DESIGN REPORT

Sedimentation Structure

J27-A

Black Mesa Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure J27-A will be a partially incised structure with an earthen embankment, designed and constructed 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 J27-A is shown on Plate 1, Site Plan.

This design report contains information specific to Structure J27-A. 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

The proposed site of Structure J27-A was inspected by a senior geotechnical engineer from Dames & Moore in October, 1985 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.

SITE DESCRIPTION

LAND USE

Structure J27-A has a 162.1-acre tributary drainage area and is located near Moenkopi Wash at the Black Mesa Mine. The watershed is classified as 53% reclaimed, 24% disturbed, 18% Sagebrush/grass, and 5% Pinion/Juniper.

EMBANKMENT

A homogeneous earthen embankment was assumed for the hydraulic analysis and to develop the volume-elevation curve shown on Plate 2. Upstream and downstream slopes of 2:1 and 3:1 (horizontal to vertical), respectively, were used. The assumed slopes were not evaluated for geotechnical considerations such as slope stability since the foundation or embankment material types have not been determined. The incised portion of the structure will be excavated at 3:1 (horizontal to vertical) slopes.

DESIGN ANALYSES

GENERAL

Structure J27-A was designed by an interdisciplinary team of engineers from Dames & Moore. 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 Coal

Company files includes topographic maps developed from aerial photography flown in 1983 for Peabody Coal Company and was used in the analyses of the structure.

STABILITY

The slopes of Structure J27-A will be chosen based on the stability analyses performed for existing structures in the General Report. The embankment fill materials and the type of foundation will be identified in the field and the stable slopes chosen based on the category classification of the structure.

HYDROLOGY

The hydrologic analysis was completed using the U.S. Army Corps of Engineers generalized computer program HEC-1, Flood Hydrograph Package. Structure J27-A 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 J27-A was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1. Water Course length, L . . . .   0.862 mi
2. Elevation Difference, H 200   ft
3. Time of Concentration, T_c . . . .   0.284 h
4. Lag time, $0.6T_c$ . . . .   0.171 h
5. SCS Curve Number 83
6. Rainfall Depth, 10-year, 24-hour storm .   2.1   in.
                   25-year, 6-hour storm. .   1.9   in.
7. Drainage Area . . . . 162.1   acres

HYDRAULICS

The HEC-1 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.

	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	154	177	
Volume	acre-ft	10.13	7.97	
Storage				
Peak Stage	ft	6407.51	—	
Spillway Elevation . .	ft	6411.50	--	
Peak Storage	acre-ft	10.11	—	
Storage Capacity . . .	acre-ft	15.00	--	
Outflow				
Peak Flow	cfs	0	109	
Embankment Crest				
Elevation	ft	--	6415.00	
Peak Stage	ft	—	6413.66	
Freeboard	ft	—	1.34	
Spillway Channel				
Flow Depth	ft	—	2.16	
Critical Velocity. . .	fps	—	5.5	
Manning's "n"		—	0.040	
Outflow Channel			Section I	Section II
Slope	%	--	7	28
Normal Velocity. . . .	fps	--	7.8	12.2
Normal Depth	ft	—	0.81	0.54
Manning's "n"		--	0.040	0.040

Spillway Channel

The spillway for J27-A will be a trapezoidal channel with the following dimensions:

```
Channel depth . . . . . . . . . . . . . . 3.2 ft
Channel width . . . . . . . . . . . . . . 15   ft
Channel length  . . . . . . . . . . . . . 30   ft
Side slopes (horizontal to vertical). . 3:1
Average exit slope  . . . . . . . . . .  0    percent
```

Outflow Channel

The outflow channel for Structure J27-A will be a trapezoidal channel with the following dimensions:

```
Channel width . . . . . . . . . . . . . . 15   ft
Channel length  . . . . . . . . . . . . . 150  ft
Side slopes (horizontal to vertical). . 3:1
Average exit slope  . . . . . . . . . . 7-28 percent
```

The alignment of the spillway, outflow channel and stilling basin is shown on Plate 1.   The channel profile is shown on Plate 3 and the required dimensions are shown on Plates 4 and 5.   The spillway, outflow channel and stilling basin should be protected against erosion using geotextile and riprap as shown on Plate 4.

STORAGE CAPACITY

The impoundment volume-elevation curve shown on Plate 2, Volume-Elevation Curve, J27-A is based on site specific topographic data developed for Peabody Coal Company in 1985, and 1985 site specific surveys, where available.

The calculations for the sediment load entering Structure J27-A were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.31
3. Slope Factor, LS 3.49
4. Cover Factor, C 0.339
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 storage capacity of J27-A is shown on Plate 2, Volume-Elevation Curve, J27-A, and the results of the sediment inflow analysis are summarized in the following table.
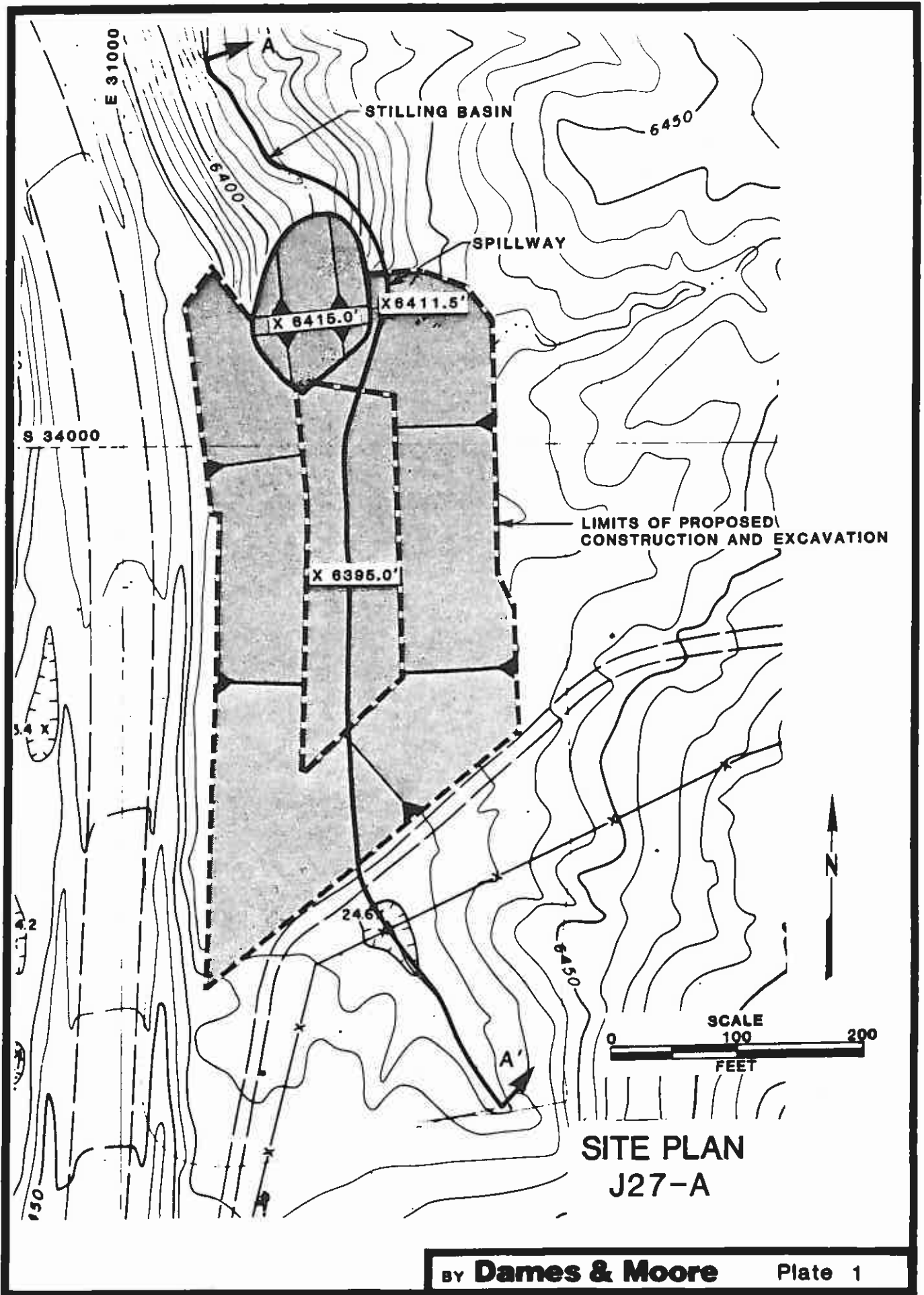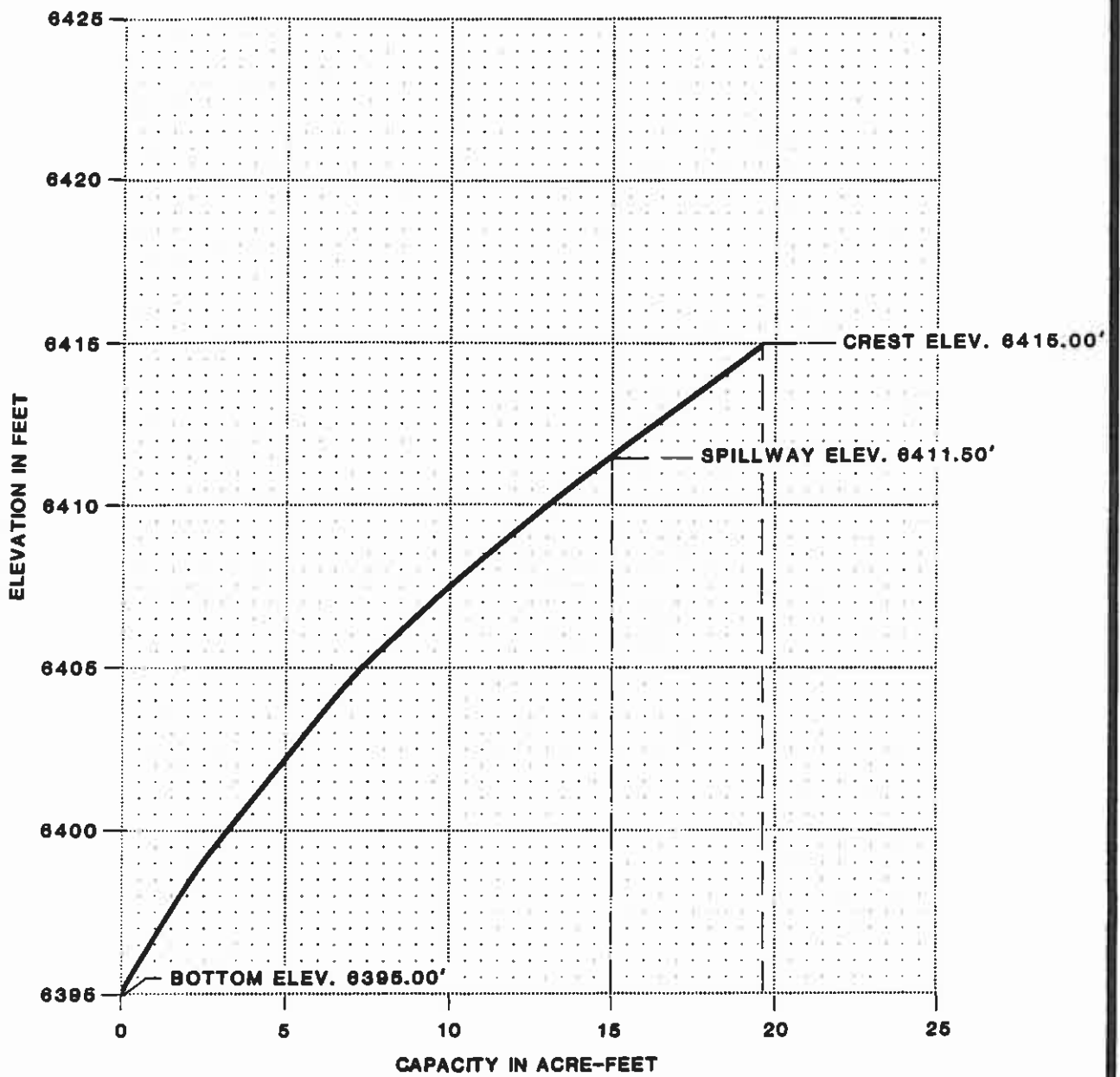
J27-A STORAGE

Total Storage Capacity . . . . 15.00 acre-ft
10-year, 24-hour Storm Inflow . . . . . 10.13 acre-ft
Available Sediment Storage Capacity . . 4.89 acre-ft
Sediment Inflow Rate . . . . 1.05 acre-ft/yr
Sediment Storage Life . . . . 5 yrs

*   *   *
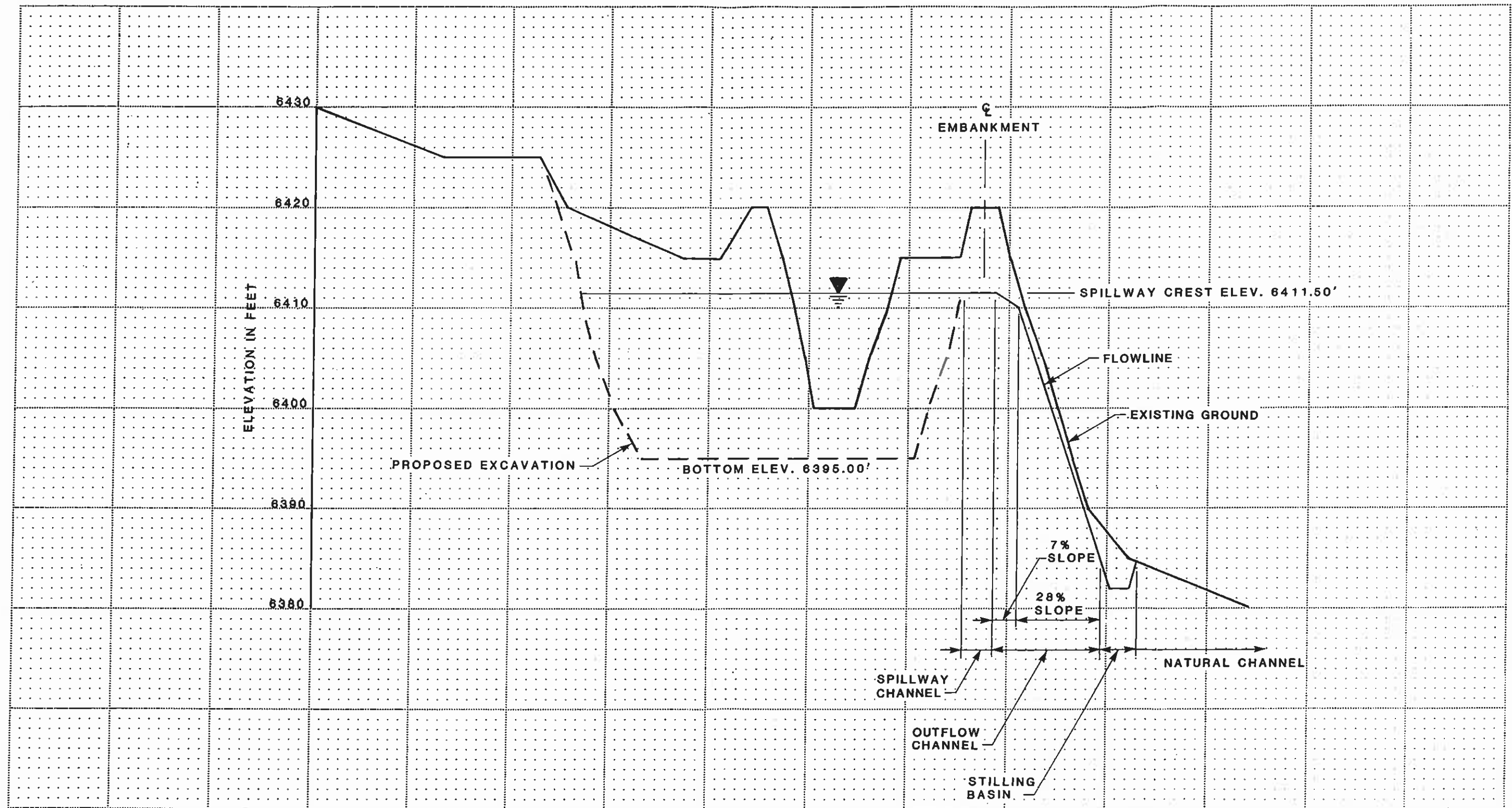
The following plates and appendix are attached and complete this design report.

Plate 1   - Site Plan J27-A

Plate 2   - Volume-Elevation Curve J27-A

Plate 3   - Channel Profile J27-A, A-A'

Plate 4   - Spillway and Outflow Channel Cross Section J27-A

Plate 5   - Spillway Stilling Basin Plan J27-A

Appendix A - Hydrology and Hydraulic Calculations

STILLING BASIN

SPILLWAY

X 6411.5'
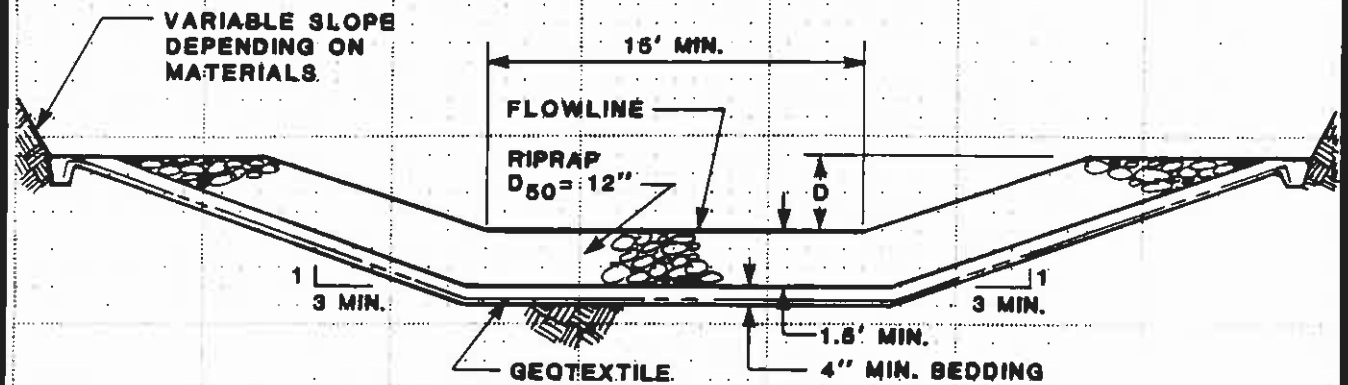
X 6415.0'

X 6395.0'

LIMITS OF PROPOSED
CONSTRUCTION AND EXCAVATION

E 31000

6450

6400

S 34000

6450

6450

N

SCALE

0   100   200

FEET

SITE PLAN
J27-A

BY **Dames & Moore**   Plate 1

VOLUME-ELEVATION
CURVE
J27-A

CHANNEL PROFILE A-A'
J27-A

ELEVATION IN FEET

6430
6420
6410
6400
6390
6380

₵ EMBANKMENT

SPILLWAY CREST ELEV. 6411.50'

FLOWLINE

EXISTING GROUND

PROPOSED EXCAVATION

BOTTOM ELEV. 6395.00'

7% SLOPE

28% SLOPE

NATURAL CHANNEL

SPILLWAY CHANNEL

OUTFLOW CHANNEL

STILLING BASIN

SCALE
0   100   200
FEET

VARIABLE SLOPE
DEPENDING ON
MATERIALS.

16' MIN.

FLOWLINE

RIPRAP
$D_{50} = 12"$

D

1
3 MIN.

1
3 MIN.

1.5' MIN.

4" MIN. BEDDING

GEOTEXTILE.

SPILLWAY CHANNEL

D = 3.2'
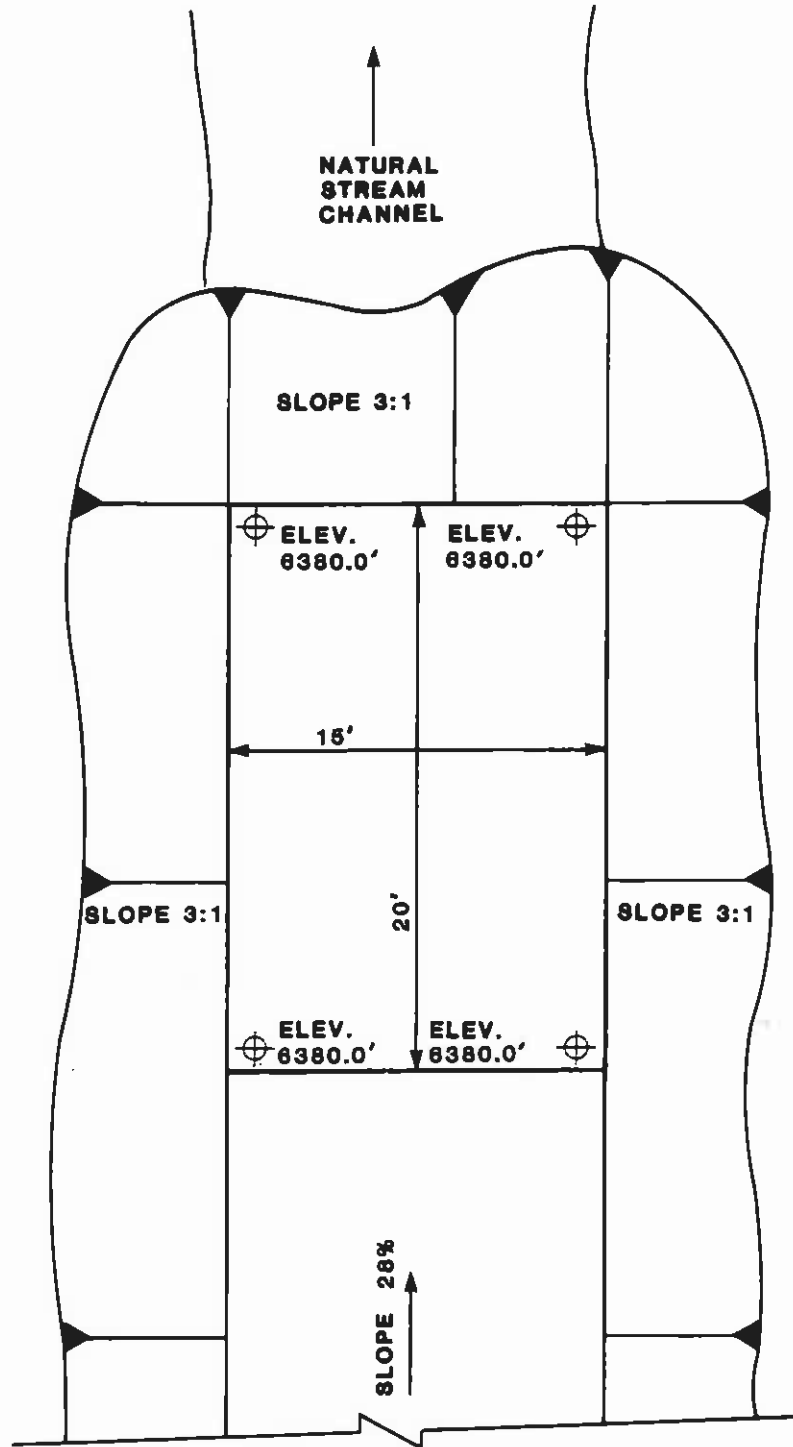LENGTH = 30'
FLOWLINE ELEV. = 6411.50'

OUTFLOW CHANNEL

D = 2.0'

SPILLWAY AND
OUTFLOW CHANNEL
CROSS SECTION
J27-A

NATURAL
STREAM
CHANNEL

SLOPE 3:1

⊕ ELEV.
6380.0'

ELEV.
6380.0' ⊕

15'

SLOPE 3:1

20'

SLOPE 3:1

⊕ ELEV.
6380.0'

ELEV.
6380.0' ⊕

SLOPE 28%

MINIMUM HEIGHT OF RIPRAP
ALONG SIDEWALLS ABOVE
THE BASIN FLOOR = 6.0'

MINIMUM DEPTH OF BASIN FLOOR
BELOW NATURAL STREAMBED = 3.1'

SPILLWAY STILLING
BASIN PLAN
J27-A

BY **Dames & Moore** Plate 5

APPENDIX A

HYDROLOGY AND HYDRAULIC CALCULATIONS

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6596 − 6396 = 200' ✓

WATER COURSE LENGTH = 4550' = .862 mi ✓

T_c = 0.284 ✓

LAG TIME = $0.6 T_c$ = 0.171 hr (.170)

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
30.0	S-G	fair	D	70 (.18)
8.5	P-J	fair	D	80 (.05)
38.2	d.s. mined (and)	—	—	89 (.24)
85.4	reclaimed (~0, 15"- 5' c'). law	—	—	$[.5(81) + .5(37)](.53)$

$$82.48$$

use 82 ✓

DRAINAGE BASIN AREA

162.1 ACRE   0.253 SQ MILE ✓

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

$R = 40$

SOIL ERODIBILITY FACTOR

SOIL TYPE =	53%	EH #35	(.53)(.42)
	47%	EH #23	(.47)(.18)
			.307 ✓

$K = .31$

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
850'	35	4.1	1.0 (.5) ✓
400'	45	11.2	3.3 (.3) ✓
600	120	20	9.99 ~~10.33~~ (.2)
			3.56 ≃ 49

COVER FACTOR

AREA (ac)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
18%	S-G	60	25	(.082)(.18)
5%	P-J	60	25	(.085)(.05)
24%	disturbed	—	—	1.0 (.24)
53%	reclaimed	—	—	(.15)(.53)
				0.339 ✓

EROSION CONTROL FACTOR

$P = 1.0$

SEDIMENT INFLOW

$$A = 40(.31)(\overset{349}{\underset{3.56}{3.58}})(.339)(1.0) = \overset{14.67}{14.96} \quad \text{ton/acre/year}$$

$$A = 14.96 \left(\frac{1}{2047} \right)(162.1)(.9) = \overset{1.05}{1.07} \quad \text{acre-feet/year}$$

Dames & Moore