection or completion of any necessary repair or modification. If the weekly inspections indicate no change in the embankment structure, inspection frequency will return to the monthly schedule after the fourth week. In the event of a significant rainfall or seismic event, if the initial inspection indicates no significant change in the embankment structure, weekly confirmation inspections will continue for a period of two weeks before returning to the monthly inspection schedule. In addition to the standard information provided in the MSHA Dam Inspection Reports, the reports will include an estimate of the remaining freeboard at the time of the inspection and rainfall records will continue to be collected and will be available for review by authorized MSHA personnel at the minesite.

Thank you for your consideration and prompt action on this request. If there are any questions or comments, please contact Jim Schlenvogt at (520) 677-5089.

Sincerely,

Registered Professional Engineer (Civil)
CERTIFICATE NO.
18782
JAMES GARY
SCHLENVOGT
Arizona, U.S.A.

FEB 03 1999

Jim Schlenvogt
Manager Compliance Engineering

Enc.

cc: B. Bippus (PWCC)
B. Dunfee (PWCC)
G. Wendt (PWCC)

Peabody Western Coal Company · P.O. Box 625 · Kayenta, Arizona 86033 · Telephone (520) 677-5072 · Fax (520) 677-5083

APPENDIX A

1996 ANNUAL MSHA DAM INSPECTION REPORT

1997 ANNUAL MSHA DAM INSPECTION REPORT

1998 ANNUAL MSHA DAM INSPECTION REPORT

U. S. Department of Labor

Mine Safety and Health Administration
P.O. Box 25367
Denver, Colorado 80225-0367

Coal Mine Safety and Health
District 9

OCT - 1 1996

Buck Woodward
Production Manager
Peabody Western Coal Company
P. O. Box 605
Kayenta, AZ 86033

RE: Black Mesa Mine, ID No. 02-00533
J-7 Dam, ID No. 1211-AZ-09-00533-01
J2-A Wild Ram Valley Dam,
ID No. 1211-AZ-09-00533-02
Annual Impoundment Reports

Dear Mr. Woodward:

This is in response to Peabody Coal Company's letter and annual reports dated September 3, 1996, for the referenced impounding structures for the subject mine. The reports have been reviewed and made part of the mine file.

Sincerely,

John A. Kuzar
John A. Kuzar
District Manager

U. S. Department of Labor

Mine Safety and Health Administration
P.O. Box 25367
Denver, Colorado 80225-0367

OCT - 1 1996

Coal Mine Safety and Health
District 9

Robert Boone
Production Manager
Peabody Western Coal Company
P. O. Box 605
Kayenta, AZ 86033

RE: Kayenta Mine, ID No. 02-01195
Kayenta Fresh Water Pond,
ID No. 1211-AZ-09-01195-01
N14-D Dam, ID No. 1211-AZ-09-01195-02
N14-E Dam, ID No. 1211-AZ-09-01195-03
N14-F Dam, ID No. 1211-AZ-09-01195-04
N14-G Dam, ID No. 1211-AZ-09-01195-05
N14-H Dam, ID No. 1211-AZ-09-01195-06
J16-A Dam, ID No. 1211-AZ-09-01195-07
J16-L Dam, ID No. 1211-AZ-09-01195-08
Annual Impoundment Reports

Dear Mr. Boone:

This is in response to Peabody Coal Company's letter and annual reports dated September 3, 1996, for the referenced impounding structures for the subject mine. The reports have been reviewed and made part of the mine file.

Sincerely,

John A. Kuzar
District Manager

PEABODY WESTERN

Peabody Western Coal Company

September 3, 1996

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Peabody Western Coal Company's Kayenta and Black Mesa Mines Annual M.S.H.A. Dam Inspection Report.

Dear Sir:

Pursuant to the 30 CFR 77.261-4 regulations are the certified annual M.S.H.A. Dam Inspection Reports for the following dams:

<u>Black Mesa Mine</u>

J-7 Dam	ID No. 1211-AZ-09-00533-01
J2-A Wild Ram Valley Dam	ID No. 1211-AZ-09-00533-02

<u>Kayenta Mine</u>

Kayenta Fresh Water Pond	ID No. 1211-AZ-09-01195-01
N14-D Dam	ID No. 1211-AZ-09-01195-02
N14-E Dam	ID No. 1211-AZ-09-01195-03
N14-F Dam	ID No. 1211-AZ-09-01195-04
N14-G Dam	ID No. 1211-AZ-09-01195-05
N14-H Dam	ID No. 1211-AZ-09-01195-06
J16-A Dam	ID No. 1211-AZ-09-01195-07
J16-L Dam	ID No. 1211-AZ-09-01195-08

Should you have any questions, do not hesitate to contact me.

Sincerely,

Jim Schlenvogt

James G. Schlenvogt, P.E.
Compliance Engineering
Manager

smm

c: Bill Bippus
Brian Dunfee
Scott Williams

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 3, 1996

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-00533-01
Other: J-7 Dam
Mine: Black Mesa Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period August 31, 1995 to August 31, 1996 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6354.8
4. Storage Capacity	No Change
5. Water Volume	Decrease per water elevation
6. Stability	No Change
7. Spillway Elevation	6368.5
8. Other	

All work at the above site during the period August 31, 1995 to August 31, 1996 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) Certificate No. 13782 James Gary Schlenvogt Signed ... Arizona, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 03 1996

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 3, 1996

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-00533-02
Other: J2-A Wild Ram Valley Dam
Mine: Black Mesa Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period August 31, 1995 to August 31, 1996 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	See Attachments
3. Current Water Elevation	6328.4
4. Storage Capacity	No Change
5. Water Volume	Decrease per water elevation
6. Stability	No Change
7. Spillway Elevation	6348.2
8. Other	

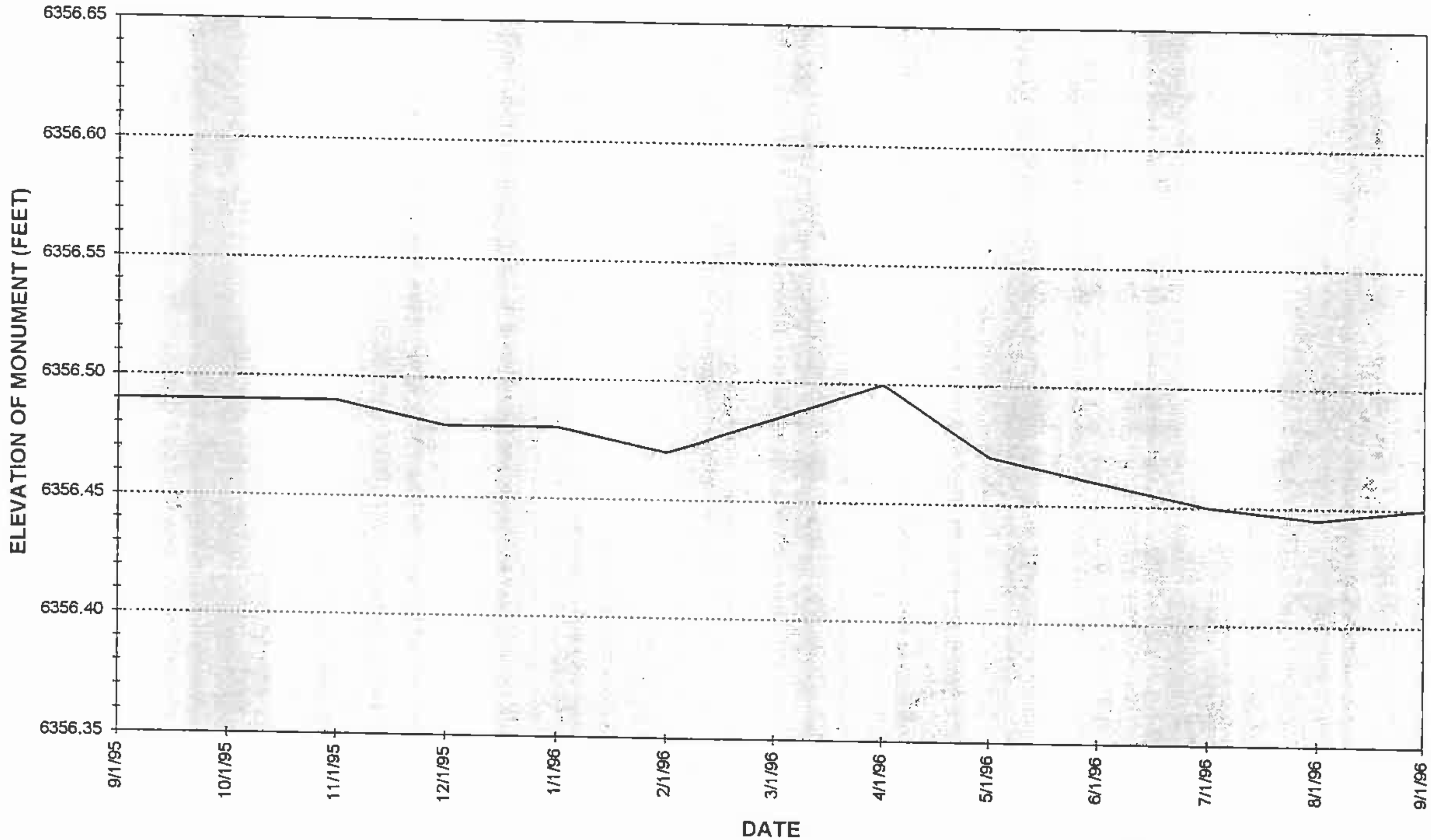
All work at the above site during the period August 31, 1995 to August 31, 1996 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) Certificate No. 18782 James Gary Schlenvogt State of Arizona, U.S.A.

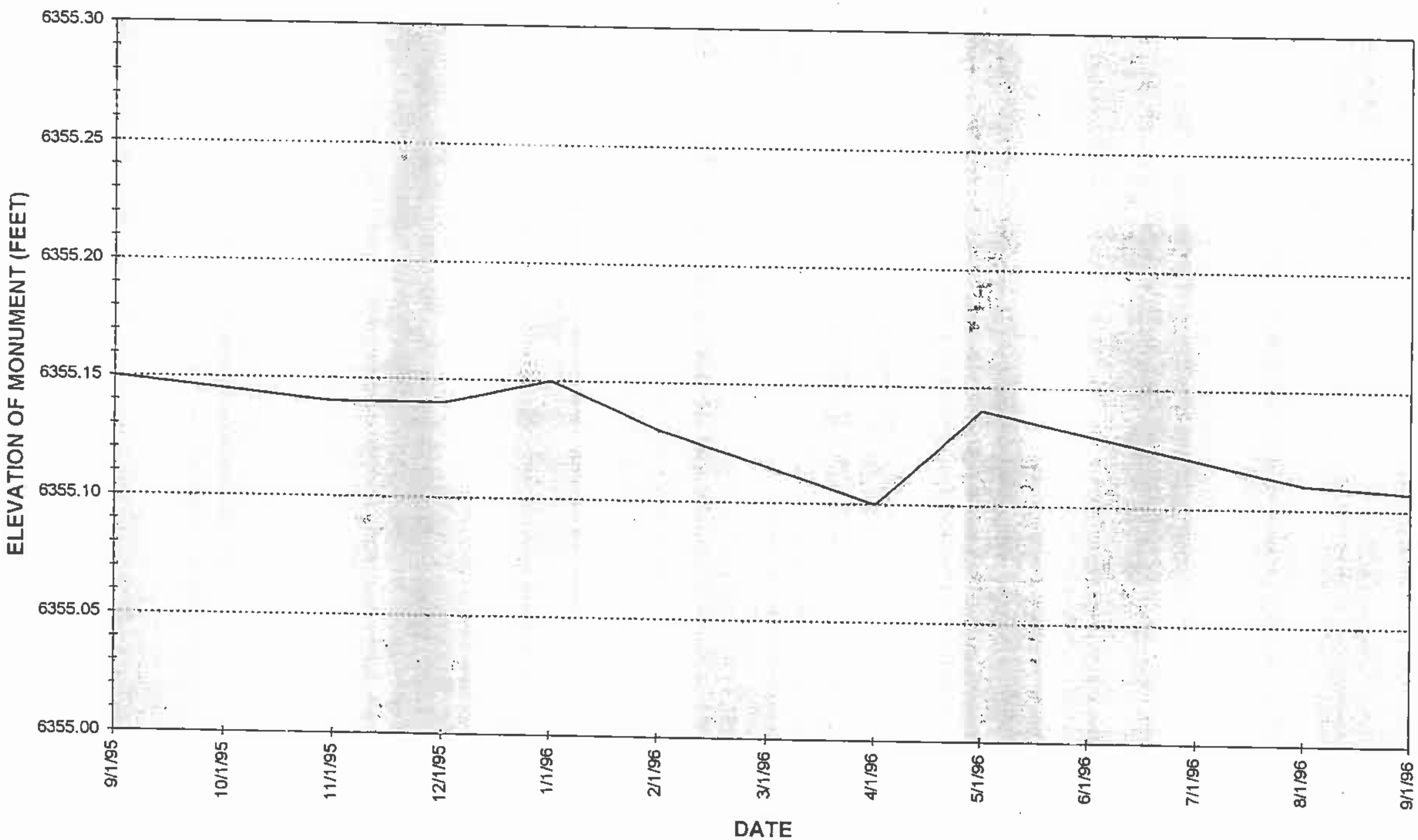
James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 03 1996

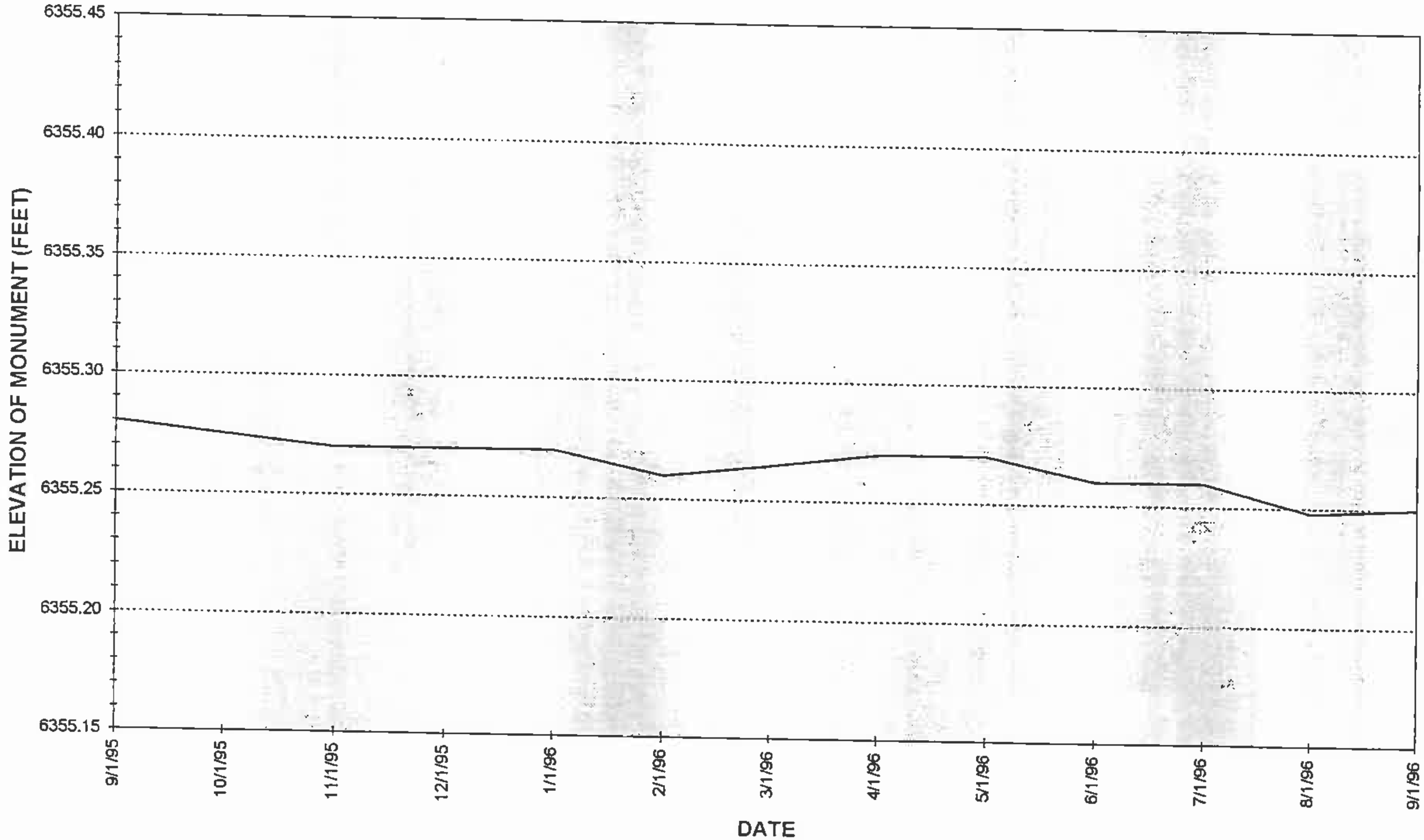
1995-1996 J2-A DAM SETTLEMENT MONUMENT #1



1995-1996 J2-A DAM SETTLEMENT MONUMENT #2



1995-1996 J2-A DAM SETTLEMENT MONUMENT #3



PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 3, 1996

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-01
Other: Kayenta Fresh Water Pond
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period August 31, 1995 to August 31, 1996 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6615.5
4. Storage Capacity	No Change
5. Water Volume	Decrease per water elevation
6. Stability	No Change
7. Spillway Elevation	6615.83
8. Other	

All work at the above site during the period August 31, 1995 to August 31, 1996 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
18732
JAMES GARY
SCHLENVOGT
Date Signed
ARIZONA, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 03 1996

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 3, 1996

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-02
Other: N14-D Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period August 31, 1995 to August 31, 1996 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6617.7
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6653.05
8. Other	

All work at the above site during the period August 31, 1995 to August 31, 1996 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) Certificate No. 18782 James Garth Schlenvogt, Arizona, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 03 1996

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 3, 1996

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-03
Other: N14-E Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period August 31, 1995 to August 31, 1996 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6668.3
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6685.99
8. Other	

All work at the above site during the period August 31, 1995 to August 31, 1996 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) Certificate No. 18782 James Gary Schlenvogt, Arizona, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 03 1996

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 3, 1996

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-04
Other: N14-F Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period August 31, 1995 to August 31, 1996 is submitted:

	STATUS
1. Geometry	No Change.
2. Instrumentation	No Change.
3. Current Water Elevation	6641.8.
4. Storage Capacity	No Change.
5. Water Volume	Decrease per water elevation.
6. Stability	No Change.
7. Spillway Elevation	6658.54.
8. Other	

All work at the above site during the period August 31, 1995 to August 31, 1996 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer CERTIFICATE NO. 18782 JAMES GARY SCHLENVOGT Arizona, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 03 1996

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 3, 1996

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-05
Other: N14-G Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period August 31, 1995 to August 31, 1996 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6633.9
4. Storage Capacity	No Change
5. Water Volume	Decrease per water elevation
6. Stability	No Change
7. Spillway Elevation	6660.84
8. Other	

All work at the above site during the period August 31, 1995 to August 31, 1996 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) Certificate No. 18782 James Gary Schlenvogt Arizona, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 03 1996

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 3, 1996

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-06
Other: N14-H Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period August 31, 1995 to August 31, 1996 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6695.0
4. Storage Capacity	No Change
5. Water Volume	Decrease per water elevation
6. Stability	No Change
7. Spillway Elevation	6719.07
8. Other	

All work at the above site during the period August 31, 1995 to August 31, 1996 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
18782
JAMES CARL
SCHLENVOGT
ARIZONA, U.S.A.

James C. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 03 1996

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 3, 1996

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-07
Other: J16-A Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period August 31, 1995 to August 31, 1996 is submitted:

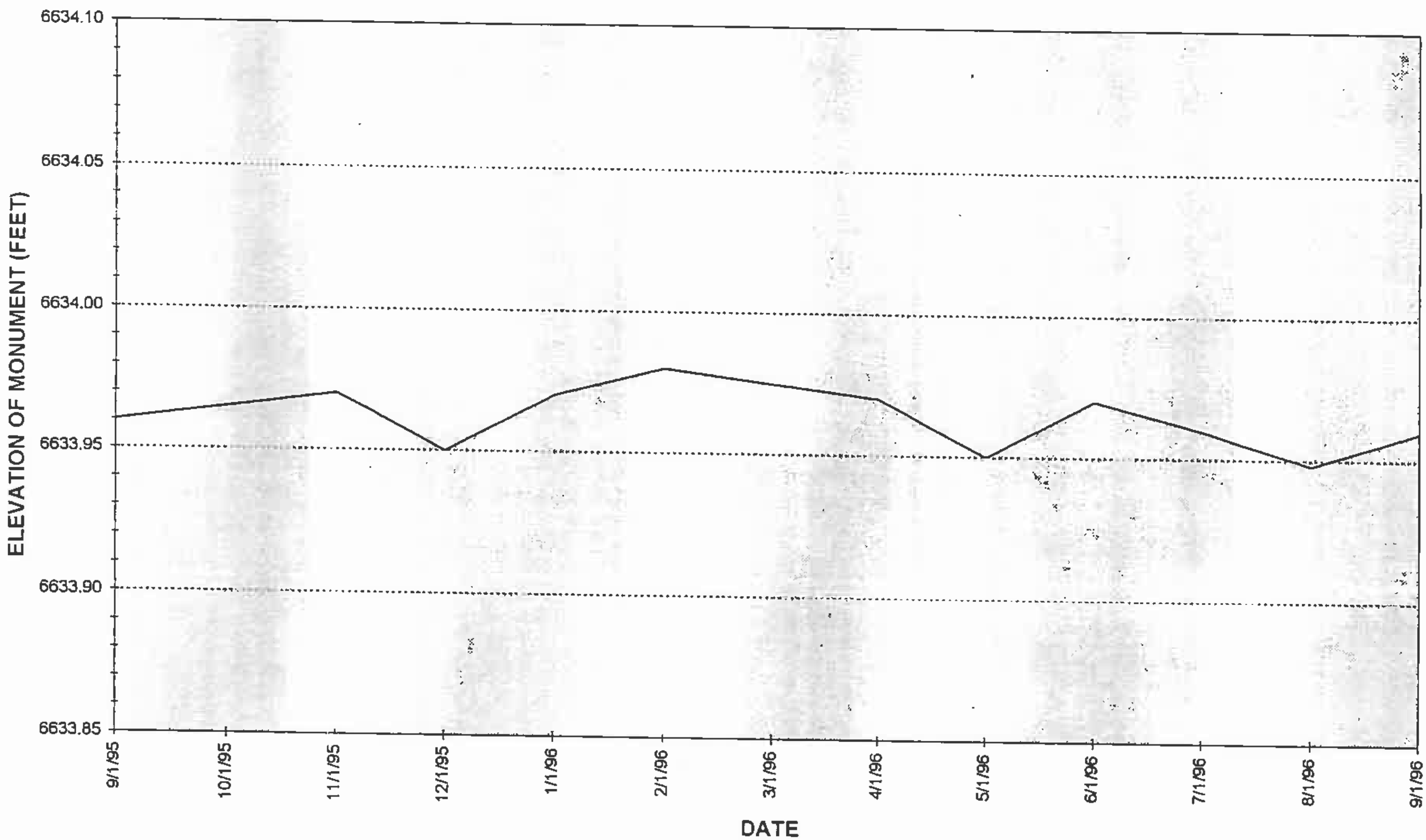
	STATUS
1. Geometry	No Change
2. Instrumentation	See Attachments
3. Current Water Elevation	6613.6
4. Storage Capacity	No Change
5. Water Volume	Decrease per water elevation
6. Stability	No Change
7. Spillway Elevation	6635.13
8. Other	Guardrails installed on top of embankment.

All work at the above site during the period August 31, 1995 to August 31, 1996 was performed in accordance with the approved plan to the best of my knowledge and belief.

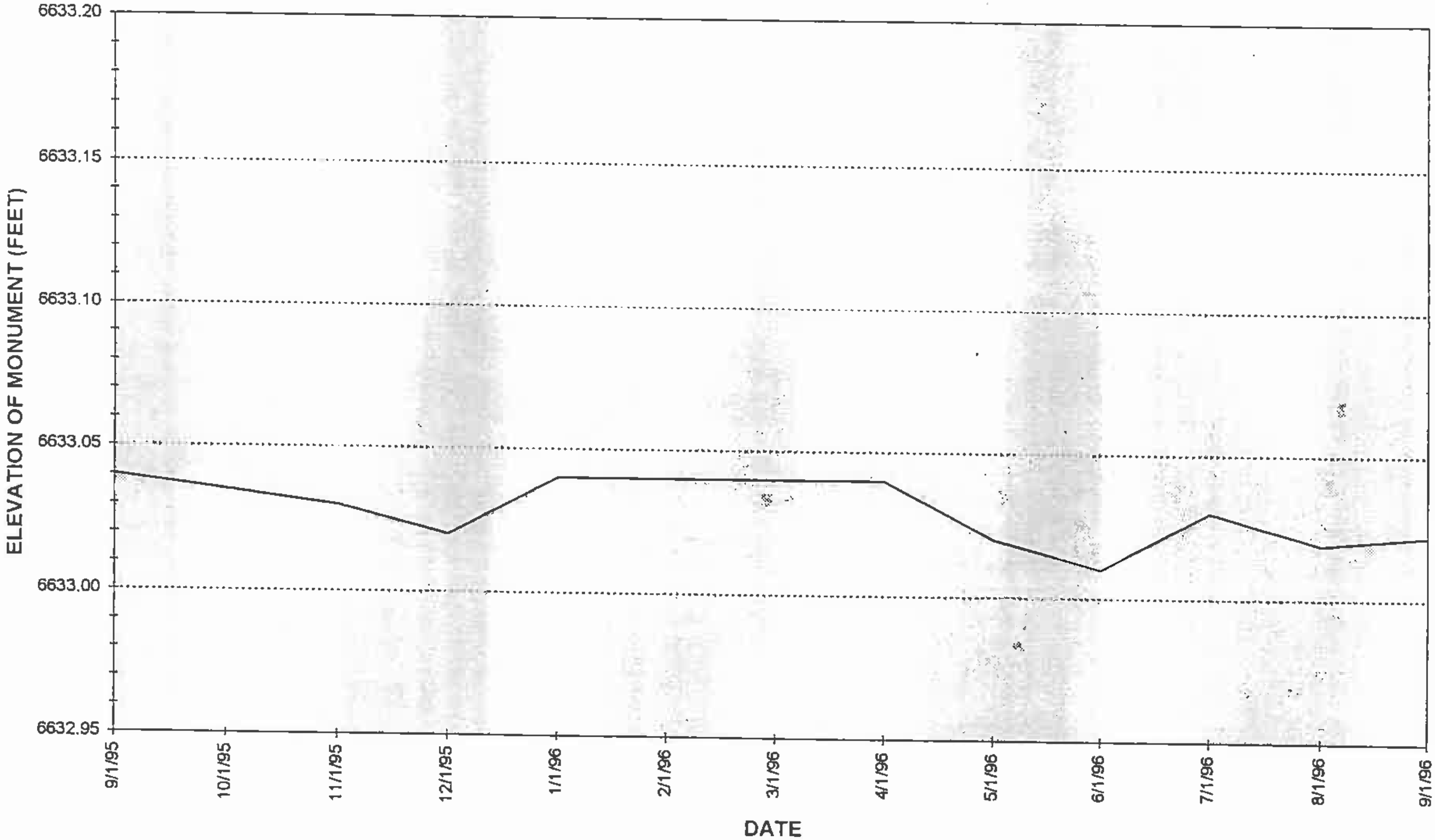
Registered Professional Engineer (Civil) CERTIFICATE NO. 18782 JAMES GARY SCHLENVOGT Date Signed ARIZONA, U.S.A. SEP 03 1996

James G. Schlenvogt, P.E.
Peabody Western Coal Company

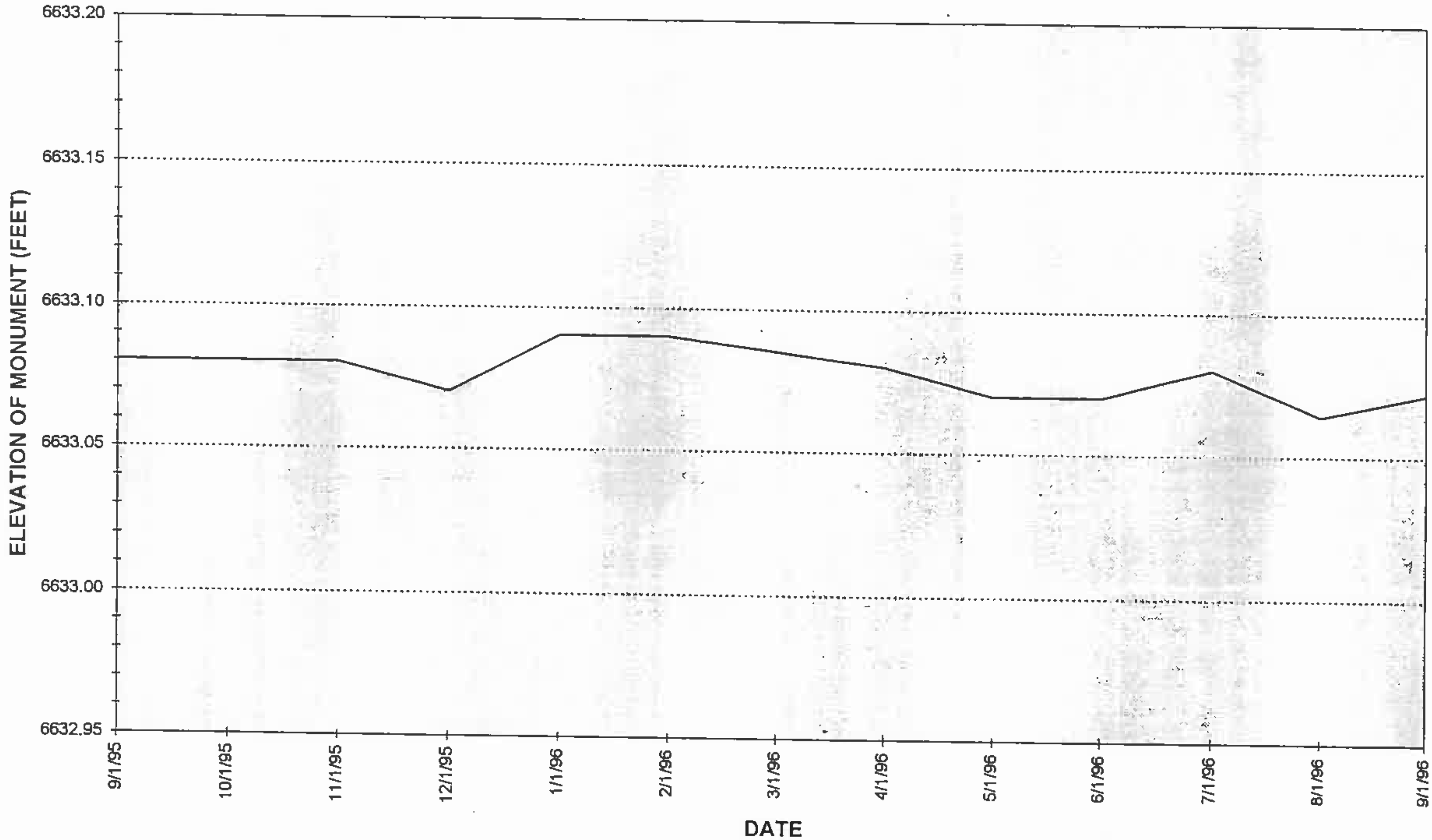
1995-1996 J16-A DAM SETTLEMENT MONUMENT #1



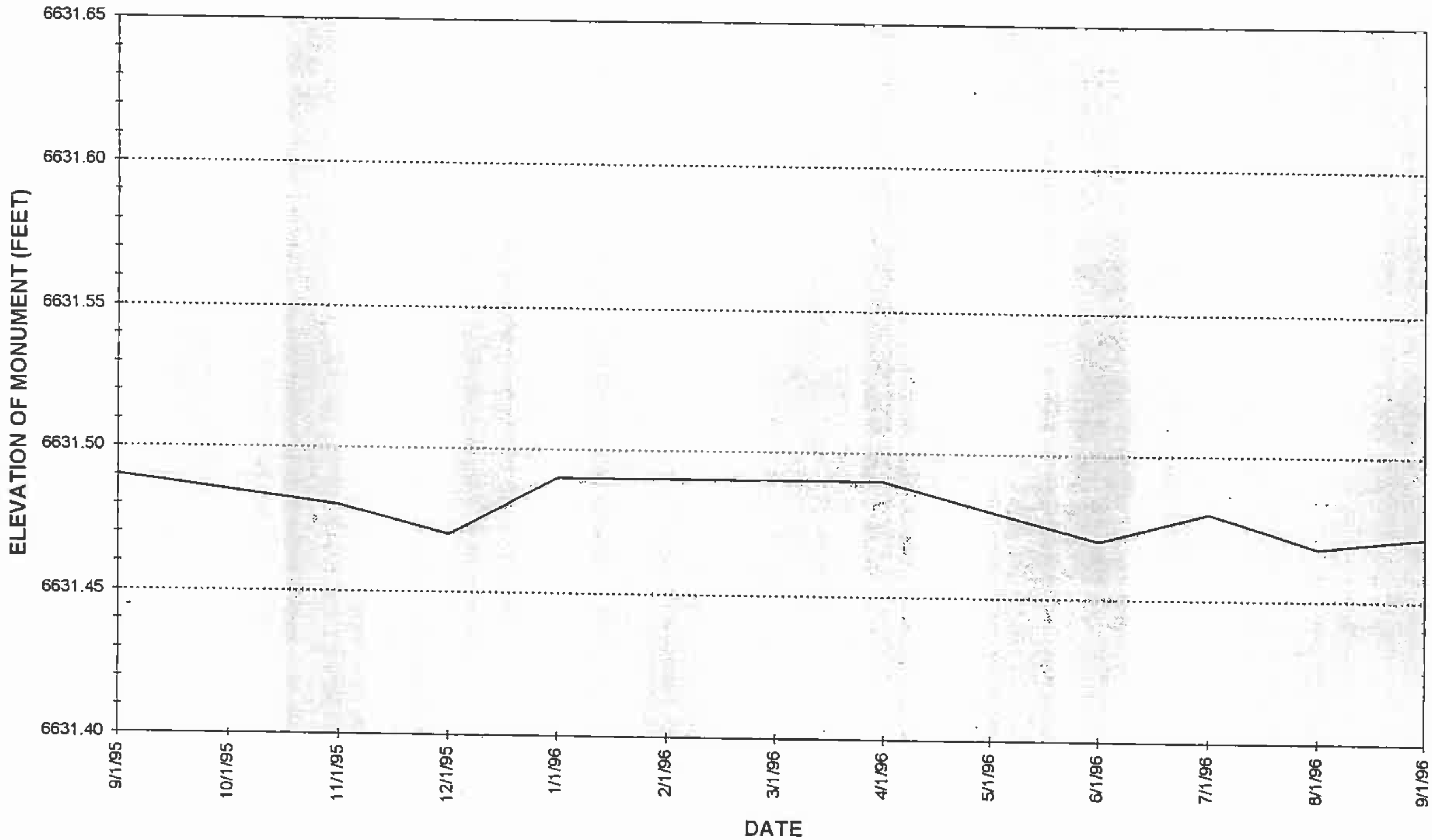
1995-1996 J16-A DAM SETTLEMENT MONUMENT #2



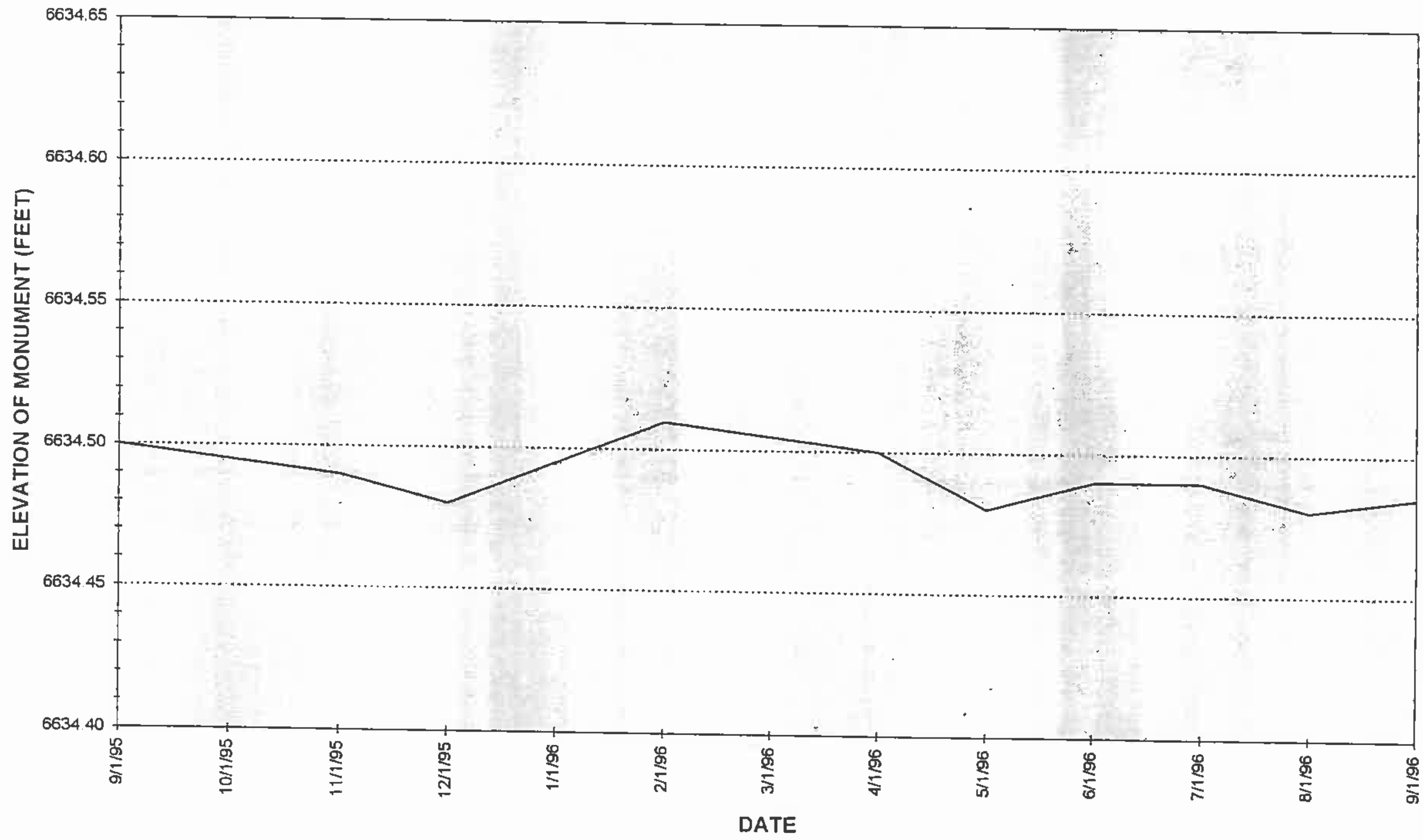
1995-1996 J16-A DAM SETTLEMENT MONUMENT #3



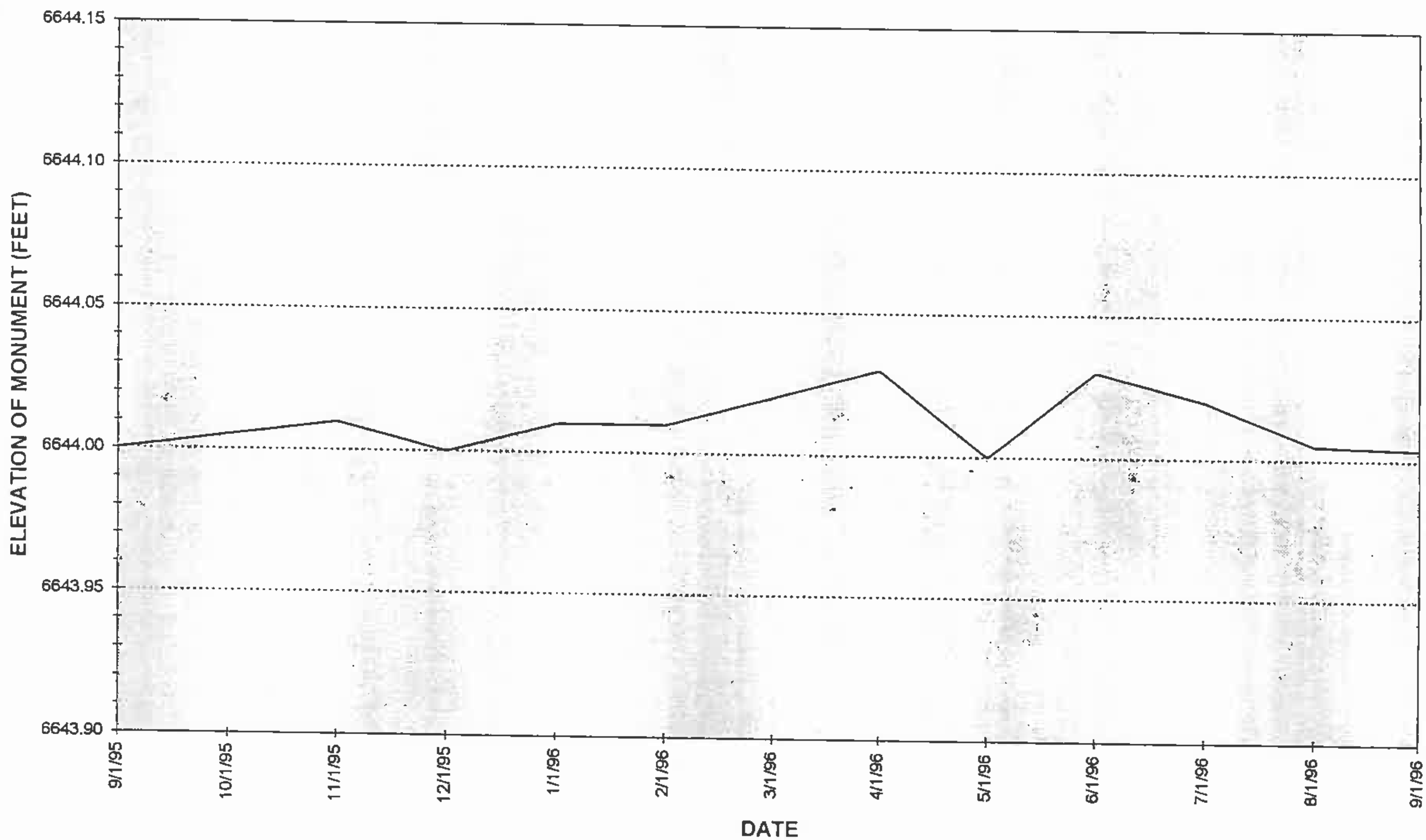
1995-1996 J16-A DAM SETTLEMENT MONUMENT #4



1995-1996 J16-A DAM SETTLEMENT MONUMENT #5



1995-1996 J16-A DAM SETTLEMENT MONUMENT #6



PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 3, 1996

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-08
Other: J16-L Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period August 31, 1995 to August 31, 1996 is submitted:

		STATUS
1.	Geometry	No Change
2.	Instrumentation	See Attachments
3.	Current Water Elevation	6556.4
4.	Storage Capacity	No Change
5.	Water Volume	Increase per water elevation
6.	Stability	No Change
7.	Spillway Elevation	6571.20
8.	Other	Revision submitted 8/22/96 to raise Spillway Elevation to 6573.0.

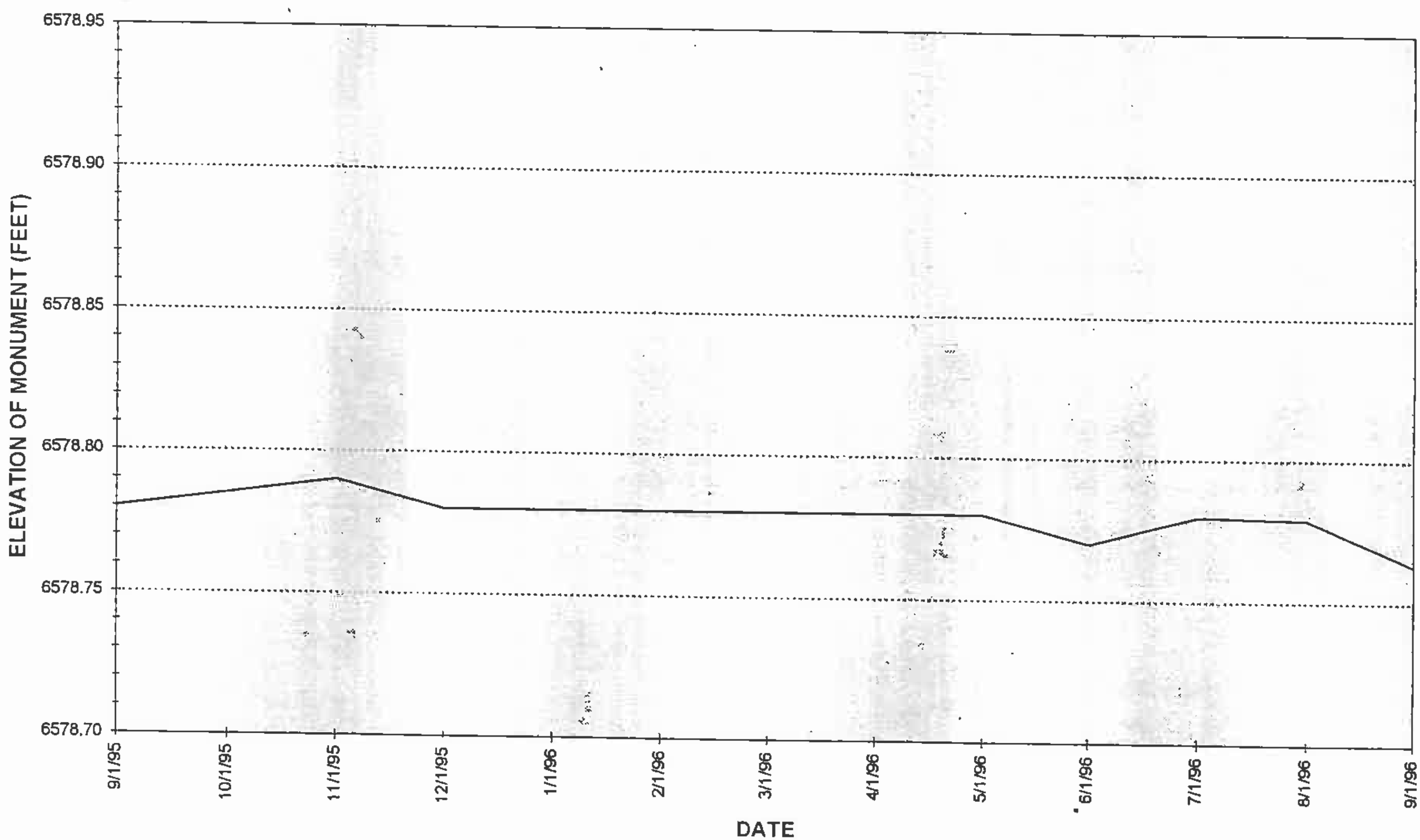
All work at the above site during the period August 31, 1995 to August 31, 1996 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) CERTIFICATE NO. 18782 JAMES GARY SCHLENVOGT ARIZONA, U.S.A.

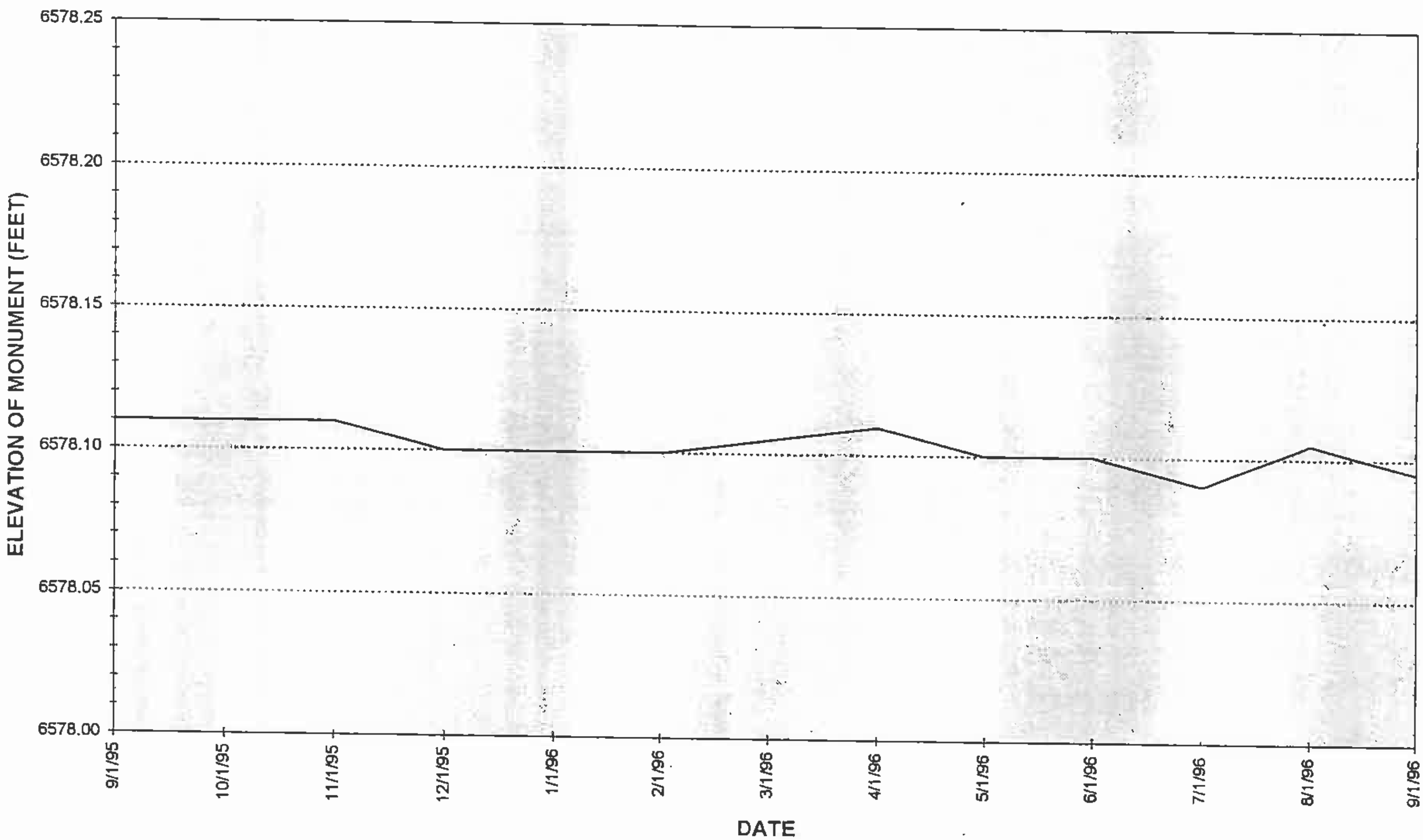
James G. Schlenvogt, P.E.

SEP 03 1996

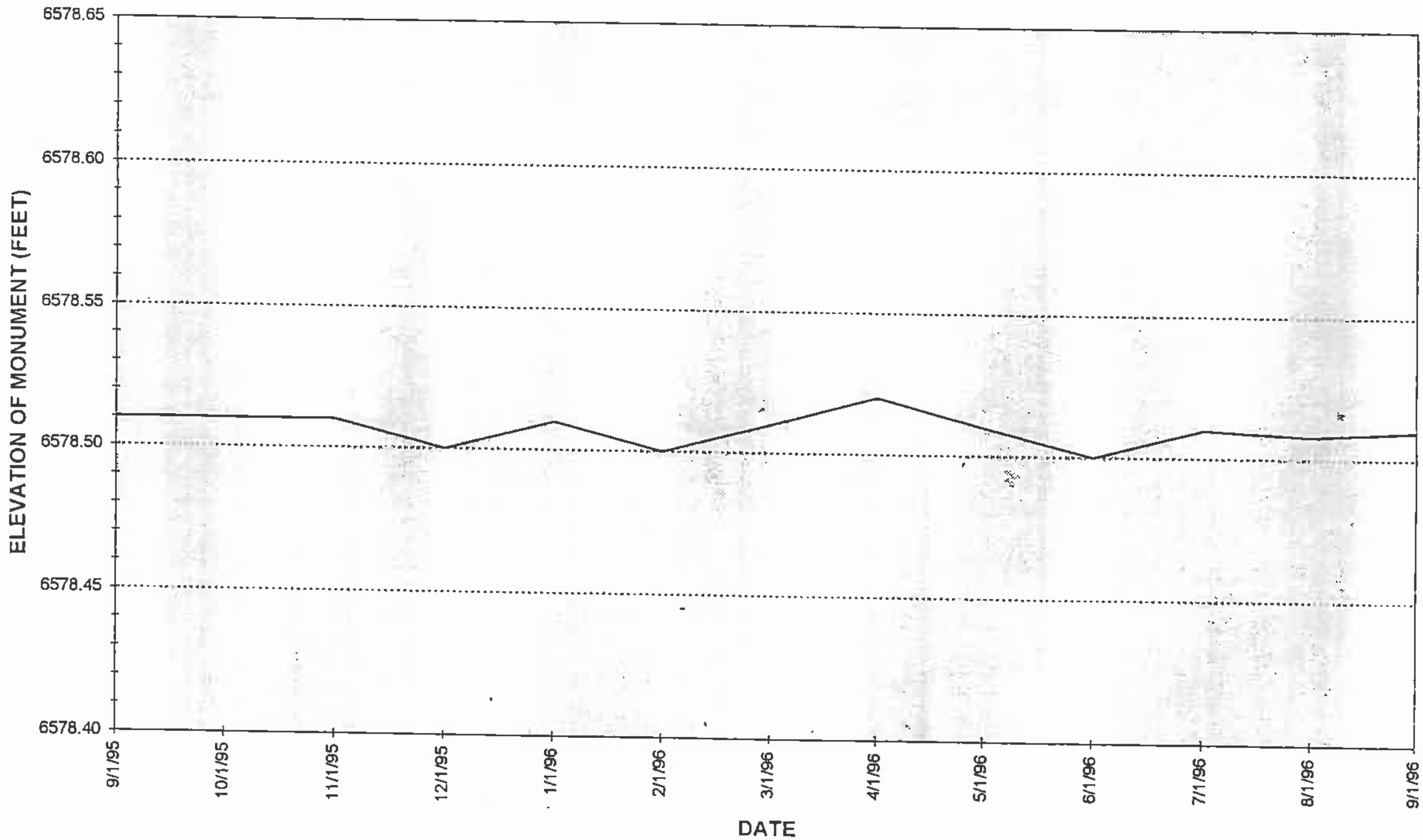
1995-1996 J16-L DAM SETTLEMENT MONUMENT #1



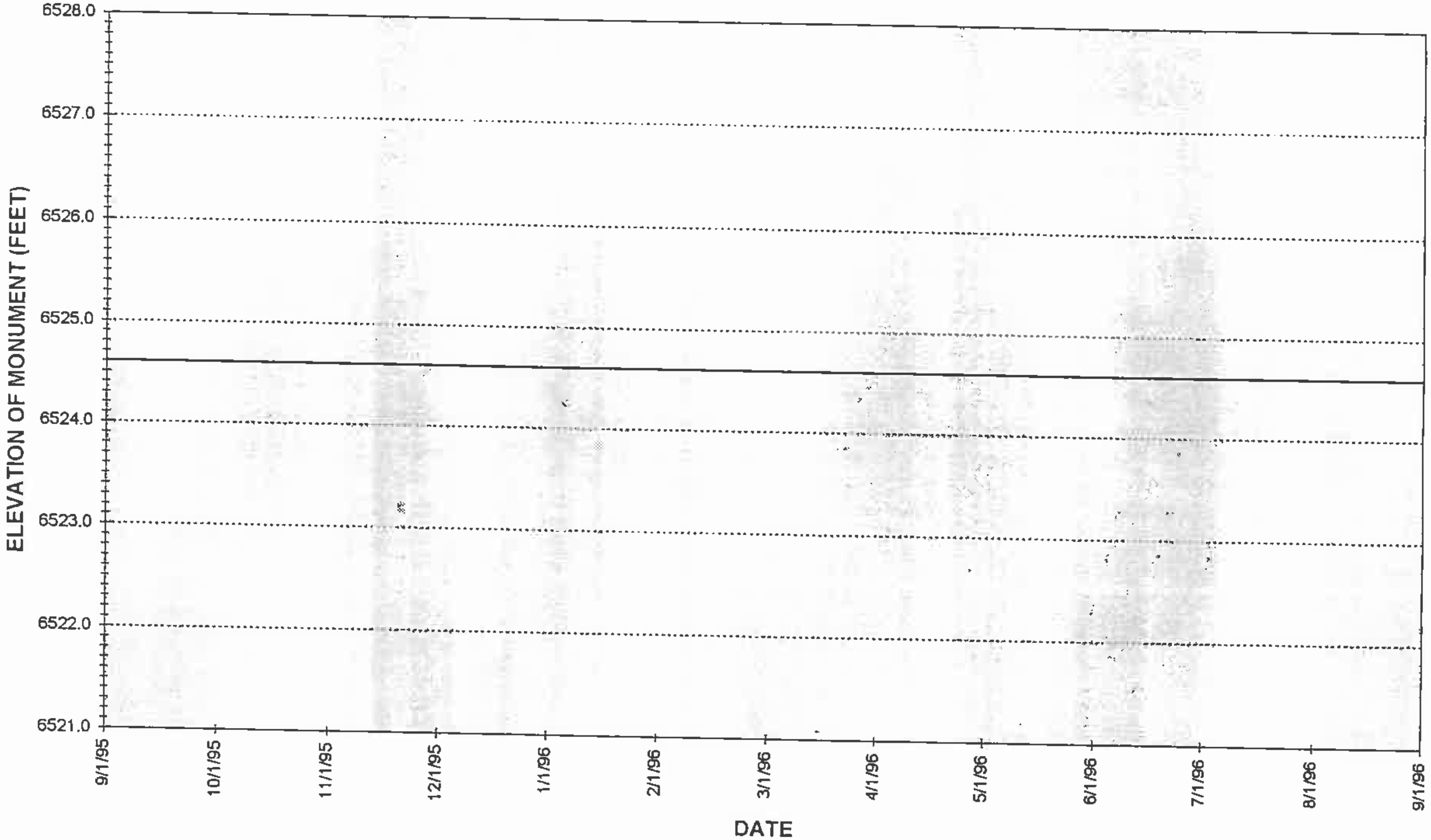
1995-1996 J16-L DAM SETTLEMENT MONUMENT #2



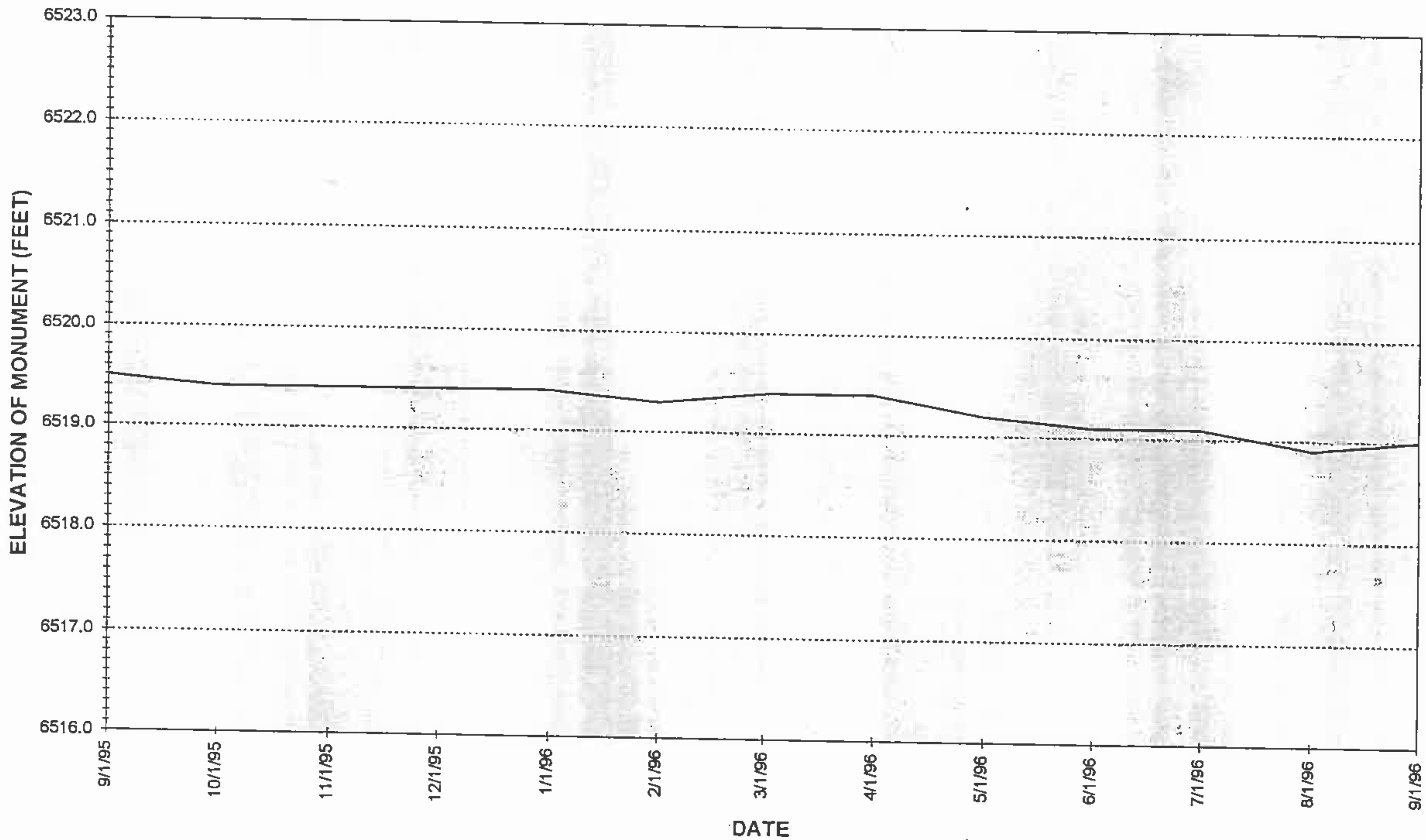
1995-1996 J16-L DAM SETTLEMENT MONUMENT #3



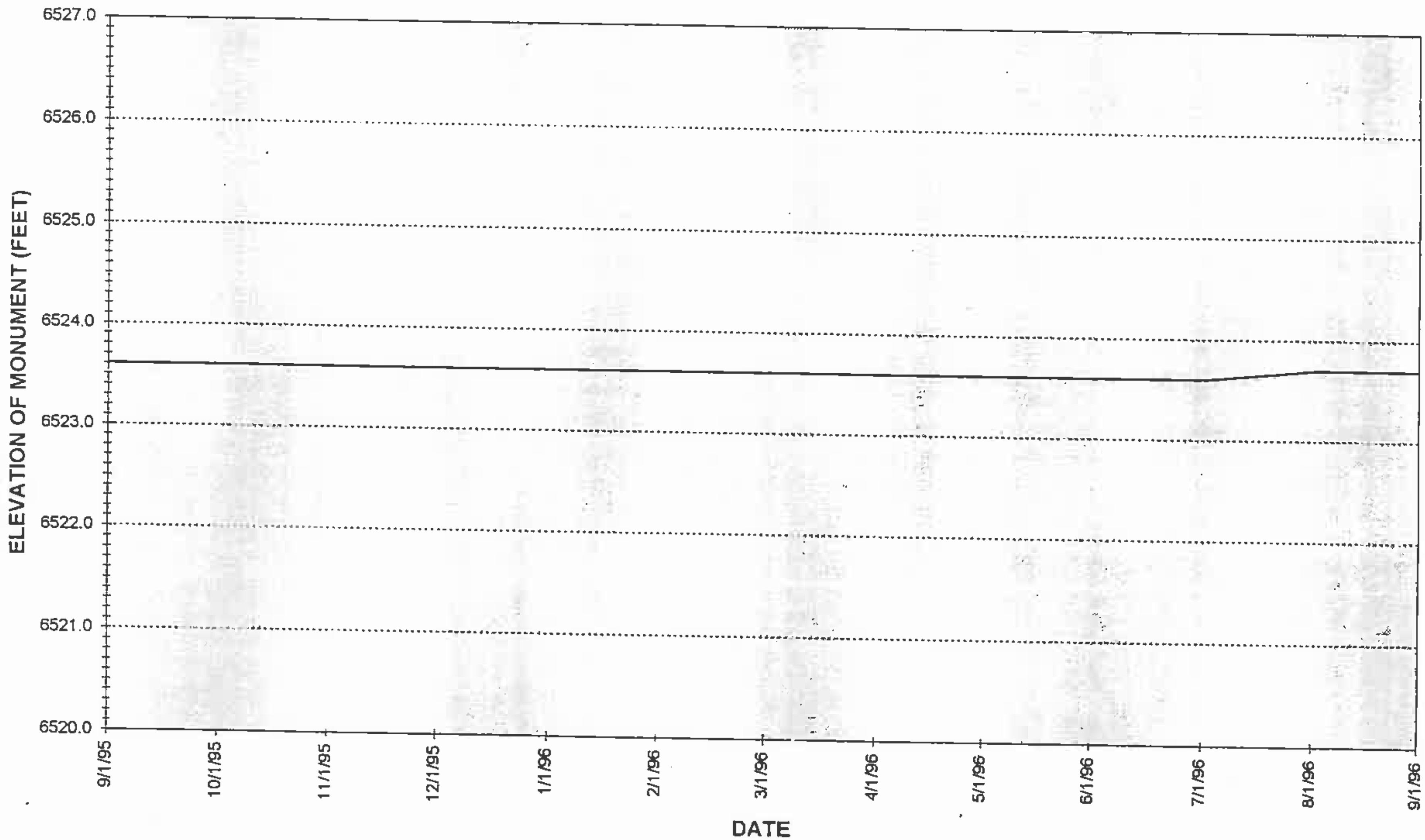
1995-1996 J16-L DAM WATER MONITORING WELL #1



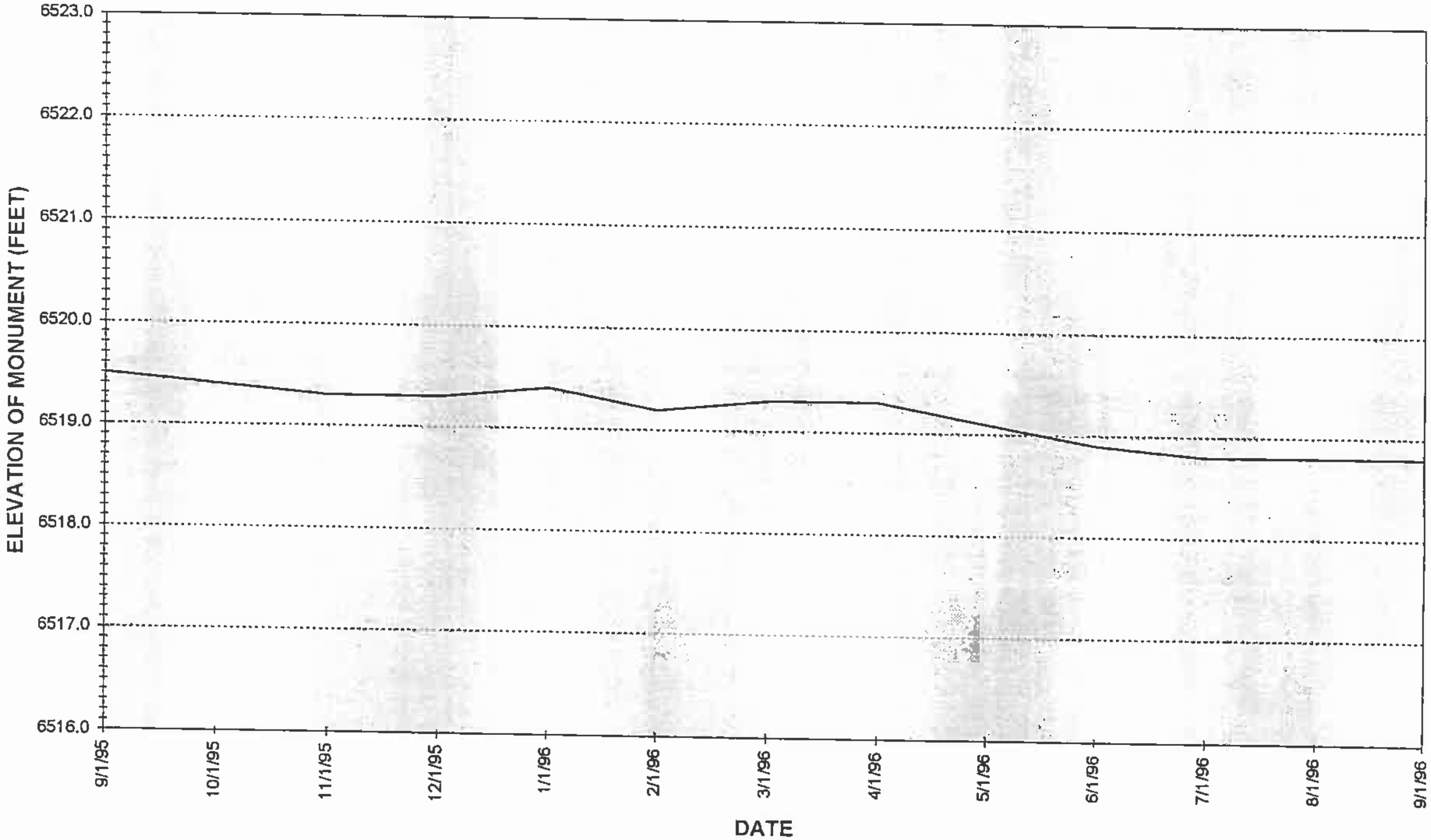
1995-1996 J16-L DAM WATER MONITORING WELL #2



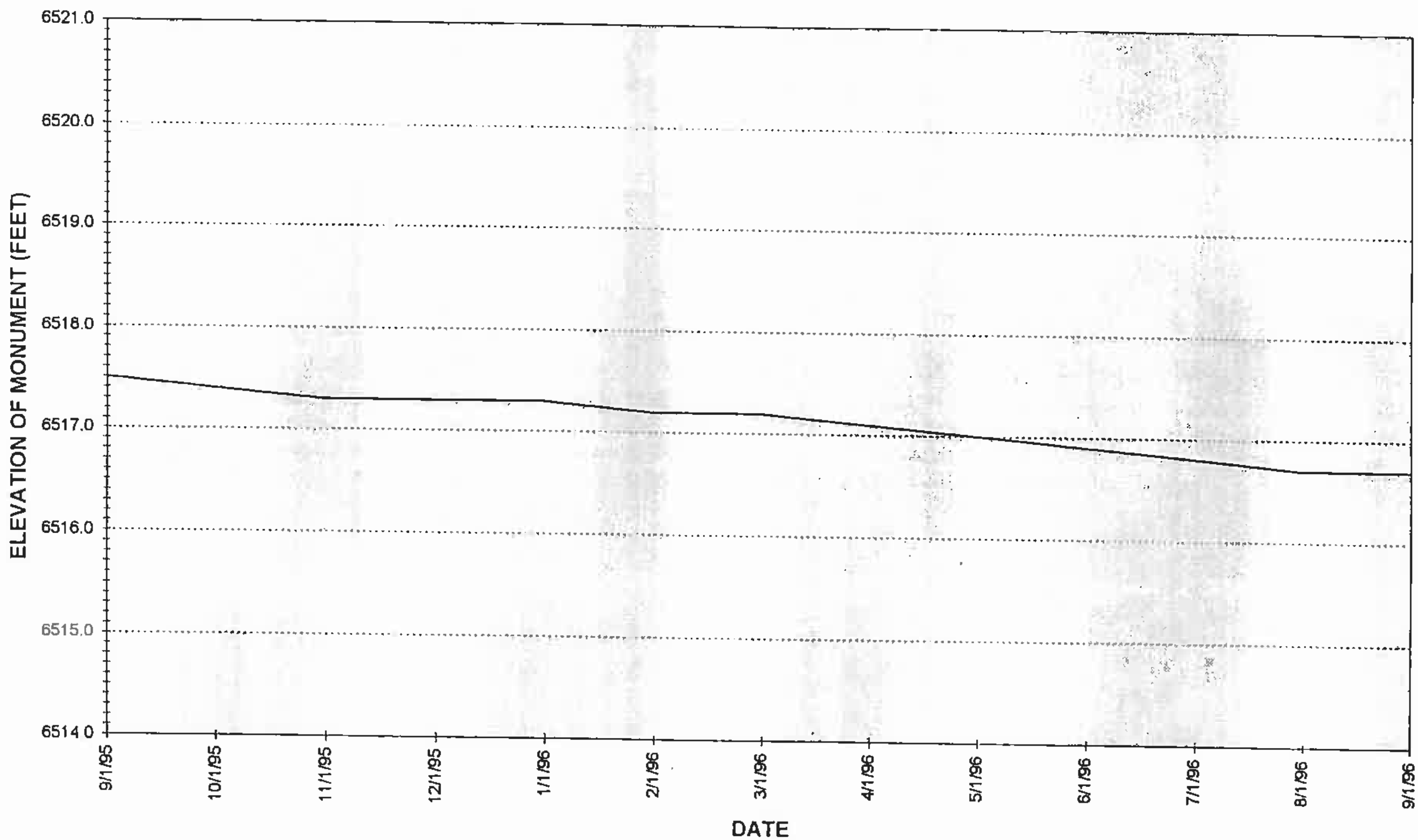
1995-1996 J16-L DAM WATER MONITORING WELL #3



1995-1996 J16-L DAM WATER MONITORING WELL #4



1995-1996 J16-L DAM WATER MONITORING WELL #5



U. S. Department of Labor

Mine Safety and Health Administration
P.O. Box 25367
Denver, Colorado 80225-0367

Coal Mine Safety and Health
District 9

SEP 24 1997

Buck Woodward
Production Manager
Peabody Western Coal Company
P. O. Box 605
Kayenta, AZ 86033

RE: Black Mesa
Mine ID No. 02-00533
Annual Impoundment Report
Impoundments ID #1211-AZ-09-00533-01
ID #1211-AZ-09-00533-02

Dear Mr. Woodward:

The annual impoundment report for the above referenced structures, dated September 2, 1997, has been reviewed and will be made a part of the mine file.

Sincerely,

for John A. Kuzar
District Manager

U. S. Department of Labor

Mine Safety and Health Administration
P.O. Box 25367
Denver, Colorado 80225-0367

Coal Mine Safety and Health
District 9

SEP 24 1997

SEP 1997
Received
Bob Boone

Robert Boone
Production Manager
Peabody Western Coal Company
P. O. Box 605
Kayenta, AZ 86033

RE: Kayenta
Mine ID No. 02-01195
Annual Impoundment Report
Impoundments ID #1211-AZ-09-01195-01
ID #1211-AZ-09-01195-02
ID #1211-AZ-09-01195-03
ID #1211-AZ-09-01195-04
ID #1211-AZ-09-01195-05
ID #1211-AZ-09-01195-06
ID #1211-AZ-09-01195-07
ID #1211-AZ-09-01195-08

Dear Mr. Boone:

The annual impoundment reports for the above referenced structures, dated September 2, 1997, has been reviewed and will be made a part of the mine file.

Sincerely,

for John A. Kuzar
District Manager

PEABODY WESTERN

Peabody Western Coal Company

September 2, 1997

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Peabody Western Coal Company's Kayenta and Black Mesa Mines Annual M.S.H.A. Dam Inspection Report.

Dear Sir:

Pursuant to the 30 CFR 77.261-4 regulations, enclosed are the certified annual M.S.H.A. Dam Inspection Reports for the following dams:

Black Mesa Mine

J-7 Dam	ID No. 1211-AZ-09-00533-01
J2-A Wild Ram Valley Dam	ID No. 1211-AZ-09-00533-02

Kayenta Mine

Kayenta Fresh Water Pond	ID No. 1211-AZ-09-01195-01
N14-D Dam	ID No. 1211-AZ-09-01195-02
N14-E Dam	ID No. 1211-AZ-09-01195-03
N14-F Dam	ID No. 1211-AZ-09-01195-04
N14-G Dam	ID No. 1211-AZ-09-01195-05
N14-H Dam	ID No. 1211-AZ-09-01195-06
J16-A Dam	ID No. 1211-AZ-09-01195-07
J16-L Dam	ID No. 1211-AZ-09-01195-08

Should you have any questions, do not hesitate to contact me.

Sincerely,

James Schlenvogt

James G. Schlenvogt, P.E.
Compliance Engineering
Manager

smm

c: Bill Bippus
Brian Dunfee
Scott Williams

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 2, 1997

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-00533-01
Other: J7 Dam
Mine: Black Mesa Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1996 to August 31, 1997 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6357.6
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6368.5
8. Other	

All work at the above site during the period September 1, 1996 to August 31, 1997 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) CERTIFICATE NO. 18782 JAMES G. SCHLENVOGT ARIZONA, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 02 1997

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 2, 1997

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-00533-02
Other: J2-A Wild Ram Valley Dam
Mine: Black Mesa Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1996 to August 31, 1997 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	See Attachments
3. Current Water Elevation	6324.4
4. Storage Capacity	No Change
5. Water Volume	Decrease per water elevation
6. Stability	No Change
7. Spillway Elevation	6348.2
8. Other	

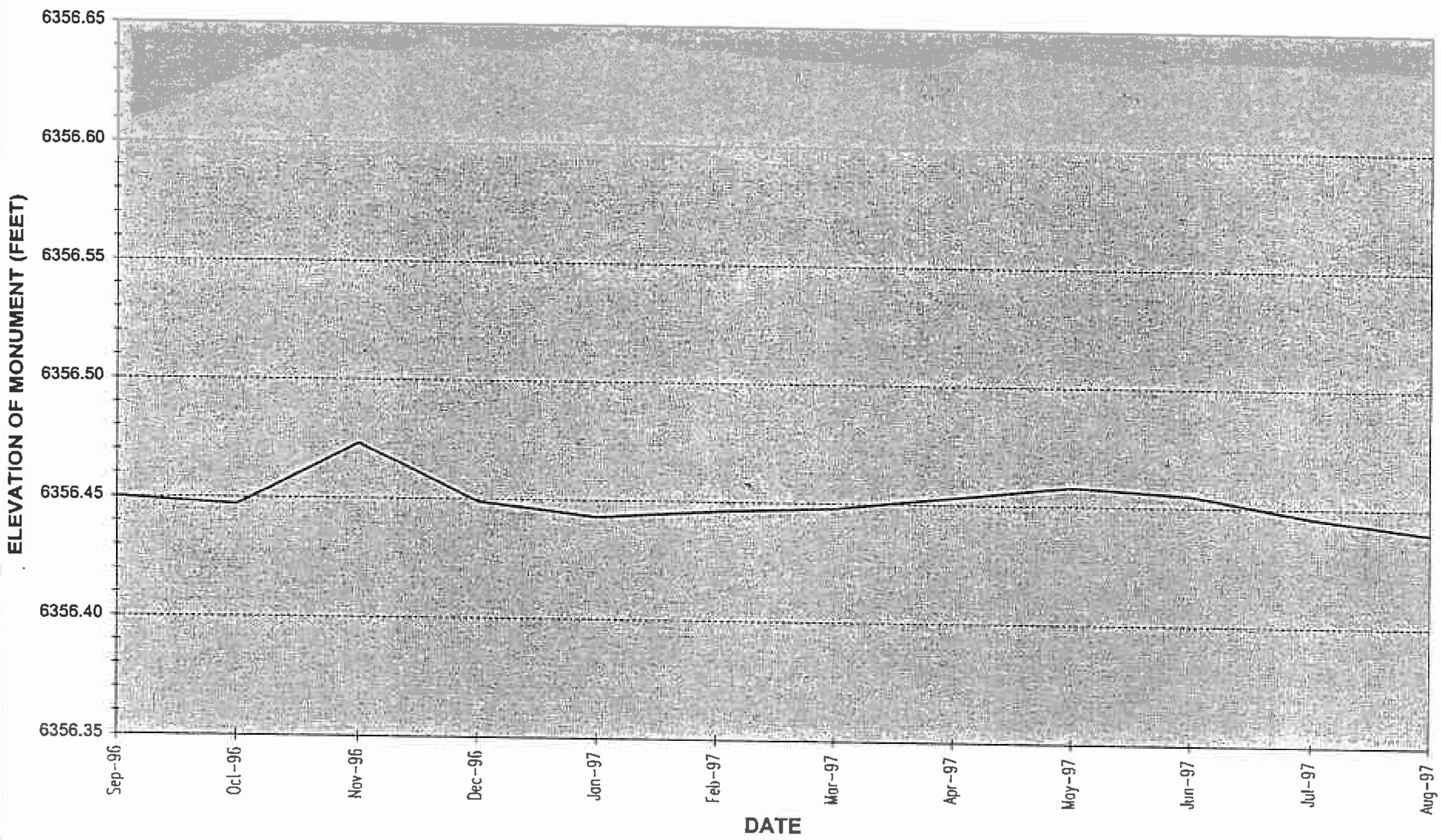
All work at the above site during the period September 1, 1996 to August 31, 1997 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) CERTIFICATE NO. 18782 JAMES GARY SCHLENVOGT ARIZONA, U.S.A.

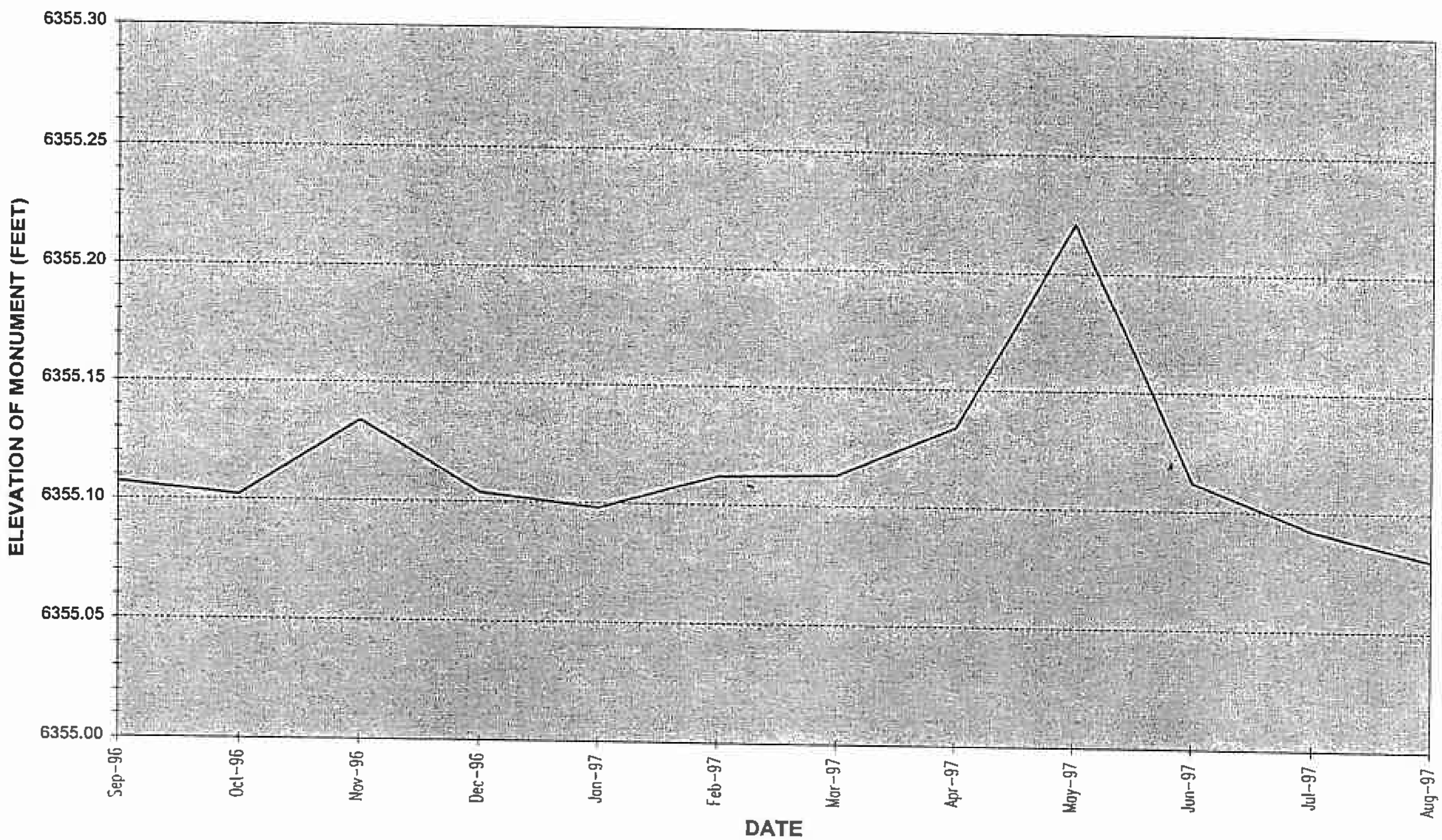
James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 02 1997

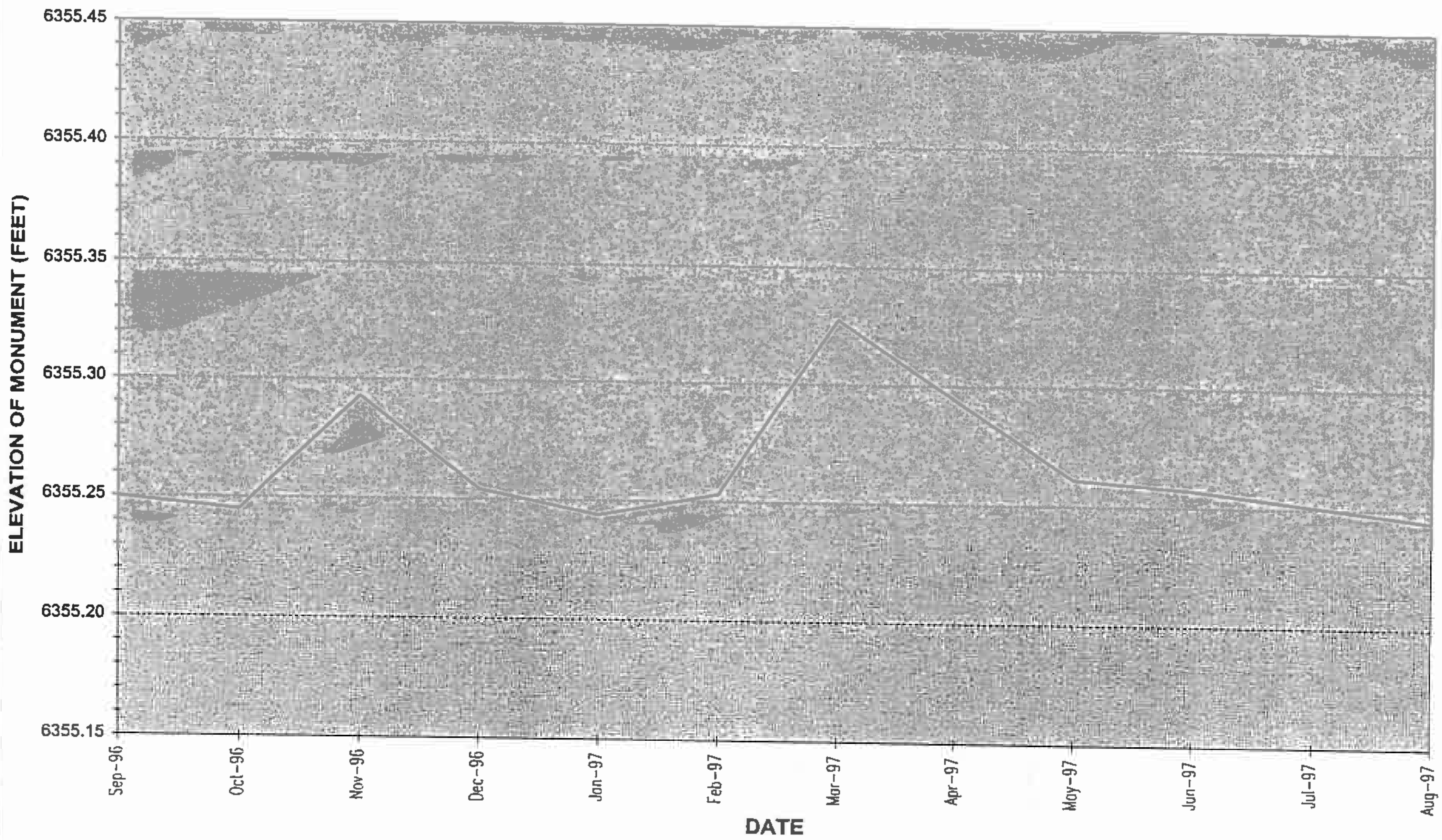
1996-1997 J2-A DAM SETTLEMENT MONUMENT #1



1996-1997 J2-A DAM SETTLEMENT MONUMENT #2



1996-1997 J2-A DAM SETTLEMENT MONUMENT #3



PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 2, 1997

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-01
Other: Kayenta Fresh Water Pond
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1996 to August 31, 1997 is submitted:

		STATUS
1.	Geometry	No Change
2.	Instrumentation	No Change
3.	Current Water Elevation	6612.0
4.	Storage Capacity	No Change
5.	Water Volume	Decrease per water elevation
6.	Stability	No Change
7.	Spillway Elevation	6615.83
8.	Other	

All work at the above site during the period September 1, 1996 to August 31, 1997 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) CERTIFICATE NO. 18782 JAMES GARY SCHLENVOGT ARIZONA, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 02 1997

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 2, 1997

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-02
Other: N14-D Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1996 to August 31, 1997 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6618.5
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6653.05
8. Other	

All work at the above site during the period September 1, 1996 to August 31, 1997 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) CERTIFICATE NO. 18782 JAMES GARY SCHLENVOGT Signed ARIZONA, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 02 1997

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 2, 1997

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-03
Other: N14-E Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1996 to August 31, 1997 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6666.7
4. Storage Capacity	No Change
5. Water Volume	Decrease per water elevation
6. Stability	No Change
7. Spillway Elevation	6685.99
8. Other	

All work at the above site during the period September 1, 1996 to August 31, 1997 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) CERTIFICATE NO. 18782 JAMES GARY SCHLENVOGT Date Signed ARIZONA, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 02 1997

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 2, 1997

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-04
Other: N14-F Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1996 to August 31, 1997 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6640.2
4. Storage Capacity	No Change
5. Water Volume	Decrease per water elevation
6. Stability	No Change
7. Spillway Elevation	6658.54
8. Other	

All work at the above site during the period September 1, 1996 to August 31, 1997 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer Certificate No. 18782 JAMES GARY SCHLENVOGT Arizona, U.S.A.

SEP 02 1997

James G. Schlenvogt, P.E.
Peabody Western Coal Company

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 2, 1997

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-05
Other: N14-G Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1996 to August 31, 1997 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6632.2
4. Storage Capacity	No Change
5. Water Volume	Decrease per water elevation
6. Stability	No Change
7. Spillway Elevation	6660.84
8. Other	

All work at the above site during the period September 1, 1996 to August 31, 1997 was performed in accordance with the approved plan to the best of my knowledge and belief.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

Registered Professional Engineer
Certificate No. 18782
JAMES GARVO SCHLENVOGT
Date Signed
ARIZONA, U.S.A.

SEP 02 1997

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 2, 1997

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-06
Other: N14-H Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1996 to August 31, 1997 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6696.6
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6719.07
8. Other	

All work at the above site during the period September 1, 1996 to August 31, 1997 was performed in accordance with the approved plan to the best of my knowledge and belief.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

[Seal: Registered Professional Engineer, Certificate No. 18782, James Gary Schlenvogt, Arizona, U.S.A.]

SEP 02 1997

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 2, 1997

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-07
Other: J16-A Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1996 to August 31, 1997 is submitted:

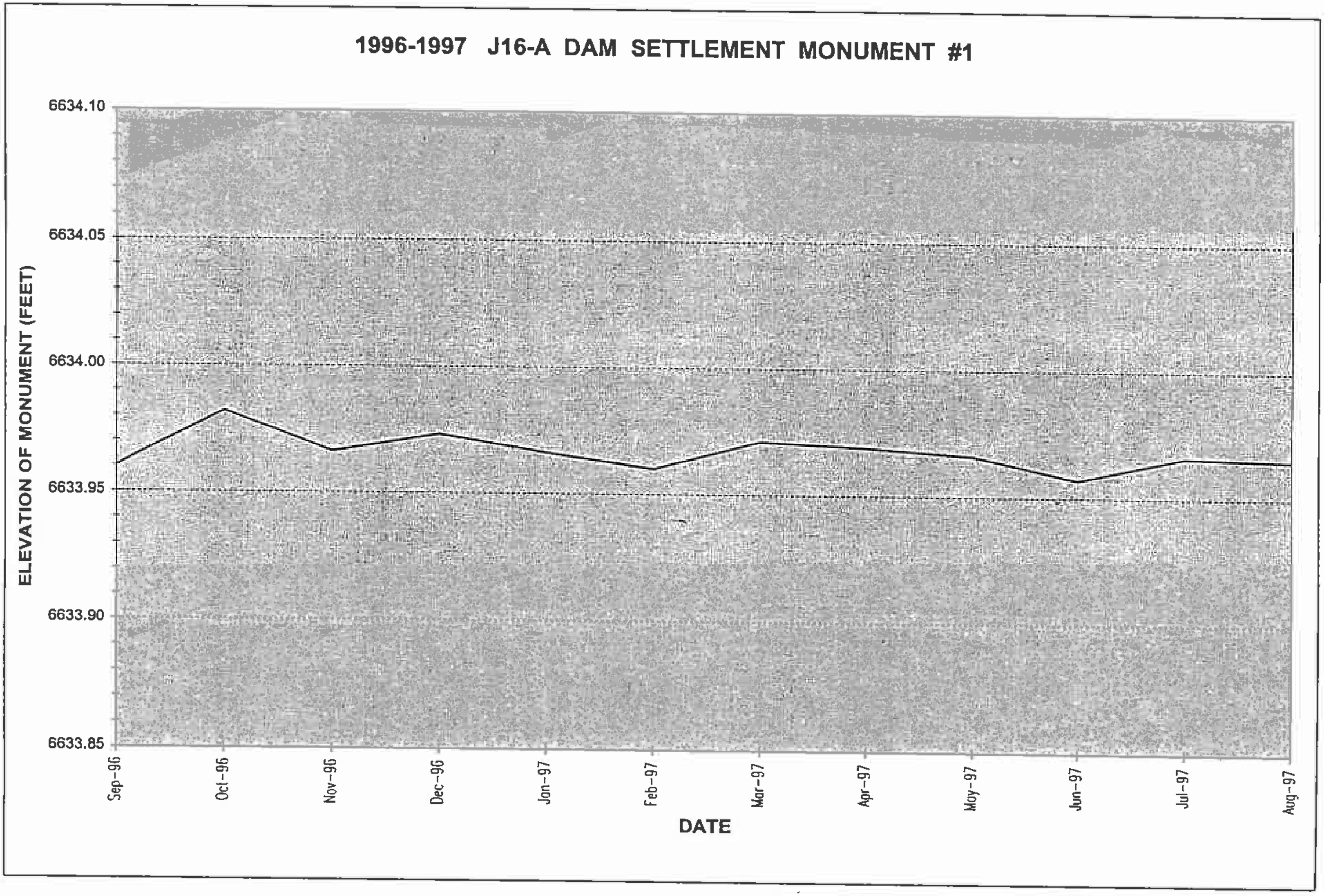
	STATUS
1. Geometry	No Change
2. Instrumentation	See Attachments
3. Current Water Elevation	6614.6
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6635.13
8. Other	

All work at the above site during the period September 1, 1996 to August 31, 1997 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) Certificate No. 18782 JAMES GARY SCHLENVOGT Dated Signed ARIZONA, U.S.A.

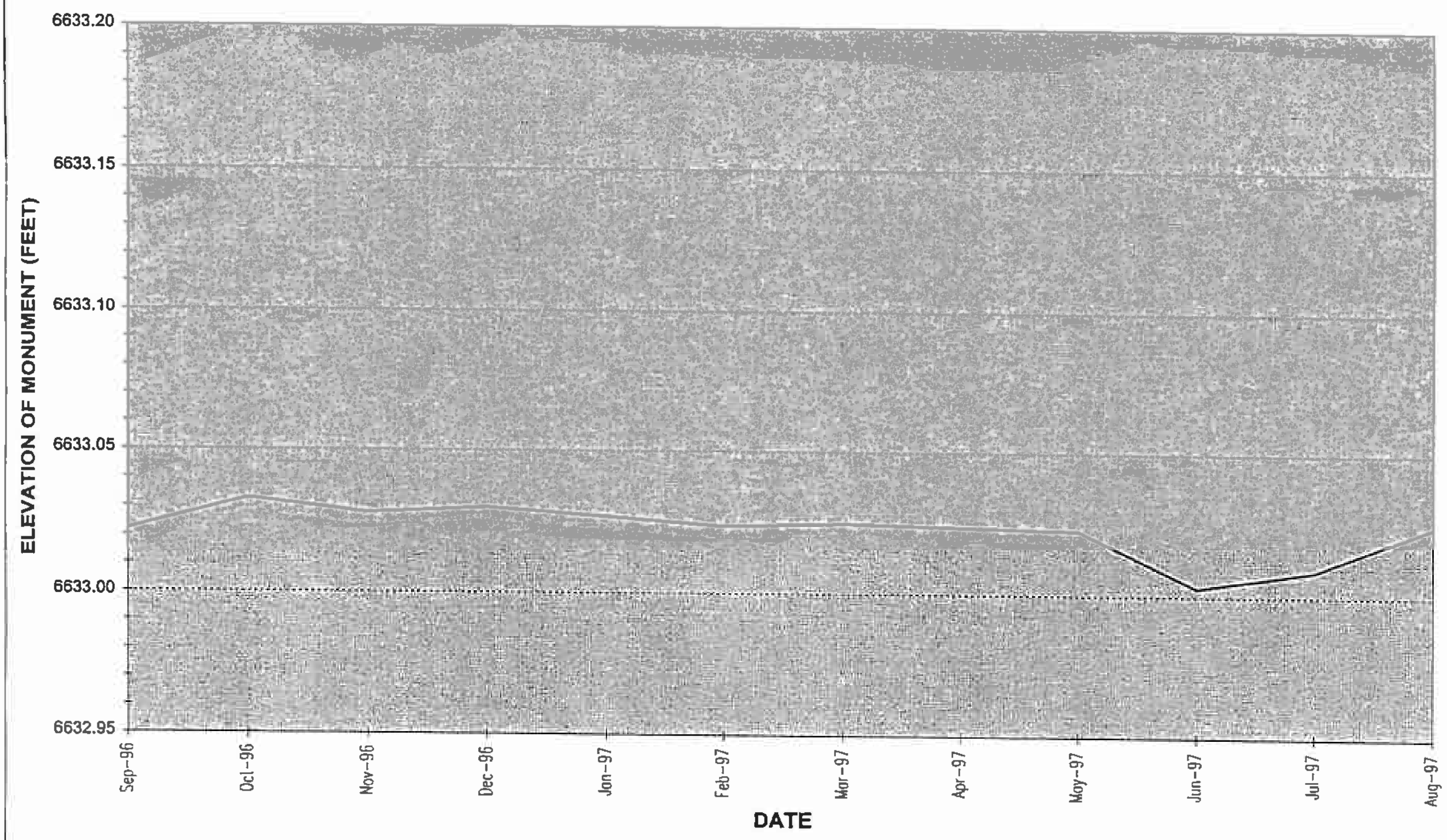
James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 02 1997

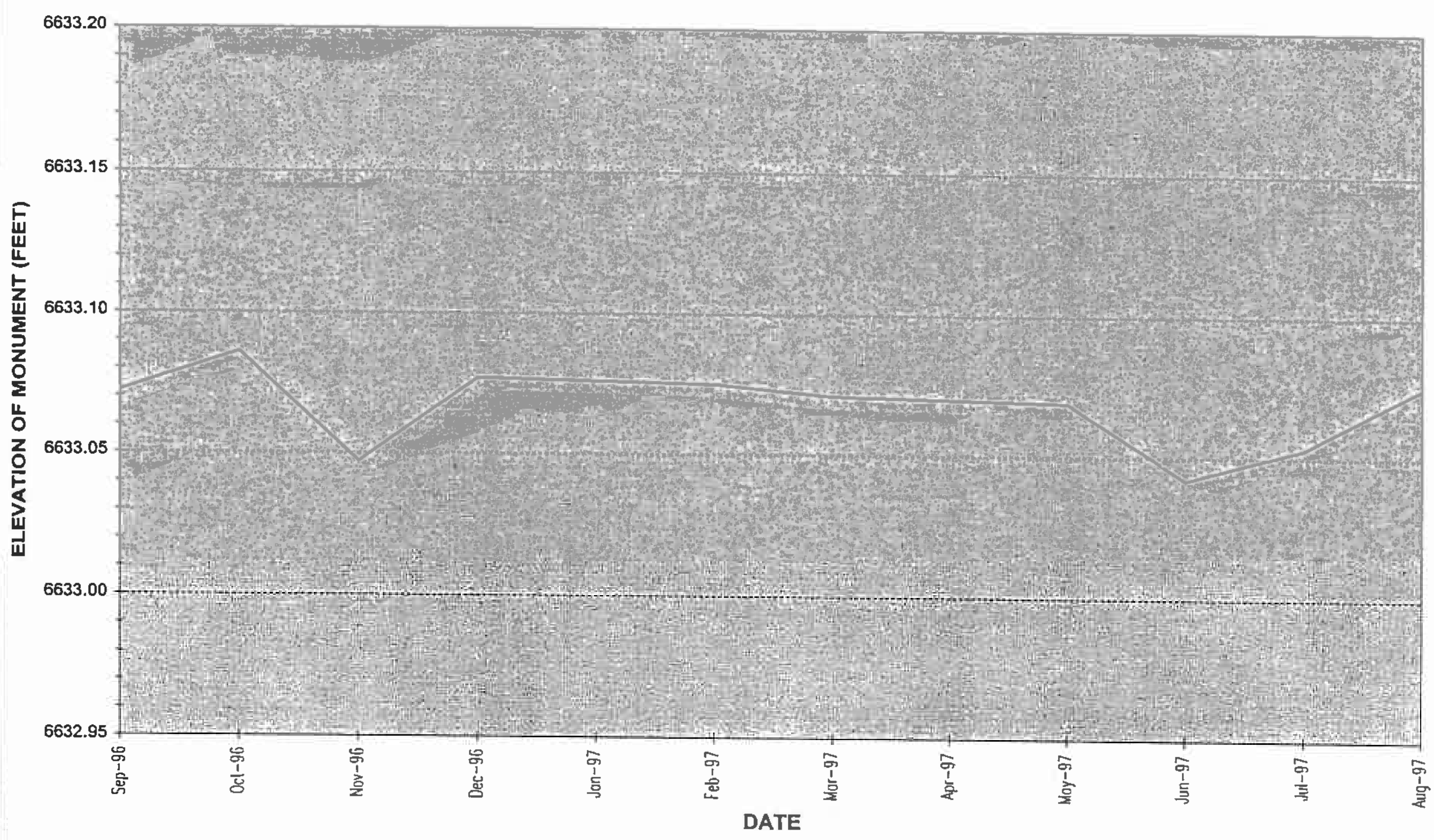


1996-1997 J16-A DAM SETTLEMENT MONUMENT #1
ELEVATION OF MONUMENT (FEET)
6634.10
6634.05
6634.00
6633.95
6633.90
6633.85
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Aug-97
DATE

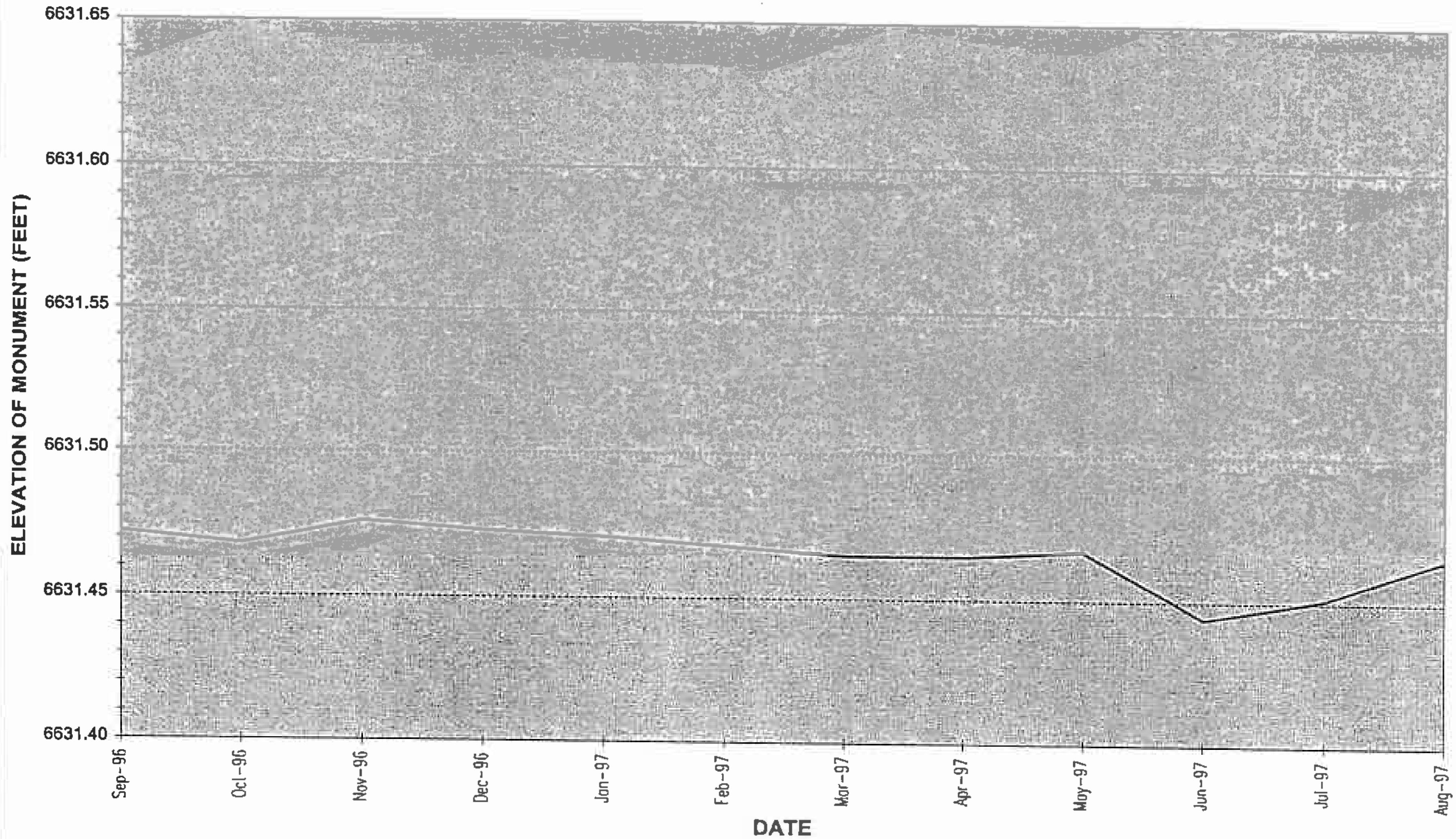
1996-1997 J16-A DAM SETTLEMENT MONUMENT #2



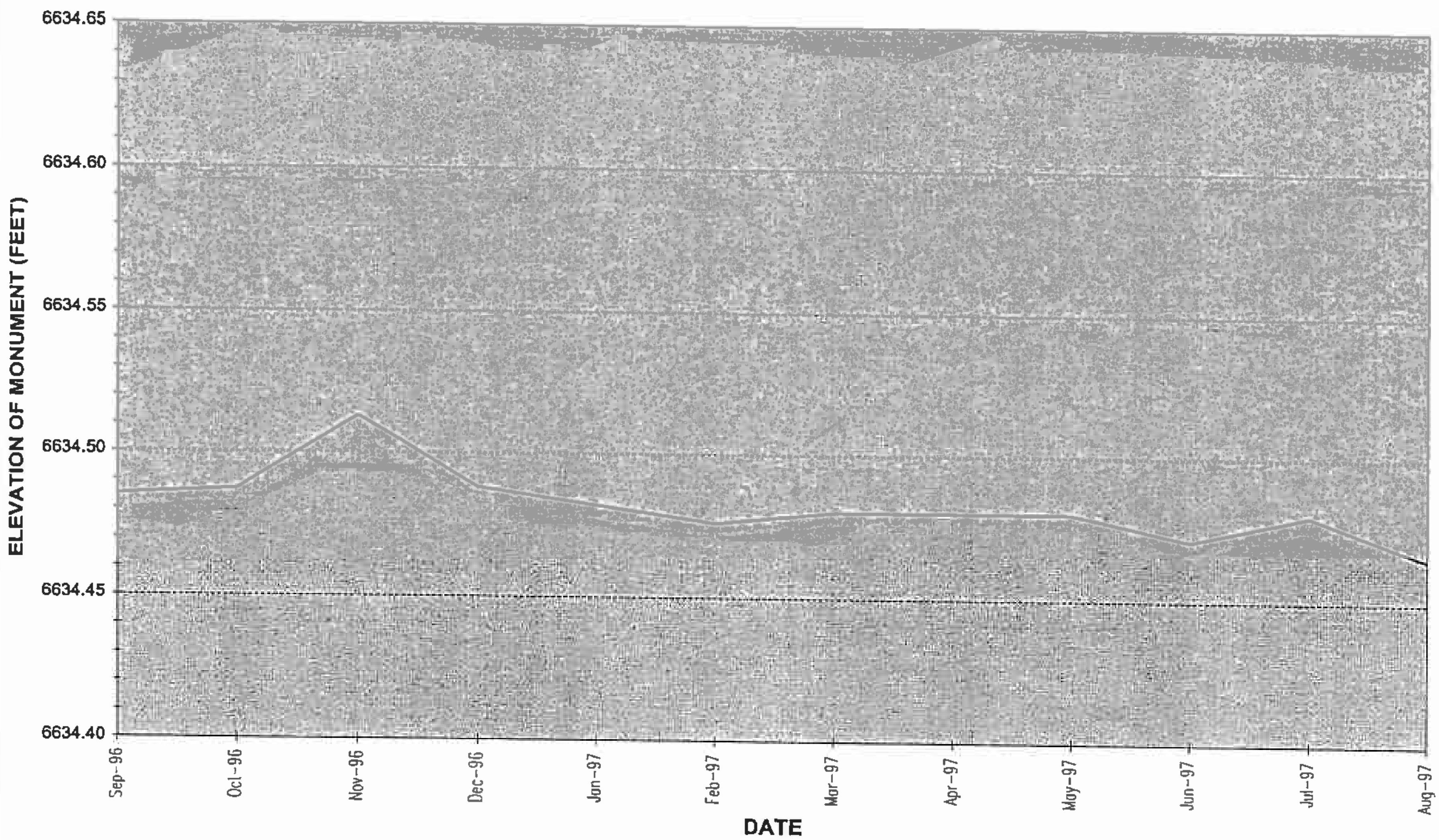
1996-1997 J16-A DAM SETTLEMENT MONUMENT #3

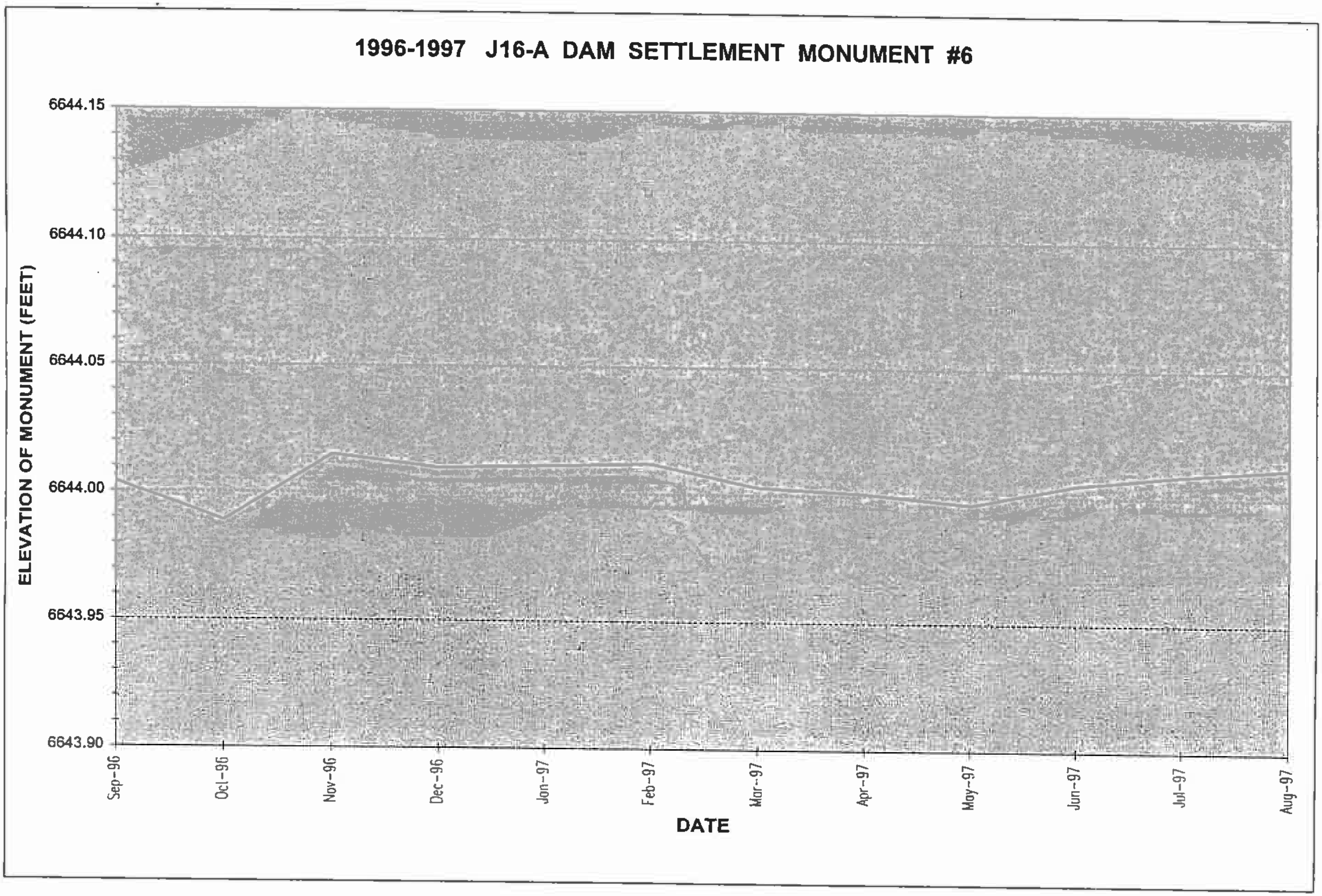


1996-1997 J16-A DAM SETTLEMENT MONUMENT #4



1996-1997 J16-A DAM SETTLEMENT MONUMENT #5




1996-1997 J16-A DAM SETTLEMENT MONUMENT #6
ELEVATION OF MONUMENT (FEET)
6644.15
6644.10
6644.05
6644.00
6643.95
6643.90
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Aug-97
DATE

PEABODY WESTERN COAL COMPANY
1300 South Yale
Flagstaff, Arizona 86001
Telephone (520) 774-5253

September 2, 1997

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-08
Other: J16-L Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1996 to August 31, 1997 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	See Attachments
3. Current Water Elevation	6556.5
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6573.4
8. Other	Remedial work performed; ESW and TOD raised; as-built submitted 6/9/97

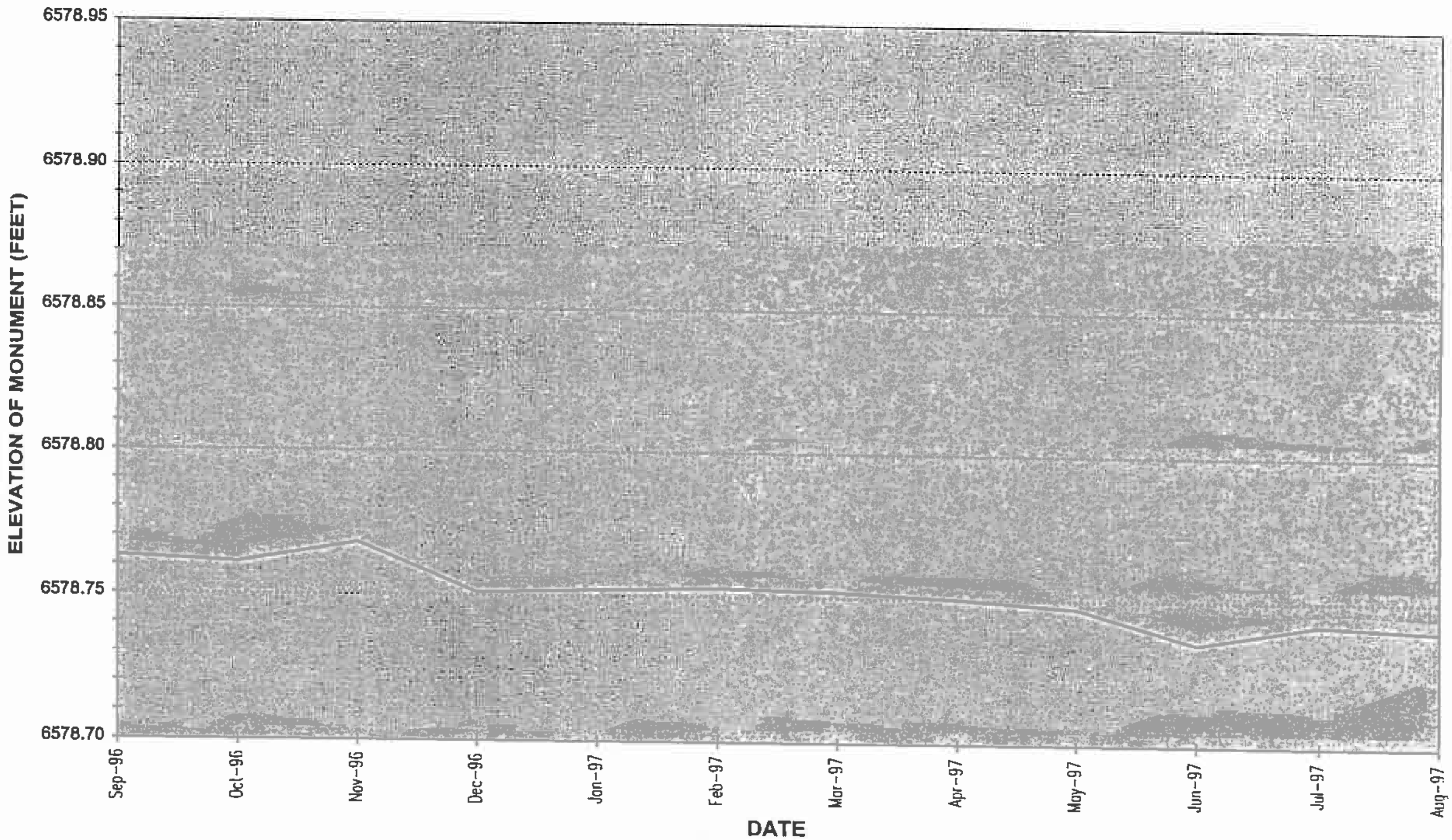
All work at the above site during the period September 1, 1996 to August 31, 1997 was performed in accordance with the approved plan to the best of my knowledge and belief.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

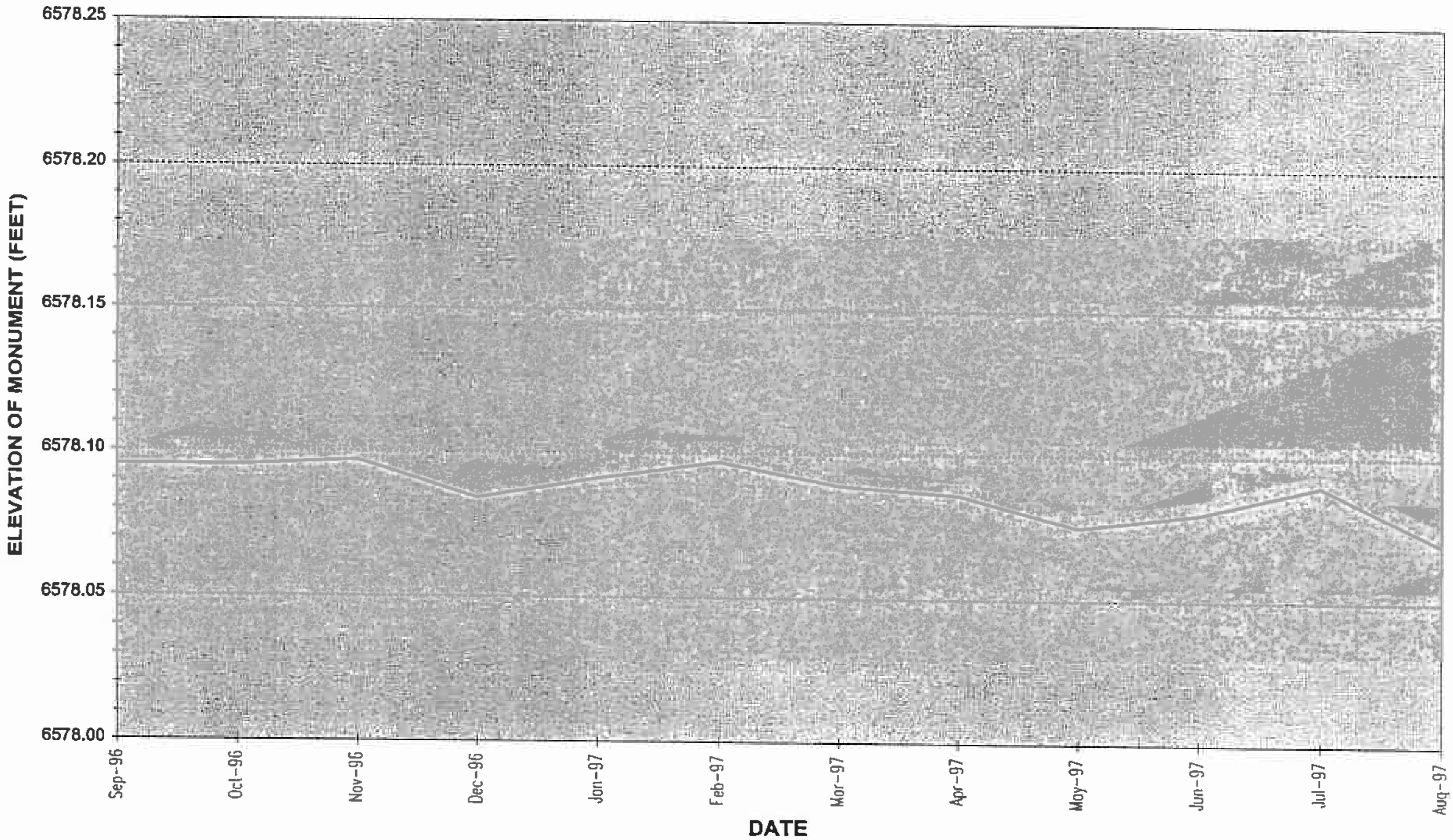
Registered Professional Engineer
CERTIFICATE NO. 18782
JAMES GARY SCHLENVOGT
Date Signed
ARIZONA, U.S.A.

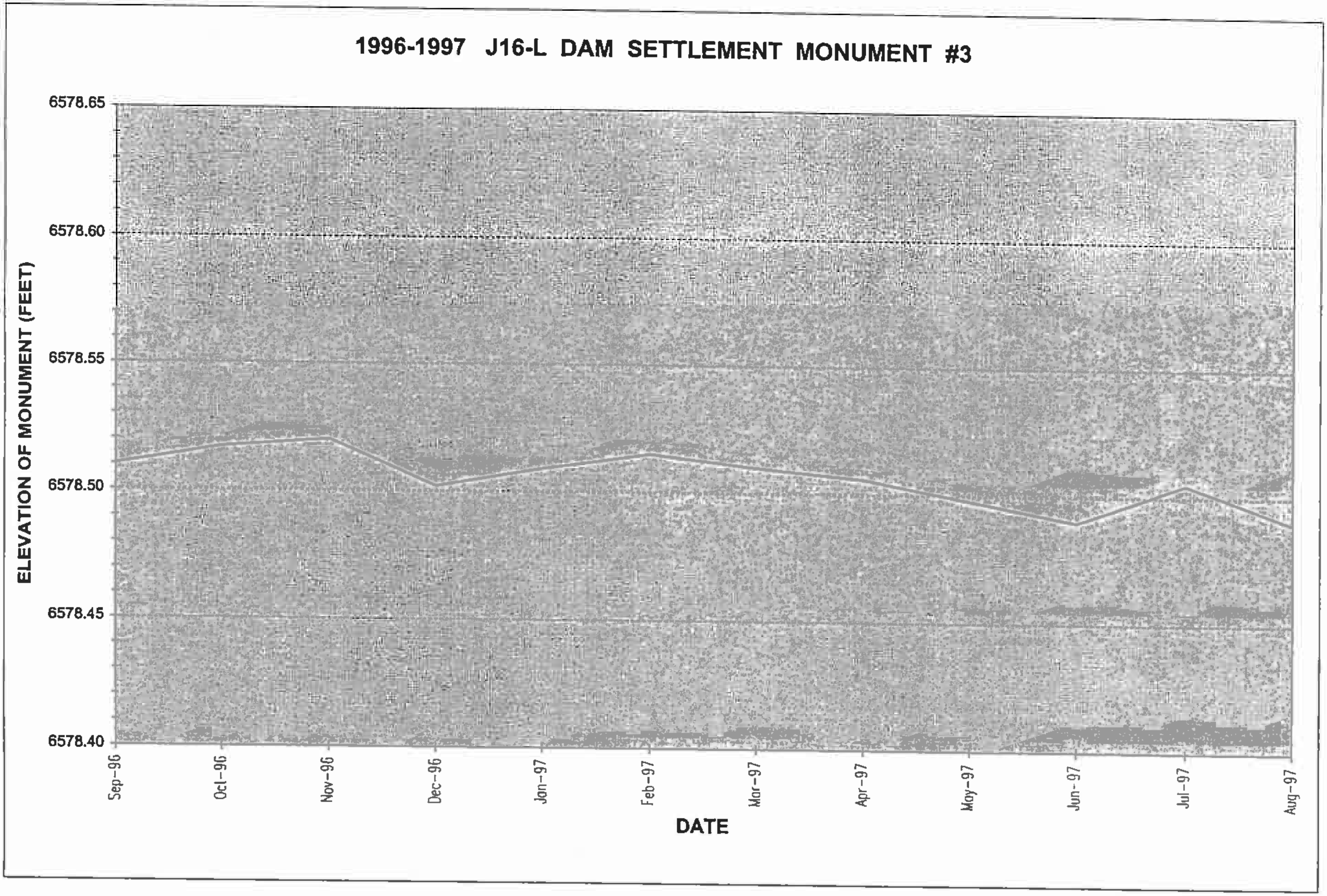
SEP 02 1997

1996-1997 J16-L DAM SETTLEMENT MONUMENT #1



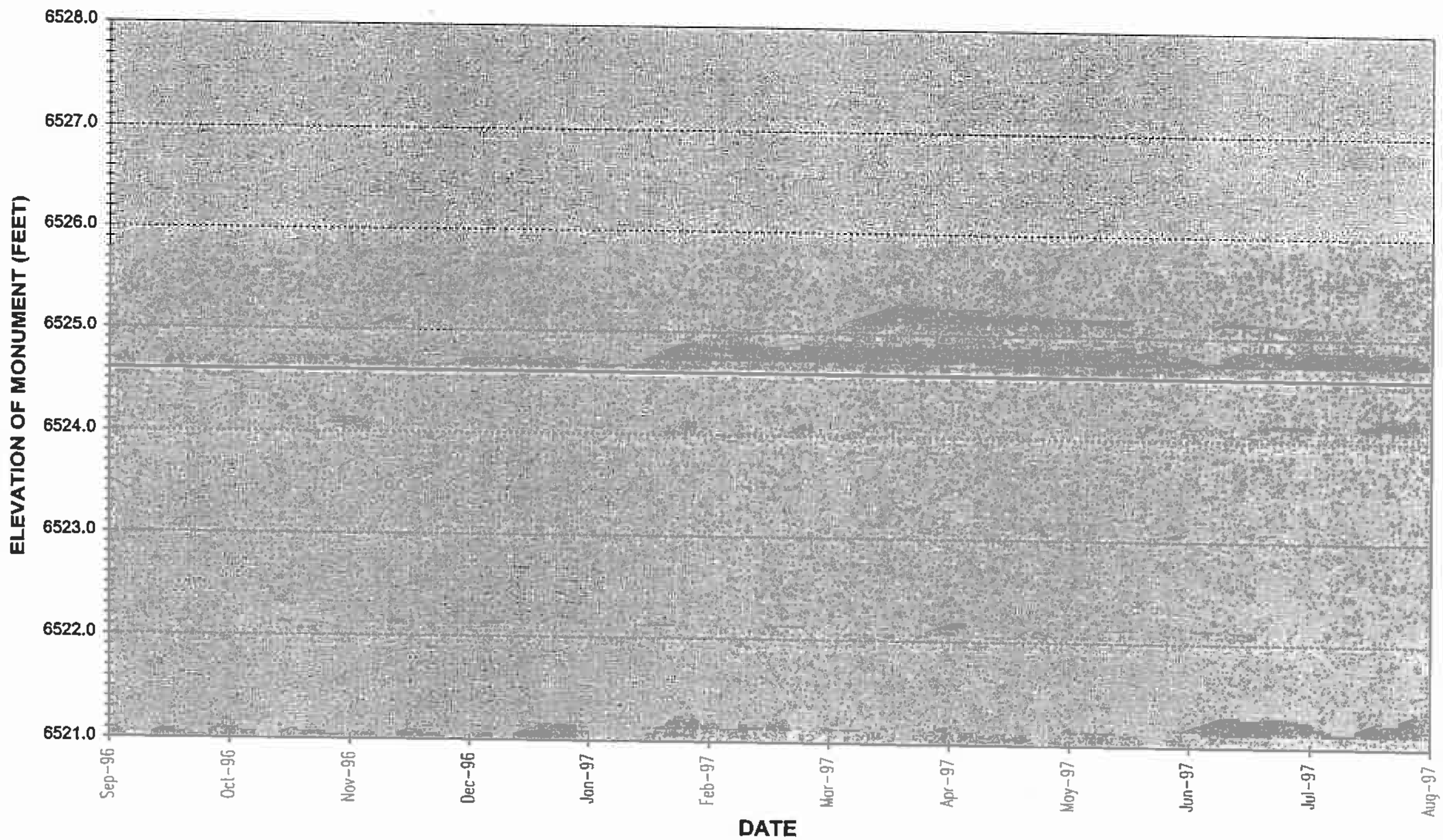
1996-1997 J16-L DAM SETTLEMENT MONUMENT #2

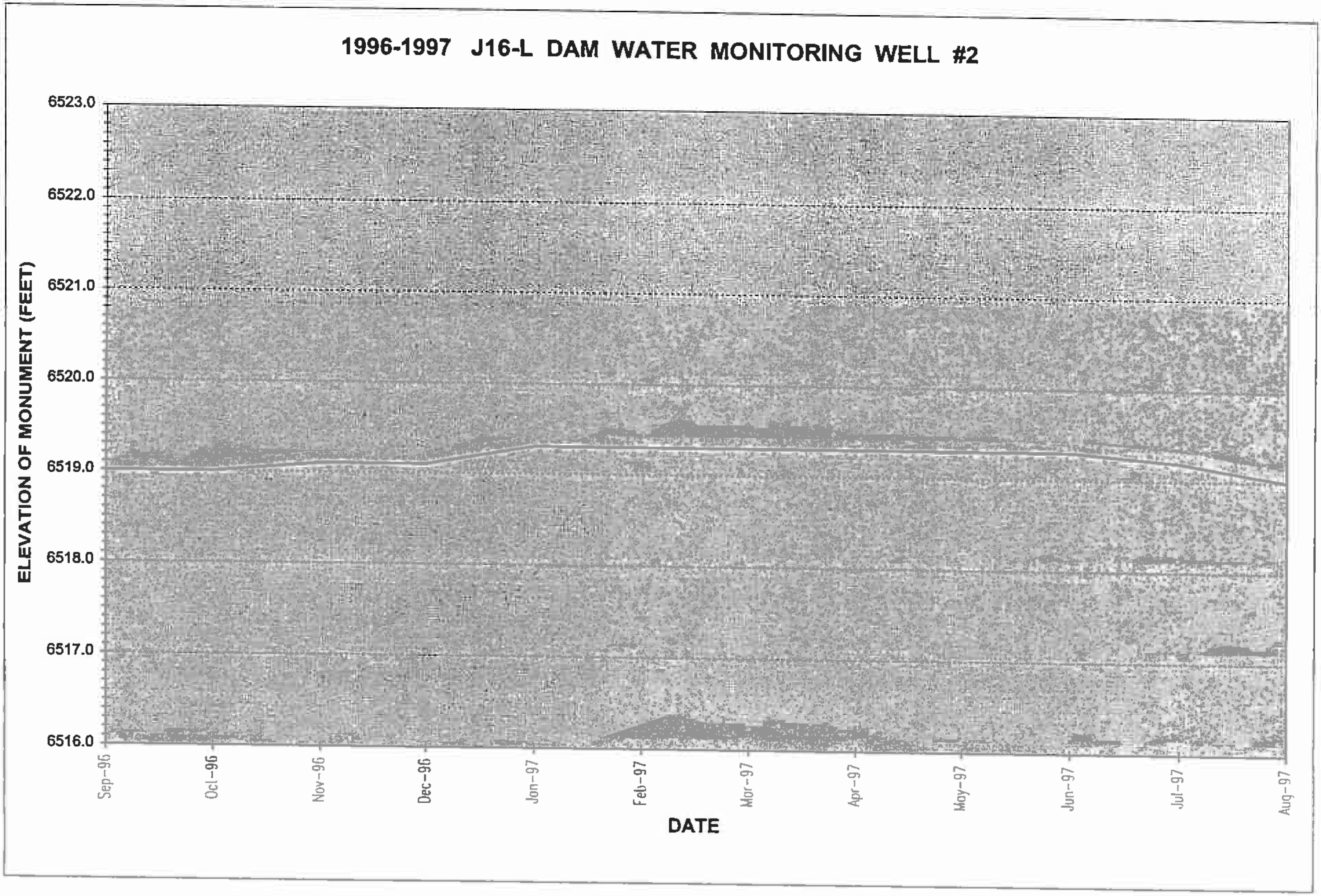


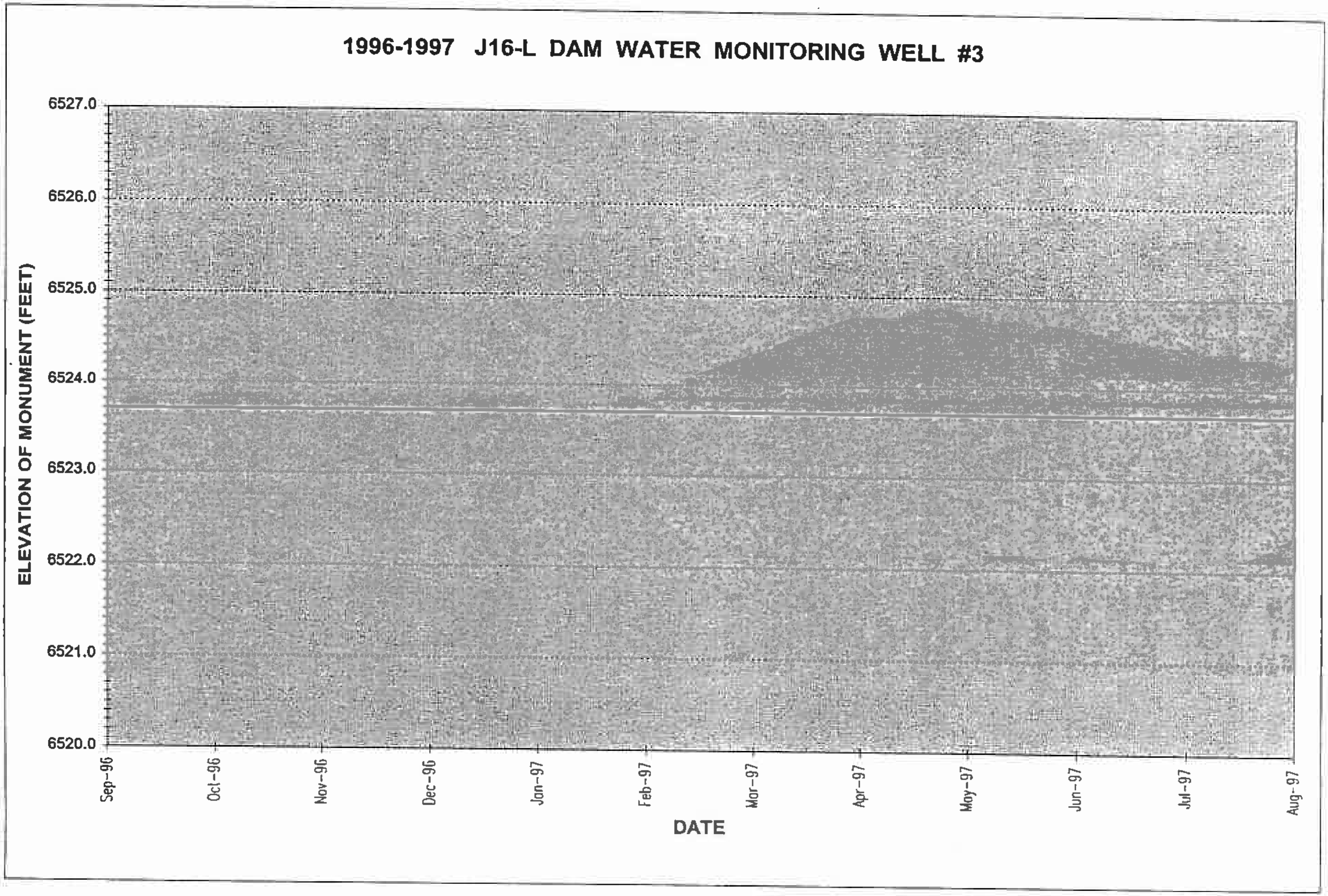


1996-1997 J16-L DAM SETTLEMENT MONUMENT #3
ELEVATION OF MONUMENT (FEET)
6578.65
6578.60
6578.55
6578.50
6578.45
6578.40
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Aug-97
DATE

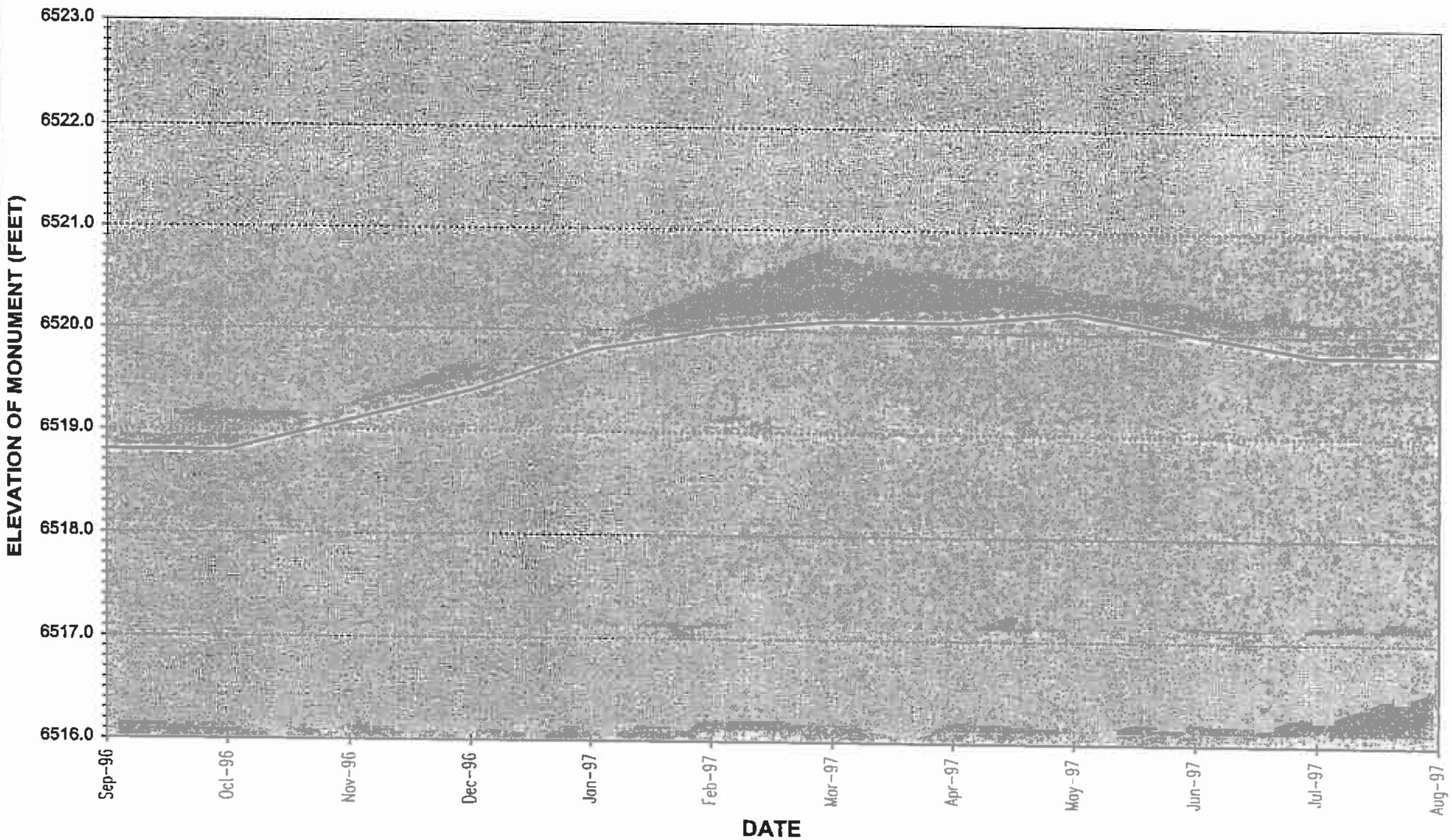
1996-1997 J16-L DAM WATER MONITORING WELL #1



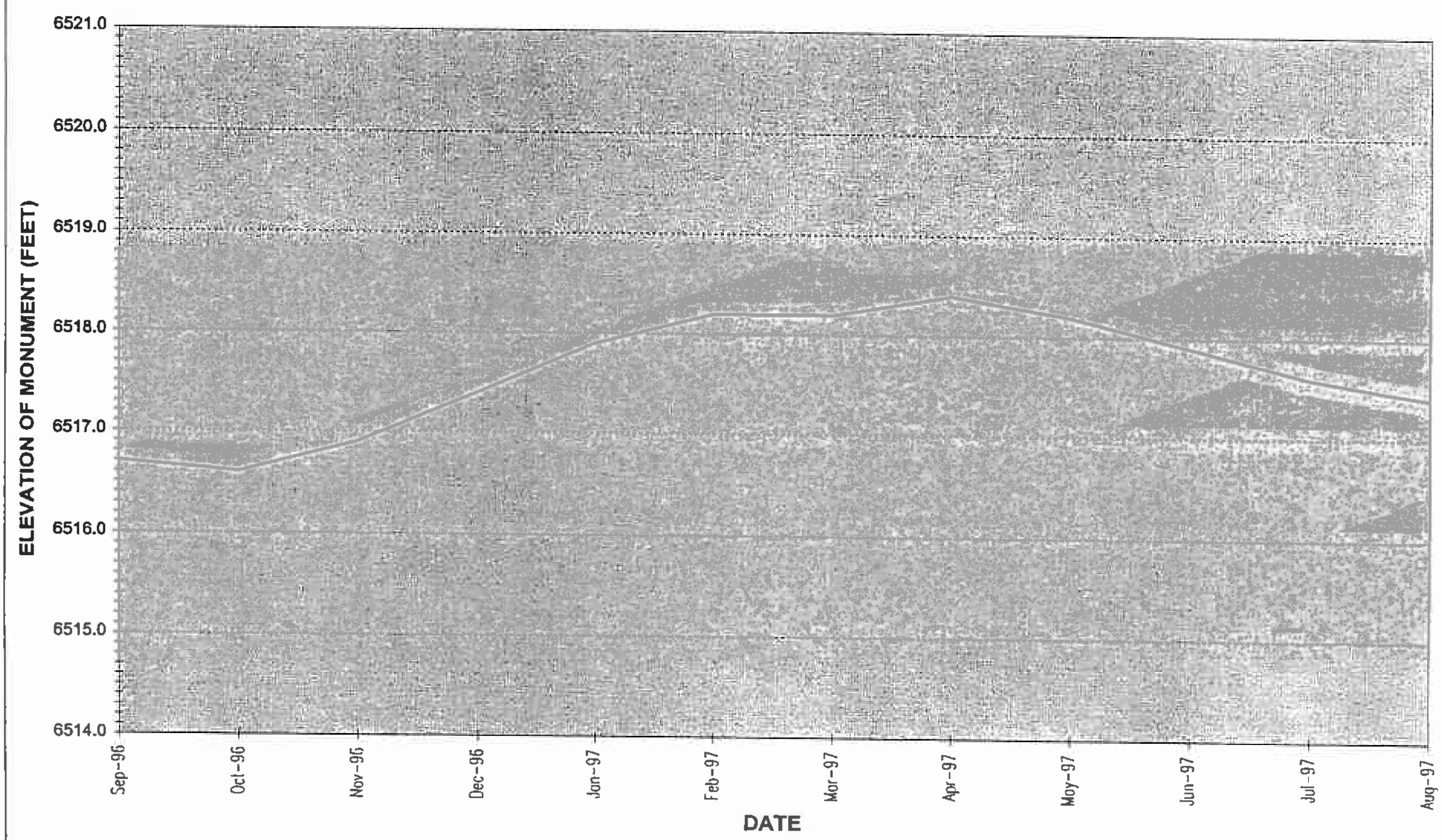

1996-1997 J16-L DAM WATER MONITORING WELL #2
ELEVATION OF MONUMENT (FEET)
6523.0
6522.0
6521.0
6520.0
6519.0
6518.0
6517.0
6516.0
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Aug-97
DATE


1996-1997 J16-L DAM WATER MONITORING WELL #3
ELEVATION OF MONUMENT (FEET)
6527.0
6526.0
6525.0
6524.0
6523.0
6522.0
6521.0
6520.0
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Aug-97
DATE

1996-1997 J16-L DAM WATER MONITORING WELL #4



1996-1997 J16-L DAM WATER MONITORING WELL #5



U. S. Department of Labor

Mine Safety and Health Administration
P.O. Box 25367
Denver, Colorado 80225–0367
Coal Mine Safety and Health
District 9

SEP 22 1998

Buck Woodward
Production Manager
Peabody Western Coal Company
P. O. Box 605
Kayenta, AZ 86033

RE: Black Mesa
Mine ID No. 02-00533
Annual Impoundment Report
Impoundment ID #1211-AZ-09-00533-01
#1211-AZ-09-00533-02

Dear Mr. Woodward:

The annual impoundment reports, dated September 10, 1998, for the above referenced structures, have been reviewed and will be made a part of the mine file.

Sincerely,

John A. Kuzar
District Manager

U. S. Department of Labor

Mine Safety and Health Administration
P.O. Box 25367
Denver, Colorado 80225–0367
Coal Mine Safety and Health
District 9

SEP 22 1998

D. Scott Pearson
Mine Manager
Peabody Western Coal Company
P. O. Box 605
Kayenta, AZ 86033

RE: Kayenta
Mine ID No. 02-01195
Annual Impoundment Report
Impoundment ID #1211-AZ-09-01195-01
#1211-AZ-09-01195-02
#1211-AZ-09-01195-03
#1211-AZ-09-01195-04
#1211-AZ-09-01195-05
#1211-AZ-09-01195-06
#1211-AZ-09-01195-07
#1211-AZ-09-01195-08

Dear Mr. Pearson:

The annual impoundment reports, dated September 10, 1998, for the above referenced structures, have been reviewed and will be made a part of the mine file.

Sincerely,

John A. Kuzar
District Manager

Peabody Western Coal Company

September 10, 1998

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Peabody Western Coal Company's Kayenta and Black Mesa Mines Annual M.S.H.A. Dam Inspection Report.

Dear Sir:

Pursuant to the 30 CFR 77.261-4 regulations are the certified annual M.S.H.A. Dam Inspection Reports for the following dams:

Black Mesa Mine

J-7 Dam	ID No. 1211-AZ-09-00533-01
J2-A Wild Ram Valley Dam	ID No. 1211-AZ-09-00533-02

Kayenta Mine

Kayenta Fresh Water Pond	ID No. 1211-AZ-09-01195-01
N14-D Dam	ID No. 1211-AZ-09-01195-02
N14-E Dam	ID No. 1211-AZ-09-01195-03
N14-F Dam	ID No. 1211-AZ-09-01195-04
N14-G Dam	ID No. 1211-AZ-09-01195-05
N14-H Dam	ID No. 1211-AZ-09-01195-06
J16-A Dam	ID No. 1211-AZ-09-01195-07
J16-L Dam	ID No. 1211-AZ-09-01195-08

Should you have any questions, do not hesitate to contact me.

Sincerely,

James Schlenvogt

James G. Schlenvogt, P.E.
Compliance Engineering
Manager

Js

C: Bill Bippus
Brian Dunfee
Scott Williams

PEABODY WESTERN COAL COMPANY
P.O. Box 605
Kayenta, Arizona 86033
Telephone (520) 677-3201

September 10, 1998

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-00533-01
Other: J-7 Dam
Mine: Black Mesa Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1997 to August 31, 1998 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6359.9
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6368.5
8. Other	

All work at the above site during the period September 1, 1997 to August 31, 1998 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) Certificate No. 18792 James Gary Schlenvogt Arizona, U.S.A.

SEP 10 1998

James G. Schlenvogt, P.E.
Peabody Western Coal Company

PEABODY WESTERN COAL COMPANY
P.O. Box 605
Kayenta, Arizona 86033
Telephone (520) 677-3201

September 10, 1998

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-00533-02
Other: J2-A Wild Ram Valley Dam
Mine: Black Mesa Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1997 to August 31, 1998 is submitted:

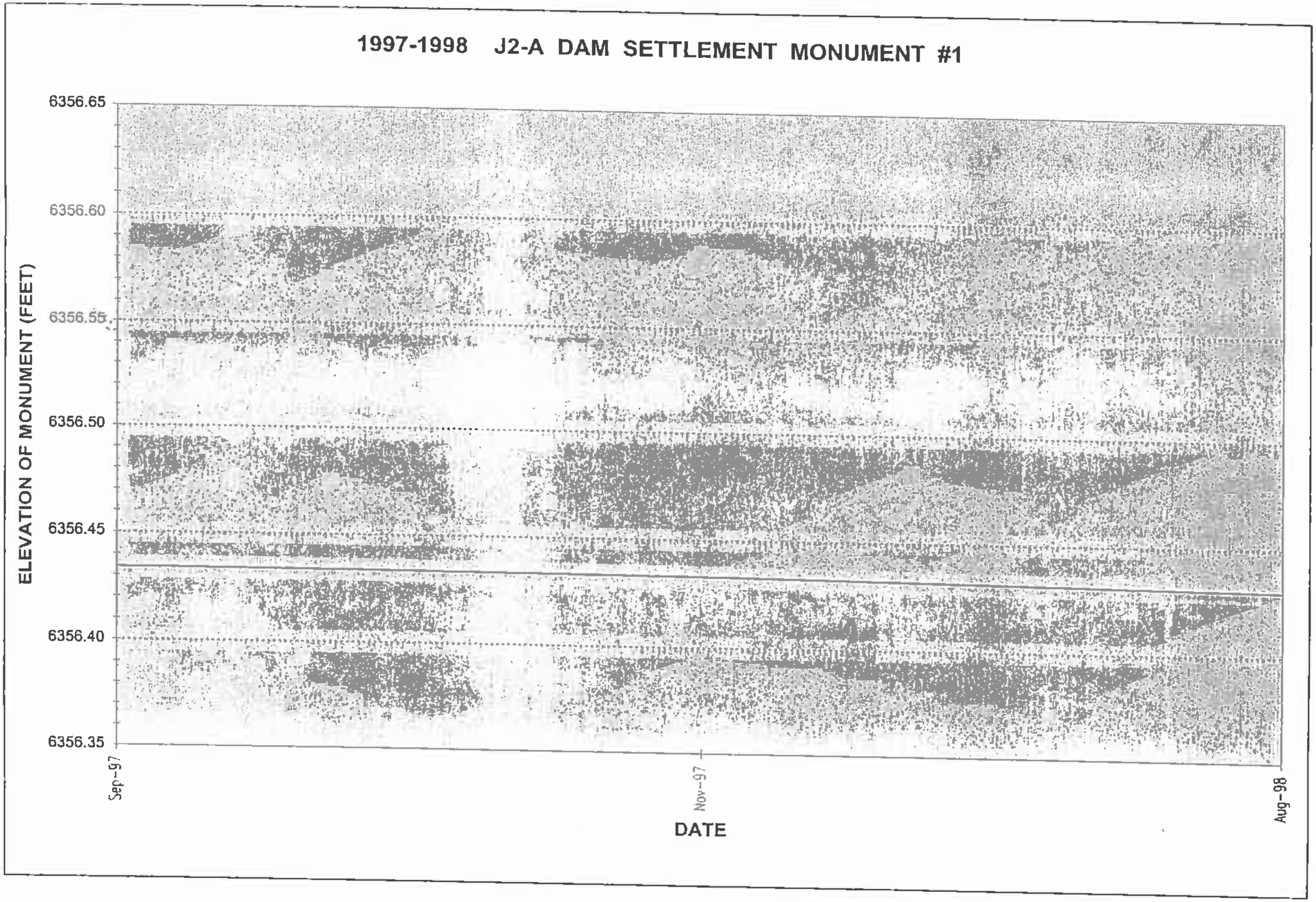
	STATUS
1. Geometry	No Change
2. Instrumentation	See Attachments
3. Current Water Elevation	6326.1
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6348.2
8. Other	

All work at the above site during the period September 1, 1997 to August 31, 1998 was performed in accordance with the approved plan to the best of my knowledge and belief.

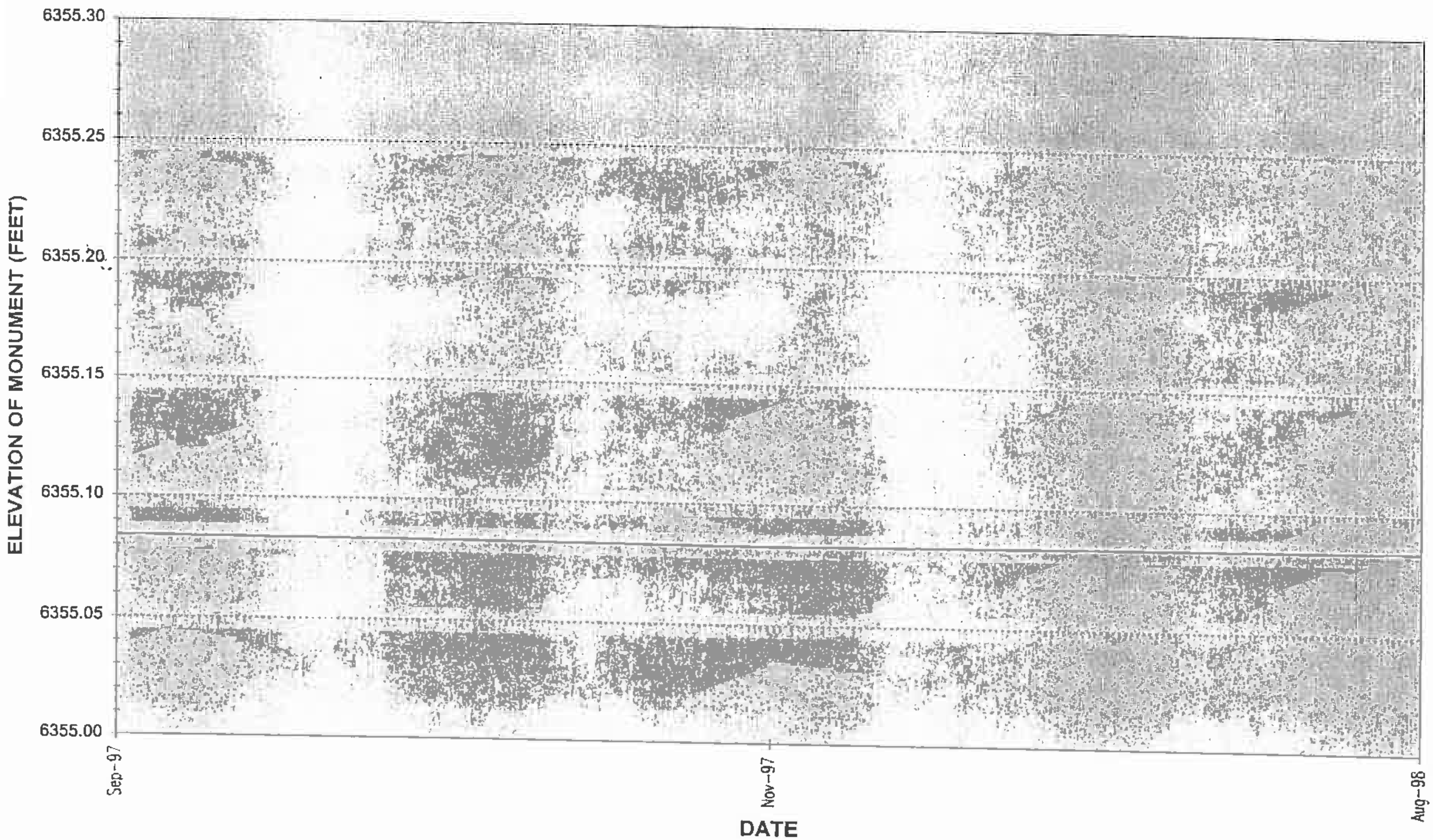
Registered Professional Engineer (Civil) Certificate No. 18782 James Gary Schlenvogt, Arizona, U.S.A.

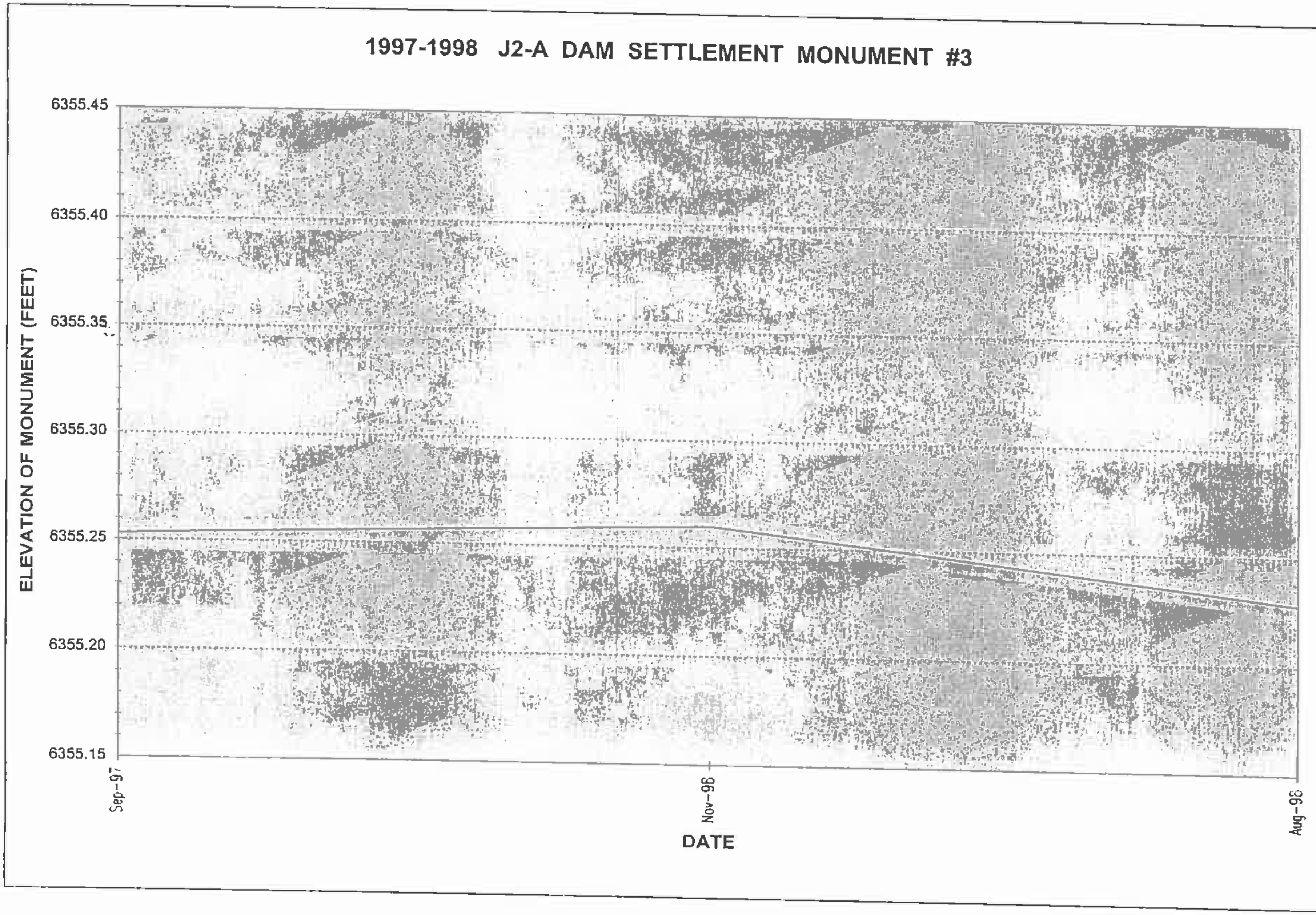
James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 10 1998


1997-1998 J2-A DAM SETTLEMENT MONUMENT #1
ELEVATION OF MONUMENT (FEET)
6356.65
6356.60
6356.55
6356.50
6356.45
6356.40
6356.35
Sep-97
Nov-97
Aug-98
DATE

1997-1998 J2-A DAM SETTLEMENT MONUMENT #2




1997-1998 J2-A DAM SETTLEMENT MONUMENT #3
ELEVATION OF MONUMENT (FEET)
6355.45
6355.40
6355.35
6355.30
6355.25
6355.20
6355.15
Sep-97
Nov-98
Aug-98
DATE

PEABODY WESTERN COAL COMPANY
P.O. Box 605
Kayenta, Arizona 86033
Telephone (520) 677-3201

September 10, 1998

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-01
Other: Kayenta Fresh Water Pond
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1997 to August 31, 1998 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6615.3
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6615.8
8. Other	

All work at the above site during the period September 1, 1997 to August 31, 1998 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) Certificate No. 18782 JAMES GARY SCHLENOGT Dated ...... ARIZONA, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 10 1998

PEABODY WESTERN COAL COMPANY
P.O. Box 605
Kayenta, Arizona 86033
Telephone (520) 677-3201

September 10, 1998

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-02
Other: N14-D Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1997 to August 31, 1998 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6621.7
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6653.1
8. Other	

All work at the above site during the period September 1, 1997 to August 31, 1998 was performed in accordance with the approved plan to the best of my knowledge and belief.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 10 1998

PEABODY WESTERN COAL COMPANY
P.O. Box 605
Kayenta, Arizona 86033
Telephone (520) 677-3201

September 10, 1998

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-03
Other: N14-E Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1997 to August 31, 1998 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	Dry
4. Storage Capacity	No Change
5. Water Volume	Dry
6. Stability	No Change
7. Spillway Elevation	6686.0
8. Other	

All work at the above site during the period September 1, 1997 to August 31, 1998 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil)
Certificate No. 18782
JAMES GARY SCHLENVOGT
Signed ......
ARIZONA, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 10 1998

Peabody Western Coal Company · P.O. Box 605 · Kayenta, Arizona 86033 · Telephone (520) 677-3201 · Fax (520) 677-5083

PEABODY WESTERN COAL COMPANY
P.O. Box 605
Kayenta, Arizona 86033
Telephone (520) 677-3201

September 10, 1998

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-04
Other: N14-F Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1997 to August 31, 1998 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6641.0
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6658.5
8. Other	

All work at the above site during the period September 1, 1997 to August 31, 1998 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) CERTIFICATE NO. 18782 JAMES GARY SCHLENVOGT ARIZONA, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 10 1998

PEABODY WESTERN COAL COMPANY
P.O. Box 605
Kayenta, Arizona 86033
Telephone (520) 677-3201

September 10, 1998

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-05
Other: N14-G Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1997 to August 31, 1998 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6640.1
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6660.8
8. Other	

All work at the above site during the period September 1, 1997 to August 31, 1998 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) Certificate No. 18782 James Gary Schlenvogt Arizona, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 10 1998

PEABODY WESTERN COAL COMPANY
P.O. Box 605
Kayenta, Arizona 86033
Telephone (520) 677-3201

September 10, 1998

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-06
Other: N14-H Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1997 to August 31, 1998 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	No Change
3. Current Water Elevation	6700.3
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6719.1
8. Other	

All work at the above site during the period September 1, 1997 to August 31, 1998 was performed in accordance with the approved plan to the best of my knowledge and belief.

Registered Professional Engineer (Civil) CERTIFICATE NO. 18782 JAMES GARY SCHLENVOGT ARIZONA, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 10 1998

PEABODY WESTERN COAL COMPANY
P.O. Box 605
Kayenta, Arizona 86033
Telephone (520) 677-3201

September 10, 1998

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-07
Other: J16-A Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1997 to August 31, 1998 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	See Attachments
3. Current Water Elevation	Dry
4. Storage Capacity	No Change
5. Water Volume	Dry
6. Stability	No Change
7. Spillway Elevation	6635.1
8. Other	

All work at the above site during the period September 1, 1997 to August 31, 1998 was performed in accordance with the approved plan to the best of my knowledge and belief.

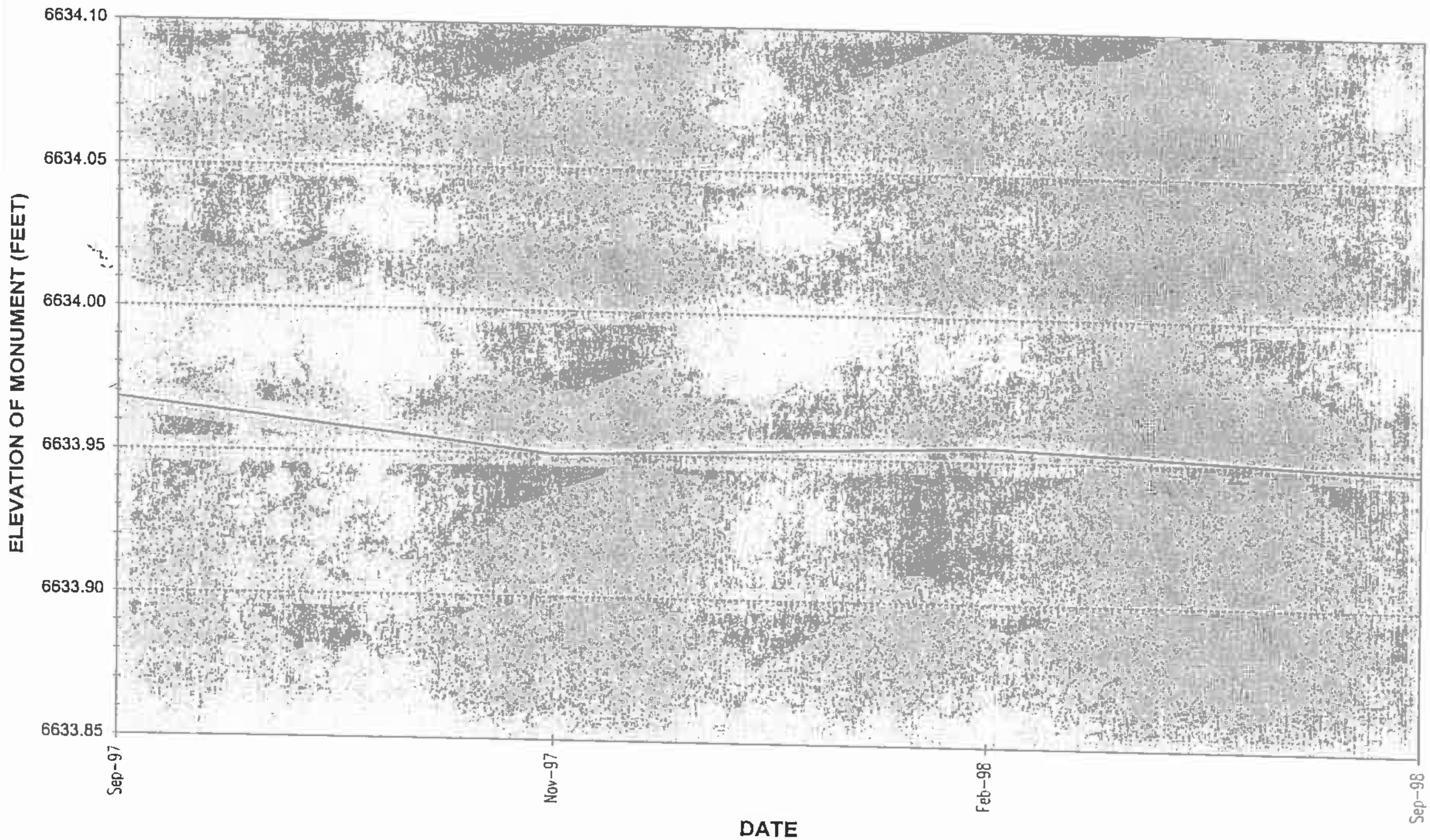
Registered Professional Engineer (Civil) CERTIFICATE NO. 13782 JAMES G. SCHLENVOGT ARIZONA, U.S.A.

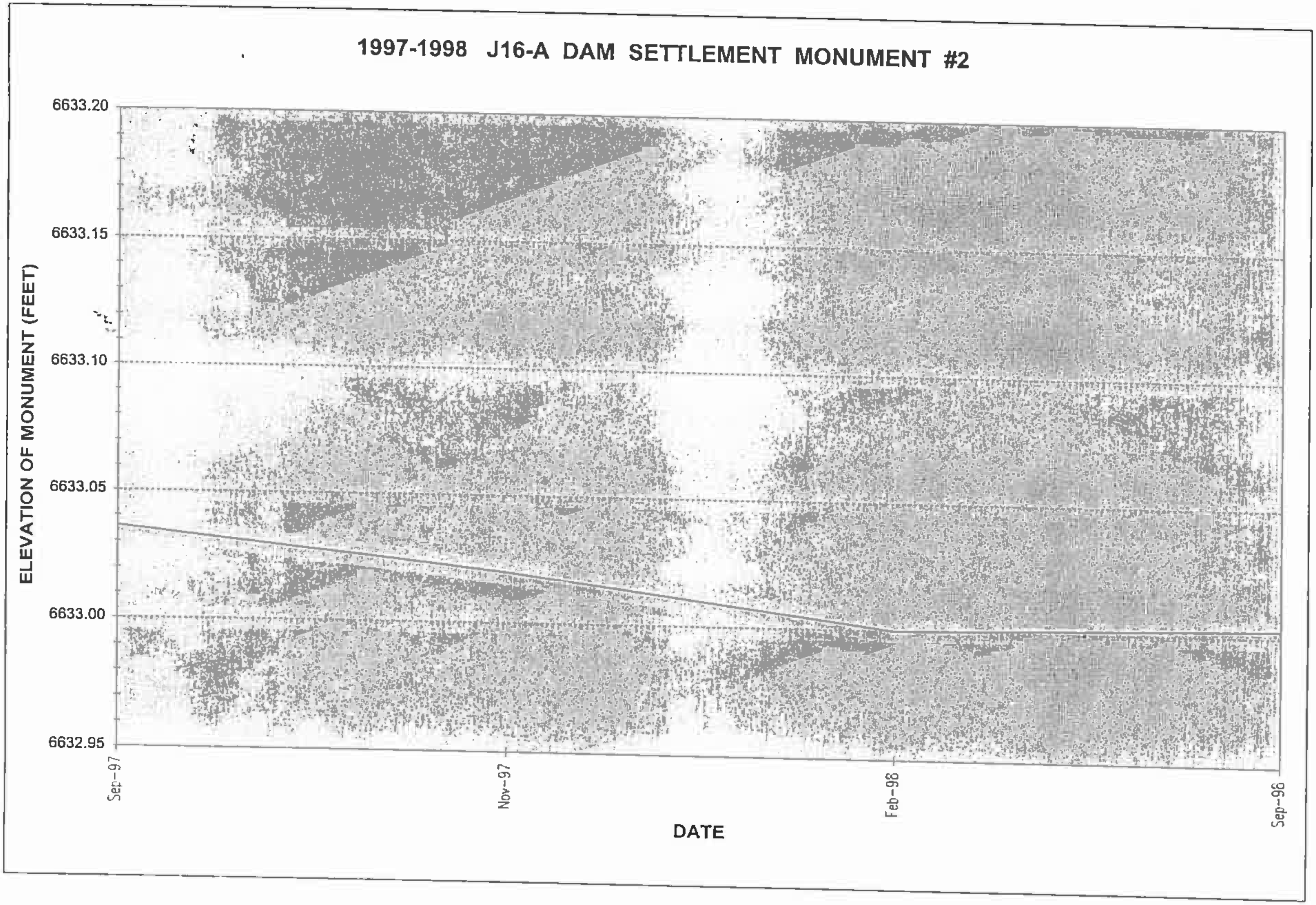
James G. Schlenvogt, P.E.
Peabody Western Coal Company

SEP 10 1998

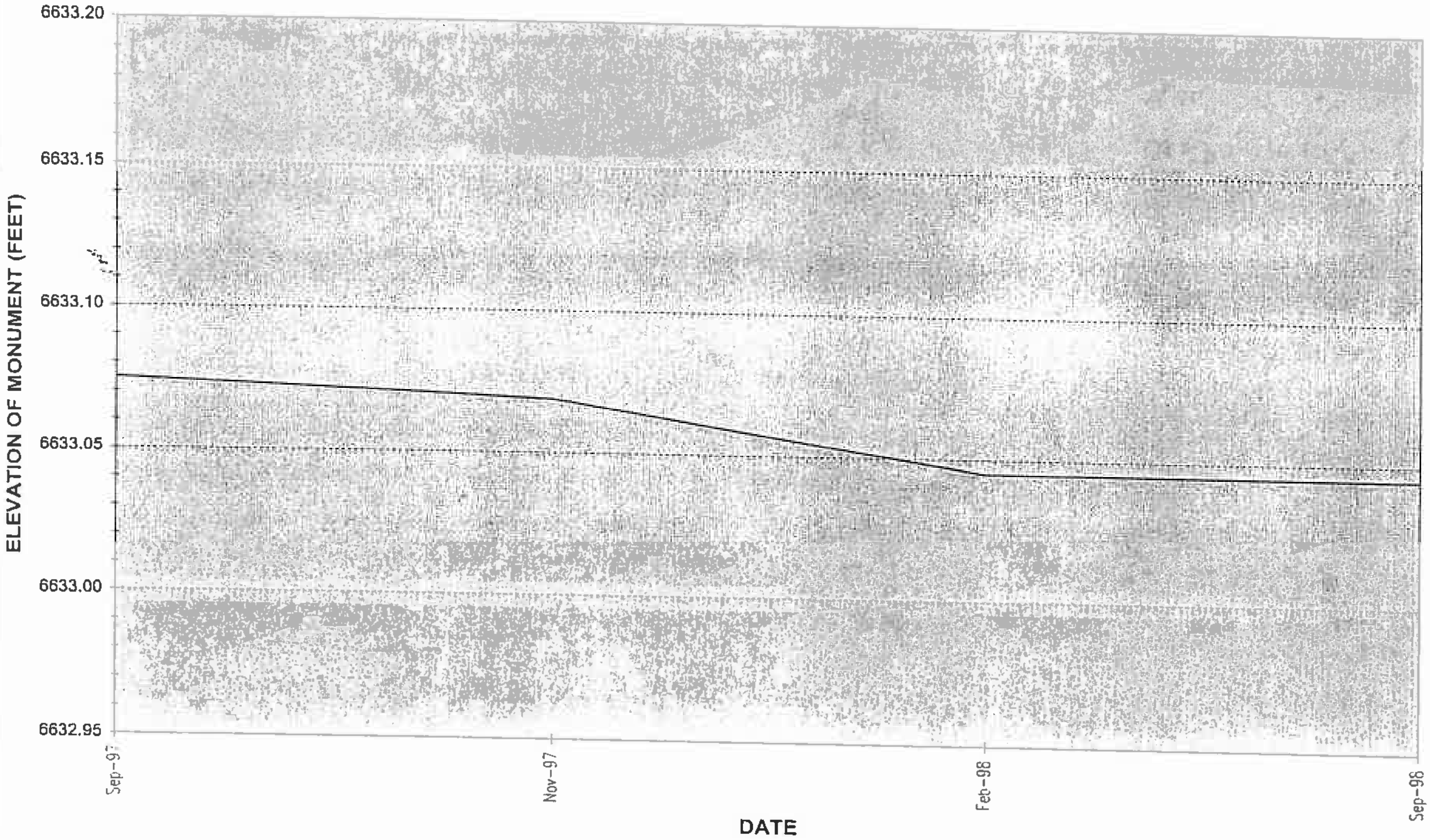
Peabody Western Coal Company · P.O. Box 605 · Kayenta, Arizona 86033 · Telephone (520) 677-3201 · Fax (520) 677-5083

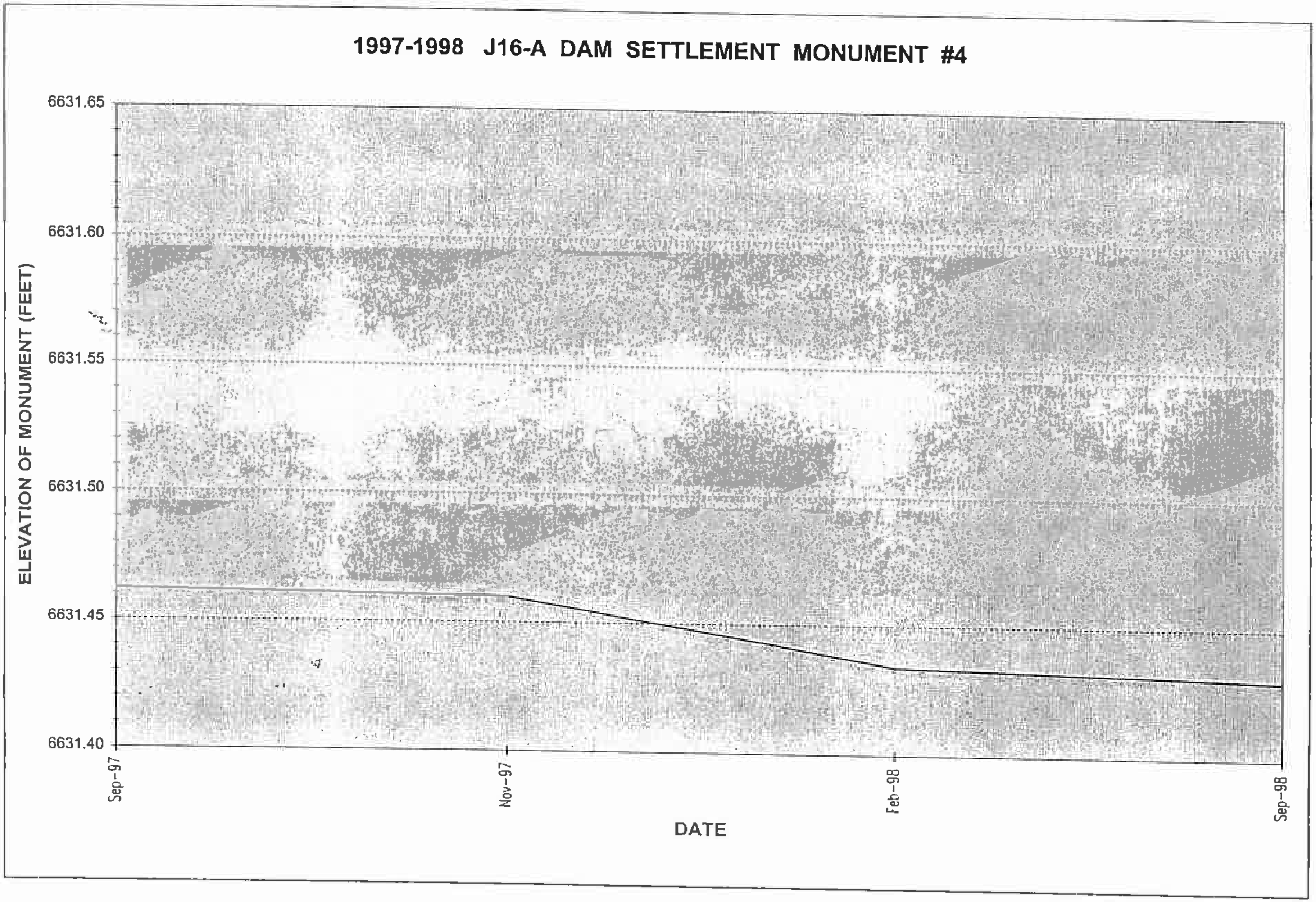
1997-1998 J16-A DAM SETTLEMENT MONUMENT #1




1997-1998 J16-A DAM SETTLEMENT MONUMENT #2
ELEVATION OF MONUMENT (FEET)
6633.20
6633.15
6633.10
6633.05
6633.00
6632.95
Sep-97
Nov-97
Feb-98
Sep-98
DATE

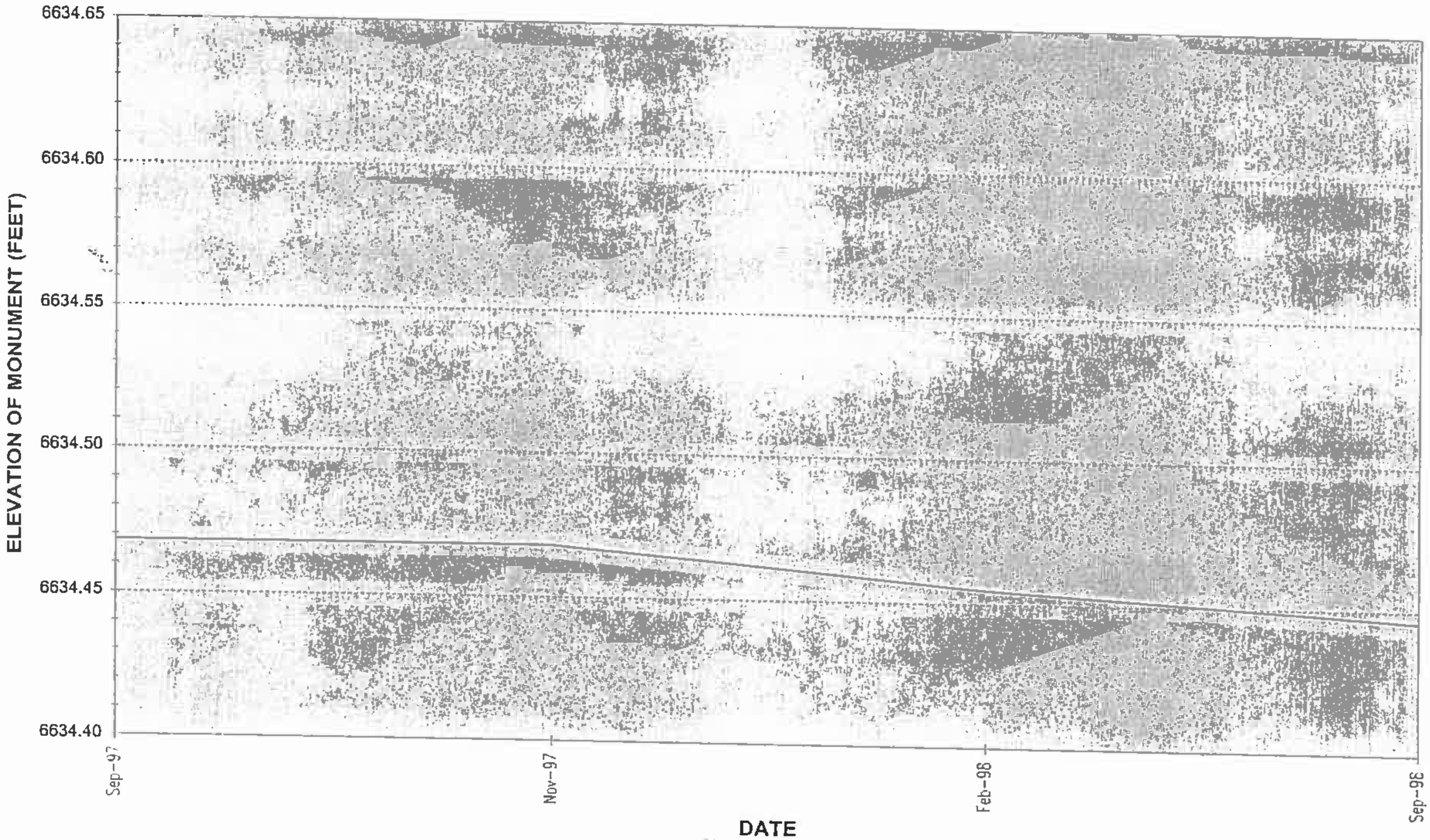
1997-1998 J16-A DAM SETTLEMENT MONUMENT #3

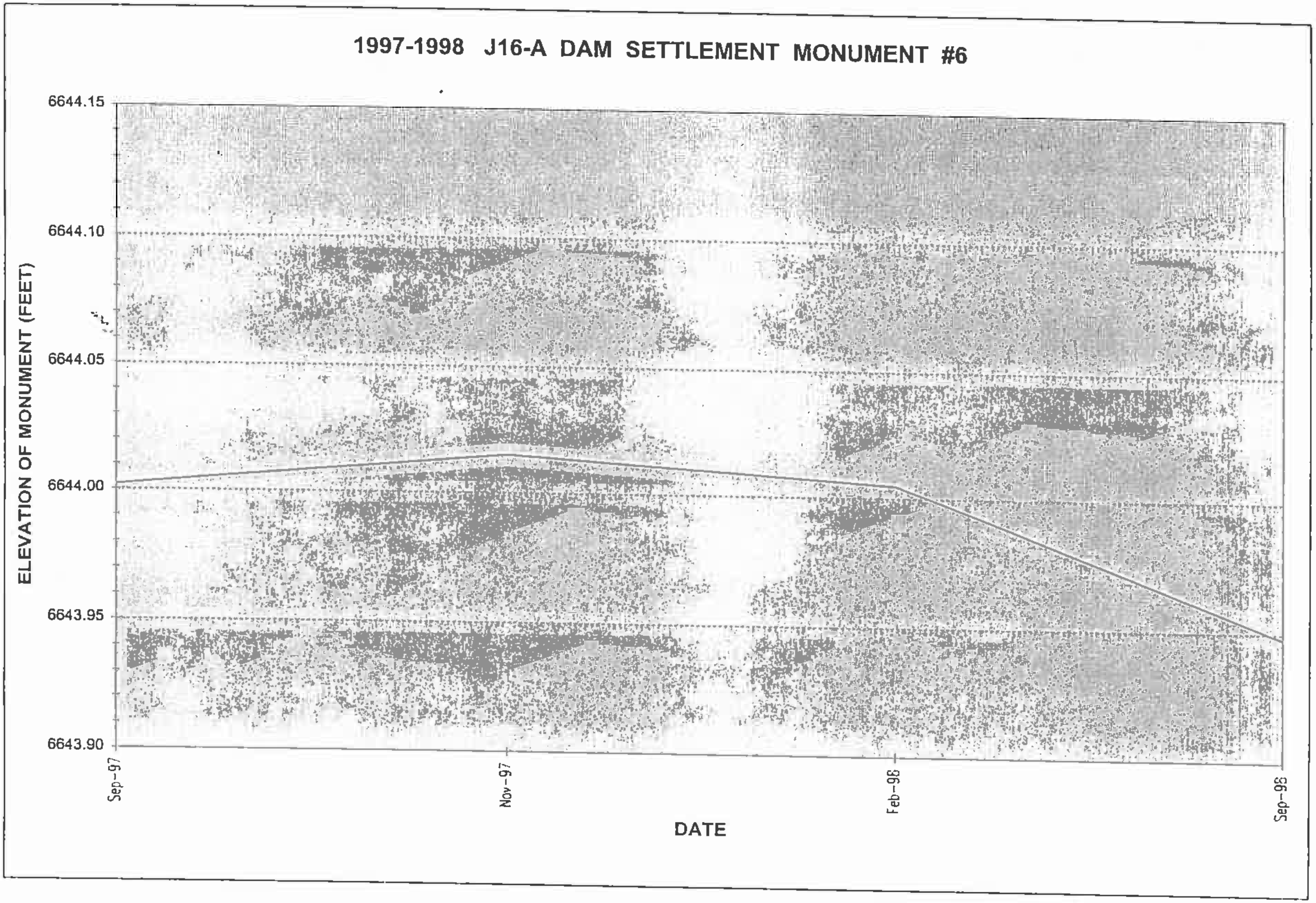




1997-1998 J16-A DAM SETTLEMENT MONUMENT #4
ELEVATION OF MONUMENT (FEET)
6631.65
6631.60
6631.55
6631.50
6631.45
6631.40
Sep-97
Nov-97
Feb-98
Sep-98
DATE

1997-1998 J16-A DAM SETTLEMENT MONUMENT #5




1997-1998 J16-A DAM SETTLEMENT MONUMENT #6
ELEVATION OF MONUMENT (FEET)
6644.15
6644.10
6644.05
6644.00
6643.95
6643.90
Sep-97
Nov-97
Feb-98
Sep-98
DATE

PEABODY WESTERN COAL COMPANY
P.O. Box 605
Kayenta, Arizona 86033
Telephone (520) 677-3201

September 10, 1998

District Manager
Mine Safety and Health Administration
Post Office Box 25367, DFC
Denver, Colorado 80225

RE: Annual Report per 30 CFR 77.216-4
ID No: 11211-AZ-09-01195-08
Other: J16-L Dam
Mine: Kayenta Mine

Gentlemen:

In accordance with 30 CFR 77.261-4, the following status report at the above site during the period September 1, 1997 to August 31, 1998 is submitted:

	STATUS
1. Geometry	No Change
2. Instrumentation	See Attachments
3. Current Water Elevation	6557.3
4. Storage Capacity	No Change
5. Water Volume	Increase per water elevation
6. Stability	No Change
7. Spillway Elevation	6573.4
8. Other	

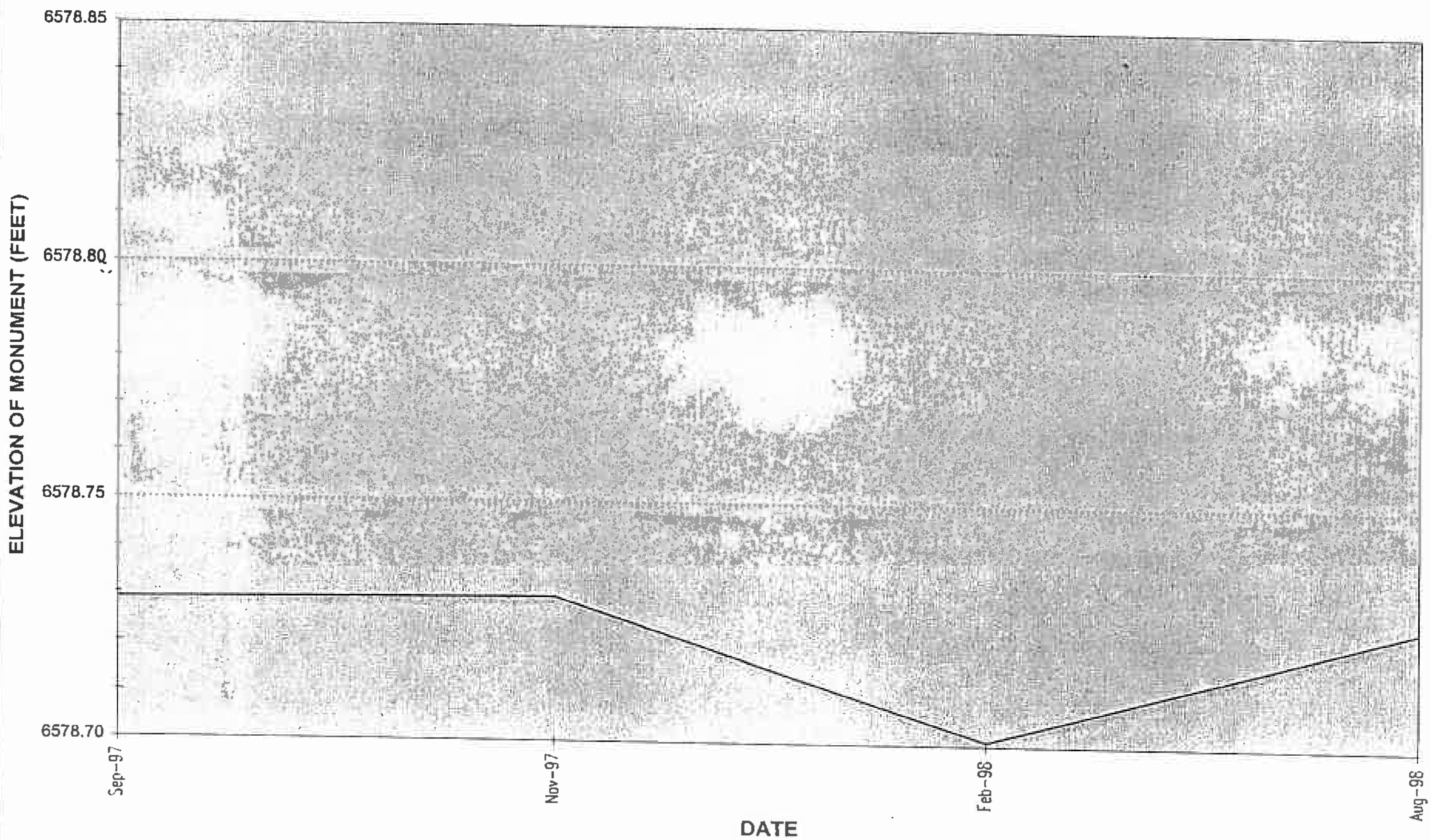
All work at the above site during the period September 1, 1997 to August 31, 1998 was performed in accordance with the approved plan to the best of my knowledge and belief.

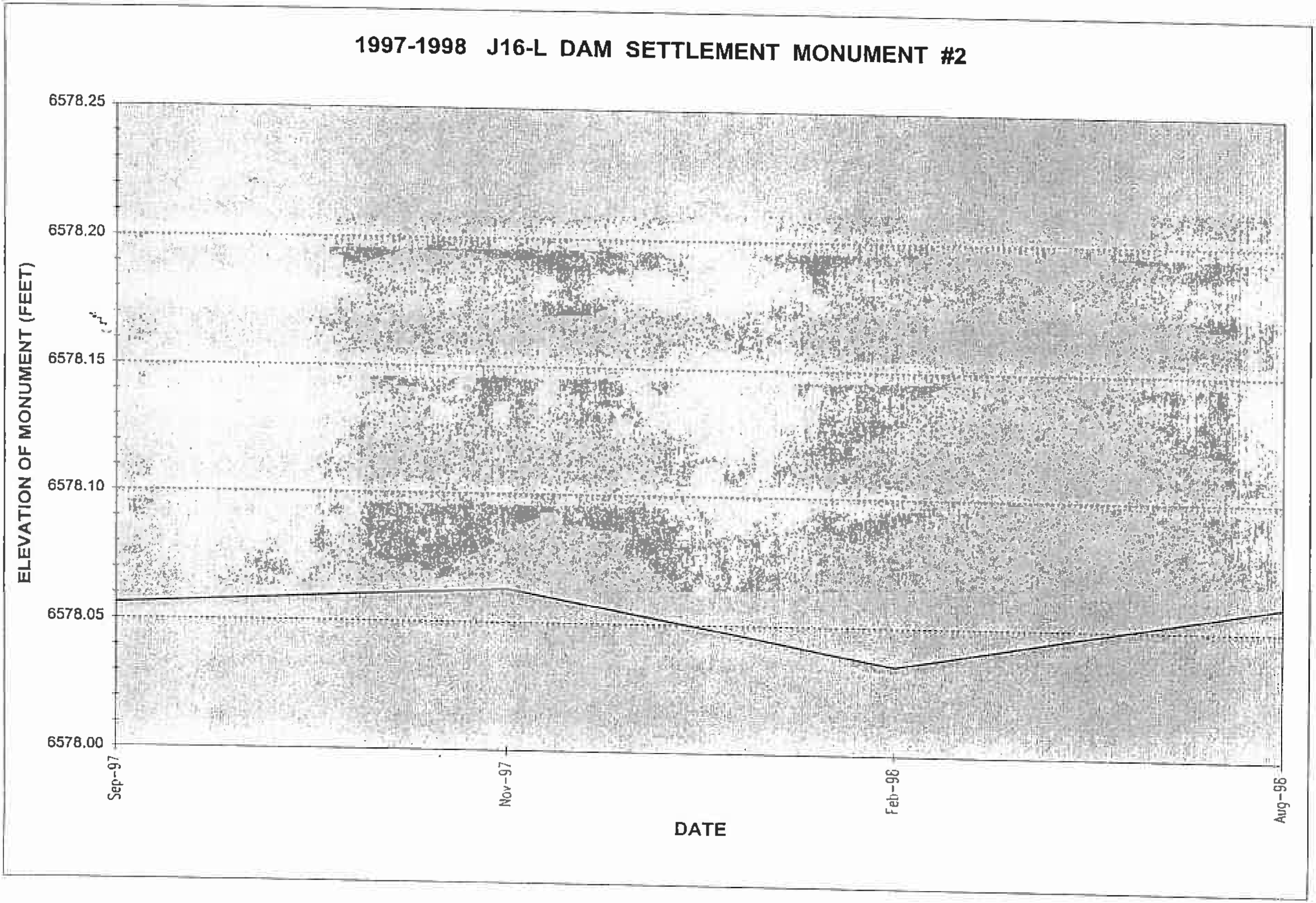
Registered Professional Engineer (Civil) Certificate No. 18782 James Gary Schlenvogt Arizona, U.S.A.

James G. Schlenvogt, P.E.
Peabody Western Coal Company

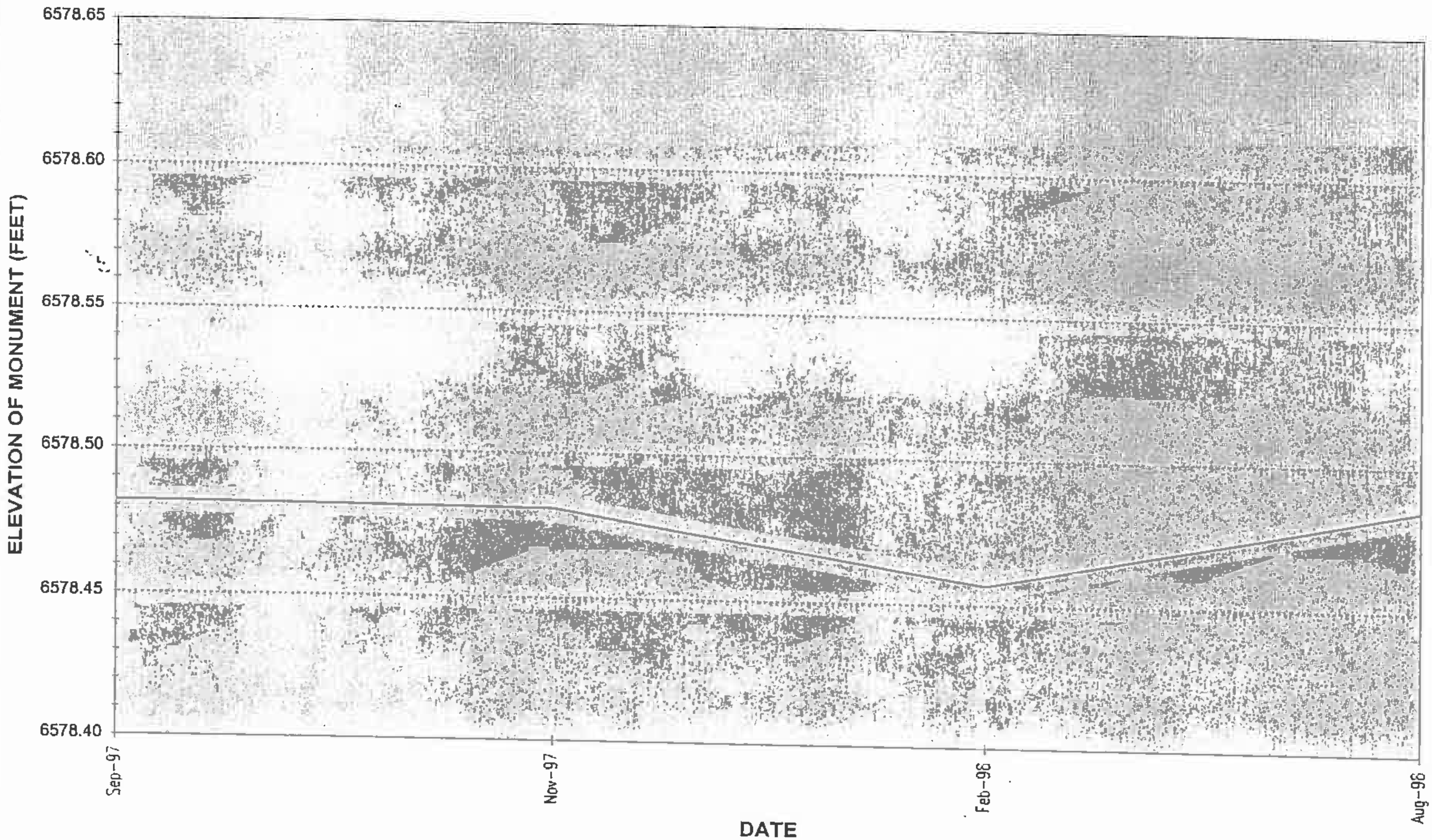
SEP 10 1998

1997-1998 J16-L DAM SETTLEMENT MONUMENT #1

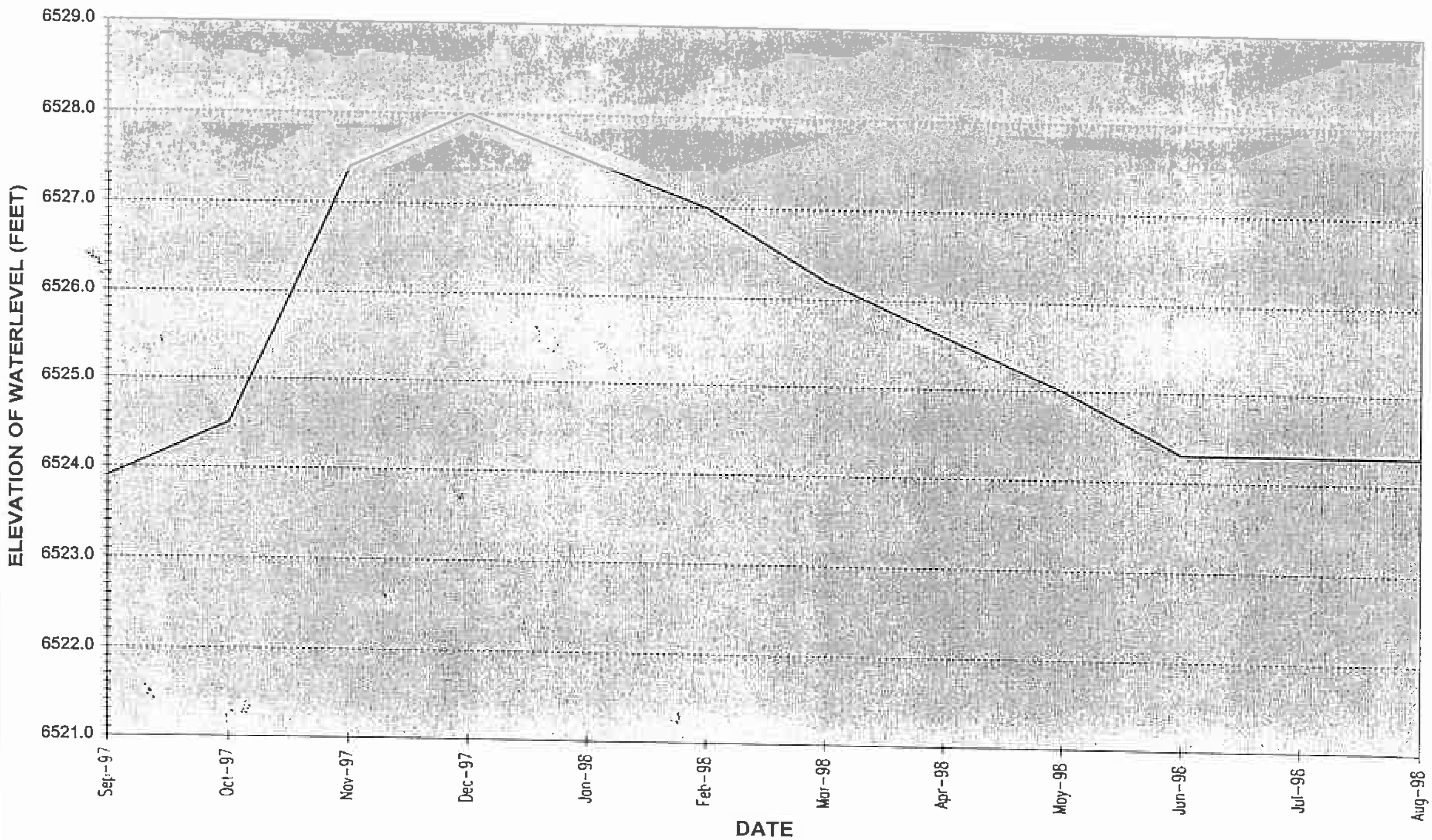



1997-1998 J16-L DAM SETTLEMENT MONUMENT #2
ELEVATION OF MONUMENT (FEET)
6578.25
6578.20
6578.15
6578.10
6578.05
6578.00
Sep-97
Nov-97
Feb-98
Aug-98
DATE

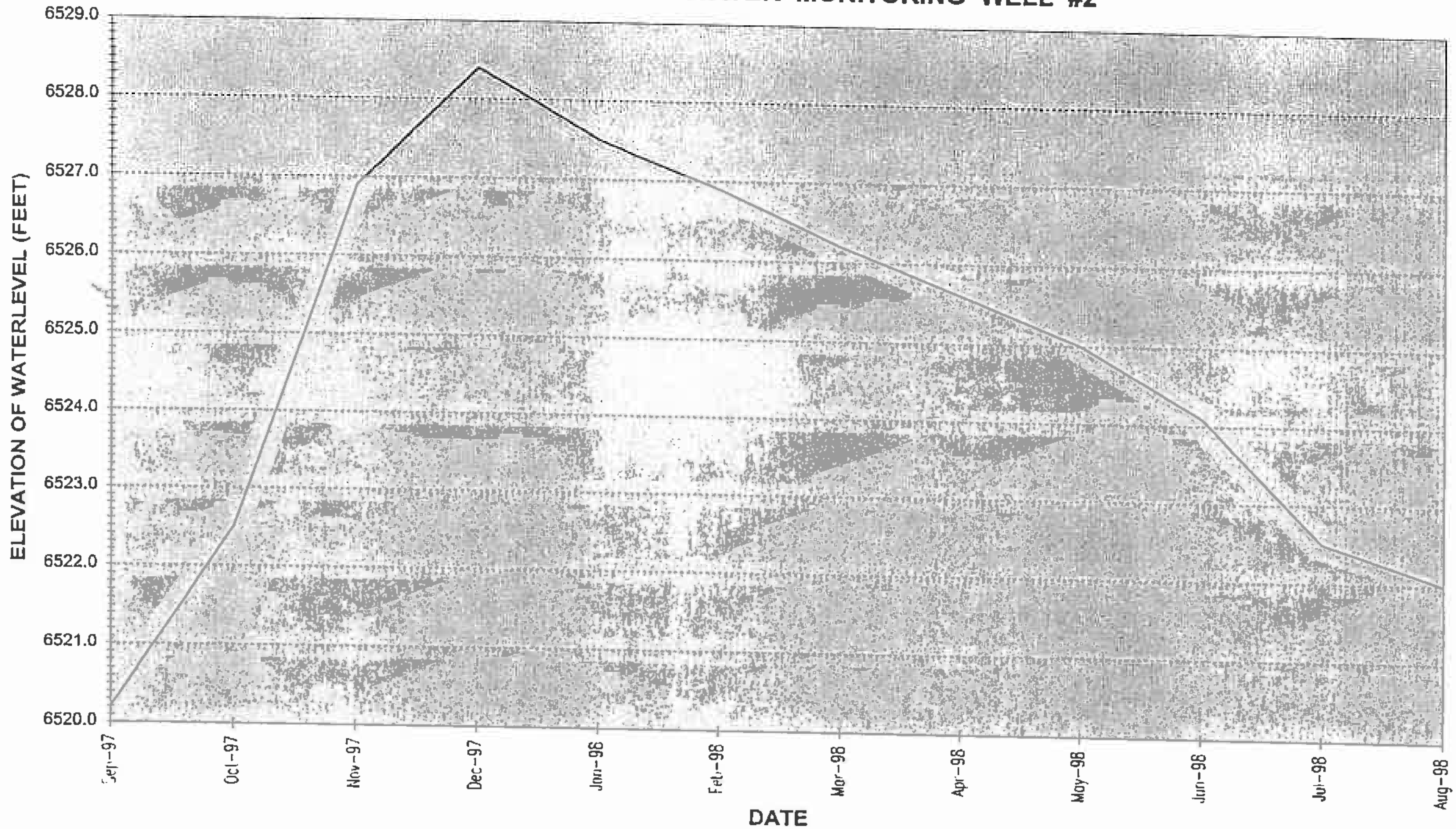
1997-1998 J16-L DAM SETTLEMENT MONUMENT #3

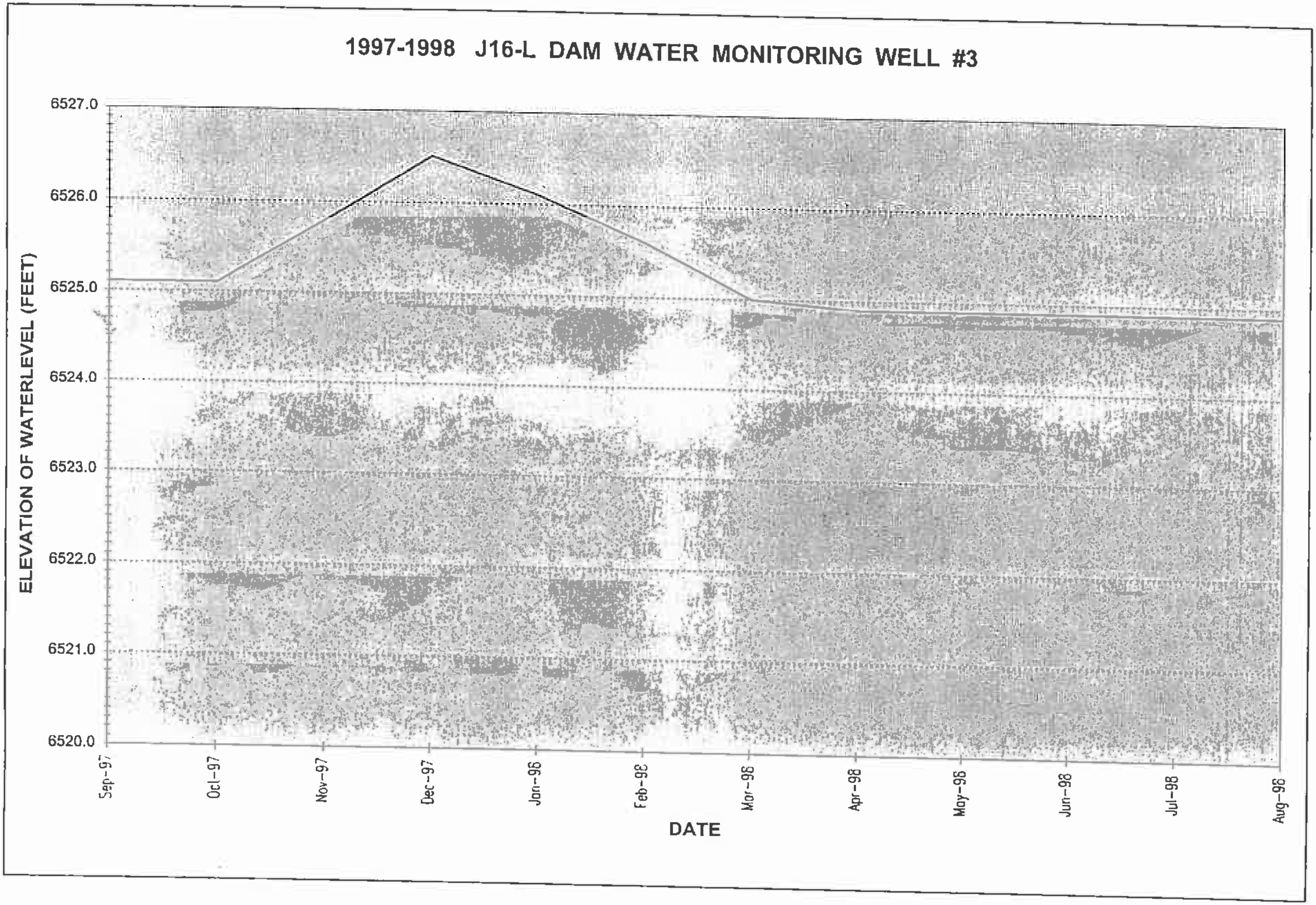


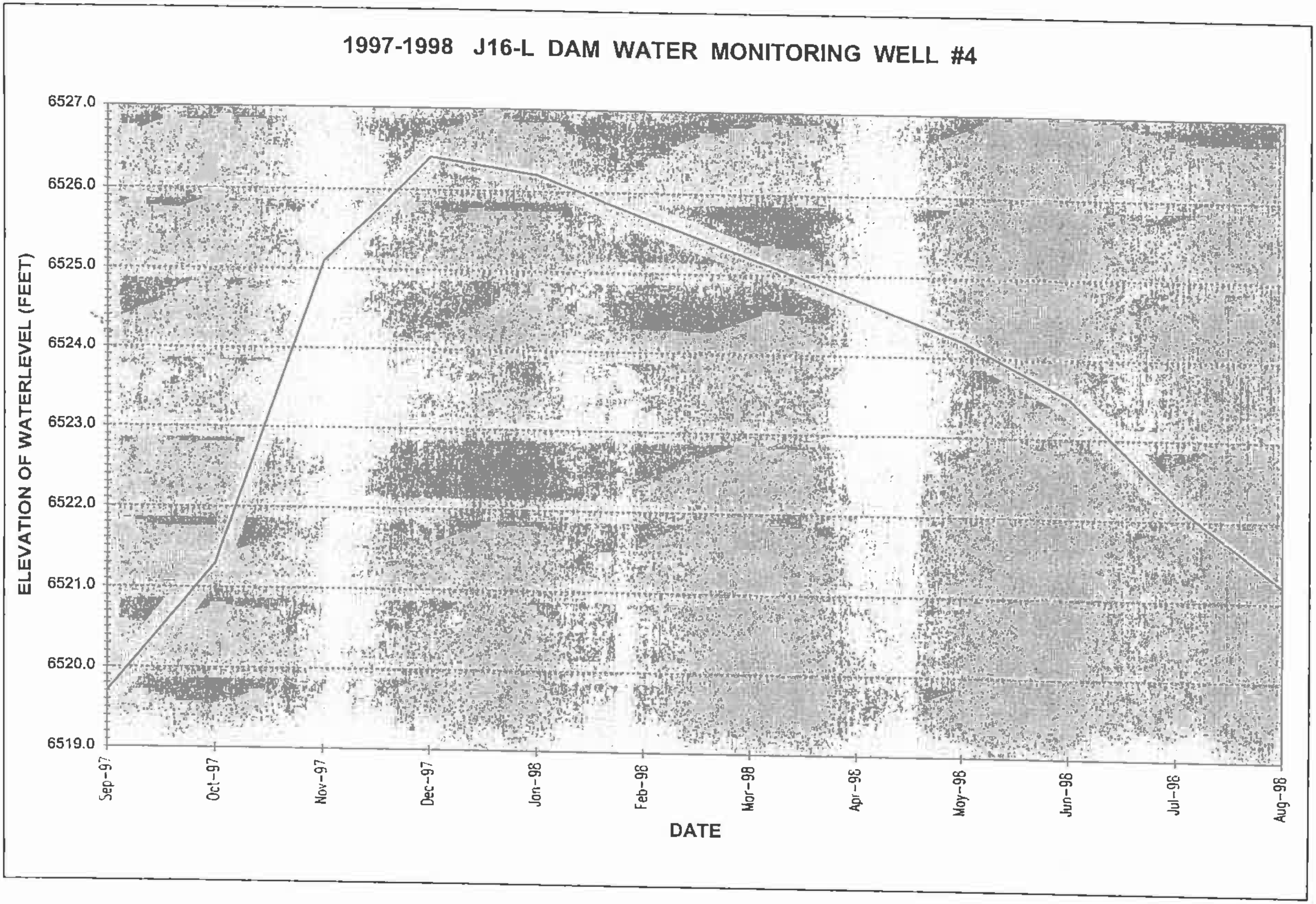
1997-1998 J16-L DAM WATER MONITORING WELL #1



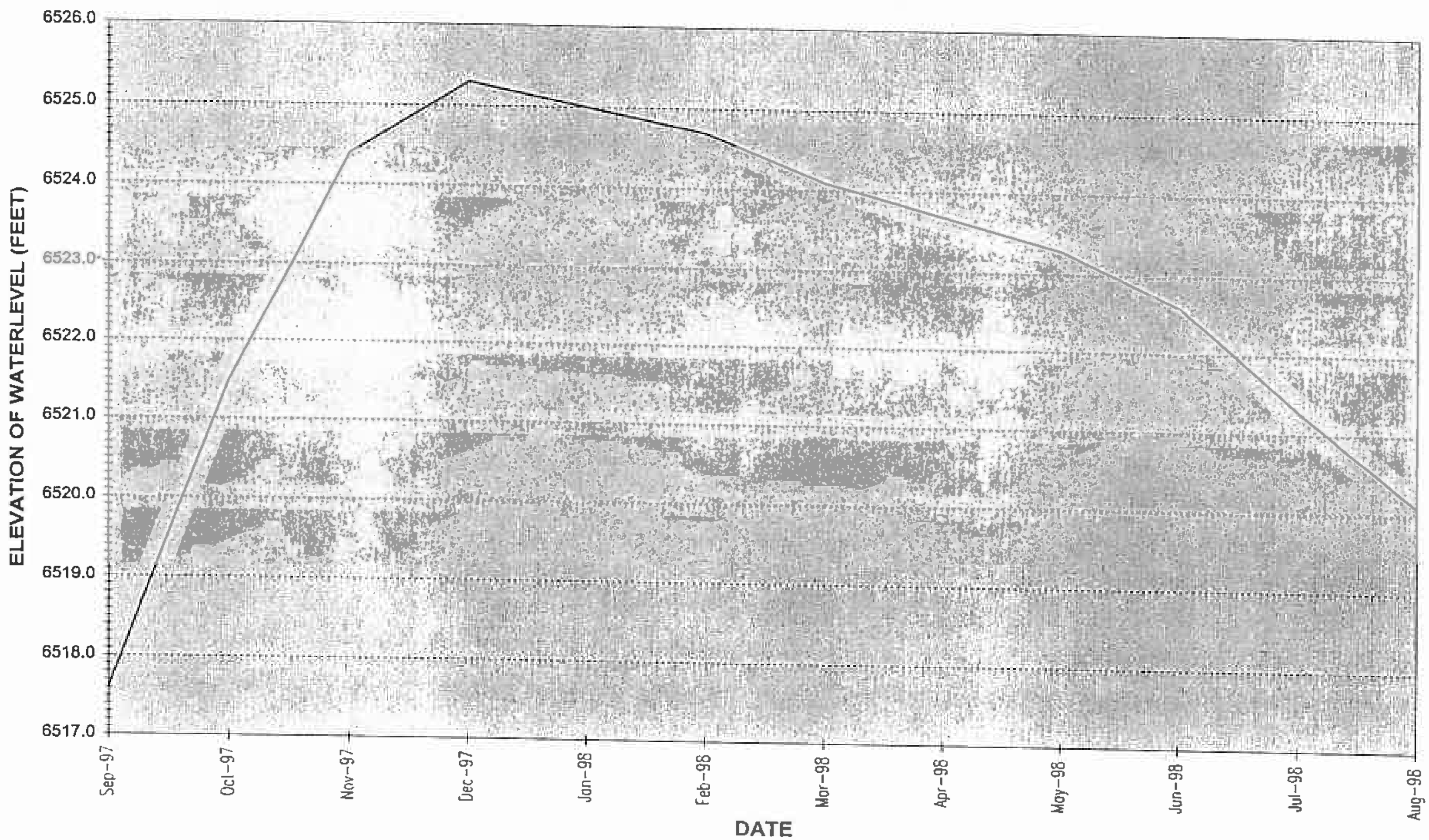
1997-1998 J16-L DAM WATER MONITORING WELL #2




1997-1998 J16-L DAM WATER MONITORING WELL #3
6527.0
6526.0
6525.0
6524.0
6523.0
6522.0
6521.0
6520.0
ELEVATION OF WATERLEVEL (FEET)
Sep-97
Oct-97
Nov-97
Dec-97
Jan-98
Feb-98
Mar-98
Apr-98
May-98
Jun-98
Jul-98
Aug-98
DATE


1997-1998 J16-L DAM WATER MONITORING WELL #4
ELEVATION OF WATERLEVEL (FEET)
6527.0
6526.0
6525.0
6524.0
6523.0
6522.0
6521.0
6520.0
6519.0
Sep-97
Oct-97
Nov-97
Dec-97
Jan-98
Feb-98
Mar-98
Apr-98
May-98
Jun-98
Jul-98
Aug-98
DATE

1997-1998 J16-L DAM WATER MONITORING WELL #5

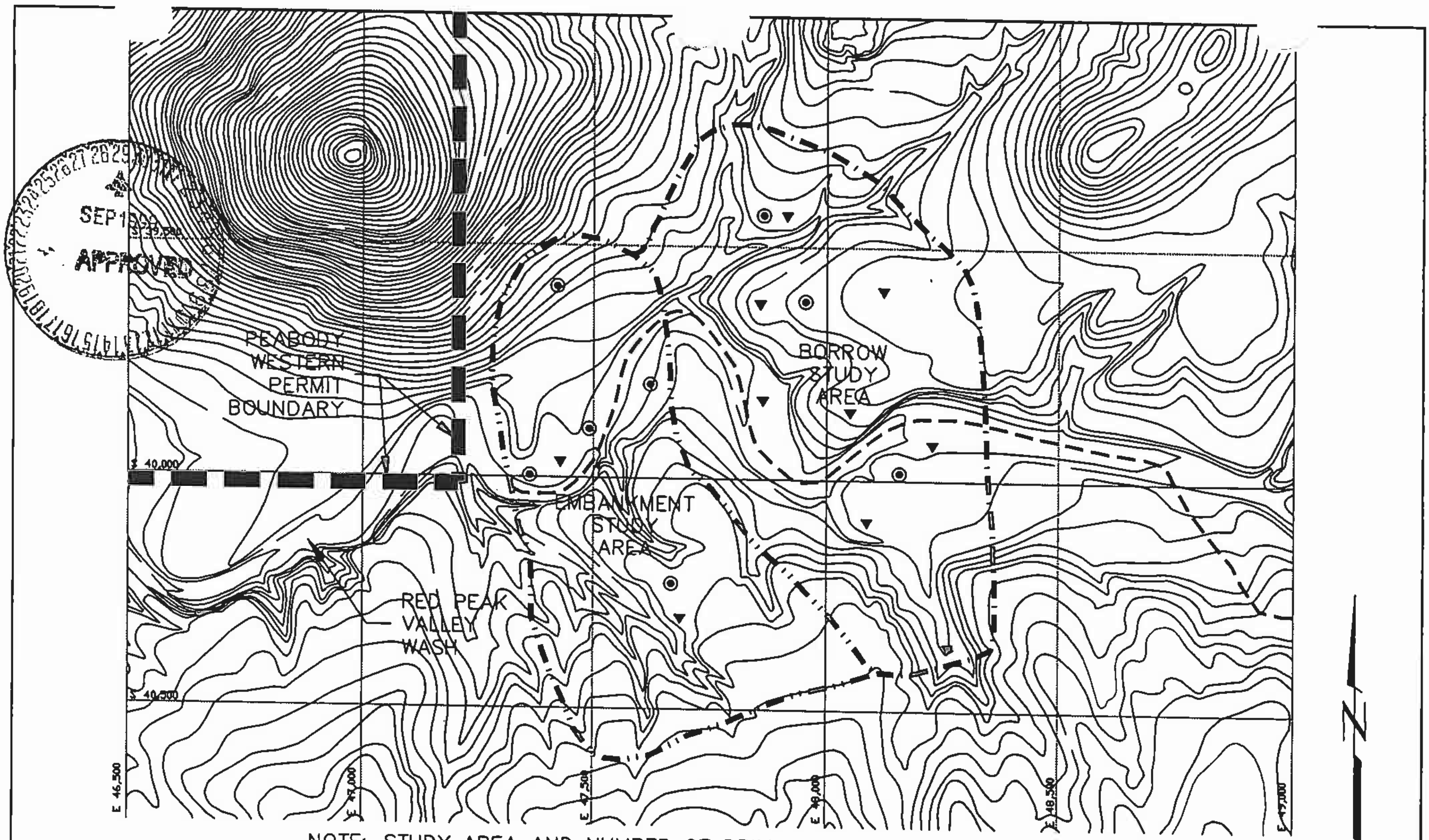


ATTACHMENT AH

NOTIFICATION OF PROPOSED GEOTECHNICAL

INVESTIGATION for the J7-JR DAM

Revised 09/15/99



NOTE: STUDY AREA AND NUMBER OF DRILL HOLES AND BACKHOE PITS ARE SUBJECT TO CHANGE BASED ON DECISIONS MADE BY THE FIELD ENGINEER.

LEGEND

- ◉ PROPOSED DRILL HOLE
- ▼ PROPOSED BACKHOE PIT
- — — — ACCESS TO SITE

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	8/99	Kavacher	Bever	Leidich

MONTGOMERY WATSON

PROJECT No.: 1342052
AutoCAD FILE: FIGURE1.DWG
SCALE: As Shown
FIGURE No: 1

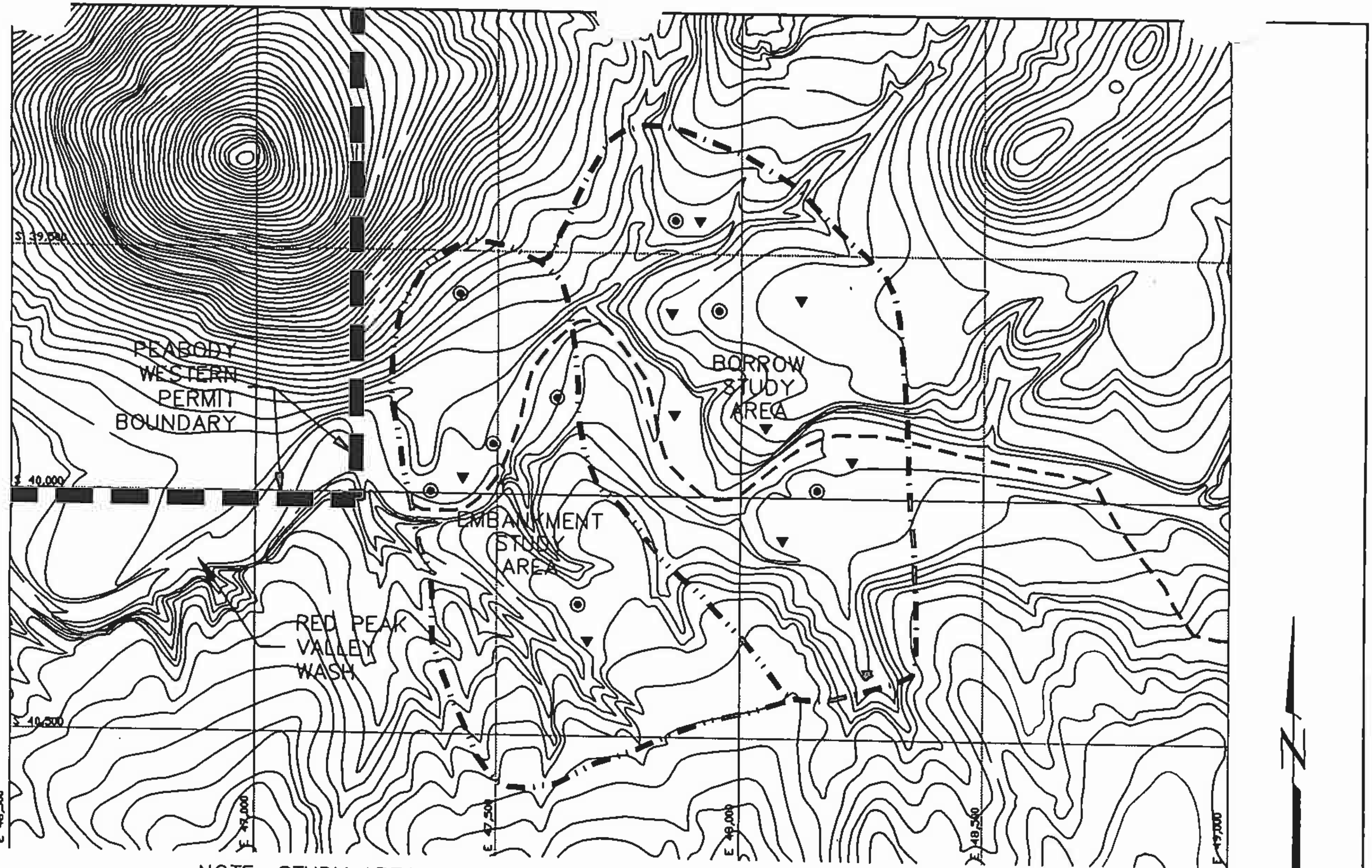
PEABODY WESTERN COAL

GEOTECH INVESTIGATION AREA
POND J7 JR

ATTACHMENT AH

NOTIFICATION OF PROPOSED GEOTECHNICAL INVESTIGATION for the J7-JR DAM

Revised 09/15/99



NOTE: STUDY AREA AND NUMBER OF DRILL HOLES AND BACKHOE PITS ARE SUBJECT TO CHANGE BASED ON DECISIONS MADE BY THE FIELD ENGINEER.

LEGEND

- ⊙ PROPOSED DRILL HOLE
- ▼ PROPOSED BACKHOE PIT
- — — — ACCESS TO SITE

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	8/99	Keuscher	Bever	Leidich

MONTGOMERY WATSON

PROJECT No.: 1342052
AutoCAD FILE: FIGURE1.DWG
SCALE: As Shown
FIGURE No: 1

PEABODY WESTERN COAL

GEOTECH INVESTIGATION AREA
POND J7 JR

ATTACHMENT AH

NOTIFICATION OF PROPOSED GEOTECHNICAL INVESTIGATION for the J7-JR DAM

Revised 09/15/99

J7 Jr
DESIGN REPORT

ATTACHMENT AI

KAYENTA MINE

J7-Jr MSHA DAM DESIGN REPORT

(SEE VOLUME 7.1 OF PERMIT AZ-0001D)

Revised 01/18/01

ATTACHMENT AJ

KAYENTA MINE

TRANSFER "C" CONVEYOR

BTCA DRAINAGE CONTROL PLAN

Revised 01/18/01

PEABODY WESTERN COAL COMPANY
BTCA PLAN FOR MAINTENANCE AND DRAINAGE CONTROL
CONVEYOR TRANSFER 'C'

The downslope area northwest of Conveyor Transfer 'C' is permitted as a Small Area Exemption Area (SAE). After reviewing the site with the OSM Permit Team, Peabody is requesting approval of the BTCA, Best Management Practices implemented by Peabody at the site. Due to the steep terrain, limited access, desire to minimize additional disturbance, and occurrence of occasional minor coal spillage from the elevated overland conveyor in this area, the BTCA practices described below are the best and most rational approaches for protecting the environment and stabilizing the site.

The overland conveyor was constructed in the early 1970's, prior to implementation of SMCRA; however, because the structure has continued operating after 1977, the area is part of the AZ-0001D Permit. Practical operating, maintenance, and safety concerns preclude modification of the elevated conveyor to totally eliminate or contain spillage, so periodic maintenance and cleanup of the minor coal spillage from the subject area is necessary.

In order to address the need for both effective interim drainage and sediment control and ongoing site cleanup and maintenance, PWCC has developed site-specific operational drainage control and maintenance plans for this area incorporating the requirements of 30 CFR 815.45, Best Technology Currently Available (BTCA) methods and practices. These plans are summarized as follows and graphically illustrated by Drawing No. 1.

1) Route the natural drainage from the area upstream of the overland conveyor to the existing rock downdrains and linear filtering structures.

2) Maintain the stilling basin just beyond the end of the riprapped downdrain in the existing drainage to minimize, to the extent possible, additional contributions of sediment to runoff outside the permit area.

3) Broadcast seed the disturbed area within the right-of-way and establish a vegetative cover to act as a vegetative filter and reduce the offsite runoff of coal material.

4) Place native hay or straw mulch at a rate of 2-3 tons per acre on all surface disturbance areas.

5) Inspect the area at least semi-annually for evidence of coal accumulations or significant surface erosion.

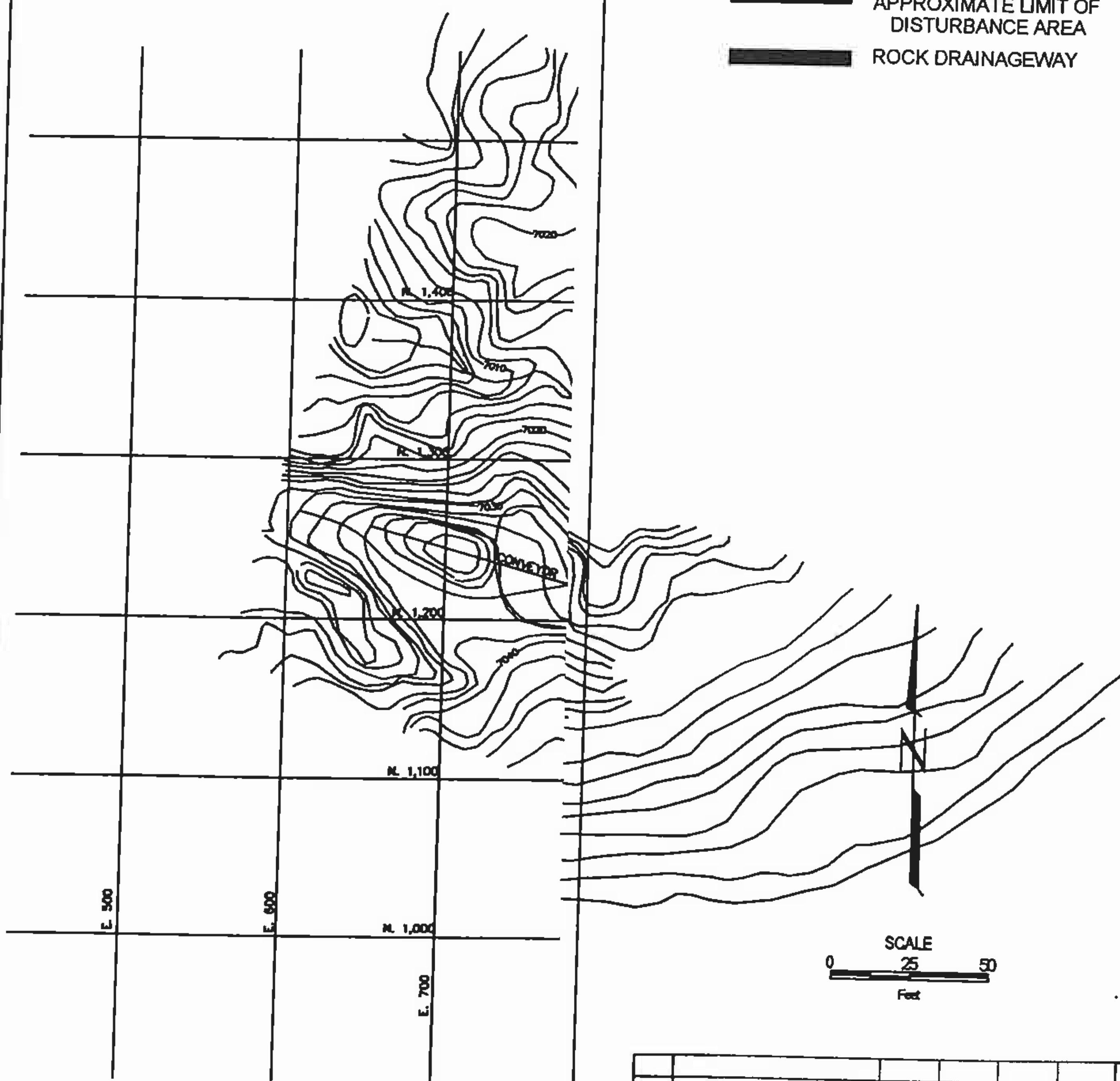
6) As necessary, based on the periodic inspections, remove coal accumulations using a backhoe or small loader and dump truck, maintain the rock downdrains, repair any significant erosion, install straw bale dikes, and re-mulch any areas where the mulch has been removed during site maintenance work.

The subject disturbance area is small (approximately 1.7 acres) and located in extremely steep terrain with limited right-of-way area. Construction of conventional drainage and sediment control structures (i.e.: a sedimentation pond and associated ditches) is not practical and will result in unnecessary additional surface disturbance and impacts. The proposed operational drainage control and maintenance plans represent BTCA for this area and should be effective both in controlling site drainage and providing for necessary ongoing site maintenance.

Revised 12/18/00

LEGEND

- EPHEMERAL DRAINAGE
- APPROXIMATE LIMIT OF DISTURBANCE AREA
- ROCK DRAINAGEWAY



FEB 2001
APPROVED

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
1	OSM REV.	12/18/00	J. G.S.	J.G.S	J.G.S
0	Transfer C – BTCA Plan	[illegible]	[illegible]	[illegible]	[illegible]

PEABODY WESTERN
COAL COMPANY

PROJECT:
CONVEYOR TRANSFER C

DRAWING TITLE:
BTCA PLAN FOR MAINTENANCE AND DRAINAGE CONTROL

MONTGOMERY WATSON

Sheet 1 Of 1 Sheets

SCALE: As Shown

DRAWING No. 1

PROJECT NUMBER: 1342052

AutoCAD FILE: 0321[illegible]

ATTACHMENT AK

KAYENTA MINE

J-19, J-21, & J7-JR MSHA DAM CONSTRUCTION PROJECT

SUPPORT FACILITIES PERMIT REVISION

Revised 01/30/2001

J-19, J-21, & J7-Jr MSHA Dam Construction Project
Support Facilities Permit Revision

Purpose:

The purpose of this Permanent Program permit revision submittal is to permit: (1) the proposed topsoil stockpile (J7-JrXX); (2) the proposed scoria borrow area (J-19 West Scoria Pit) for riprap material for the upstream face, emergency spillway, and miscellaneous riprap requirements for the J7-Jr MSHA Dam Construction Project and in the J-19 area; (3) the additional "worst case" disturbance area (approximately 93 acres) around the J7-Jr MSHA Dam site for the Contractor's parking lot, borrow areas, topsoil stockpile footprint, and associated site disturbance area; (4) the approximately 2.5 miles of temporary ancillary road, connecting the Contractor's and mine traffic to the J7-Jr MSHA Dam site; (5) the location of approximately 4 miles of proposed waterline from the existing J-28 Water Tank to the Proposed J-19 Water Tank on the south end of J-19: and (6) the locations for linear topsoil stockpiles, (ID=J19-LP or J21-LP, etc.) in the J-19 and J-21 mining areas. The Contractor and Mine personnel will need to access the J7-Jr MSHA Dam site during the construction time period, and then after construction, every 7-30 days, PWCC personnel will need to perform the MSHA Dam inspections. Long term, these segments of road will be utilized on an infrequent basis; therefore, these road segments are ancillary roads. The location of these six items can be found on the enclosed Mine Plan Map, Drawing No. 85210, SE Sheet. The "worst case" anticipated affected lands is shown on the enclosed Jurisdictional Permit and Affected Lands Map, Drawing No. 85360, SE Sheet.

The J7-Jr MSHA Dam construction project is anticipated to begin in March, 2001. For erosion and sediment control, silt fence will be installed downstream of the J7-Jr MSHA Dam construction site and Best Management Practices (BMP's) as described in Chapter 6 and Chapter 26 will be utilized where appropriate within and downstream of the disturbance areas. The proposed J-19 West Scoria Pit is located on a hill within the future J-19 West mining and coal recovery area. The J-19 Waterline will be HPDE pipe installed on the surface to minimize surface disturbance, and for inspection and maintenance. The J-19 Water Tank will be the relocated existing N-14 Water Tank. All of the above support facilities and topsoil stockpiles are located within the J-19 and J-21 area and within areas included within PWCC's previous environmental studies area. All of the first five items identified above will be upstream of the J7-Jr MSHA Dam construction site. The linear topsoil stockpiles are located on graded spoil areas next to the active J-19 or J-21 pits. Bonding calculation is included in the enclosed Chapter 6, Attachment AK. PWCC will submit the appropriate additional bond upon approval. All reclamation will be in accordance with the approved reclamation plan in the AZ-0001D Permit.

Bonding Estimate:

The bonding estimate for this Permit Revision is approximately $1,137,007, (see attached worksheets).

KAYENTA MINE
AZ-0001D Permit
J-19 & J7-Jr Dam Site
Bonding Estimate
January 30, 2001

TABLE	AREA	PROJECT	TASK	EQUIPMENT	EQUIPMENT UNIT COST	HOURS	LABOR COST	QUANTITY	UNITS	HOURLY COST	TOTAL COST	UNIT COST
		(J7-Jr Dam Site)										
24-5-04a	Kayenta	Surface Ripping	Dozer Ripping	D11R Dozer - Ripper Equipped	$215.17	133	$24.39	450,200	cy	$239.56	$31,882	$0.07
		(J7-Jr Dam Site)		Surface Ripping Subtotal		133					$31,882	
24-5-05a	Kayenta	Grade Facilities Areas	Facilities Area Grading	D11R Dozer	$194.56	669	$24.39	450,200	cy	$218.95	$146,479	$0.33
		(J7-Jr Dam Site)		Grade Facilities Area Subtotal		669					$146,479	
24-5-06a	Kayenta	Topsoil Replacement	Haul and Place Topsoil	637E P-P Scraper	$150.82	425	$24.39	240,100	cy	$175.21	$74,464	$0.31
		(J7-Jr Dam Site)		Topsoil Replacement Subtotal		425					$74,464	
24-5-07a	Kayenta	Revegetation	Revegetation	Miscellaneous	-	-	-	93	acres	-	$151,823	$1,632.51
		(J7-Jr Dam Site)		Revegetation Subtotal							$151,823	
				Facilities Subtotal		1,227					$ 404,628	
		(J-19 West Scoria Pit)										
24-5-10a	Kayenta Scoria Pits	Surface Ripping	Dozer Ripping	D11R Dozer - Ripper Equipped	$215.17	100	$24.39	338,800	cy	$239.56	$23,956	$0.07
24-5-11a	Kayenta Scoria Pits	Grade Scoria Pit Area	Scoria Pit Grading	D11R Dozer	$194.56	420	$24.39	338,800	cy	$218.95	$91,960	$0.27
24-5-12a	Kayenta Scoria Pits	Topsoil Replacement	Haul and Place Topsoil	637E P-P Scraper	$150.82	453	$24.39	180,700	cy	$175.21	$79,370	$0.44
24-5-13a	Kayenta Scoria Pits	Revegetation	Revegetation	Miscellaneous	-	-	-	70	acres	-	$114,275	$1,632.50
				Scoria Pit Subtotal		973					$309,561	
		(J-19 West Anc. Roads)										
24-5-32a	Kayenta Ancillary Roads	Culvert Removal	Culvert Removal/Disposal	D11R Dozer	$194.56	61	$24.39	30,027	cy	$218.95	$13,356	$0.44
24-5-33a	Kayenta Ancillary Roads	Surfacing Removal	Surfacing Removal/Disposal	D11R Dozer	$194.56	18	$24.39	30,027	cy	$218.95	$3,941	$0.13
24-5-34a	Kayenta Ancillary Roads	Surface Ripping	Dozer Ripping	D11R Dozer - Ripper Equipped	$215.17	27	$24.39	90,080	cy	$239.56	$6,468	$0.07
24-5-35a	Kayenta Ancillary Roads	Grade Ripped Areas	Grading	D11R Dozer	$194.56	454	$24.39	41	acres	$218.95	$99,404	$2,424.49
24-5-36a	Kayenta Ancillary Roads	Topsoil Replacement	Haul and Place Topsoil	637E P-P Scraper	$150.82	401	$24.39	106,761	cy	$175.21	$70,259	$0.66
24-5-37a	Kayenta Ancillary Roads	Revegetation	Revegetation	Miscellaneous	-	-	-	41	acres	-	$67,518	$1,646 78
				Ancillary Roads Subtotal		961					$260,946	

TOTAL DIRECT COST:	$ 975,135
INDIRECT COST PERCENT:	16.6%
TOTAL INDIRECT COST:	$ 161,872
TOTAL ESTIMATED BONDING COST:	$ 1,137,007

Table 24-2-9
SCORIA PIT RECLAMATION
Black Mesa and Kayenta Mines

Location	Area (ac)	Disturbed		Reclaimed		Undisturbed	
		%	acres	%	acres	%	acres
J-7N	153.2	0	0.0	0	0.0	100	153.2
J-27S	176.8	0	0.0	0	0.0	100	176.8
N-5	97.8	75	73.4	0	0.0	25	24.5
N-6 East	148.2	0	0.0	0	0.0	100	148.2
J-16	21.0	0	0.0	0	0.0	100	21.0
J-21N	151.0	75	113.3	0	0.0	25	37.8
N-10	4.0	100	4.0	0	0.0	0	0.0
N-14	16.0	100	16.0	0	0.0	0	0.0
N-14E	37.0	100	37.0	0	0.0	0	0.0
J-19W	70	100	70	0	0.0	0	0.0
Total	875		314		0		561

Reference: Bonding Map (Drawing 89800)

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Table:	24-5-04a
Mine Area:	Kayenta
Project:	Surface Ripping: J7-Jr Dam
Task:	Dozer Ripping
Equipment:	D11R Dozer - Ripper Equipped

Earthmoving Activity
Rip 3' of subbase to aid in vegetation establishment.

Characterization of Dozer and Ripper Used:
D11R, three shank ripper, semi-u blade

Description of Ripping (ripping depth, cut spacing, cut length, and material to be ripped):

Rip depth (ft)	3
Cut spacing (ft/pass)	6.4
Cut length (ft)	300
Speed (ft/min)	120

Quantity of Material to be Ripped
450,200 cy

Cycle Time	=	300 (Cut Length)	/	120 (Speed Factor (fpm))	+	0.25 (Turn Time)	=	2.8 min/pass		
Passes per hour	=	60 (min/hr)	/	2.8 (Cycle Time)	=	21.8 pass/hr				
Volume cut per pass	=	3.00 (Tool Penetration)	x	6.4 (Cut Spacing)	x	300 (Cut Length)	/	27 (cf/cy)	=	213 bank cy/pass

Ripping Production	=	213 (Volume cut per pass)	x	21.8 (Passes per hour)	=	4,655 hours	
Hours Required	=	450,200 (Volume to be Ripped)	/	4,655 (Ripping Production)	x	1.371 (Work Schedule Factor)	= 133 hours

Reference: Cat Handbook, Ed. 28, Table 24-2-8.

Table:	24-5-05a
Mine Area:	Kayenta
Project:	Grade Facilities Areas: J7-Jr Dam
Task:	Facilities Area Grading
Equipment:	D11R Dozer

Earthmoving Activity

Grading the cut and fills to blend into the surrounding topography to drain, burial of road surface material a minimum of three feet.

Characterization of Dozer Used (type, size, etc):

D11R, three-shank ripper, U-blade

Power shift transmission (1.0)	yes

Description of Dozer Use

Average dozing distance (feet)	200
Hourly production (from chart)	1,500
Grade (in percent)	0
Grade Correction	1
Material Unit Weight (lb/lcy)	2,800
Density Correction	0.82

Productivity Adjustment Factors

Operator Factor

Is operator excellent (1)	no
Is operator average (.75)	yes
Is operator poor (.6)	no

Material Factor

Loose stockpile (1.2)	no
Hard to cut; frozen -	
with tilt cylinder (.8)	no
without tilt cyliner (.7)	no
Normal material (1)	yes
Hard to drift; (.8)	no
Rock, ripped or blasted (.75)	no

Production Method/Blade Factor

Slot dozing (1.2)	no
Side by side dozing (1.2)	no
Normal dozing (1.0)	yes

Poor Visibility

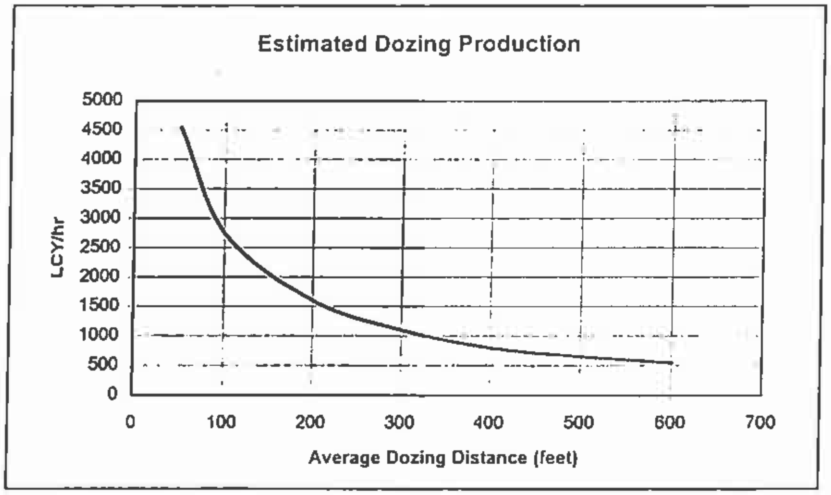
(I.e., dust, rain, snow, fog, or darkness) (0.8)	no

Elevation Factor

<7,500 feet (1.0)	yes

Quantity of Material to be Moved

450,200 cy



Productivity Adjustment Factor = 0.75 (Operating Factor) x 1.0 (Material Factor) x 1.0 (Grade Factor) x 0.82 (Density Correction) x 1.00 (Production Method) x 1.00 (Visibility) x 1.00 (Elevation) x 1.00 (Direct Drive Trans) = **0.62**

Net Hourly Production = 1,500 (Normal Hourly Production (see graph above)) x 0.62 (Productivity Adjustment Factor) = **923 cy/hr**

Hours Required = 450,200 (Volume to be Moved) / 923 (Net Hourly Production) x 1.371 (Work Schedule Factor) = **669 Hours**

References: Cat Handbook, Ed. 28, Table 24-2-8

Table: 24-5-06a
Mine Area: Kayenta
Project: Topsoil Replacement: J7-Jr Dam
Task: Haul and Place Topsoil
Equipment: 637E P-P Scraper

Earthmoving Activity

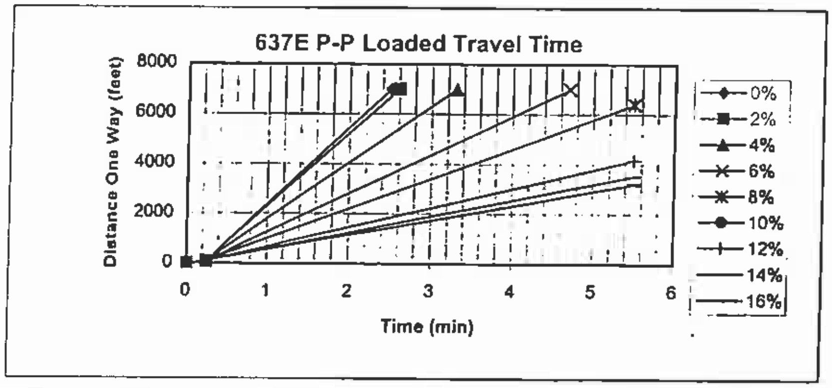
Haul 1.6' of material to cover remaining parking/storage/disturbance areas.

Characterization of Scraper Used (type, capacity, etc)

637E P-P Scraper - capacity = 31 cy

Description of Scraper Route (haul distance, % grade, average rolling resistance for each segment, etc.)

Loaded Distance (ft)	500
Loaded Grade (%)	0
Loaded Effective Grade (%)	3
Empty Distance (ft)	500
Empty Grade (%)	0
Empty Effective Grade (%)	3

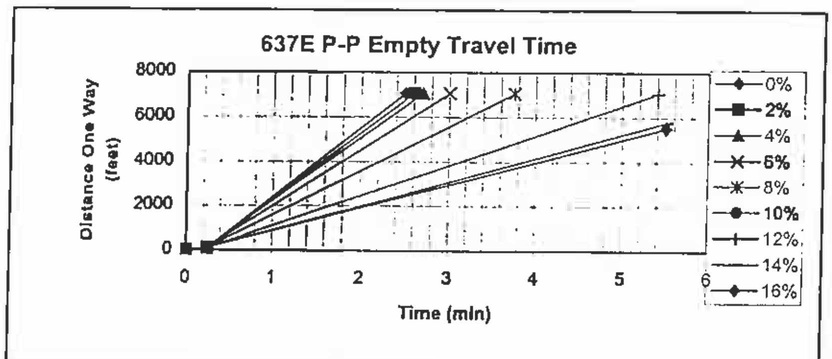


Production Times

Typical Load Time for 657E P-P	1.0
Maneuver and spread or dump	0.6
Loaded Travel Time (from chart)	0.4
Empty Travel Time (from chart)	0.4

Quantity of Material to be Moved

240,100 cy



Cycle Time = 1.0 (Load Time) + 0.4 (Loaded Trip Time) + 0.6 (Maneuver and Spread Time) + 0.4 (Empty Trip Time) = **2.4 min**

Cycles/Hour = 60 (min/hr) / 2.4 (Cycle Time) = **25 cycles/hr**

Hourly Production = 31 (Adjusted Load (cy)) x 25.00 (Cycles/Hour) = **775 cy/hr**

Hours Required = 240,100 (Volume) / 775 (Hourly Production) x 1.371 (Work Schedule Factor) = **425 hrs**

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Reference: Table 24-2-8, Cat Handbook, Ed. 28

Table:	24-5-07a
Mine Area:	Kayenta .
Project:	Revegetation: J7-Jr Dam
Task:	Revegetation
Equipment:	Miscellaneous

Revegetation Area Description

Kayenta Mine major facilities

Revegetation Area

Area (acre)	93
Seeding, fertilizing, mulching and fencing costs (per acre)	$954.00
Tree and Shrub Costs (per acre)	$275.00
Reseeding Cost (per acre)	$807.00
Percent Failure	50%

Revegetation Costs	=	93 Acres	* (	$954.00 $/Acre for seeding, fertilizing, mulching and fencing	+	$275.00 $/Acre for planting trees and shrubs	) =	$114,297

Reseeding Costs	=	93 Acres	*	0.5 Failure	*	$807.00 Reseeding Cost	=	$37,526

References: Table 24-1-3 and Table 24-2-8

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Table:	24-5-10a
Mine Area:	Kayenta Scoria Pits
Project:	Surface Ripping - J19 West
Task:	Dozer Ripping
Equipment:	D11R Dozer - Ripper Equipped

Earthmoving Activity

Rip 3' of scoria pit prior to grading

Characterization of Dozer and Ripper Used:

D11R, three shank ripper, semi-u blade

Description of Ripping (ripping depth, cut spacing, cut length, and material to be ripped):

Rip depth (ft)	3
Cut spacing (ft/pass)	6.4
Cut length (ft)	300
Speed (ft/min)	120

Quantity of Material to be Ripped

338,800 cy

Cycle Time	=	300 (Cut Length)	/	120 (Speed Factor (fpm))	+	0.25 (Turn Time)			= 2.8 min/pass
Passes per hour	=	60 (min/hr)	/	2.8 (Cycle Time)					= 21.8 pass/hr
Volume cut per pass	=	3.00 (Tool Penetration)	x	6.4 (Cut Spacing)	x	300 (Cut Length)	/	27 (cf/cy)	= 213 bank cy/pass

Ripping Production	=	213 (Volume cut per pass)	x	21.8 (Passes per hour)			= 4655 hours
Hours Required	=	338,800 (Volume to be Ripped)	/	4655 (Ripping Production)	x	1.371 (Work Schedule Factor)	= 100 hours

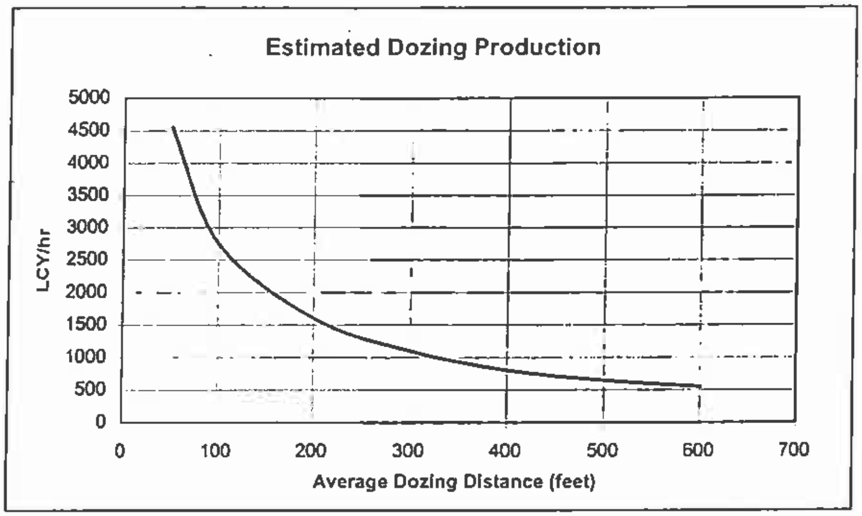
Reference: Cat Handbook, Ed. 28, Table 24-2-9.

Table:	24-5-11a
Mine Area:	Kayenta Scoria Pits
Project:	Grade Scoria Pit Area - J19 West
Task:	Scoria Pit Grading
Equipment:	D11R Dozer

<u>Earthmoving Activity</u>
Grade scoria pit to blend into surrounding area.

<u>Characterization of Dozer Used (type, size, etc):</u>
D11R, three-shank ripper, U-blade

Power shift transmission (1.0)	yes
Description of Dozer Use	
Average dozing distance (feet)	200
Hourly production (from chart)	1500
Grade (in percent)	-10
Grade Correction	1.2
Material Unit Weight (lb/lcy)	2800
Density Correction	0.82
Productivity Adjustment Factors	
Operator Factor	
Is operator excellent (1)	no
Is operator average (.75)	yes
Is operator poor (.6)	no
Material Factor	
Loose stockpile (1.2)	no
Hard to cut; frozen - with tilt cylinder (.8)	no
Hard to cut; frozen - without tilt cyliner (.7)	no
Normal material (1)	yes
Hard to drift; (.8)	no
Rock, ripped or blasted (.75)	no
Production Method/Blade Factor	
Slot dozing (1.2)	no
Side by side dozing (1.2)	no
Normal dozing (1.0)	yes
Poor Visibility	
(I.e., dust, rain, snow, fog, or darkness) (0.8)	no
Elevation Factor	
<7,500 feet (1.0)	yes
Quantity of Material to be Moved	
338,800	cy



Productivity Adjustment Factor = 0.75 (Operating Factor) x 1.0 (Material Factor) x 1.2 (Grade Factor) x 0.82 (Density Correction) x 1.00 (Production Method) x 1.00 (Visibility) x 1.00 (Elevation) x 1.00 (Direct Drive Trans) = **0.74**

Net Hourly Production = 1,500 (Normal Hourly Production (see graph above)) x 0.74 (Productivity Adjustment Factor) = **1107 cy/hr**

Hours Required = 338,800 (Volume to be Moved) / 1107 (Net Hourly Production) x 1.371 (Work Schedule Factor) = **420 Hours**

References: Cat Handbook, Ed. 28, Table 24-2-9

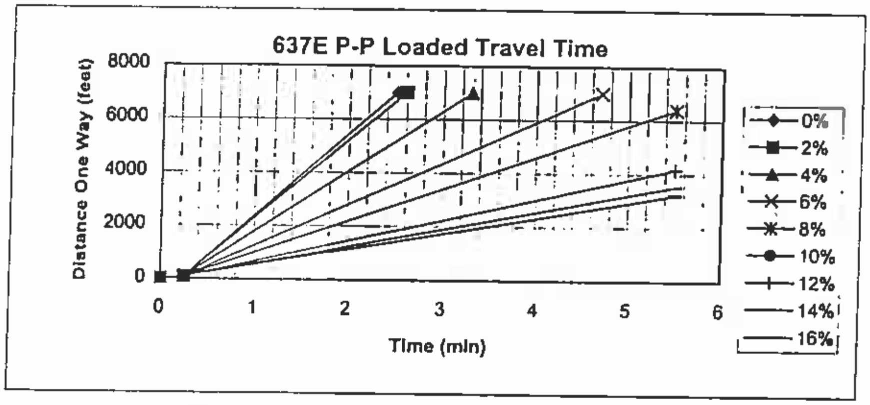
Table:	24-5-12a
Mine Area:	Kayenta Scoria Pits
Project:	Topsoil Replacement - J19 West
Task:	Haul and Place Topsoil
Equipment:	637E P-P Scraper

<u>Earthmoving Activity</u>
Topsoil disturbance area around scoria pits

<u>Characterization of Scraper Used (type, capacity, etc)</u>
637E P-P Scraper - capacity = 31 cy

<u>Description of Scraper Route (haul distance, % grade, average rolling resistance for each segment, etc.)</u>

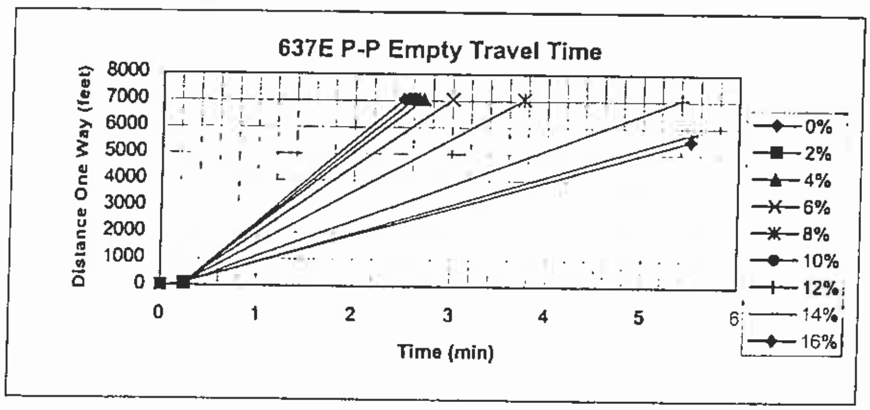
Loaded Distance (ft)	1500
Loaded Grade (%)	0
Loaded Effective Grade (%)	5
Empty Distance (ft)	1500
Empty Grade (%)	0
Empty Effective Grade (%)	5



<u>Production Times</u>

Typical Load Time for 657E P-P	1.0
Maneuver and spread or dump	0.6
Loaded Travel Time (from chart)	1.0
Empty Travel Time (from chart)	0.8

<u>Quantity of Material to be Moved</u>
180,700 cy



Cycle Time = 1.0 (Load Time) + 1.0 (Loaded Trip Time) + 0.6 (Maneuver and Spread Time) + 0.8 (Empty Trip Time) = **3.4 min**

Cycles/Hour = 60 (min/hr) / 3.4 (Cycle Time) = **18 cycles/hr**

Hourly Production = 31 (Adjusted Load (cy)) x 17.65 (Cycles/ Hour) = **547 cy/hr**

Hours Required = 180,700 (Volume) / 547 (Hourly Production) x 1.371 (Work Schedule Factor) = **453 hrs**

Reference: Table 24-2-9, Cat Handbook, Ed. 28

Table:	24-5-13a
Mine Area:	Kayenta Scoria Pits
Project:	Revegetation - J19 West
Task:	Revegetation
Equipment:	Miscellaneous

Revegetation Area Description

Kayenta Mine regraded scoria pits

Revegetation Area

Area (acre)	70
Seeding, fertilizing, mulching and fencing costs (per acre)	$954.00
Tree and Shrub Costs (per acre)	$275.00
Reseeding Cost (per acre)[1]	$807.00
Percent Failure	50%

$$\text{Revegetation Costs} = \frac{70}{\text{Acres}} * \left(\frac{\$954.00}{\text{\$/Acre for seeding, fertilizing, mulching and fencing}} + \frac{\$275.00}{\text{\$/Acre for planting trees and shrubs}} \right) = \$86{,}030$$

$$\text{Reseeding Costs} = \frac{70}{\text{Acres}} * \frac{0.5}{\text{Failure}} * \frac{\$807.00}{\text{Reseeding Cost}} = \$28{,}245$$

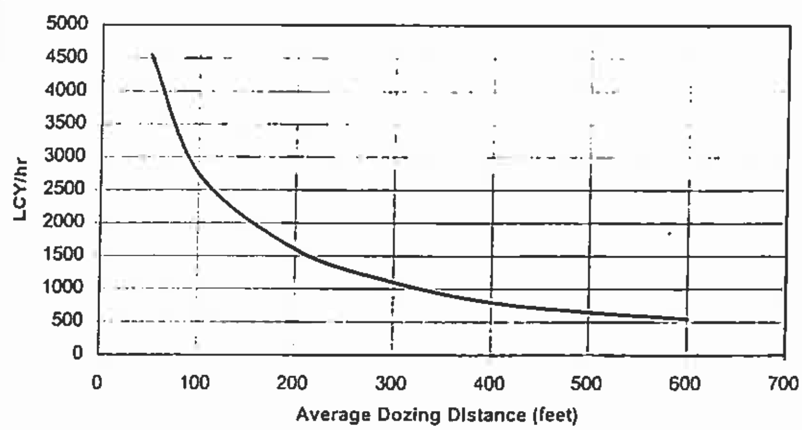
References: Table 24-1-3 and Table 24-2-9

Table:	24-5-32a
Mine Area:	Kayenta Ancillary Roads
Project:	Culvert Removal - J19 West
Task:	Culvert Removal/Disposal
Equipment:	D11R Dozer

Earthmoving Activity:
Remove and dispose of culvert embankment material and culverts.

Characterization of Dozer Used (type, size, etc):
D11R, three-shank ripper, U-blade
Power shift transmission (1.0) — yes

Estimated Dozing Production



Description of Dozer Use	
Average dozing distance (feet)	300
Hourly production (from chart)	1100
Grade (in percent)	0
Grade Correction	1
Material Unit Weight (lb/lcy)	2800
Density Correction	0.82

Productivity Adjustment Factors	
Operator Factor	
Is operator excellent (1)	no
Is operator average (.75)	yes
Is operator poor (.6)	no
Material Factor	
Loose stockpile (1.2)	no
Hard to cut; frozen - with tilt cylinder (.8)	no
without tilt cyliner (.7)	no
Normal material (1)	yes
Hard to drift; (.8)	no
Rock, ripped or blasted (.75)	no
Production Method/Blade Factor	
Slot dozing (1.2)	no
Side by side dozing (1.2)	no
Normal dozing (1.0)	yes
Poor Visibility	
(I.e., dust, rain, snow, fog, or darkness) (0.8)	no
Elevation Factor	
<7,500 feet (1.0)	yes
Quantity of Material to be Moved	
Total (cy)	30,027

Productivity Adjustment Factor = 0.75 (Operating Factor) x 1.0 (Material Factor) x 1.0 (Grade Factor) x 0.82 (Density Correction) x 1.00 (Production Method) x 1.00 (Visibility) x 1.00 (Elevation) x 1.00 (Direct Drive Trans) = **0.62**

Net Hourly Production = 1,100 (Normal Hourly Production (see graph above)) x 0.62 (Productivity Adjustment Factor) = **676.5 cy/hr**

Hours Required = 30,027 (Total (cy) Volume to be Moved) / 676.5 (Net Hourly Production) x 1.371 (Work Schedule Factor) = **61 Hours**

Culvert (ft)	0
Culvert Disposal Cost (at $0.23/cf)	$0

Note: Quantity of material and culvert are 60% of total for Kayenta portion of the cost.

References: Cat Handbook, Ed. 28

Table:	24-5-33a
Mine Area:	Kayenta Ancillary Roads
Project:	Surfacing Removal - J19 West
Task:	Surfacing Removal/Disposal
Equipment:	D11R Dozer

Earthmoving Activity:
Push one foot of gravel/scoria off the side of the road for burial

Characterization of Dozer Used (type, size, etc):
D11R, three-shank ripper, U-blade
Power shift transmission (1.0) yes

Description of Dozer Use

Average dozing distance (feet)	50
Hourly production (from chart)	4550
Grade (in percent)	0
Grade Correction	1
Material Unit Weight (lb/lcy)	2800
Density Correction	0.82

Productivity Adjustment Factors

Operator Factor

Is operator excellent (1)	no
Is operator average (.75)	yes
Is operator poor (.6)	no

Material Factor

Loose stockpile (1.2)	no
Hard to cut; frozen - with tilt cylinder (.8)	no
without tilt cyliner (.7)	no
Normal material (1)	no
Hard to drift; (.8)	yes
Rock, ripped or blasted (.75)	no

Production Method/Blade Factor

Slot dozing (1.2)	no
Side by side dozing (1.2)	no
Normal dozing (1.0)	yes

Poor Visibility

(I.e., dust, rain, snow, fog, or darkness) (0.8)	no

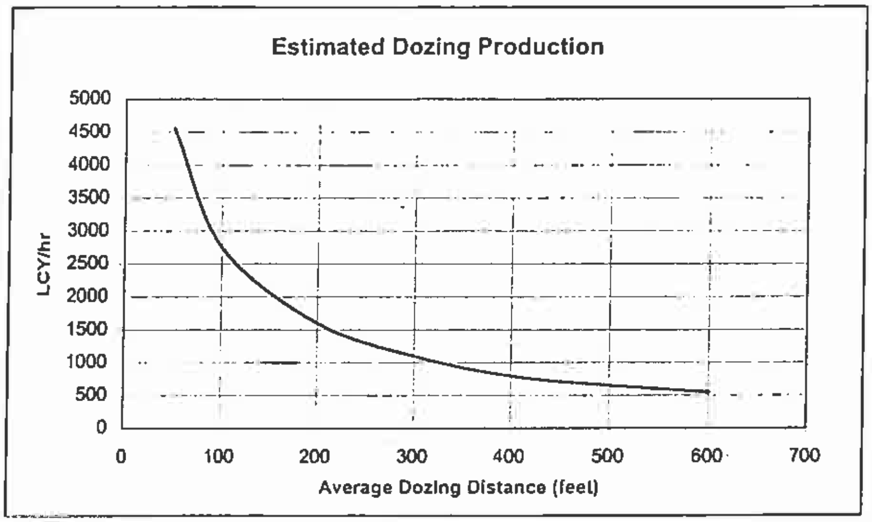
Elevation Factor

<7,500 feet (1.0)	yes

Quantity of Material to be Moved

Length (ft)	18,016
Width (ft)	45
Total (cy)	30,027

References: Cat Handbook, Ed. 28



Productivity Adjustment Factor = 0.75 (Operating Factor) x 0.8 (Material Factor) x 1.0 (Grade Factor) x 0.82 (Density Correction) x 1.00 (Production Method) x 1.00 (Visibility) x 1.00 (Elevation) x 1.00 (Direct Drive Trans) = **0.49**

Net Hourly Production = 4,550 (Normal Hourly Production (see graph above)) x 0.49 (Productivity Adjustment Factor) = **2238.6 cy/hr**

Hours Required = 30,027 (Total (cy) Volume to be Moved) / 2238.6 (Net Hourly Production) x 1.371 (Work Schedule Factor) = **18 Hours**

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Table:	24-5-34a
Mine Area:	Kayenta Ancillary Roads
Project:	Surface Ripping - J19 West
Task:	Dozer Ripping
Equipment:	D11R Dozer - Ripper Equipped

Earthmoving Activity
Rip 3' of subbase to aid in vegetation establishment.

Characterization of Dozer and Ripper Used:
D11R, three shank ripper, semi-u blade

Description of Ripping (ripping depth, cut spacing, cut length, and material to be ripped):

Rip depth (ft)	3
Cut spacing (ft/pass)	6.4
Cut length (ft)	300
Speed (ft/min)	120

Quantity of Material to be Ripped

Length (ft)	18016
Width (ft)	45
Total (cy)	90080

Cycle Time = 300 (Cut Length) / 120 (Speed Factor (fpm)) + 0.25 (Turn Time) = 2.8 min/pass

Passes per hour = 60 (min/hr) / 2.8 (Cycle Time) = 21.8 pass/hr

Volume cut per pass = 3.00 (Tool Penetration) x 6.4 (Cut Spacing) x 300 (Cut Length) / 27 (cf/cy) = 213 bank cy/pass

Ripping Production = 213 (Volume cut per pass) x 21.8 (Passes per hour) = 4655 hours

Hours Required = 90,080 (Volume to be Ripped) / 4655 (Ripping Production) x 1.371 (Work Schedule Factor) = 27 hours

Reference: Cat Handbook, Ed. 28

Table:	24-5-35a
Mine Area:	Kayenta Ancillary Roads
Project:	Grade Ripped Areas - J19 West
Task:	Grading
Equipment:	D11R Dozer

Earthmoving Activity

Grade the cut and fills to blend into surrounding topography and to drain and bury road surface material a minimum of 3'.

Characterization of Dozer Used (type, size, etc)

D11R, three shank ripper, U-blade

Production Rate (acres/shift) 1.0

Acres to be Graded

Length (ft)	18,016
Width (ft)	100
Total (acres)	41

Hours Required	=	41	/	0.125	x	1.371	=	454 Hours
		Area to be Graded (acres)		Net Hourly Production (acres/hr)		Work Schedule Factor		

Note: Production rate based on PWCC experience.

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Table:	24-5-36a
Mine Area:	Kayenta Ancillary Roads
Project:	Topsoil Replacement - J19 West
Task:	Haul and Place Topsoil
Equipment:	637E P-P Scraper

<u>Earthmoving Activity</u>

Haul and place 1.6' topsoil to cover graded area.

<u>Characterization of Scraper Used (type, capacity, etc)</u>

637E P-P Scraper - capacity = 31 cy

<u>Description of Scraper Route (haul distance, % grade, average rolling resistance for each segment, etc.)</u>

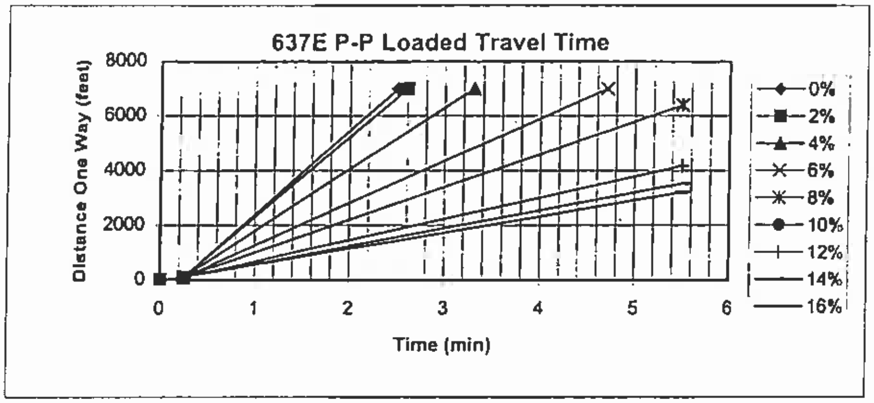
Loaded Distance (ft)	3000
Loaded Grade (%)	0
Loaded Effective Grade (%)	5
Empty Distance (ft)	3000
Empty Grade (%)	0
Empty Effective Grade (%)	5

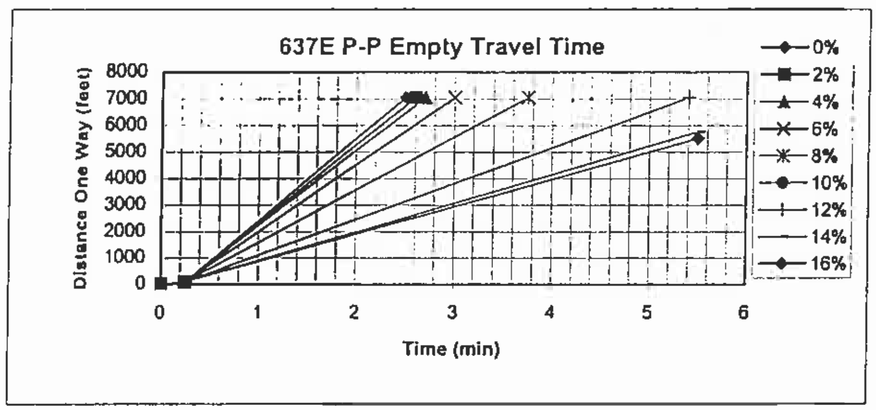
<u>Production Times</u>

Typical Load Time for 657E P-P	1.0
Maneuver and spread or dump	0.6
Loaded Travel Time (from chart)	2.0
Empty Travel Time (from chart)	1.5

<u>Quantity of Material to be Moved</u>

Length (ft)	18,016
Width (ft)	100
Total (cy)	106,761





Cycle Time = 1.0 (Load Time) + 2.0 (Loaded Trip Time) + 0.6 (Maneuver and Spread Time) + 1.5 (Empty Trip Time) = **5.1 min**

Cycles/Hour = 60 (min/hr) / 5.1 (Cycle Time) = **12 cycles/hr**

Hourly Production = 31 (Adjusted Load (cy)) x 11.76 (Cycles/Hour) = **365 cy/hr**

Hours Required = 106,761 (Volume) / 365 (Hourly Production) x 1.371 (Work Schedule Factor) = **401 hrs**

Reference: Cat Handbook, Ed. 28

Table:	24-5-37a
Mine Area:	Kayenta Ancillary Roads
Project:	Revegetation - J19 West
Task:	Revegetation
Equipment:	Miscellaneous

<u>Revegetation Area Description</u>

Kayenta Mine ancillary roads

<u>Revegetation Area</u>

Area (acre)	41
Seeding, fertilizing, mulching and fencing costs (per acre)	$954.00
Tree and Shrub Costs (per acre)	$275.00
Reseeding Cost (per acre)'	$807.00
Percent Failure	50%

Revegetation Costs = 41 Acres * ($954.00 $/Acre for seeding, fertilizing, mulching and fencing + $275.00 $/Acre for planting trees and shrubs) = **$50,830**

Reseeding Costs = 41 Acres * 0.5 Failure * $807.00 Reseeding Cost = **$16,688**

References: Table 24-1-3

ATTACHMENT AL

KAYENTA MINE

N-11 & N-14 Support Facilities

Permit Revision

Revised 02/02/2001

ATTACHMENT AL

KAYENTA MINE

N-11 & N-14 Support Facilities

Permit Revision

Revised 02/02/2001

N-11 & N-14 Support Facilities Permit Revision

Purpose:

The purpose of this Permanent Program permit revision submittal is to permit: (1) approximately 1.7 miles of temporary ancillary road, connecting light use mine traffic to the interior and northern perimeter of the N-14 East reclamation area; and (2) show the locations for linear topsoil stockpiles, (ID=N11-LP, etc.) in the N-11 mining area. PWCC personnel will need to perform reclamation area inspections, will need access to PWCC's surveying control points and other mine related activities. These segments of road will be utilized on an infrequent basis; therefore, these road segments are ancillary roads. The location of these two items can be found on the enclosed Mine Plan Map, Drawing No. 85210, NE & NW Sheets and on the enclosed Jurisdictional Permit and Affected Lands Map, Drawing No. 85360, NE & NW Sheets.

All of the above support facilities and topsoil stockpiles are located within the N-11 and N-14 areas where reclamation and environmental studies have been conducted. The first item identified above will be upstream of the N14-G and N14-H MSHA Dams, which provide runoff and sediment control for this portion of the N-14 reclamation area. Where these segments of ancillary roads cross the reclaimed drainage in the N14-G and N14-H upstream main reclaimed drainage channels, PWCC will construct low-water road crossings in accordance with the approved Drawing No. 85432. As shown on Drawing No. 85642A, these reaches of the N14-G and H14-H channels have been disturbed and reclaimed under the AZ-0001 Initial Program Permit, and are not part of the Permanent Program stream buffer zone areas. The linear topsoil stockpiles are located on graded spoil areas next to the active N-11 pit. Bonding calculation is included in the enclosed Chapter 6, Attachment "AL". PWCC will submit the appropriate additional bond upon approval. All reclamation will be in accordance with the approved reclamation plan in the AZ-0001D Permit.

Bonding Estimate:

The bonding estimate for this Permit Revision is approximately $117,930, (see attached worksheets).

KAYENTA MINE
AZ-0001D Permit
N-14 East Roads
Bonding Estimate
February 1, 2001

TABLE	AREA	PROJECT	TASK	EQUIPMENT	EQUIPMENT UNIT COST	HOURS	LABOR COST	QUANTITY	UNITS	HOURLY COST	TOTAL COST	UNIT COST
		(N-14 East Anc. Roads)										
24-5-32b	Kayenta Ancillary Roads	Culvert Removal	Culvert Removal/Disposal	D11R Dozer	$194.56	17	$24.39	8,333	cy	$218.95	$3,722	$0.45
24-5-33b	Kayenta Ancillary Roads	Surfacing Removal	Surfacing Removal/Disposal	D11R Dozer	$194.56	5	$24.39	8,333	cy	$218.95	$1,095	$0.13
24-5-34b	Kayenta Ancillary Roads	Surface Ripping	Dozer Ripping	D11R Dozer - Ripper Equipped	$215.17	7	$24.39	25,000	cy	$239.56	$1,677	$0.07
24-5-35b	Kayenta Ancillary Roads	Grade Ripped Areas	Grading	D11R Dozer	$194.56	181	$24.39	17	acres	$218.95	$39,630	$2,331.19
24-5-36b	Kayenta Ancillary Roads	Topsoil Replacement	Haul and Place Topsoil	637E P-P Scraper	$150.82	160	$24.39	42,667	cy	$175.21	$28,034	$0.66
24-5-37b	Kayenta Ancillary Roads	Revegetation	Revegetation	Miscellaneous	-	-	-	17	acres	-	$26,983	$1,587.24
				Ancillary Roads Subtotal		370					$101,141	

TOTAL DIRECT COST:	$ 101,141
INDIRECT COST PERCENT:	16.6%
TOTAL INDIRECT COST:	$ 16,789
TOTAL ESTIMATED BONDING COST:	$ 117,930

Table:	24-5-32b
Mine Area:	Kayenta Ancillary Roads
Project:	Culvert Removal - N14 East
Task:	Culvert Removal/Disposal
Equipment:	D11R Dozer

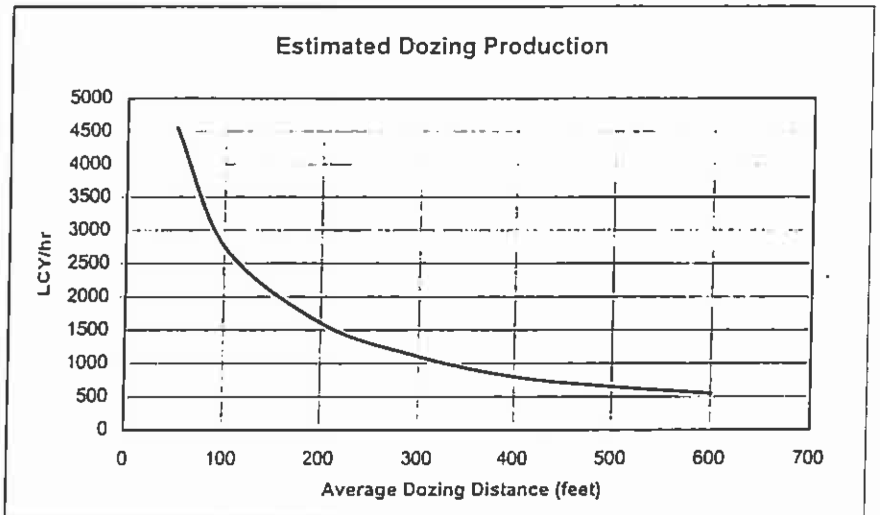
Earthmoving Activity:

Remove and dispose of culvert embankment material and culverts.

Characterization of Dozer Used (type, size, etc):

D11R, three-shank ripper, U-blade

Power shift transmission (1.0) yes



Description of Dozer Use	
Average dozing distance (feet)	300
Hourly production (from chart)	1100
Grade (in percent)	0
Grade Correction	1
Material Unit Weight (lb/lcy)	2800
Density Correction	0.82

Productivity Adjustment Factors

Operator Factor	
Is operator excellent (1)	no
Is operator average (.75)	yes
Is operator poor (.6)	no

Material Factor	
Loose stockpile (1.2)	no
Hard to cut; frozen -	
with tilt cylinder (.8)	no
without tilt cyliner (.7)	no
Normal material (1)	yes
Hard to drift; (.8)	no
Rock, ripped or blasted (.75)	no

Production Method/Blade Factor	
Slot dozing (1.2)	no
Side by side dozing (1.2)	no
Normal dozing (1.0)	yes

Poor Visibility	
(I.e., dust, rain, snow, fog, or darkness) (0.8)	no

Elevation Factor	
<7,500 feet (1.0)	yes

Quantity of Material to be Moved	
Total (cy)	8,333

Productivity Adjustment Factor = 0.75 (Operating Factor) x 1.0 (Material Factor) x 1.0 (Grade Factor) x 0.82 (Density Correction) x 1.00 (Production Method) x 1.00 (Visibility) x 1.00 (Elevation) x 1.00 (Direct Drive Trans) = **0.62**

Net Hourly Production = 1,100 (Normal Hourly Production (see graph above)) x 0.62 (Productivity Adjustment Factor) = **676.5 cy/hr**

Hours Required = 8,333 (Total (cy) Volume to be Moved) / 676.5 (Net Hourly Production) x 1.371 (Work Schedule Factor) = **17 Hours**

Culvert (ft)	0
Culvert Disposal Cost (at $0.23/cf)	$0

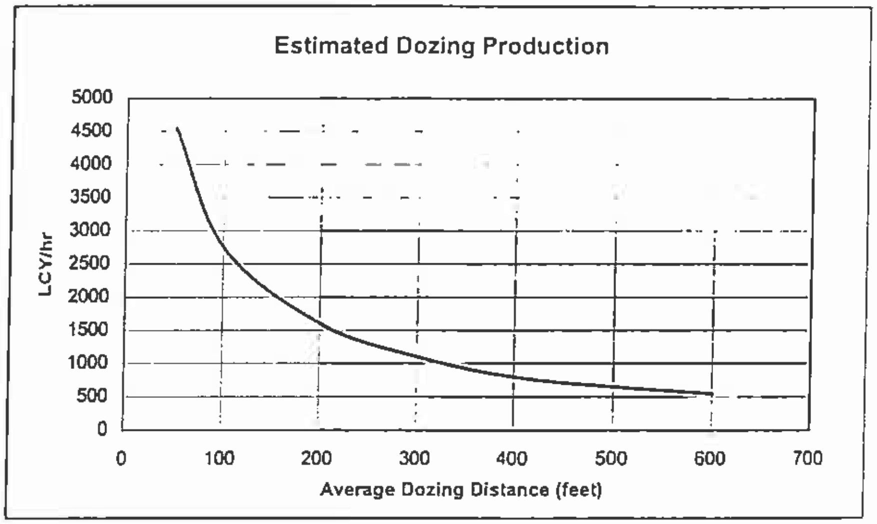
Note: Quantity of material and culvert are 60% of total for Kayenta portion of the cost.

References: Cat Handbook, Ed. 28

Table:	24-5-33b
Mine Area:	Kayenta Ancillary Roads
Project:	Surfacing Removal - N14 East
Task:	Surfacing Removal/Disposal
Equipment:	D11R Dozer

Earthmoving Activity:
Push one foot of gravel/scoria off the side of the road for burial

Characterization of Dozer Used (type, size, etc):
D11R, three-shank ripper, U-blade
Power shift transmission (1.0) yes



Description of Dozer Use	
Average dozing distance (feet)	50
Hourly production (from chart)	4550
Grade (in percent)	0
Grade Correction	1
Material Unit Weight (lb/lcy)	2800
Density Correction	0.82
Productivity Adjustment Factors	
Operator Factor	
Is operator excellent (1)	no
Is operator average (.75)	yes
Is operator poor (.6)	no
Material Factor	
Loose stockpile (1.2)	no
Hard to cut; frozen -	
with tilt cylinder (.8)	no
without tilt cyliner (.7)	no
Normal material (1)	no
Hard to drift; (.8)	yes
Rock, ripped or blasted (.75)	no
Production Method/Blade Factor	
Slot dozing (1.2)	no
Side by side dozing (1.2)	no
Normal dozing (1.0)	yes
Poor Visibility	
(I.e., dust, rain, snow, fog, or darkness) (0.8)	no
Elevation Factor	
<7,500 feet (1.0)	yes
Quantity of Material to be Moved	
Length (ft)	9,000
Width (ft)	25
Total (cy)	8,333

Productivity Adjustment Factor = 0.75 (Operating Factor) x 0.8 (Material Factor) x 1.0 (Grade Factor) x 0.82 (Density Correction) x 1.00 (Production Method) x 1.00 (Visibility) x 1.00 (Elevation) x 1.00 (Direct Drive Trans) = **0.49**

Net Hourly Production = 4,550 (Normal Hourly Production (see graph above)) x 0.49 (Productivity Adjustment Factor) = **2238.6 cy/hr**

Hours Required = 8,333 (Total (cy) Volume to be Moved) / 2238.6 (Net Hourly Production) x 1.371 (Work Schedule Factor) = **5 Hours**

References: Cat Handbook, Ed. 28

Table:	24-5-34b
Mine Area:	Kayenta Ancillary Roads
Project:	Surface Ripping - N14 East
Task:	Dozer Ripping
Equipment:	D11R Dozer - Ripper Equipped

Earthmoving Activity

Rip 3' of subbase to aid in vegetation establishment.

Characterization of Dozer and Ripper Used:

D11R, three shank ripper, semi-u blade

Description of Ripping (ripping depth, cut spacing, cut length, and material to be ripped):

Rip depth (ft)	3
Cut spacing (ft/pass)	6.4
Cut length (ft)	300
Speed (ft/min)	120

Quantity of Material to be Ripped

Length (ft)	9000
Width (ft)	25
Total (cy)	25000

Cycle Time = 300 (Cut Length) / 120 (Speed Factor (fpm)) + 0.25 (Turn Time) = **2.8 min/pass**

Passes per hour = 60 (min/hr) / 2.8 (Cycle Time) = **21.8 pass/hr**

Volume cut per pass = 3.00 (Tool Penetration) x 6.4 (Cut Spacing) x 300 (Cut Length) / 27 (cf/cy) = **213 bank cy/pass**

Ripping Production = 213 (Volume cut per pass) x 21.8 (Passes per hour) = **4655 hours**

Hours Required = 25,000 (Volume to be Ripped) / 4655 (Ripping Production) x 1.371 (Work Schedule Factor) = **7 hours**

Reference: Cat Handbook, Ed. 28

Table:	24-5-35b
Mine Area:	Kayenta Ancillary Roads
Project:	Grade Ripped Areas - N14 East
Task:	Grading
Equipment:	D11R Dozer

Earthmoving Activity
Grade the cut and fills to blend into surrounding topography and to drain and bury road surface material a minimum of 3'.

Characterization of Dozer Used (type, size, etc)
D11R, three shank ripper, U-blade

Production Rate (acres/shift) 1.0

Acres to be Graded

Length (ft)	9,000
Width (ft)	80
Total (acres)	17

Hours Required	=	17	/	0.125	x	1.371	=	181	Hours
		Area to be Graded (acres)		Net Hourly Production (acres/hr)		Work Schedule Factor			

Note: Production rate based on PWCC experience.

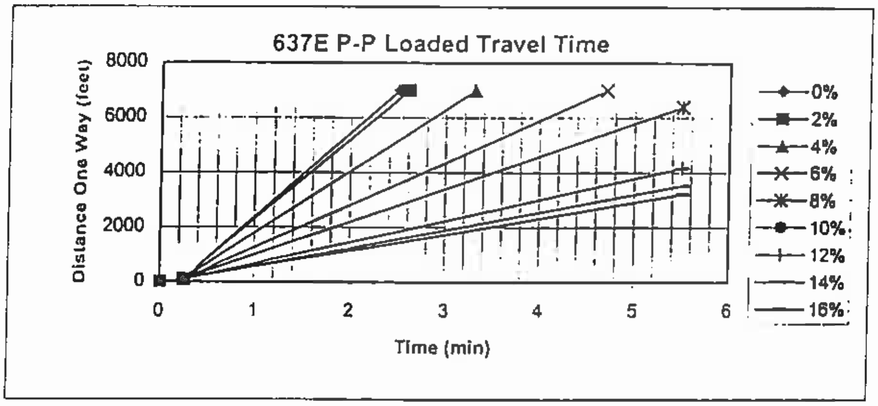
Table: 24-5-36b
Mine Area: Kayenta Ancillary Roads
Project: Topsoil Replacement - N14 East
Task: Haul and Place Topsoil
Equipment: 637E P-P Scraper

Earthmoving Activity
Haul and place 1.6' topsoil to cover graded area.

Characterization of Scraper Used (type, capacity, etc)
637E P-P Scraper - capacity = 31 cy

Description of Scraper Route (haul distance, % grade, average rolling resistance for each segment, etc.)

Loaded Distance (ft)	3000
Loaded Grade (%)	0
Loaded Effective Grade (%)	5
Empty Distance (ft)	3000
Empty Grade (%)	0
Empty Effective Grade (%)	5

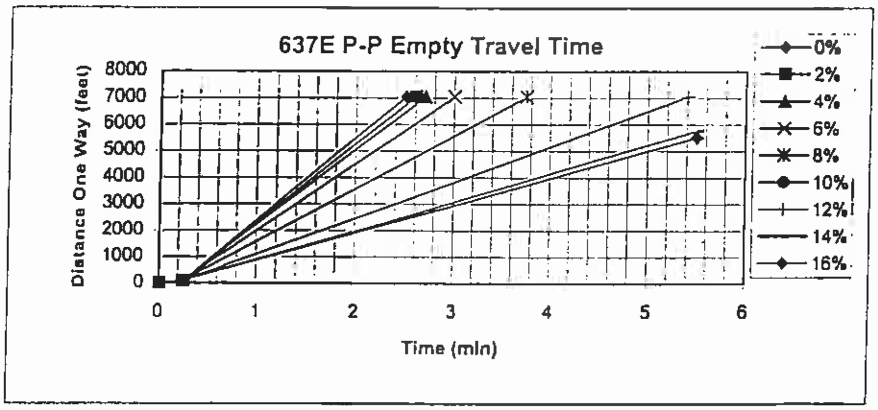


Production Times

Typical Load Time for 657E P-P	1.0
Maneuver and spread or dump	0.6
Loaded Travel Time (from chart)	2.0
Empty Travel Time (from chart)	1.5

Quantity of Material to be Moved

Length (ft)	9,000
Width (ft)	80
Total (cy)	42,667



Cycle Time = 1.0 (Load Time) + 2.0 (Loaded Trip Time) + 0.6 (Maneuver and Spread Time) + 1.5 (Empty Trip Time) = 5.1 min

Cycles/Hour = 60 (min/hr) / 5.1 (Cycle Time) = 12 cycles/hr

Hourly Production = 31 (Adjusted Load (cy)) x 11.76 (Cycles/Hour) = 365 cy/hr

Hours Required = 42,667 (Volume) / 365 (Hourly Production) x 1.371 (Work Schedule Factor) = 160 hrs

Reference: Cat Handbook, Ed. 28

Table:	24-5-37b
Mine Area:	Kayenta Ancillary Roads
Project:	Revegetation - N14 East
Task:	Revegetation
Equipment:	Miscellaneous

Revegetation Area Description
Kayenta Mine ancillary roads

Revegetation Area

Area (acre)	17
Seeding, fertilizing, mulching and fencing costs (per acre)	$954.00
Tree and Shrub Costs (per acre)	$275.00
Reseeding Cost (per acre)'	$807.00
Percent Failure	50%

Revegetation Costs = 17 Acres * ($954.00 $/Acre for seeding, fertilizing, mulching and fencing + $275.00 $/Acre for planting trees and shrubs) = **$20,314**

Reseeding Costs = 17 Acres * 0.5 Failure * $807.00 Reseeding Cost = **$6,669**

References: Table 24-1-3