

INSPECTION REPORT
Sedimentation Structure
N6-E
Black Mesa Mine
Navajo County, Arizona
for
PEABODY COAL COMPANY



Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure N6-E is a partially incised structure with 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 Black Mesa Mine. The location of Structure N6-E is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure N6-E. 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 N6-E was inspected on September 4, 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 N6-E 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 N6-E has a 82.0-acre tributary drainage area and is located near Coal Mine Wash at the Black Mesa Mine. The watershed is classified as 72% Pinion/Juniper and 25% disturbed.

EMBANKMENT

Structure N6-E is a partially incised structure with a homogeneous earthen embankment classified as a cross-valley embankment. Physical characteristics of the embankment are listed in the following table:

Structure N6-E

Embankment	Residual Sandstone Soil/Scoria
Foundation	Sandstone
Right Abutment	Sandstone/Shale
Left Abutment	Sandstone/Shale
Height	6.1 ft
Crest Width	14 ft
Upstream Slope	2.4 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 N6-E, A-A'.

ANALYSES

STABILITY

Structure N6-E is a category A-5 embankment. A standard category A-5 embankment has static and seismic factors of safety equal to or greater than 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 = 3.25 H : 1 V
4. Normal pool with steady seepage saturation conditions

The N6-E 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 N6-E 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 N6-E was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.402	mi
2.	Elevation Difference, H	107	ft
3.	Time of Concentration, T_c	0.150	h
4.	Lag time, $0.6T_c$	0.090	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	82.0	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. The initial conditions and results of the analysis are summarized in the following table.

N6-E 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	163	210
Volume acre-ft	8.53	7.45
Storage		
Peak Stage ft	6447.89	6458.16
Spillway Elevation . . ft	6456.11	--
Peak Storage acre-ft	8.53	--
Storage Capacity . . . acre-ft	17.0	--
Outflow		
Peak Flow cfs	--	124
Embankment Crest		
Elevation ft	--	6460.58
Peak Stage ft	--	6458.16
Freeboard ft	--	2.42
Spillway Channel		
Flow Depth ft	--	2.05
Critical Velocity . . . fps	--	5.4
Manning's "n"	--	0.040
Outflow Channel		
Slope %	--	26
Normal Velocity fps	--	11.4
Normal Depth ft	--	0.50
Manning's "n"	--	0.040

Spillway Channel

The existing spillway for N6-E has a trapezoidal channel with the following dimensions:

Channel depth	4.2 ft
Channel width	26 ft
Channel length	36 ft
Side slopes (horizontal to vertical). . .	2:1
Average exit slope	0 percent

There is presently partial erosion protection within the channel.

Outflow Channel

The existing outflow channel for N6-E has a trapezoidal channel with the following dimensions:

Channel width	30 ft
Channel length	100 ft
Side slopes (horizontal to vertical). . .	2:1
Average exit slope	34 percent

Rock provides adequate 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, N6-E.

The calculations for the sediment load entering Structure N6-E 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 3.60
4. Cover Factor, C 0.568
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 N6-E and the results of the sediment inflow analysis are summarized in the following table.

N6-E STORAGE

Total Storage Capacity	17.0	acre-ft
10-year, 24-hour Storm Inflow	8.53	acre-ft
Available Sediment Storage Capacity	8.47	acre-ft
Sediment Inflow Rate	0.498	acre-ft/yr
Sediment Storage Life	17	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure N6-E indicated that the only geotechnical problem is rill and gully erosion on the upstream and downstream slopes. Correction of erosion is considered a periodic maintenance task and does not require remedial action. The downstream slope should be flattened to 3.25 horizontal to 1 vertical to meet stability requirements.

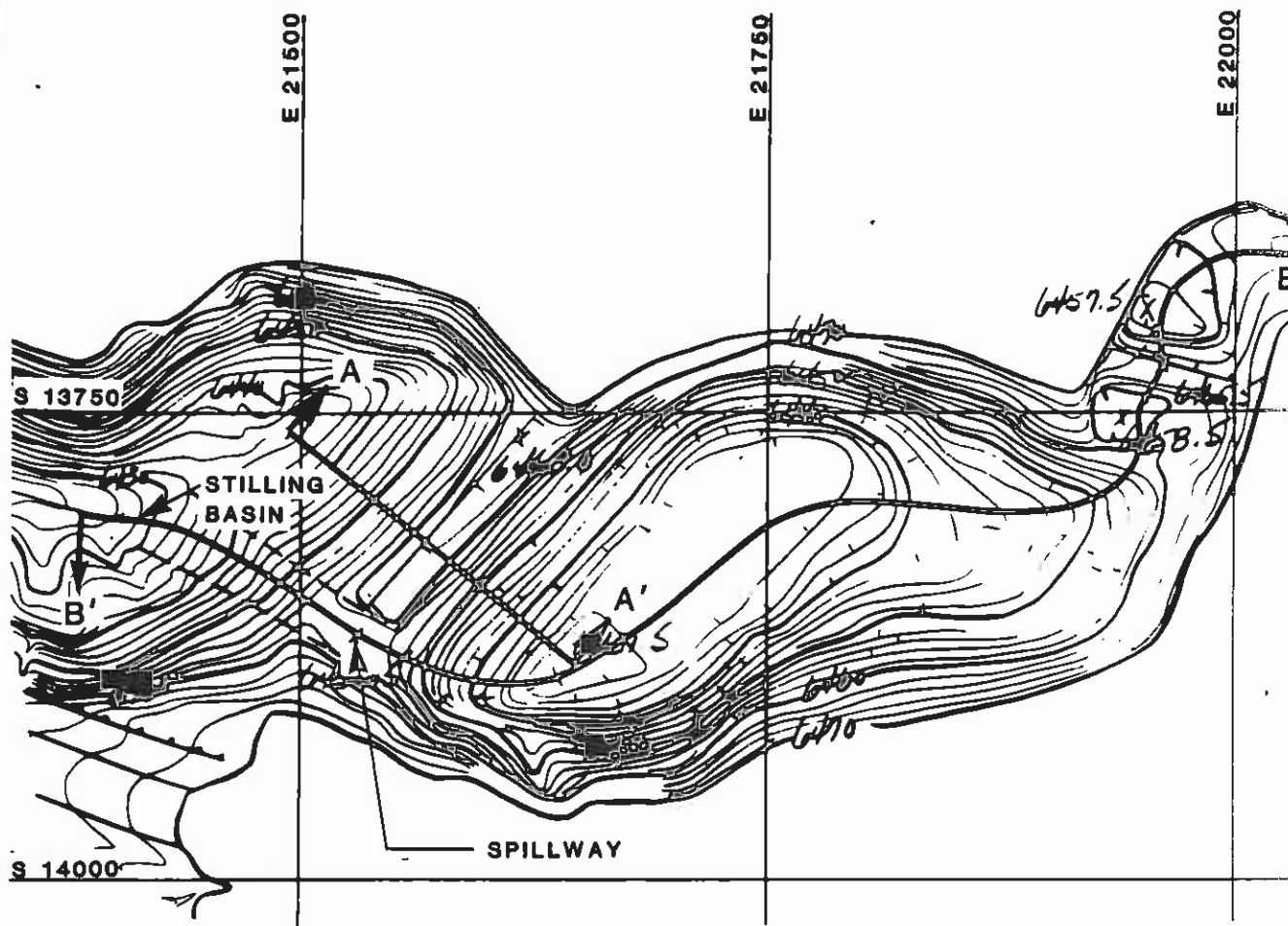
HYDRAULICS

The storage capacity and spillway capacity of Structure N6-E are adequate. The outflow channel is protected with riprap but the spillway channel is only partially protected with riprap. The spillway channel should be protected against erosion using geotextile and riprap as shown in Plate 5. A stilling basin should be constructed to the dimensions shown in Plate 6 and protected against erosion using geotextile and riprap as shown in Plate 5. Plate 4 shows the profile for the existing spillway, outflow channel and proposed stilling basin.

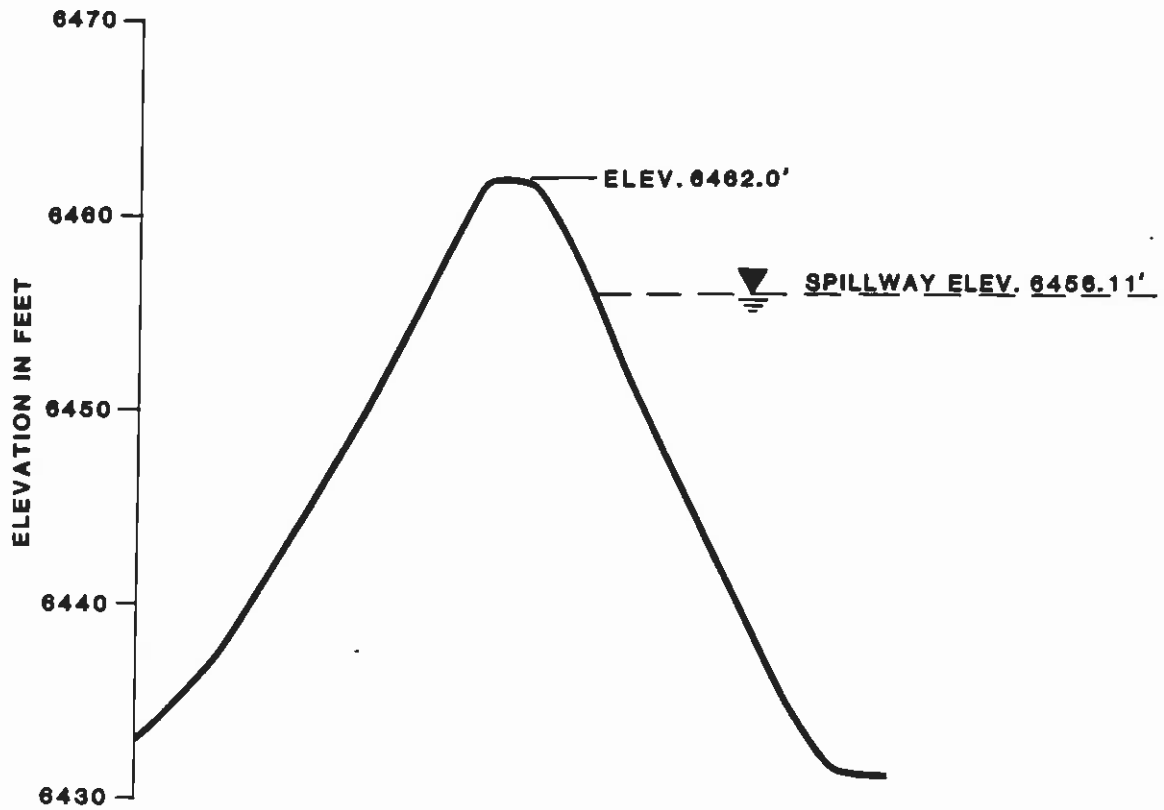
* * *

The following plates and appendix are attached and complete this inspection report.

- Plate 1 - Site Plan N6-E
- Plate 2 - Existing Maximum Cross Section N6-E, A-A'
- Plate 3 - Volume-Elevation Curve N6-E
- Plate 4 - Channel Profile N6-E, B-B'
- Plate 5 - Spillway and Outflow Channel Cross Section N6-E
- Plate 6 - Spillway Stilling Basin Plan N6-E
- Appendix A - Inspection Check List
- Appendix B - Hydrology and Hydraulic Calculations



SITE PLAN
N6-E

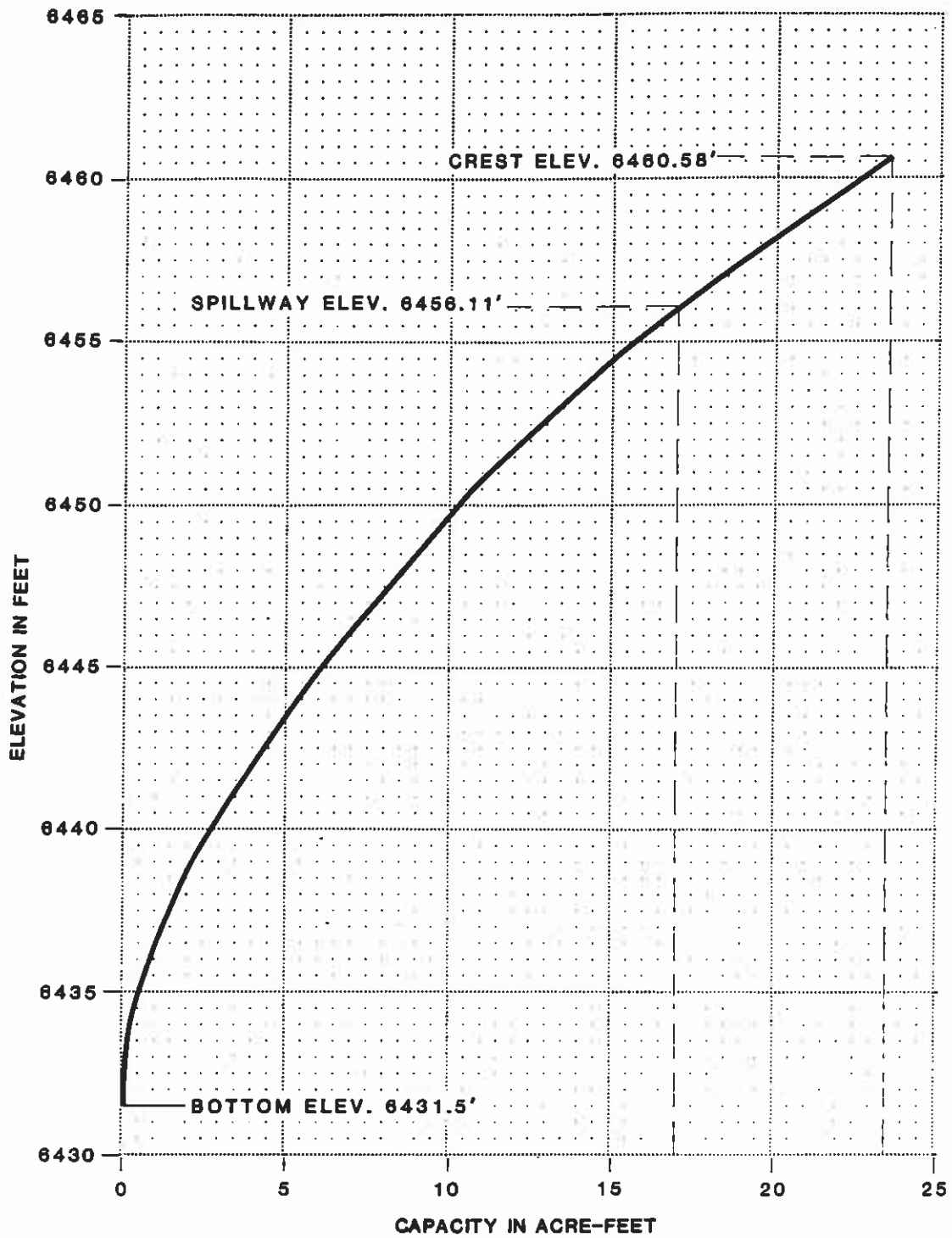


EXISTING
MAXIMUM CROSS-SECTION
A-A'
N6-E

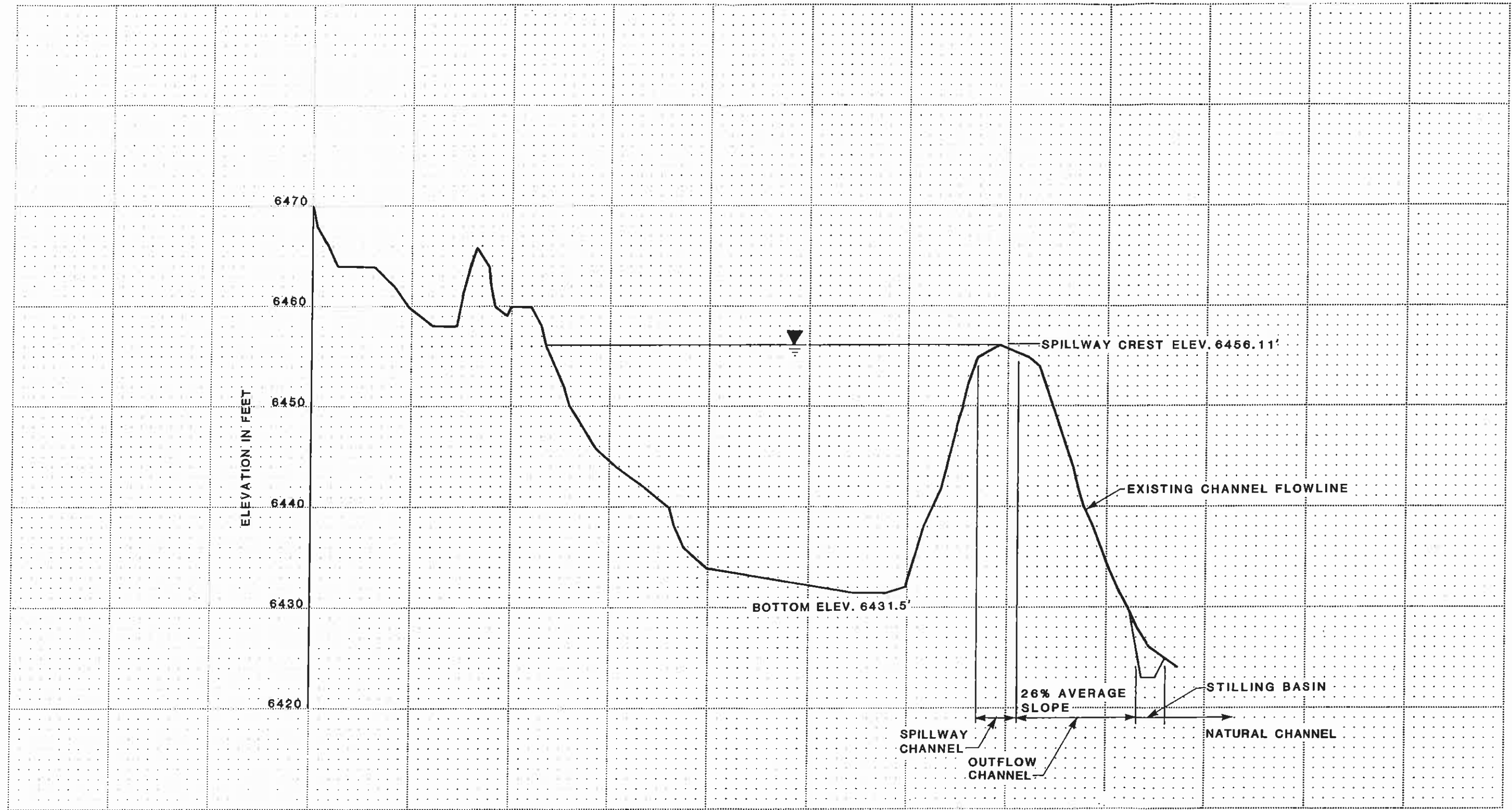
FOR LOCATION SEE PLATE 1

BY **Dames & Moore**

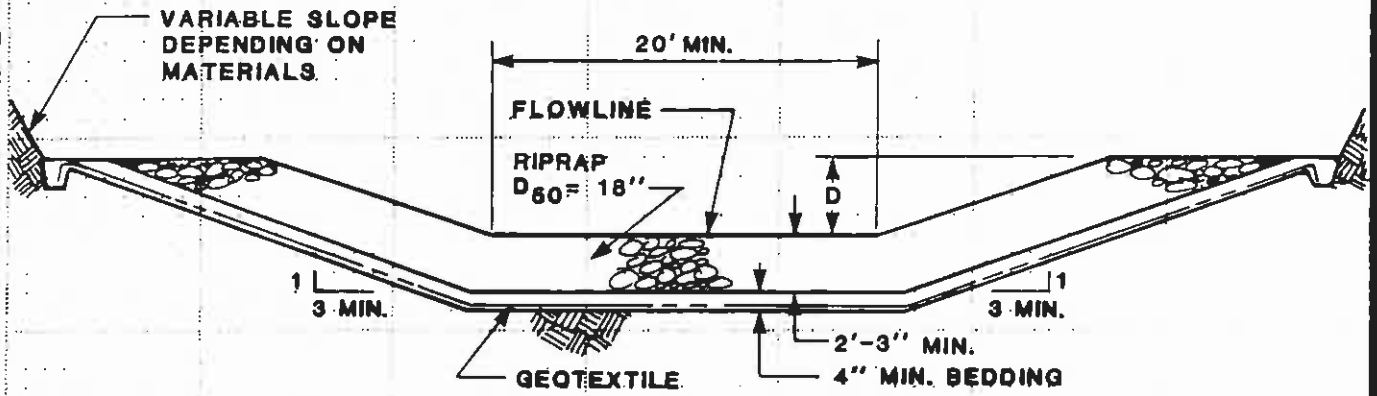
Plate 2



VOLUME-ELEVATION
CURVE
N6-E



CHANNEL PROFILE B-B'
N6-E



SPILLWAY CHANNEL

D = 3.1'

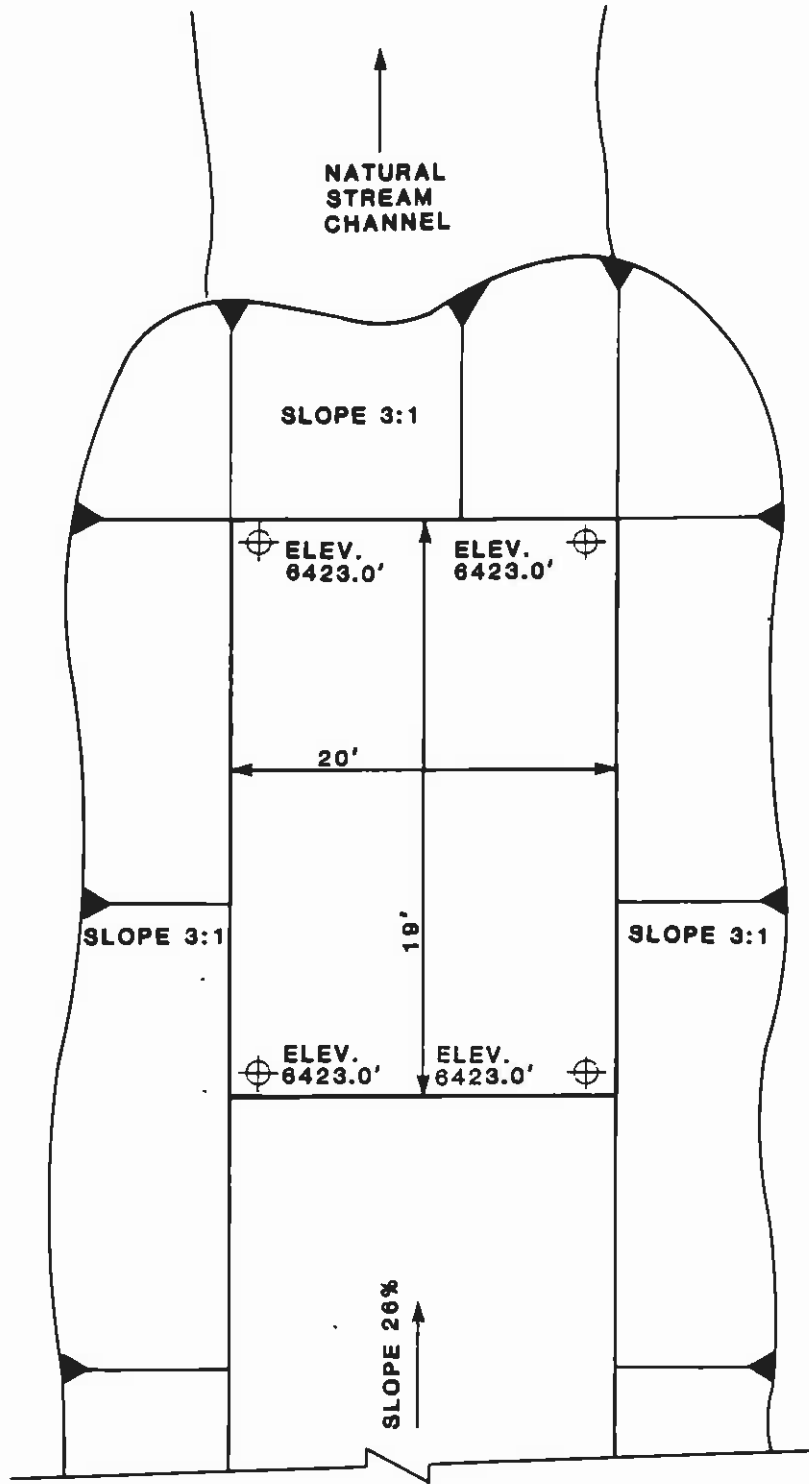
LENGTH = 30'

FLOWLINE ELEV. = 6456.11'

OUTFLOW CHANNEL

D = 1.5'

SPILLWAY AND
OUTFLOW CHANNEL
CROSS SECTION
N6-E



MINIMUM HEIGHT OF RIPRAP
ALONG SIDEWALLS ABOVE
THE BASIN FLOOR = 5.3'

MINIMUM DEPTH OF BASIN FLOOR
BELOW NATURAL STREAMBED = 3.1'

SPILLWAY STILLING BASIN PLAN N6-E

APPENDIX A
INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			23°
a. Adequate grass cover?		X	
b. Any erosion?	X		Gully near L.A. Rill elsewhere
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			21°
a. Adequate grass cover?		X	
b. Any erosion?	X		Rills growing into gulleys
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?			NA
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?			Rock
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?			Rock

ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			
a. Location:			
Left abutment?			
Right abutment?			
Crest of Embankments?	X		Near L.A.
b. Approach Channel:		X	
Are side slopes eroding?			NA
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:	X		
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		1/2 Rock 1/2 No DSU 18"
d. Outflow Channel:	X		
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	Rock DSU 18
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?		<input checked="" type="checkbox"/>	(Elev.) feet
b. Water present?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	(Elev.) feet
c. Siltation?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Could not tell
d. Watershed matches soil map?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Bare 60
9. GENERAL COMMENTS			

CANOPY COVER 20 %
 GROUND COVER 30 %

APPENDIX B
HYDROLOGY AND HYDRAULIC CALCULATIONS

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6563 - 6456 = 107 ft.

WATER COURSE LENGTH = $SS(400) = \frac{2120}{2320}$ ft. = $\frac{0.402}{0.439}$ mi.

$T_c = \frac{(11.9 (0.402 / 0.439)^3)^{0.385} \cdot 0.150 \text{ ME}}{107} = 0.666$ hr.

Lag Time = $0.6 T_c = \frac{0.090 \text{ ME}}{0.100}$ hr.

Note: Length reduced to match future reclamation plan.

Note: TWO CALCULATIONS ON BACK.

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
180 (22%)	Scoria Pit	—	D	0.22(94) = 20.7
569 (72%)	P-J	poor	D	0.72(89) = 64.1
5.1 (6%)	Ham Road	—	D	0.06(91) = 5.5
EH #2d				90.3

Use 91

DRAINAGE BASIN AREA

92.0 ACRES 0.128 SQ MILE

REVISIONS
 BY _____ DATE _____ TO EO _____
 BY _____ DATE _____ TO EO _____

S. DOLAN DATE 9-9-85

CHECKED BY _____

COPY TO EO _____

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

$R = 40$

SOIL ERODIBILITY FACTOR

SOIL TYPE = 100% EH #24 = .16

$K = .16$

SLOPE FACTOR

<u>LENGTH (ft.)</u>	<u>Δ ELEV (ft.)</u>	<u>SLOPE (%)</u>	<u>LS</u>
600	50	8.3	2.58 (.3)
450	75	16.7	6.43 (.3)
700	60	8.6	2.90 (.3)
600	10	1.7	.3 (.10)

use 3.60

COVER FACTOR

<u>AREA (ac)</u>	<u>COVER TYPE</u>	<u>% COVER</u>	<u>CANOPY (%)</u>	<u>WEIGHTED C</u>
28%	disturbed	—	—	.28 (1.0)
72%	P-J	10	25	.72 (.4)
				<u><u>C = .568</u></u>

EROSION CONTROL FACTOR

$P = 1.0$

SEDIMENT INFLOW

$A = 40 (.16) (3.6) (.568) (1.0) = 13.09$ ton/acre/year

$A = 13.09 \left(\frac{1}{2047} \right) (82.) (.95) = .498$ acre-feet/year

REVISIONS
 BY _____ DATE _____ TO EO _____
 BY _____ DATE _____ TO EO _____

BY _____ DATE _____
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