INSPECTION REPORT

Sedimentation Structure

BM-SS

Black Mesa Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

TABLE OF CONTENTS

	Page
INTRODUCTION	1
INSPECTION	1
SITE DESCRIPTION	2
LAND USE	2
EMBANKMENT	2
ANALYSES	3
STABILITY	3
HYDROLOGY	3
HYDRAULICS	4
Spillway Channel	6
Outflow Channel	6
STORAGE CAPACITY	6
REMEDIAL COMPLIANCE PLAN	7
GEOTECHNICS	7
HYDRAULICS	8
APPENDIX A - INSPECTION CHECK LIST	
APPENDIX B - HYDROLOGY AND HYDRAULIC CALCULATIONS	

INTRODUCTION

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

This inspection report contains information specific to Structure BM-SS. 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 BM-SS was inspected on September 3, 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 BM-SS 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 BM-SS has a 76.5-acre tributary drainage area and is located near Moenkopi Wash at the Black Mesa Mine. The watershed is classified as 58% Sagebrush/grass, 26% Pinion/Juniper, and 16% disturbed.

EMBANKMENT

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

Structure BM-SS

Embankment	Residual Sandstone Soils
Foundation	Sandstone
Right Abutment	Sandstone/Residual Sandstone Soils
Left Abutment	Residual Sandstone Soils
Height	9.2 ft
Crest Width	15 ft
Upstream Slope	2.9 H : 1 V
Downstream Slope	3.5 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section BM-SS, A-A'.

ANALYSES

STABILITY

Structure BM-SS 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 = 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 BM-SS 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 BM-SS 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 BM-SS was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.318	mi
2.	Elevation Difference, H	125	ft
3.	Time of Concentration, T_c	0.108	h
4.	Lag time, $0.6T_c$	0.065	h
5.	SCS Curve Number	71	
6.	Rainfall Depth, 10-year, 24-hour storm	2.1	in.
	25-year, 6-hour storm	1.9	in.
7.	Drainage Area	76.5	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.

BM-SS 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	32	36	
Volume	acre-ft	2.10	1.53	
Storage				
Peak Stage	ft	6404.15	6410.34	
Spillway Elevation . .	ft	6409.67	—	
Peak Storage	acre-ft	2.14	—	
Storage Capacity . . .	acre-ft	7.25	--	
Outflow				
Peak Flow	cfs	0	4	
Embankment Crest Elevation	ft	--	6413.17	
Peak Stage	ft	—	6410.30	
Freeboard	ft	--	2.87	
Spillway Channel				
Flow Depth	ft	—	0.63	
Critical Velocity. . .	fps	--	2.0	
Manning's "n"		—	0.035	
Outflow Channel			Section I	Section II
Slope	%	--	2	18
Normal Velocity. . . .	fps	--	1.7	3.3
Normal Depth	ft	--	0.15	0.08
Manning's "n"		--	0.035	0.035

Spillway Channel

The existing spillway for BM-SS has a trapezoidal channel with the following dimensions:

Channel depth	3 ft
Channel width	13 ft
Channel length	35 ft
Side slopes (horizontal to vertical)	2:1
Average exit slope	2 percent

There is presently no erosion protection within the channel.

Outflow Channel

The existing outflow channel for BM-SS has a U-shaped channel with the following dimensions:

Channel width	13 ft
Channel length	85 ft
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, BM-SS.

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

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.207
3. Slope Factor, LS 7.05
4. Cover Factor, C 0.230
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 BM-SS and the results of the sediment inflow analysis are summarized in the following table.

BM-SS STORAGE

Total Storage Capacity	7.25	acre-ft
10-year, 24-hour Storm Inflow	2.10	acre-ft
Available Sediment Storage Capacity . .	5.11	acre-ft
Sediment Inflow Rate	0.477	acre-ft/yr
Sediment Storage Life	11	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure BM-SS indicated that the geotechnical problems consist of rill and gulley erosion on the downstream slope, the side slopes of the spillway and outlet channel and the left abutment. Correction of erosion is considered a periodic maintenance task and does not require remedial action.

HYDRAULICS

The storage capacity and spillway capacity of Structure BM-SS are adequate; however, the spillway does not have an adequate outflow channel or adequate erosion protection. 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. Both the spillway and outflow channel should be protected against erosion using geotextile and gravel as shown in Plate 5.

* * *

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

Plate 1 - Site Plan BM-SS

Plate 2 - Existing Maximum Cross Section BM-SS, A-A'

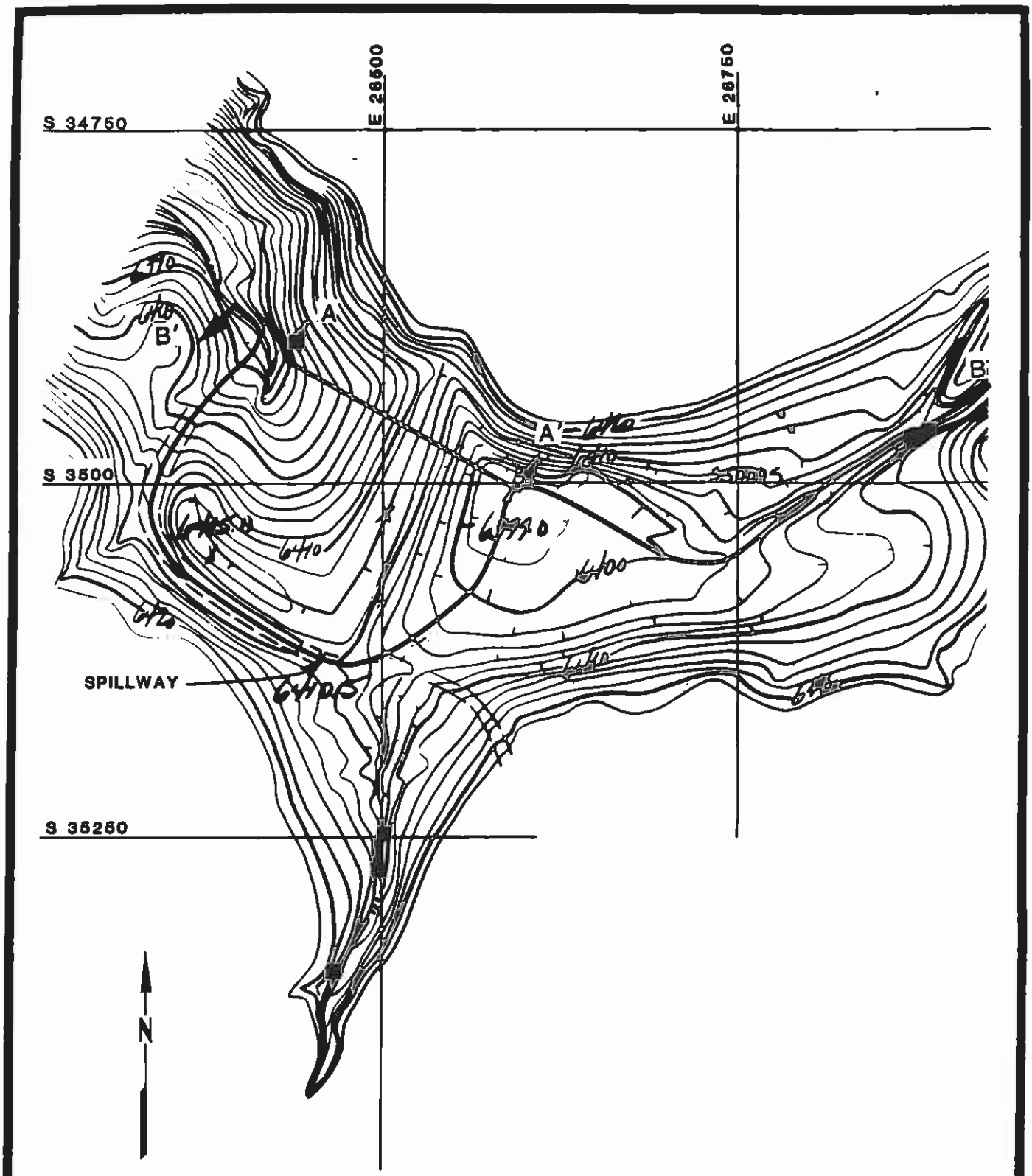
Plate 3 - Volume-Elevation Curve BM-SS

Plate 4 - Channel Profile BM-SS, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section BM-SS

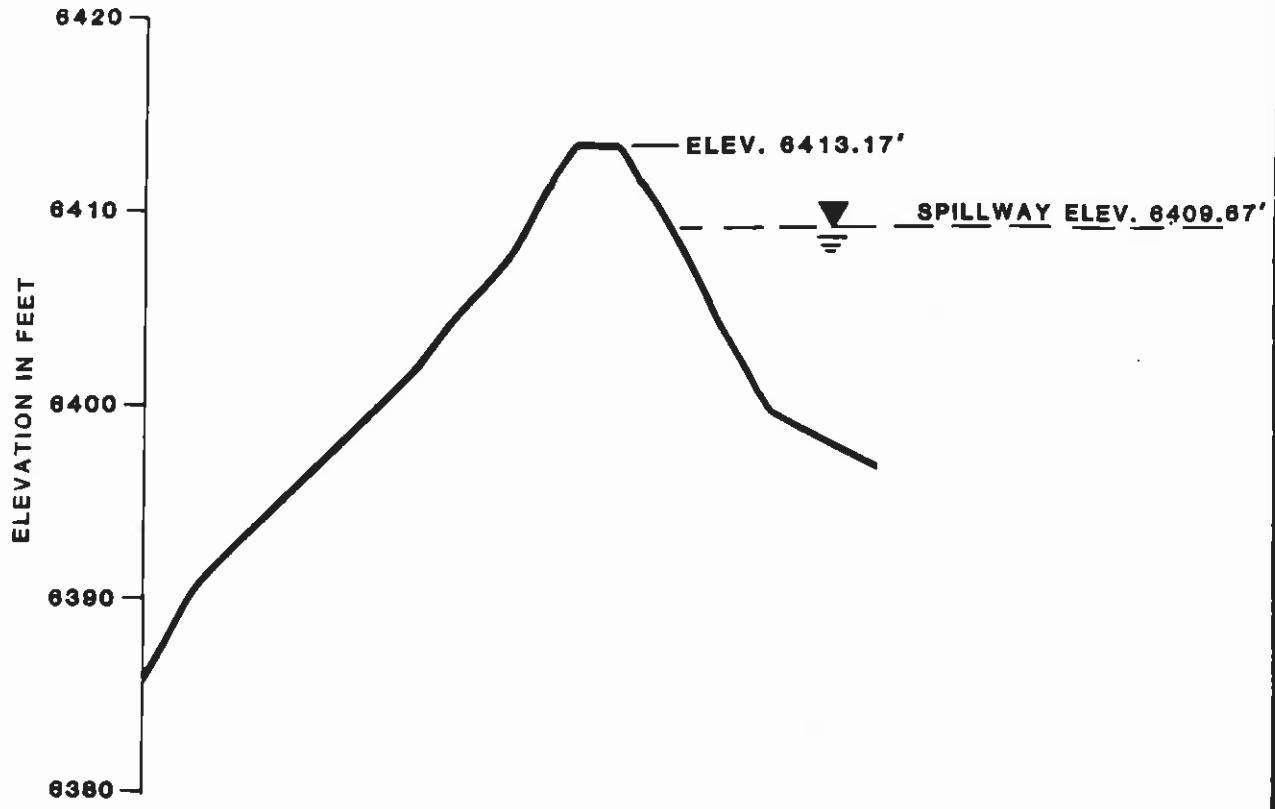
Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations



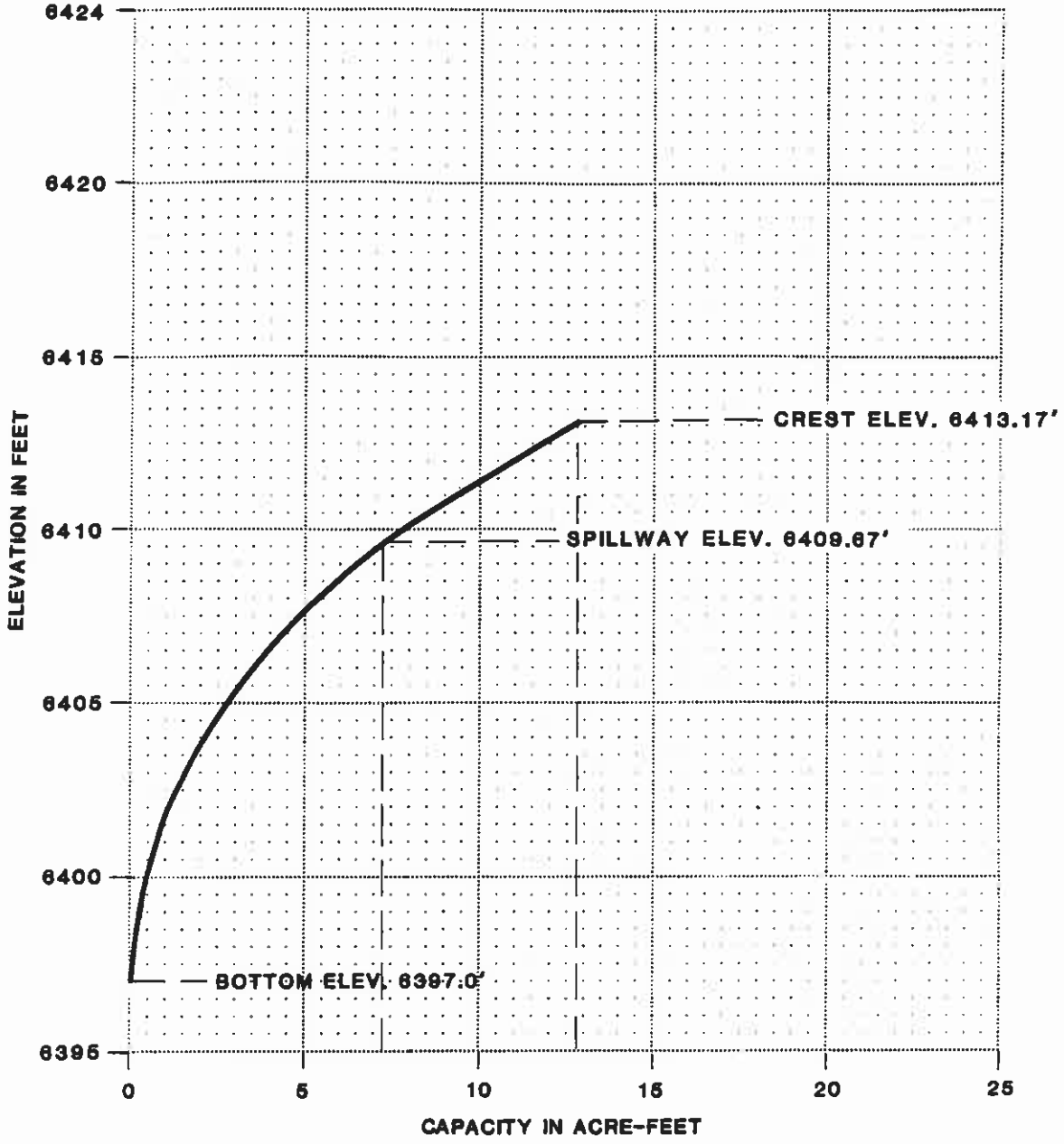
SITE PLAN
BM-SS

BY **Dames & Moore** Plate 1



EXISTING MAXIMUM CROSS-SECTION A-A' BM-SS

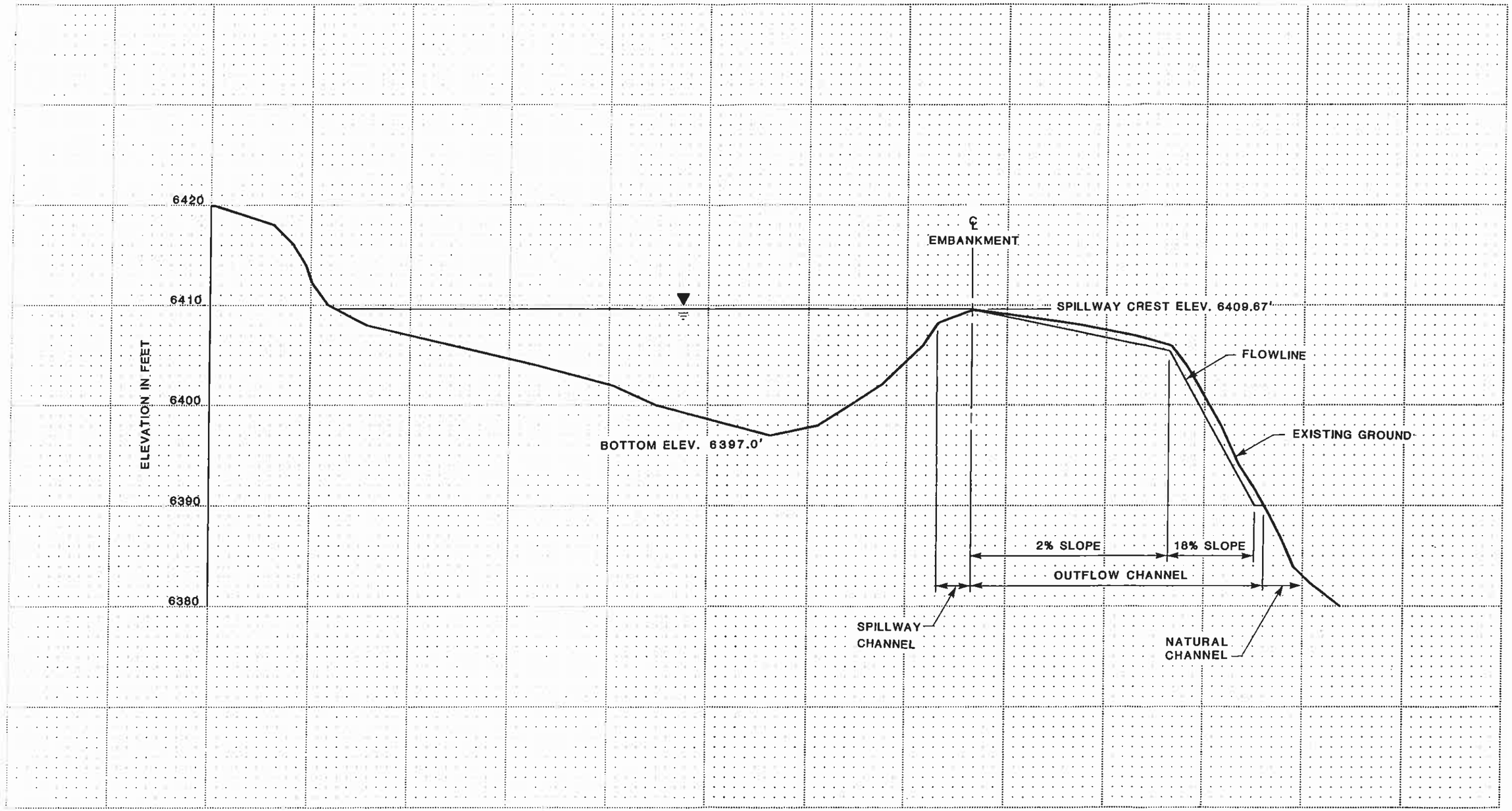
BY **Dames & Moore** Plate 2



VOLUME-ELEVATION CURVE

BM-SS

BY **Dames & Moore** Plate 3

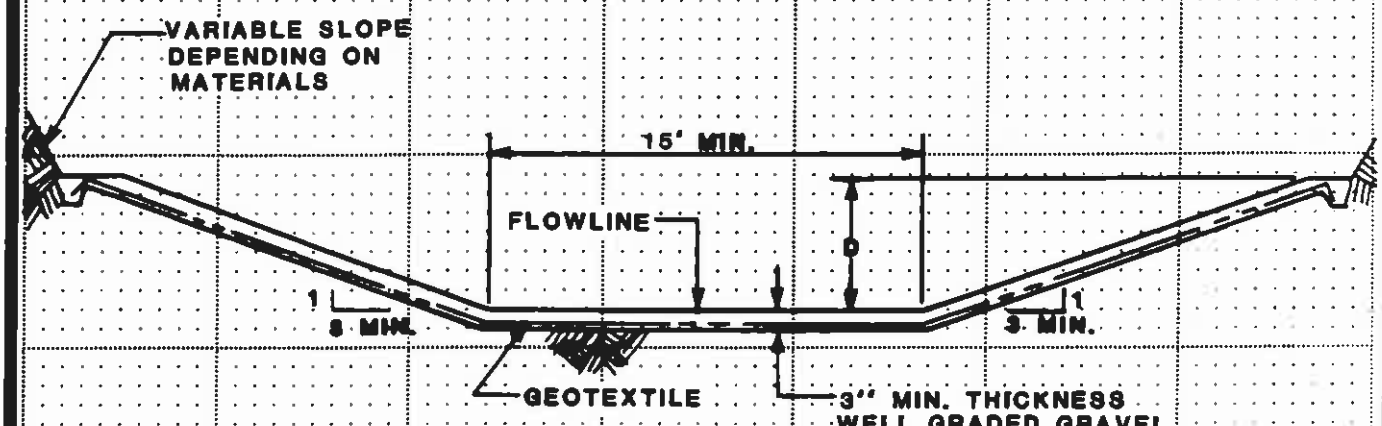


SCALE
0 100 200
FEET

CHANNEL PROFILE B–B′
BM–SS

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



SPILLWAY CHANNEL

D = 1.7'

LENGTH = 30'

FLOWLINE ELEV.= 6409.67'

OUTFLOW CHANNEL

D = 1'

SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION BM-SS

BY Dames & Moore Plate 5

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			19°
a. Adequate grass cover?		X	40%
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?			NA
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			16°
a. Adequate grass cover?		X	30%
b. Any erosion?	X		Some gulley at toe
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		Rills sm gullays
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			gray SM

ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			
a. Location:			
Left abutment?	X		
Right abutment?			
Crest of Embankments?			
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		Rills from abutment
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
d. Outflow Channel:	X		
Are side slopes eroding?	X		from abutment 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

OK - Riprap spillway & outlet.

Ground Cover 75

Canopy Cover 30

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE PEABODY COAL CO 10137-011-2
SUBJECT SEDIMENT POND HYDROLOGY
BM-SS
SHEET ___ OF ___

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

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6535 − 6410 = 125 ft.

WATER COURSE LENGTH = 4.2(400) = 1680 ft. = 0.318 mi. ✓

$T_c = \left(\frac{11.9\,(0.318)^3}{125 \text{ ft.}}\right)^{0.385} = 0.108$ hr. ✓

LAG TIME = $0.6\,T_c$ = 0.065 hr. ✓

SCS CURVE NUMBER

DRAINAGE AREA (ac)		COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
44.2	(55%)	S-G	fair	C	0.58(63) = 36.5
12.4	(16%)	DIST. GRAVEL	–	D	0.16(91) = 14.6
19.9	(26%)	P-J	fair	C	0.26(73) = 19.0
					70.1

10% EH #23
90% EH #32

USE 71

DRAINAGE BASIN AREA

76.5 ACRE 0.120 SQ MILE

BY S. DOLAN DATE 9-9-85
CHECKED BY BHM 10/24/85
COPY TO EO ___

Dames & Moore

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

BY ___ DATE ___
CHECKED BY ___
COPY TO EO ___

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

R = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE = 10% EH #23 .1 (.18)
90% EH #32 .9 (.21)
.207

K = .207

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
500	150	30.0	17.8 (.10)
600	50	8.3	2.58 (.40)
400	90	22.5	9.90 (.30)
500	80	16.0	6.35 (.20)

use 7.05

COVER FACTOR

AREA (ac)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
58%	S-G	60	25	.58 (.082)
16%	disturbed	—	—	.16 (1.0)
26%	P-J	60	25	.26 (.085)

C = .230

EROSION CONTROL FACTOR

P = 1.0

SEDIMENT INFLOW

$A = 40(.207)(7.05)(.23)(1.0) = 13.43$ ton/acre/year

$A = 13.43\left(\frac{1}{2047}\right)(76.5)(.95) = .477$ acre-feet/year