INSPECTION REPORT

Sedimentation Structure

N10-A

Kayenta Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure N10-A is an earthen embankment, designed and constructed in 1982 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 N10-A is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure N10-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

Structure N10-A was inspected on September 7, 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 N10-A project files and a field inspection of the structure. The most current information contained in the Peabody Coal Company files includes maps

developed in 1985 by Peabody Coal Company, which were 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 N10-A has a 625.1-acre tributary drainage area and is located near Coal Mine Wash at the Kayenta Mine. The watershed is classified as 60% Pinion/Juniper, 35% reclaimed, and 5% Sagebrush/grass.

EMBANKMENT

Structure N10-A is a homogeneous earthen embankment classified as a cross-valley embankment. Physical characteristics of the embankment are listed in the following table:

Structure N10-A

```
Embankment . . . . . . Mine Waste
Foundation . . . . . . Sandstone
Right Abutment . . . . Residual Shale Soils
Left Abutment  . . . . Mine Waste
Height . . . . . . . . 14.6 ft
Crest Width  . . . . . 15   ft
Upstream Slope . . . . 4.0 H : 1 V
Downstream Slope . . . 3.5 H : 1 V
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A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section N10-A, A-A'.

ANALYSES

STABILITY

Structure N10-A is an embankment that does not fit into the eleven categories outlined in the "General Report". Since extensive reconstruction is necessary to correct deficiencies found during the inspection and the hydrologic and hydraulic analyses, a stability analyses was not performed at this time. During reconstruction the embankment material can be classified, the structure placed into its proper category and safe slopes selected.

HYDROLOGY

The hydrologic analysis was completed using the U.S. Army Corps of Engineers generalized computer program HEC-1, Flood Hydrograph Package. Structure N10-A is located upstream from Structures N10-A1 and N10-A2. The three structures have a combined storage capacity that is greater than 20 acre-feet. However, the spillway for N10-A was analyzed using the 25-year, 6-hour storm because the structure is located upstream of the others. The storage capacity of Structure N10-A was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1. Water Course length, L . . . . 1.69 mi
2. Elevation Difference, H 500   ft
3. Time of Concentration, T_c . . . . 0.435 h
4. Lag time, $0.6T_c$ . . . . 0.261 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 . . . . 625.1 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.

	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	486	544
Volume	acre-ft	39.1	30.7
Storage			
Peak Stage	ft	6688.32	—
Peak Storage	acre-ft	--	--
Storage Capacity . . .	acre-ft	14.0	--
Outflow			
Peak Flow	cfs	213	481
Embankment Crest			
Elevation	ft	--	6690.40
Peak Stage	ft	--	6689.40
Freeboard	ft	--	1.0
Spillway Channel			
Flow Depth	ft	--	3.4
Critical Velocity. . .	fps	--	7.2
Manning's "n"		--	0.040

Outflow Channel			Section I	Section II
Slope	%	--	6	23
Normal Velocity. . . .	fps	--	10.4	15.9
Normal Depth	ft	--	1.37	0.92
Manning's "n"		—	0.040	0.040

Spillway Channel

The structure presently has no spillway.

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, N10-A.

The calculations for the sediment load entering Structure N10-A were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.271
3. Slope Factor, LS 7.13
4. Cover Factor, C 0.156
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 N10-A and the results of the sediment inflow analysis are summarized in the following table.

N10-A STORAGE

Total Storage Capacity	14.0	acre-ft
10-year, 24-hour Storm Inflow	39.1	acre-ft
Available Sediment Storage Capacity	0	acre-ft
Sediment Inflow Rate	3.31	acre-ft/yr
Sediment Storage Life	0	yrs

Although Structure N10-A does not have any sediment storage capacity by itself, there are two structures downstream which operate in series with N10-A. Therefore the combined sediment storage capacity was analyzed. The following table summarizes the results.

COMBINED STORAGE FOR N10-A, N10-A2, AND N10-A1

	N10-A	N10-A2	N10-A1	Total	
Total Storage Capacity	14.00	24.59	12.20	50.79	acre-ft
10-year, 24-hour Storm Inflow	39.10	2.50	0.98	42.58	acre-ft
Available Sediment Storage Capacity	—	—	—	8.21	acre-ft
Sediment Inflow Rate	3.31	0.528	0.238	4.08	acre-ft/yr
Sediment Storage Life	0	—	—	2.0	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure N10-A indicated that geotechnical problems consist of rill erosion on the upstream and downstream slopes and a 30-foot-long crack on the crest and downstream slope of the embankment near the left abutment. Correction of erosion is considered a periodic maintenance task and does not require remedial action. Extensive reconstruction of the embankment is recommended to repair the cracking evident near the left abutment. At that time the embankment can be classified and safe slopes selected.
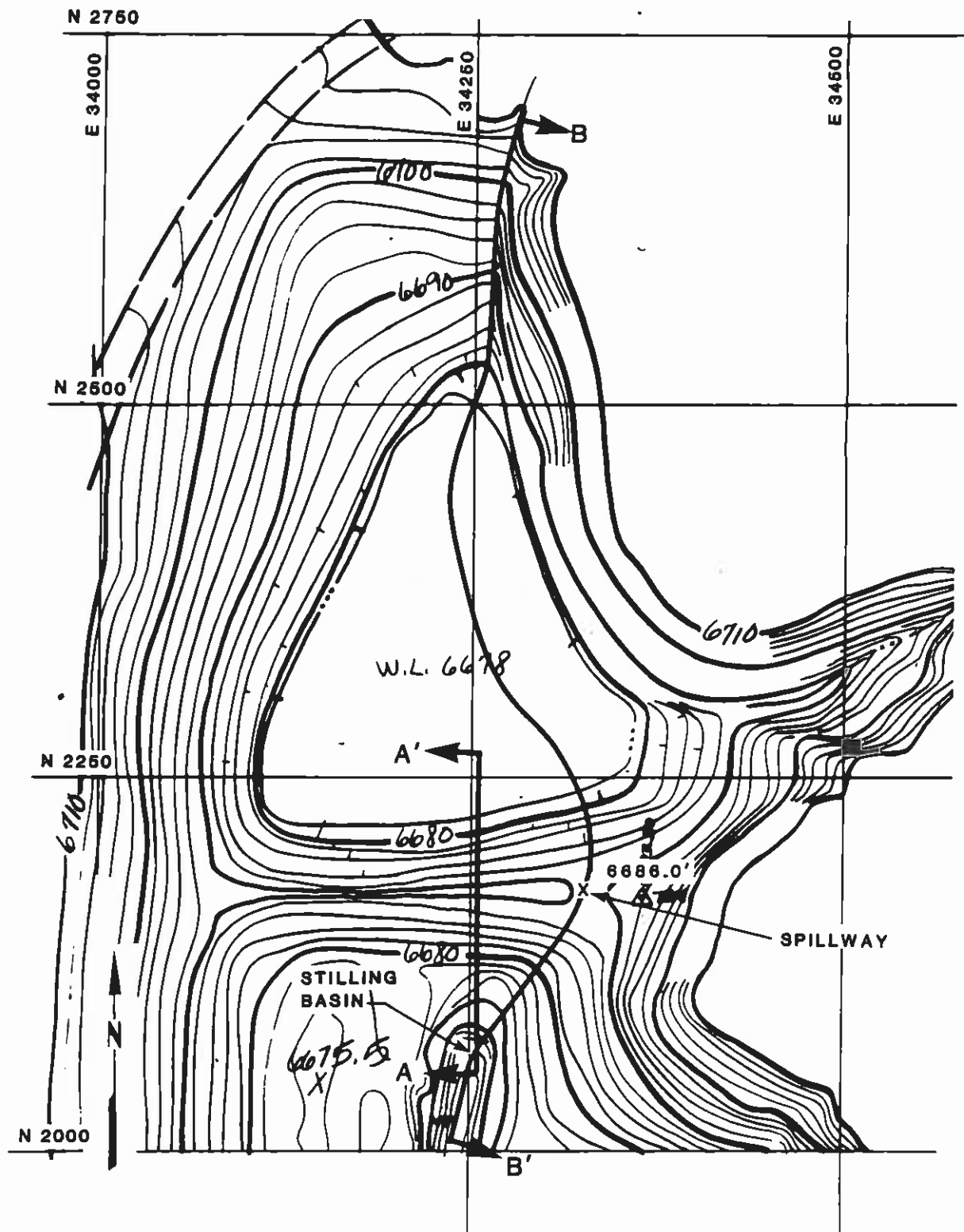
HYDRAULICS

Structure N10-A has sufficient storage capacity but it does not have a spillway or outflow channel. A trapezoidal spillway channel should be constructed at elevation 6686.0 feet. A trapezoidal outflow channel with the same bottom width as the spillway should be constructed along the alignment shown in Plate 1. The spillway, outflow channel and stilling basin profile is shown in Plate 4 and the required dimensions are shown in Plate 5 and Plate 6. Both the spillway and outflow channel should be protected against erosion using geotextile and riprap as shown in Plate 5.
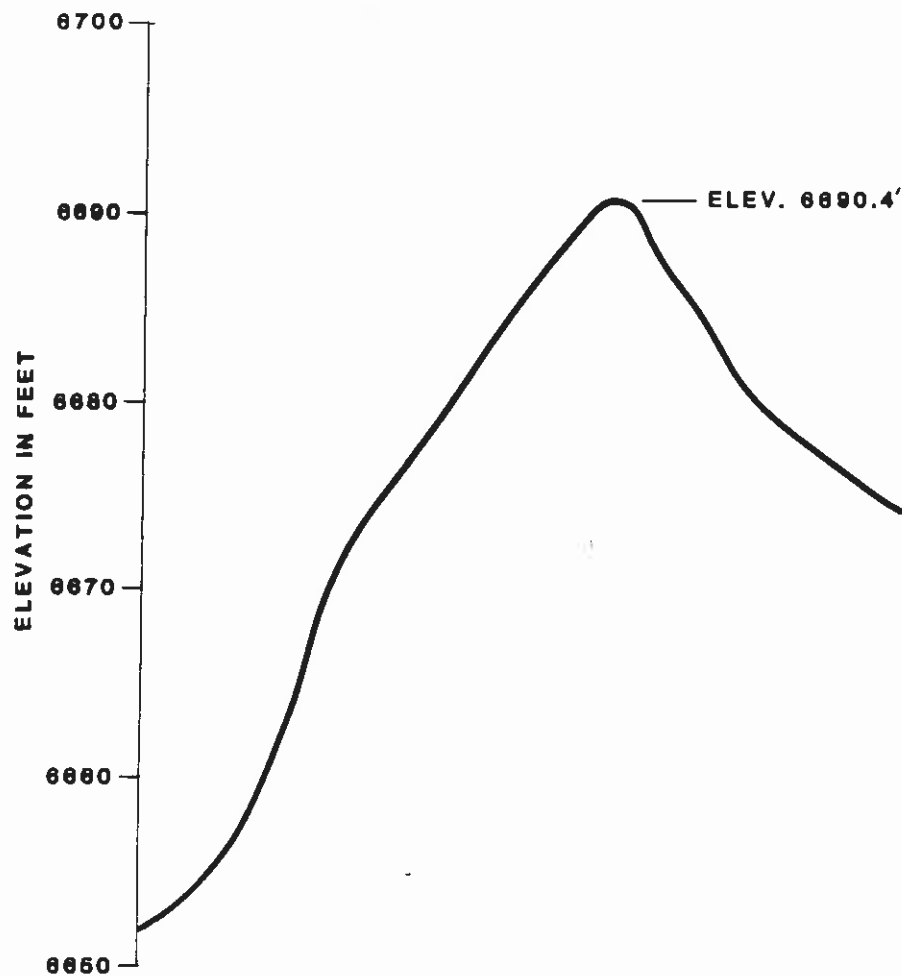
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The following plates and appendix are attached and complete this inspection report.

Plate 1   - Site Plan N10-A

Plate 2   - Existing Maximum Cross Section N10-A, A-A'

Plate 3   - Volume-Elevation Curve N10-A

Plate 4   - Channel Profile N10-A, B-B'

Plate 5   - Spillway and Outflow Channel Cross Section N10-A

Plate 6   - Spillway Stilling Basin Plan N10-A

Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations

N 2750

E 34000

E 34250

E 34500

B

6700

6690

N 2500

6710

W.L. 6678

A'

N 2250

6710

6680

6686.0'

X

SPILLWAY

6680

STILLING
BASIN

6675.5
X

A

B'

N 2000

N

SITE PLAN
N10-A

SCALE
0   100   200
FEET

ELEVATION IN FEET

6700

6690 — ELEV. 6690.4'

6680

6670

6660

6650

EXISTING
MAXIMUM CROSS-SECTION
A–A'
N10–A

VOLUME-ELEVATION
CURVE
N10-A

BY **Dames & Moore**   Plate 3

ELEVATION IN FEET

6710

6700

6690

6680

6670

6660

SPILLWAY CREST ELEV. 6686.00'

BOTTOM ELEV. 6686.90'

FLOWLINE

EXISTING GROUND

6% SLOPE

23% SLOPE

SPILLWAY CHANNEL

STILLING BASIN

NATURAL CHANNEL
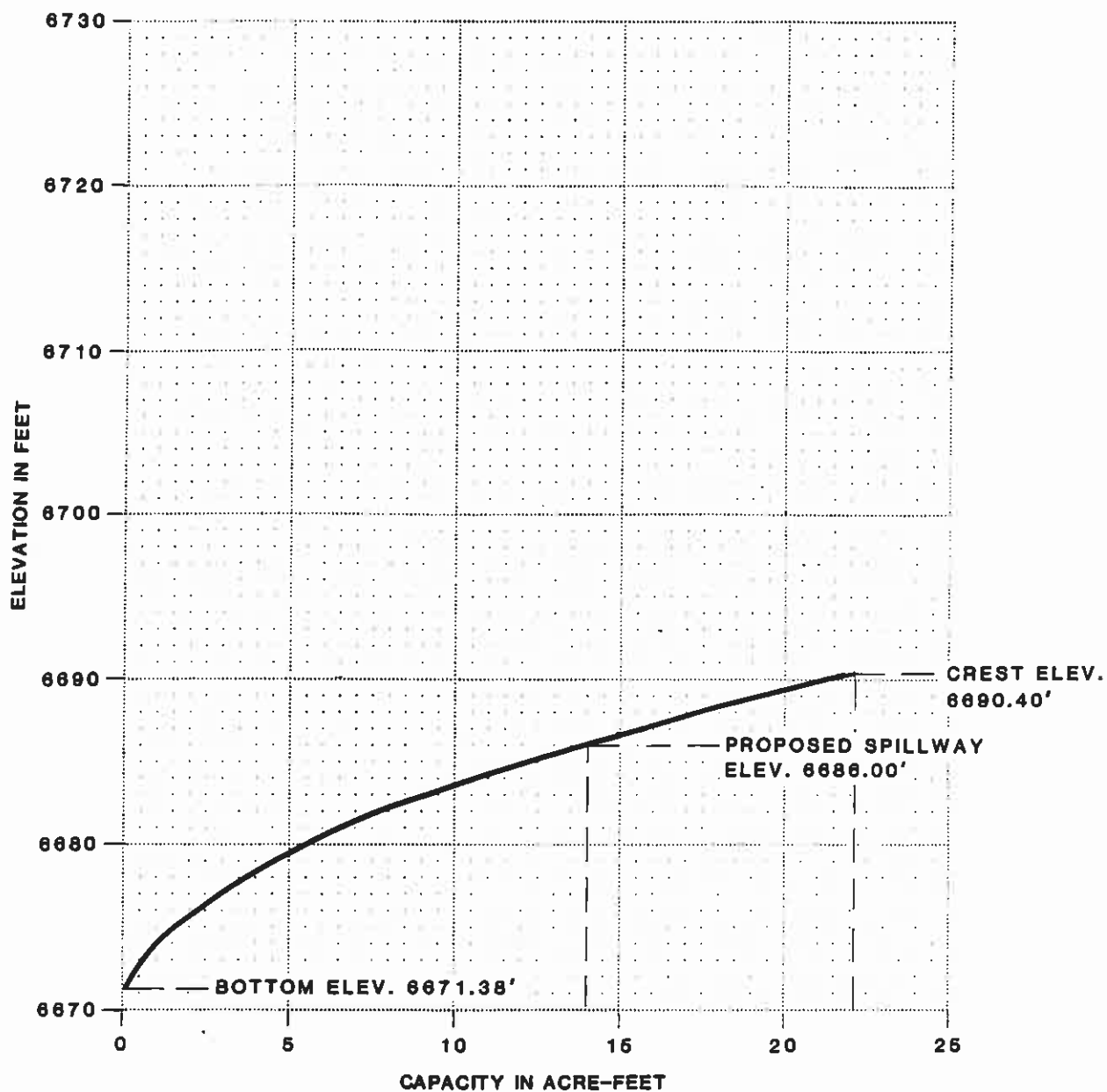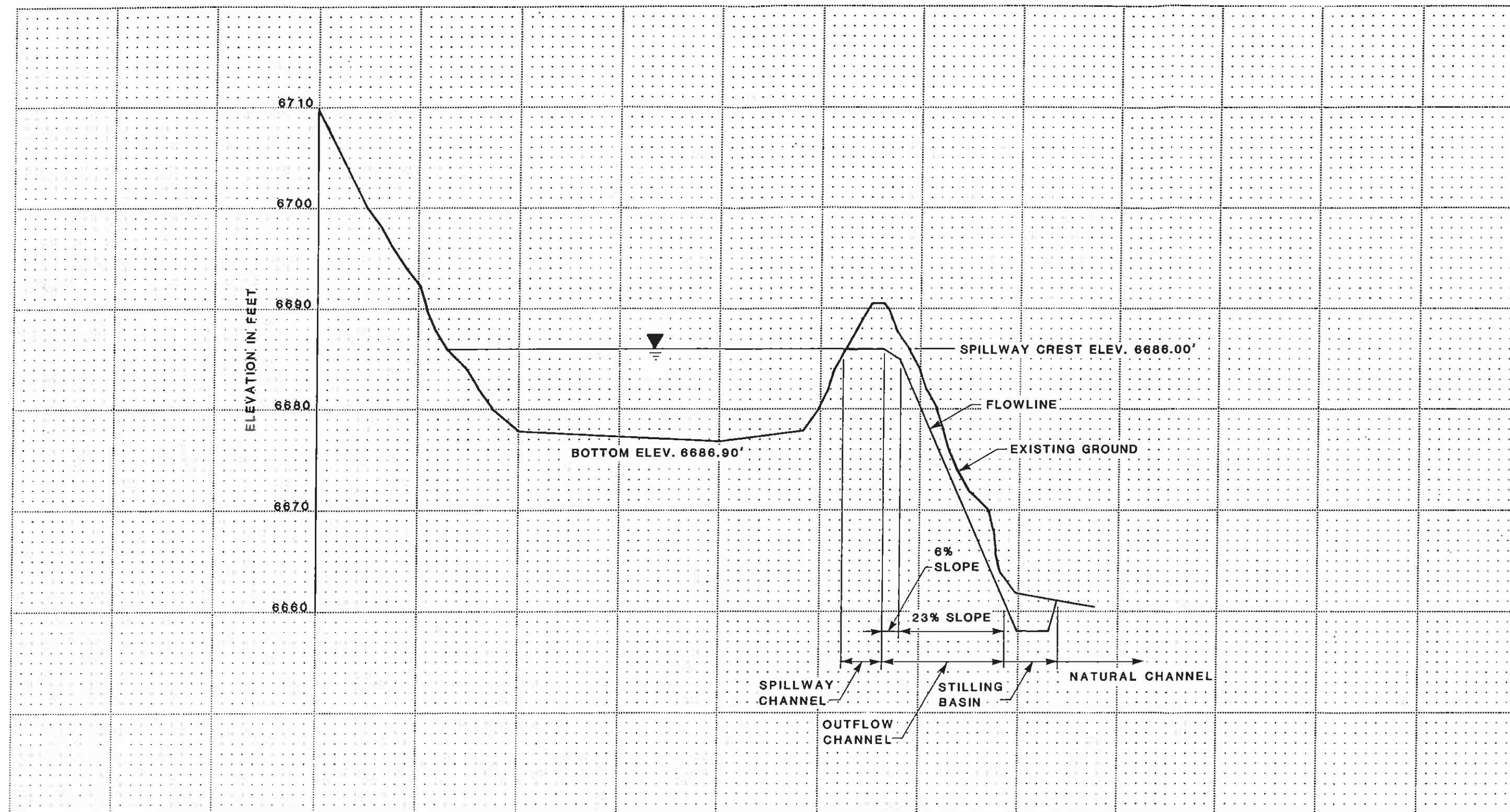
OUTFLOW CHANNEL

CHANNEL PROFILE B-B'
N10-A

SCALE
0   100   200
FEET

BY Dames & Moore   Plate 4

VARIABLE SLOPE
DEPENDING ON
MATERIALS

30' MIN.

FLOWLINE

RIPRAP
$D_{50} = 24''$

D

1
3 MIN.

1
3 MIN.

3'-0" MIN.

4" MIN. BEDDING

GEOTEXTILE
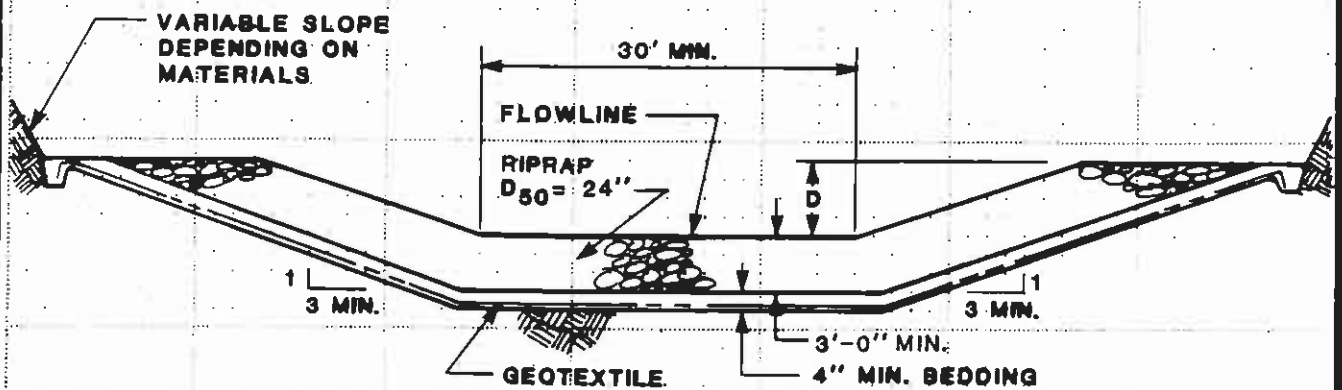
SPILLWAY CHANNEL

D = 4.4'
LENGTH = 40'
FLOWLINE ELEV. = 6686.0'

OUTFLOW CHANNEL

D = 2.5'

SPILLWAY AND
OUTFLOW CHANNEL
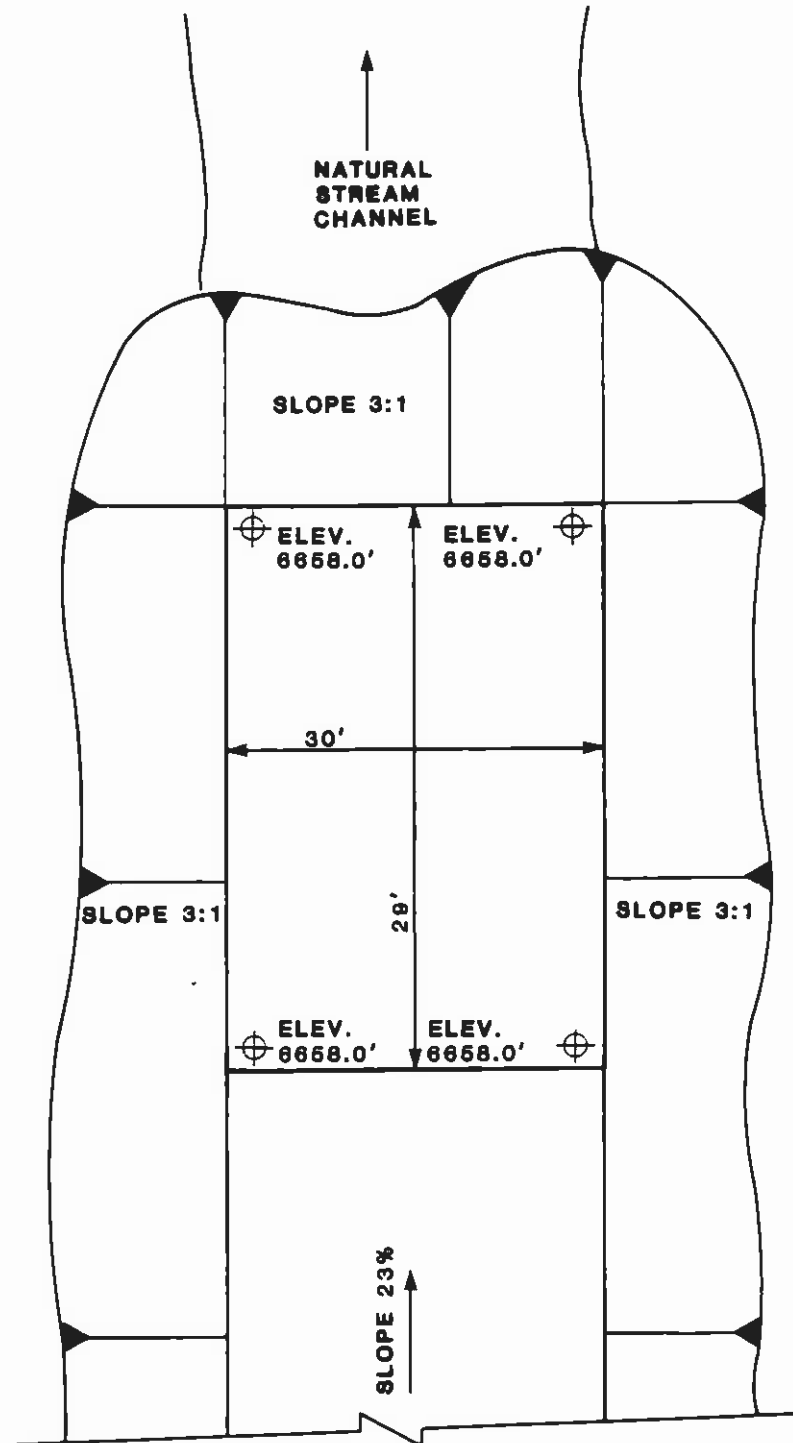CROSS SECTION
N10-A

BY **Dames & Moore**   Plate   5

NATURAL
STREAM
CHANNEL

SLOPE 3:1

⊕ ELEV.
6658.0'   ELEV.
6658.0' ⊕

30'

28'

SLOPE 3:1   SLOPE 3:1

ELEV.
6658.0'   ELEV.
6658.0'

SLOPE 23%

MINIMUM HEIGHT OF RIPRAP
ALONG SIDEWALLS ABOVE
THE BASIN FLOOR = 7.8'

MINIMUM DEPTH OF BASIN FLOOR
BELOW NATURAL STREAMBED = 4.2'

SPILLWAY STILLING
BASIN PLAN
N10-A

APPENDIX A

INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			Rounded ≃ 15' W.
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			14°
a. Adequate grass cover?		X	
b. Any erosion?	X		Rills
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?		X	
g. Any stone deterioration?			NA
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			16°
a. Adequate grass cover?		X	
b. Any erosion?	X		Rills
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?	X		30' long crack near LA
f. Visual depressions or bulges?		X	
g. Visual settlements?		X	
h. Is the toe drain dry?			NA
i. Are the relief wells flowing?			NA
j. Are boils present at the toe?		X	
k. Is seepage present?	X		below toe
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?			Reclaimed Fill
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?			Gray silt & rock

ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			No Spillway
a. Location:			
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?			
7. SPILLWAY/EMERGENCY			
a. Location:			
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?			(Elev.)	feet
b. Water present?	✕		(Elev.)	feet
c. Siltation?			2	
d. Watershed matches soil map?		✕		

9. GENERAL COMMENTS

·SPILLWAY SHOULD BE iN LA , No approach channel
needed, Do need exit channel with riprap.
crest rounded, slopes are to

DAM-Heterogeneous Fill with large rock & brown SM

Deep arroyo d.s. with SS outcrops vertical sides

Bottom of Arroyo near D.S. toe - water present
Potential Seepage thru SS or thru dam.

Crack 30' long transverse near L.A. in d.s. slope up twa.
crest

9.1'

Sketch
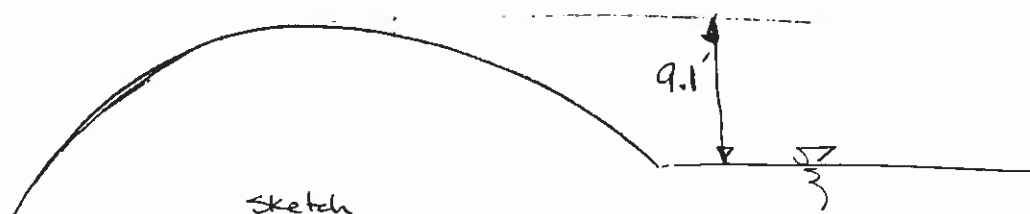
APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

Universal Soil Loss Equation

Rainfall Factor

$$R = 40$$

Soil Erodibility Factor

$$\text{Soil Type} = \begin{array}{ll} 35\% \ \text{EM \#35} & (.35)(.42) \\ 50\% \ \text{EM \#30} & (.5)(.4) \\ 15\% \ \text{EM \#27} & \underline{(.15)(.36)} \\ & 0.271 \ \checkmark \end{array}$$

$$K = \underline{0.271}$$

Slope Factor

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS	
1700'	135	7.9	4.03 ~~2.97~~	(.3)
600'	125	20.8	10.9 ~~5.97~~	(.3)
600'	80	13.3	5.05 ~~4.27~~	(.2)
1400'	80'	5.7	2.30 ~~1.76~~	(.1)
~~800'~~	180'	22.5	14.1 ~~11.50~~	(.1)
			7.13 ~~5.76~~	

Cover Factor

AREA (ac.)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
35%	reclaimed	—	—	.15(.35)
60%	P-J	40.	25	.60(.14)
15%	S-G	40	25	.15(.13)
				0.156 ✓

Erosion Control Factor

$$P = 1.0$$

Sediment Inflow

$$A = 40\,(.271)\,\overset{7.13}{(\cancel{5.76})}\,(0.156)(1.0) = \overset{12.06}{\cancel{9.79}} \quad \text{ton/acre/year}$$

$$A = \overset{12.06}{\cancel{9.79}}\left(\frac{1}{2047}\right)(625.1)(.9) = \overset{3.31}{\cancel{2.64}} \quad \text{acre-feet/year}$$

Dames & Moore

/.7

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = $710' - 6670 = 500'$ ✓

WATER COURSE LENGTH = $8.900' = 1.69$ mi ✓

$T_c = 0.433$ .435

LAG TIME = $0.6 T_c = 0.260$

              .261

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
220.8	reclaimed (pre-law)	poor	—	87 (.35)
375.3	P-J	ave	D	83 (.60)
29.0	S-G	ave	B	60 (.05)
				83.25 ✓
				use 83

DRAINAGE BASIN AREA

625.1 ACRES   0.977 SQ. MILE ✓