INSPECTION REPORT

Sedimentation Structure

N1-M

Kayenta Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure N1-M is an earthen embankment, designed and constructed in 1980 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 N1-M is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure N1-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 N1-M was inspected on September 6, 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 N1-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 N1-M has a 10.7-acre tributary drainage area and is located near Coal Mine Wash at the Kayenta Mine. The watershed is classified as 91% Pinion/Juniper and 9% disturbed.

EMBANKMENT

Structure N1-M is a homogeneous earthen embankment classified as a cross-valley embankment. Physical characteristics of the embankment are listed in the following table:

Structure N1-M

Embankment	Residual Sandstone Soils
Foundation	Alluvium
Right Abutment	Residual Sandstone Soils
Left Abutment	Residual Sandstone Soils
Height	6.9 ft
Crest Width	20 ft at right abutment 19 ft at left abutment
Upstream Slope	2.1 H : 1 V
Downstream Slope	3.7 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section N1-M, A-A'. Grass provides erosion protection on the upstream and downstream slopes of the embankment.

ANALYSES

STABILITY

Structure N1-M is a category A-3 embankment. A standard category A-3 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 = 10 ft
2. Maximum upstream slope = 1.5 H : 1 V
3. Maximum downstream slope = 2.5 H : 1 V
4. Normal pool with steady seepage saturation conditions

The N1-M 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 N1-M 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 N1-M was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.136	mi
2.	Elevation Difference, H	68	ft
3.	Time of Concentration, T_c	0.051	h
4.	Lag time, $0.6T_c$	0.031	h
5.	SCS Curve Number	80	
6.	Rainfall Depth, 10-year, 24-hour storm	2.1	in.
	25-year, 6-hour storm.	1.9	in.
7.	Drainage Area	10.7	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	14	17
Volume	acre-ft	0.59	0.46
Storage			
Peak Stage	ft	6520.78	—
Spillway Elevation . .	ft	6523.90	--
Peak Storage	acre-ft	0.59	--
Storage Capacity . . .	acre-ft	1.4	--
Outflow			
Peak Flow	cfs	0	3
Embankment Crest Elevation	ft	--	6525.10
Peak Stage	ft	--	6524.61
Freeboard	ft	--	0.50
Mannings "n"		--	0.040

Spillway Channel

The existing spillway for N1-M has a trapezoidal channel with the following dimensions:

Channel depth	1.8	ft
Channel width	5	ft
Channel length	20	ft
Side slopes (horizontal to vertical)	2:1	
Average exit slope	0	percent

There is presently no erosion protection within the channel.

Outflow Channel

The existing outflow channel for N1-M has a trapezoidal channel with the following dimensions:

Channel width	5	ft
Channel length	75	ft
Side slopes (horizontal to vertical)	2:1	
Average exit slope	3	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, N1-M.

The calculations for the sediment load entering Structure N1-M were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.26
3. Slope Factor, LS 3.50
4. Cover Factor, C 0.217
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 N1-M and the results of the sediment inflow analysis are summarized in the following table.

N1-M STORAGE

Total Storage Capacity	1.4	acre-ft
10-year, 24-hour Storm Inflow	0.59	acre-ft
Available Sediment Storage Capacity . .	0.81	acre-ft
Sediment Inflow Rate	0.040	acre-ft/yr
Sediment Storage Life	20	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure N1-M indicated that the geotechnical problems consist of rill erosion on the upstream and downstream slopes and the side slopes of the spillway and outlet channel; and two tranverse cracks near the center of the embankment. Correction of erosion is considered a

periodic maintenance task and does not require remedial action. The embankment section with the cracks should be repaired by excavating to the bottom of the crack and replacing with compacted fill.

HYDRAULICS

The storage capacity of Structure N1-M is adequate but the spillway capacity is inadequate. The structure does not have an adequate outflow channel. The bottom elevation of the existing spillway channel should be lowered to elevation 6523.0 feet while maintaining the bottom width of 15 feet as shown on Plate 5. A trapezoidal outflow channel with the same bottom width as the spillway should be constructed along the alignment shown in Plate 1. The channel profile is shown in Plate 4 and required dimensions are shown in Plate 5. Both the spillway and outflow channel should be protected against erosion using geotextile and gravel as shown in Plate 5.

Lowering the spillway elevation to 6523.0 feet decreases the storage capacity and increases the freeboard. The analysis of these conditions is summarized in the following table.

N1-M HYDRAULICS FOR REDESIGNED SPILLWAY

	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	14	17
Volume	acre-ft	0.59	0.45
Storage			
Peak Stage	ft	6520.78	6523.79
Spillway Elevation . .	ft	6523.00	--
Peak Storage	acre-ft	0.59	--
Storage Capacity . . .	acre-ft	1.17	--
Available Sediment Storage Capacity . .	acre-ft	0.58	--
Sediment Inflow Rate .	acre-ft/yr	0.040	--
Sediment Storage Life.	yrs	14	--
Outflow			
Peak Flow	cfs	0	3
Embankment Crest Elevation	ft	--	6525.10
Peak Stage	ft	--	6523.79
Freeboard	ft	--	1.31
Spillway Channel			
Flow Depth	ft	--	0.79
Critical Velocity. . .	fps	--	1.8
Manning's "n"		--	0.035
Outflow Channel			
Slope	%	--	6
Normal Velocity. . . .	fps	--	2.11
Normal Depth	ft	--	0.09
Manning's "n"		--	0.035

* * *

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

Plate 1 - Site Plan N1-M

Plate 2 - Existing Maximum Cross Section N1-M, A-A'

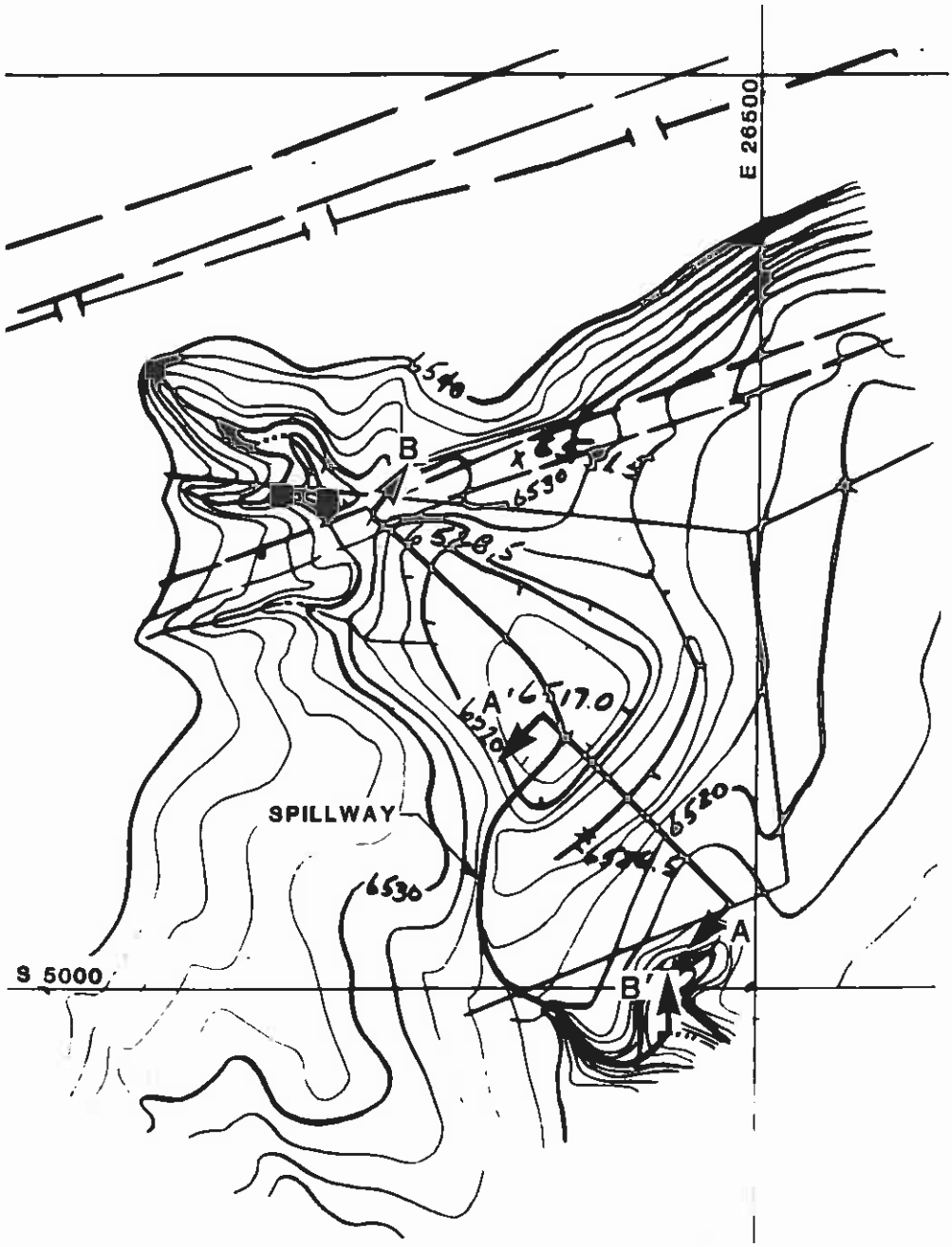
Plate 3 - Volume-Elevation Curve N1-M

Plate 4 - Channel Profile N1-M, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section N1-M

Appendix A - Inspection Check List

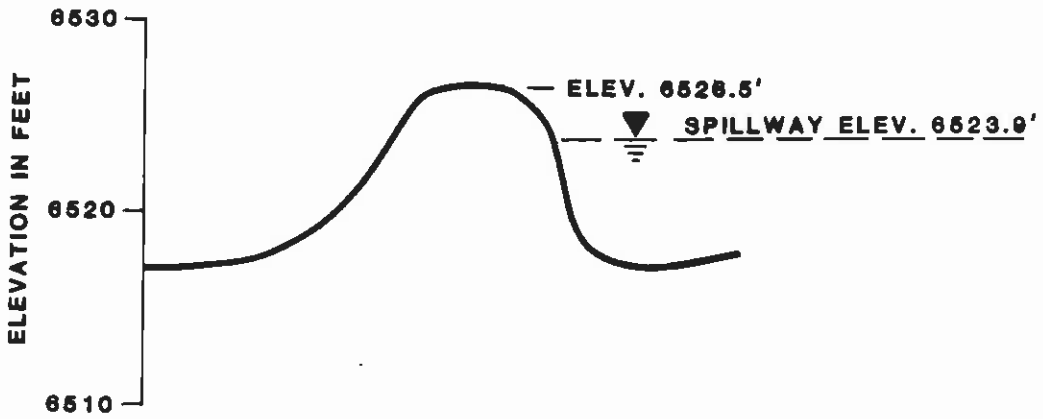
Appendix B - Hydrology and Hydraulic Calculations



SCALE
0 100 200
FEET

SITE PLAN
N1-M

BY **Dames & Moore** Plate 1



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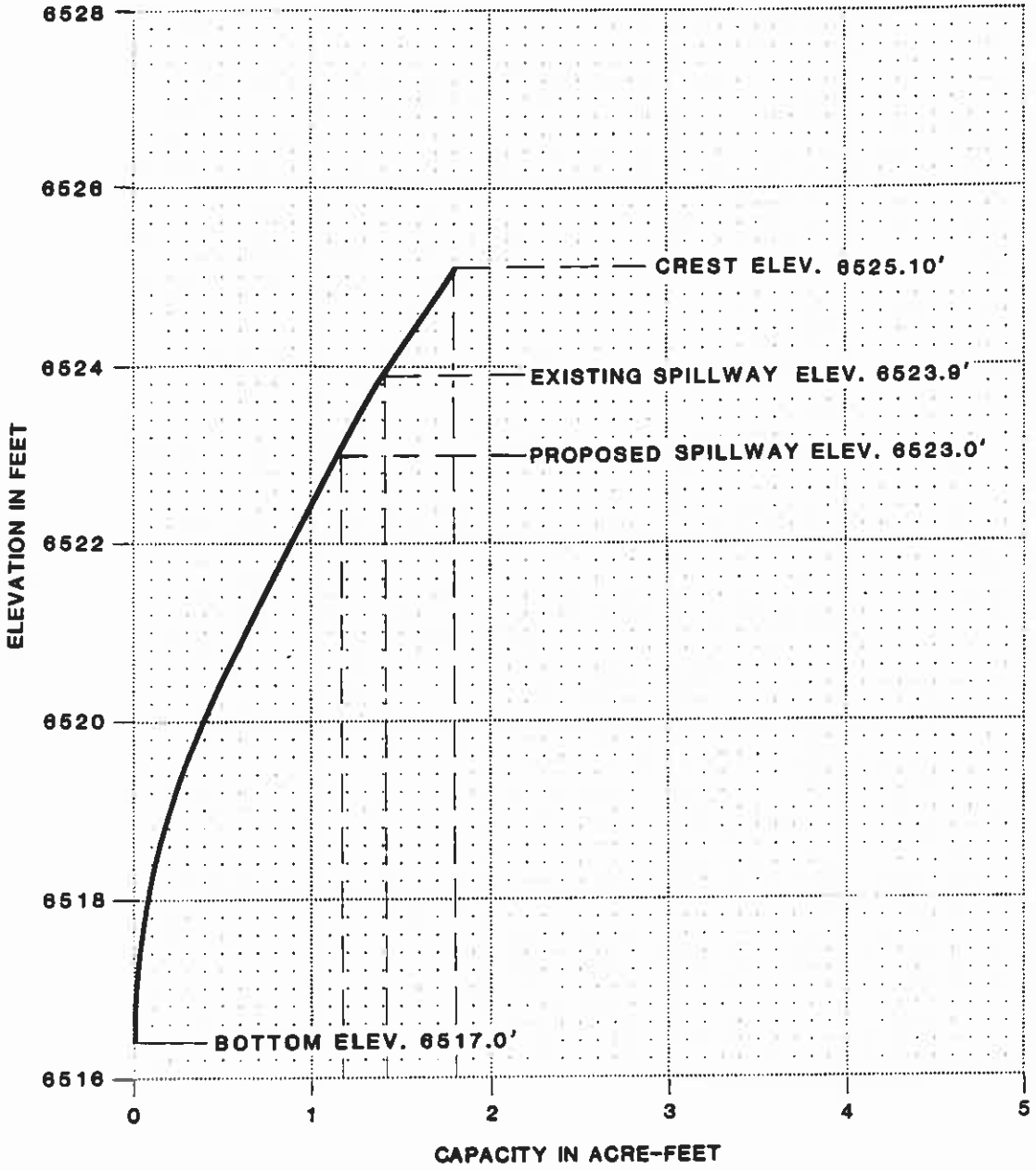
FEET

EXISTING MAXIMUM CROSS-SECTION A-A' N1-M

FOR LOCATION SEE PLATE 1

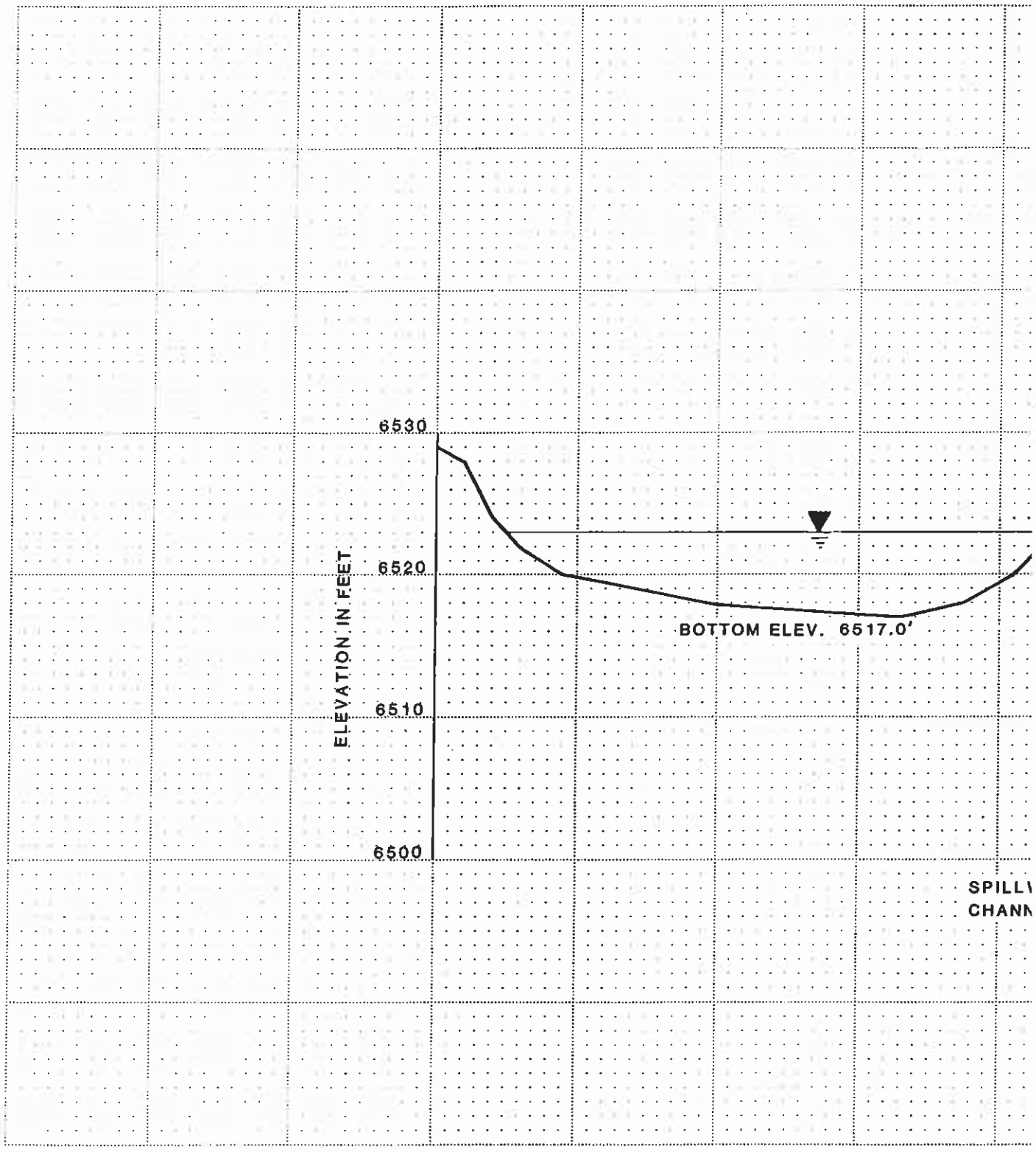
BY **Dames & Moore** Plate 2



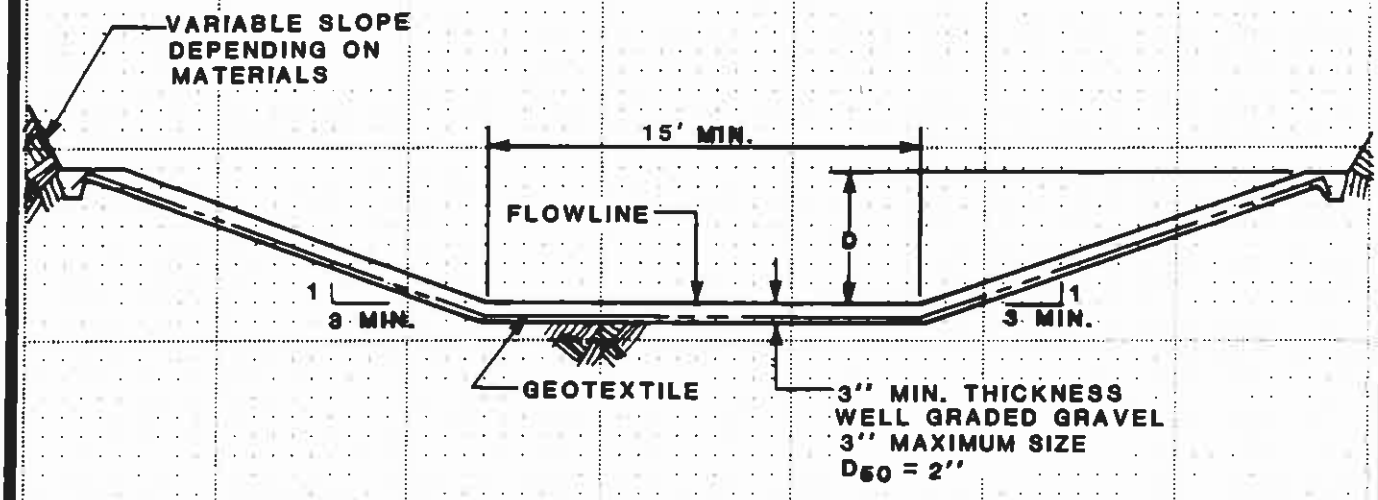
VOLUME-ELEVATION CURVE

N1-M

BY **Dames & Moore** Plate 3



FOR LOCATION SEE PLATE 1



SPILLWAY CHANNEL

D = 1.8'

LENGTH = 50'

FLOWLINE ELEV.= 6523.00'

OUTFLOW CHANNEL

D = 1'

SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION N1-M

BY **Dames & Moore** Plate 5

APPENDIX A

INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			20'w towards RA 18'w toward LA
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?	X		two transverse cracks 1 middle of Embankment
2. UPSTREAM SLOPE			25° 3" deep
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			15°
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. 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?			brown SM
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?			brown SM

ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			
a. Location:			
Left abutment?			
Right abutment?			
Crest of Embankments?	X		
b. Approach Channel:		X	
Are side slopes eroding?			NA
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:	X		5' W. 20' L 0° Slope
Are side slopes eroding?	X		Rills
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	Partial Grass
d. Outflow Channel:			5' W 75' L Slope 3%
Are side slopes eroding?	X		Rills
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
e. Weir:		X	
Condition?			
7. SPILLWAY/EMERGENCY			NA
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?		X	(Elev.) feet
b. Water present?		X	(Elev.) feet
c. Siltation?	X		
d. Watershed matches soil map?		X	

9. GENERAL COMMENTS

Powerline road would block runoff momentarily

Two transverse cracks 1/2 way across crest starting from U.S. slope - 3" deep

Canopy 25°
Ground 85°

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE PEABODY COAL CO 10139-011-22
SUBJECT SEDIMENT POND HYDROLOGY
N1-M SHEET ___ OF ___

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

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6592 − 6524 = 68 ft.

WATER COURSE LENGTH = 1.8(400) = 720 ft. = 0.136 mi.

$$T_c = \left(\frac{11.9\ (0.136)^3}{68}\right)^{0.385} = 0.051 \text{ hr.}$$

LAG TIME = $0.6 T_c$ = 0.031 hr.

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
1.0 (9%)	Haul Road	—	D	0.09(91) = 8.2
9.7 (91%)	P-J	ave	C	0.91(78) = 71.0
			80% EH #21 20% EH #34	79.2

Use 80

DRAINAGE BASIN AREA

10.7 ACRE 0.017 SQ MILE

BY S. DOLAN DATE 9-10-85
CHECKED BY ___
COPY TO EO ___

FILE FEARLY QUARRY 1039-011-22
SUBJECT SEDIMENT INFLOW
N1-M SHEET ___ OF ___

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

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

R = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE =	80%	EH 21	.8 (.27)
	20%	EH 34	.2 (.22)
			.26

K = .26

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
650 ft	70	11%	4.02 (65%)
400 ft	40	10%	2.74 (40%)

use 3.5

COVER FACTOR

AREA (ac)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
9%	disturbed	—	—	.09 (1.0)
91%	P-J	40	25	.91 (.14)
				.218

BY ___ DATE ___
CHECKED BY ___
COPY TO EO ___

EROSION CONTROL FACTOR

P = 1.0

SEDIMENT INFLOW

$A = 40(.26)(3.5)(.218)(1.0) = 7.94$ ton/acre/year

$A = (7.94)\left(\frac{1}{2047}\right)(10.7)(.95) = 0.040$ acre-feet/year

Dames & Moore