INSPECTION REPORT

Sedimentation Structure

KM-E1

Kayenta Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

TABLE OF CONTENTS

INTRODUCTION

Sedimentation Structure KM-E1 is an earthen embankment, designed and constructed in 1979 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 KM-E1 is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure KM-E1. 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 KM-E1 was inspected on September 23, 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 KM-E1 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 KM-E1 has a 12.4-acre tributary drainage area and is located near Coal Mine Wash at the Kayenta Mine. The watershed is classified as 100% disturbed.

EMBANKMENT

Structure KM-E1 is a homogeneous earthen embankment classified as a sidehill embankment. Physical characteristics of the embankment are listed in the following table:

Structure KM-E1

Embankment	Residual Shale Soils
Foundation	Residual Shale Soils/Scoria
Right Abutment	Residual Shale Soils
Left Abutment	Residual Shale Soils
Height	5.5 ft
Crest Width	15 ft
Upstream Slope	3.5 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 KM-E1, A-A'.

ANALYSES

STABILITY

Structure KM-E1 is a category B-1 embankment. A standard category B-1 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 KM-E1 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 KM-E1 is located upstream from Structure KM-E. The two structures have a combined storage capacity that is less than 20 acre-feet. Therefore, the spillway for KM-E1 was analyzed using the 25-year, 6-hour storm. The storage capacity of Structure KM-E1 was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.265	mi
2.	Elevation Difference, H	71	ft
3.	Time of Concentration, T_c	0.108	h
4.	Lag time, $0.6T_c$	0.065	h
5.	SCS Curve Number	92	
6.	Rainfall Depth, 10-year, 24-hour storm	2.1	in.
	25-year, 6-hour storm	1.9	in.
7.	Drainage Area	12.4	acres

HYDRAULICS

The existing corrugated metal pipe spillway is damaged and should be replaced by an open channel spillway. Therefore, the hydraulic analysis is presented in the remedial compliance plan.

Spillway Channel

The existing spillway for KM-E1 is a partially crushed 24-inch corrugated metal pipe (CMP).

Outflow Channel

The structure presently has no outflow channel.

STORAGE CAPACITY

The storage capacity analysis is presented in the remedial compliance plan.

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure KM-E1 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.

HYDRAULICS

Structure KM-E1 has sufficient storage capacity when analyzed in series with Structure KM-E located downstream, but it does not have an adequate spillway or outflow channel. A trapezoidal spillway channel should be constructed at elevation 6608.90 feet. The existing CMP spillway should be abandoned. A trapezoidal outflow channel with the same bottom width as the spillway should be constructed along the alignment shown in Plate 1. The spillway and outflow 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 HEC-1 program was used to evaluate inflow to the sedimentation structure, outflow from the structure and the resulting water surface elevations. Both the 10-year and 25-year storms were routed through Structure KM-E1 and into Structure KM-E. The initial conditions and results of the analysis are summarized in the following table.

KM-E1 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	28	38	
Volume	acre-ft	1.37	1.16	
Storage				
Peak Stage	ft	6607.96	6610.11	
Spillway Elevation	ft	6608.90	--	
Peak Storage	acre-ft	1.37	--	
Storage Capacity	acre-ft	1.71	--	
Outflow				
Peak Flow	cfs	0	26	
Embankment Crest Elevation	ft	--	6611.20	
Peak Stage	ft	--	6609.85	
Freeboard	ft	--	1.35	
Spillway Channel				
Flow Depth	ft	--	0.95	
Critical Velocity	fps	--	2.7	
Manning's "n"		--	0.035	
Outflow Channel			Section I	Section II
Slope	%	--	5	10
Normal Velocity	fps	--	3.2	4.0
Normal Depth	ft	--	0.20	0.16
Manning's "n"		--	0.035	0.035

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, KM-E1.

The calculations for the sediment load entering Structure KM-E1 were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.22
3. Slope Factor, LS 1.50
4. Cover Factor, C 1.00
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 KM-E1 and the results of the sediment inflow analysis are summarized in the following table.

KM-E1 STORAGE

Total Storage Capacity	1.71	acre-ft
10-year, 24-hour Storm Inflow	1.37	acre-ft
Available Sediment Storage Capacity . .	0.34	acre-ft
Sediment Inflow Rate	0.058	acre-ft/yr
Sediment Storage Life	6	yrs

* * *

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

Plate 1 - Site Plan KM-E1

Plate 2 - Existing Maximum Cross Section KM-E1, A-A'

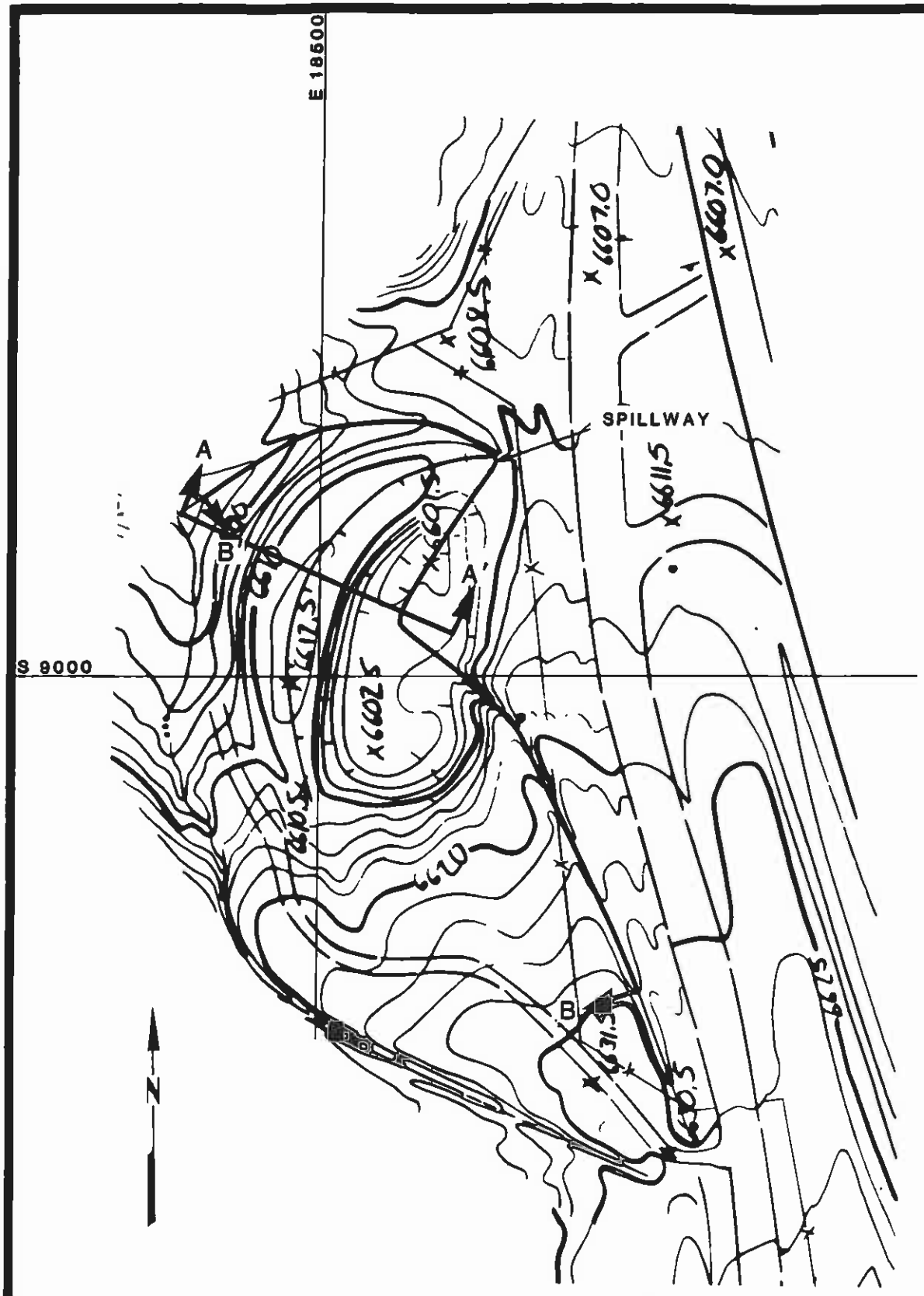
Plate 3 - Volume-Elevation Curve KM-E1

Plate 4 - Channel Profile KM-E1, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section KM-E1

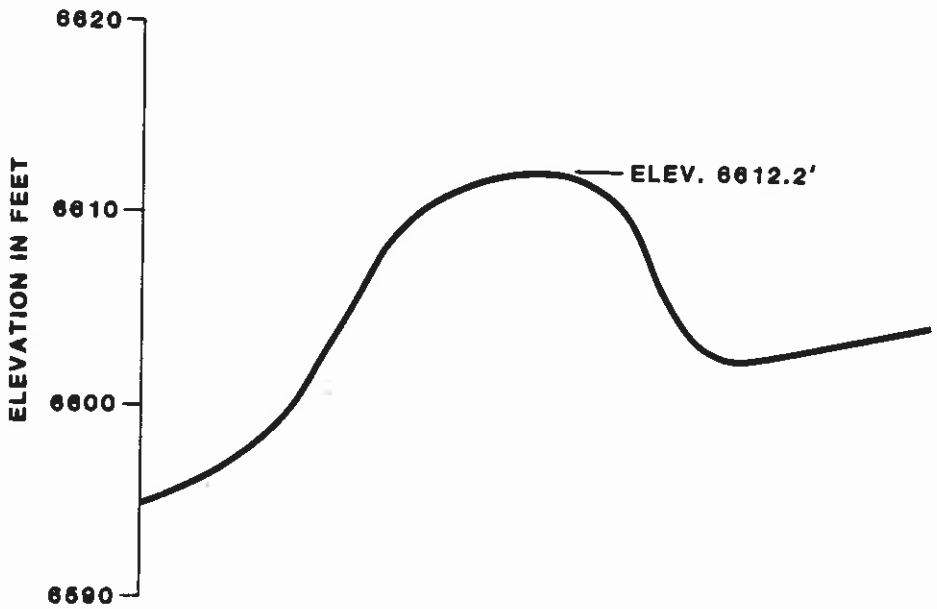
Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations



SITE PLAN
KM-E1

BY **Dames & Moore** Plate 1

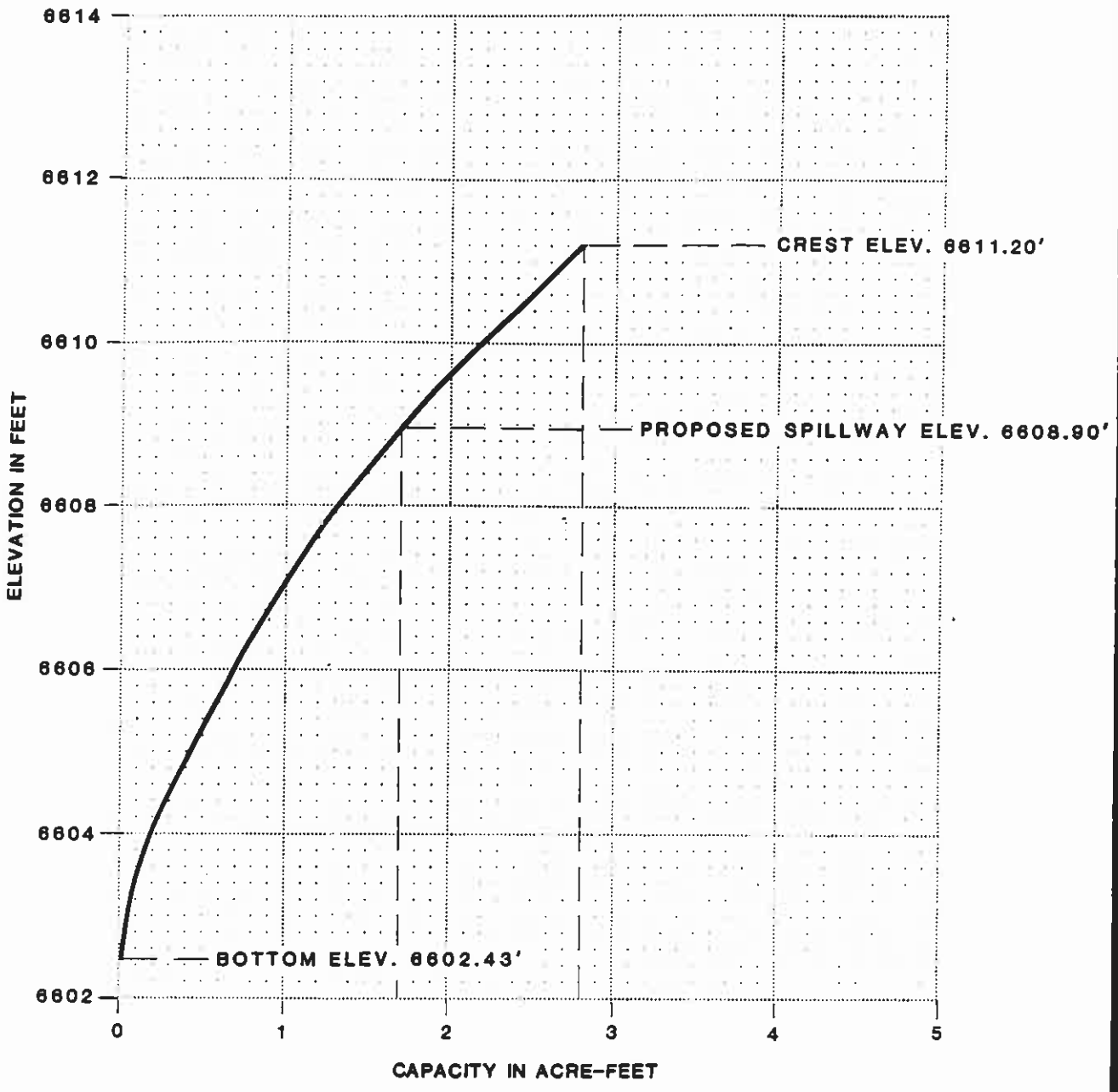


SCALE
0 50 100
FEET

EXISTING MAXIMUM CROSS-SECTION A-A' KM-E1

FOR LOCATION SEE PLATE 1

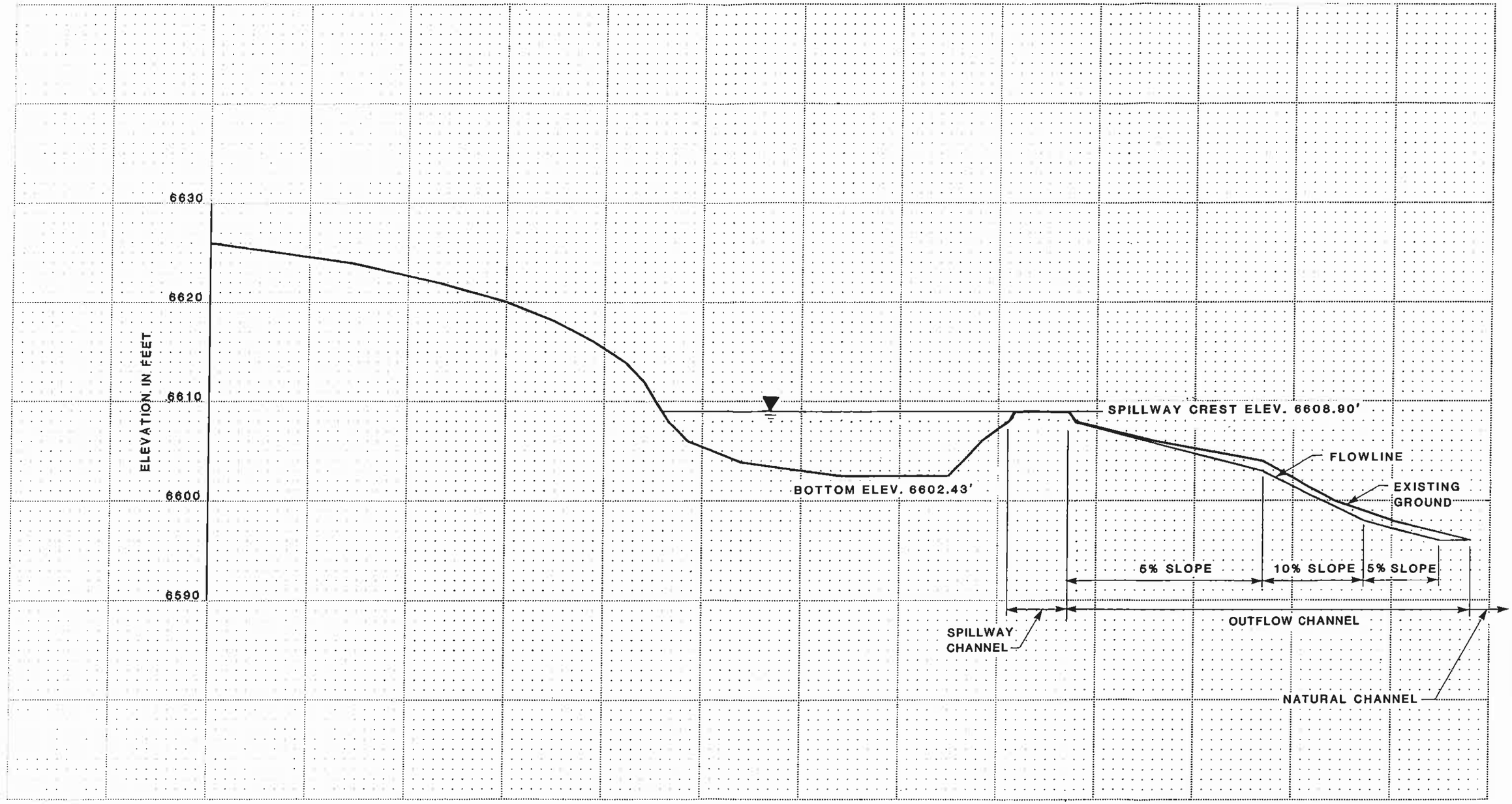
BY **Dames & Moore** Plate 2



VOLUME-ELEVATION CURVE

KM-E1

BY **Dames & Moore** Plate 3

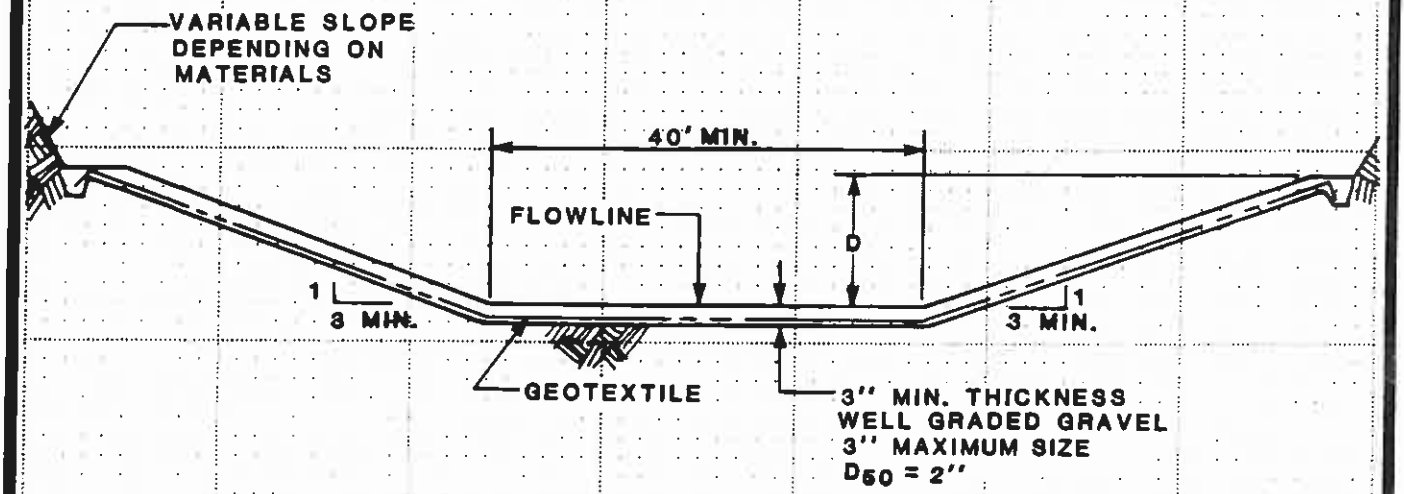


SCALE
0 50 100
FEET

CHANNEL PROFILE B-B'
KM-E1

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



SPILLWAY CHANNEL

D = 2.0'

LENGTH = 30'

FLOWLINE ELEV.= 6608.90'

OUTFLOW CHANNEL

D = 1'

SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION KM-E1

BY **Dames & Moore** Plate 5

APPENDIX A

INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			WIDTH VARIES
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			Uneven 16°
a. Adequate grass cover?		X	
b. Any erosion?	X		Rills & sm. gullys
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	
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?			RM
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?	X		Into Pond Several gullys
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			RM

Sediment Impoundment Name: KM-E1
Page:

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?			
Are side slopes sloughing?			
Bottom of channel eroding?			NA
Obstructed?			
Erosion protection?			
c. Spillway Channel:	X		24" CMP with entrance flare
Are side slopes eroding?			
Are side slopes sloughing?			NA
Bottom of channel eroding?			
Obstructed?	X		50% crushed at exit
Erosion protection?			NA
d. Outflow Channel:		X	
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
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?		No	(Elev.) feet
b. Water present?	Yes		(Elev.) feet
c. Siltation?	Yes		
d. Watershed matches soil map?		No	

9. GENERAL COMMENTS

Crest elevation & width vary

Canopy Cover 10%

Ground Cover 35%

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE PEABODY COAL CO. 10139-011-22
SUBJECT SEDIMENT POND HYDROLOGY
KM-E1 SHEET ___ OF ___

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

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6678 − 6607 = 71 ft. ✓

WATER COURSE LENGTH = 3.5(400) = 1400 ft. = 0.265 mi. ✓

$$T_c = \left(\frac{11.9\ (0.265)^3}{71}\right)^{0.385} = 0.108 \text{ hr.}$$ ✓

LAG TIME = $0.6 T_c$ = 0.065 hr. ✓

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
3.6	paved road	—	D	(.29)(93)
8.8	gravel road	—	D	(.71) 91
				91.6

100 % mine

use 92 ✓

DRAINAGE BASIN AREA

12.4 ACRE 0.019 SQ MILE ✓

BY S. DOLAN DATE 10-2-85
CHECKED BY BHM 11/5/85
COPY TO EO ___

FILE PEABODY COAL CO 1039-011-22
SUBJECT SEDIMENT INFLOW
KH-EI SHEET ___ OF ___

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

CHECKED BY BHM 11/5/85
COPY TO EO ___

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

R = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE = 100% EM # 34 .22

K = .22 ✓

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
1200	50	4.2	1.14

use 1.14 ✓

COVER FACTOR

AREA (ac.)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
100%	disturbed			1.0

C = 1.0 ✓

EROSION CONTROL FACTOR

P = 1.0

SEDIMENT INFLOW

$A = 40(.22)(1.14)(1.0)(1.0) = 10.03$ ton/acre/year ✓

$A = 10.03\left(\frac{1}{2047}\right)(12.4)(.95) = .058$ acre-feet/year ✓

Dames & Moore