INSPECTION REPORT

Sedimentation Structure

J28-G

Kayenta Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

TABLE OF CONTENTS

INTRODUCTION

Sedimentation Structure J28-G 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 J28-G is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure J28-G. 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 J28-G was inspected on September 12, 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 J28-G 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 J28-G has a 59.4-acre tributary drainage area and is located near Reed Valley at the Kayenta Mine. The watershed is classified as 46% disturbed, 43% Pinion/Juniper, and 11% Sagebrush/grass.

EMBANKMENT

Structure J28-G is a homogeneous earthen embankment classified as a sidehill embankment. Physical characteristics of the embankment are listed in the following table:

Structure J28-G

Embankment	Residual Shale Soils
Foundation	Residual Shale Soils
Right Abutment	Residual Shale Soils
Left Abutment	Residual Shale Soils
Height	18.5 ft
Crest Width	12 ft
Upstream Slope	2.6 H : 1 V
Downstream Slope	2.1 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section J28-G, A-A'.

ANALYSES

STABILITY

Structure J28-G is a category B-1 embankment. A standard category B-1 embankment has static and seismic factors of safety of 1.5 and 1.2, respectively, under the following conditions:

1. Maximum height = 30 ft
2. Maximum upstream slope = 2.0 H : 1 V
3. Maximum downstream slope = 2.5 H : 1 V
4. Normal pool with steady seepage saturation conditions

The J28-G 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 J28-G 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 J28-G was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.303	mi
2.	Elevation Difference, H	102	ft
3.	Time of Concentration, T_c	0.110	h
4.	Lag time, $0.6T_c$	0.066	h
5.	SCS Curve Number	84	
6.	Rainfall Depth, 10-year, 24-hour storm	2.1	in.
	25-year, 6-hour storm	1.9	in.
7.	Drainage Area	59.4	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	85	111
Volume	acre-ft	4.26	3.47
Storage			
Peak Stage	ft	6791.76	6803.62
Spillway Elevation . .	ft	6802.90	—
Peak Storage	acre-ft	4.26	—
Storage Capacity . . .	acre-ft	23.90	—
Outflow			
Peak Flow	cfs	0	5
Embankment Crest Elevation	ft	—	6805.00
Peak Stage	ft	—	6803.62
Freeboard	ft	--	1.83
Spillway Channel			
Flow Depth	ft	--	0.72
Critical Velocity. . .	fps	--	2.0
Manning's "n"		—	0.040
Outflow Channel			
Slope	%	—	6
Normal Velocity. . . .	fps	--	2.2
Normal Depth	ft	—	0.12
Manning's "n"		--	0.040

Spillway Channel

The existing spillway for J28-G has a trapezoidal channel with the following dimensions:

Channel depth	4.2	ft
Channel width	20	ft
Channel length	30	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 J28-G has a U-shaped channel with the following dimensions:

Channel width	20	ft
Channel length	300	ft
Average exit slope	8	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, J28-G.

The calculations for the sediment load entering Structure J28-G were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.32
3. Slope Factor, LS 3.53
4. Cover Factor, C 0.535
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 J28-G is shown on Plate 3, Volume-Elevation Curve, J28-G, and the results of the analysis are summarized in the following table.

J28-G STORAGE

Total Storage Capacity	23.90	acre-ft
10-year, 24-hour Storm Inflow	4.26	acre-ft
Available Sediment Storage Capacity . .	19.64	acre-ft
Sediment Inflow Rate	0.666	acre-ft/yr
Sediment Storage Life	29	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure J28-G indicated that the only geotechnical problem is rill erosion on the side slopes of the spillway channel and the right abutment. Correction of erosion is considered a periodic maintenance task and does not require remedial action. The upstream slope of the embankment is uneven and should be trimmed smooth.

The downstream slope should be flattened to 2.5 horizontal to 1 vertical to meet stability requirements. The reason for this action is that the present condition may mask evidence of potential future problems.

HYDRAULICS

The storage capacity of Structure J28-G exceeds the maximum allowable capacity of 20 acre-feet. The spillway elevation should be reduced to 6801.0 feet, resulting in a storage capacity of 19.22 acre-feet.

The reduced storage capacity and spillway capacity of Structure J28-G are adequate; however, the spillway and outflow channel do not have adequate erosion protection. Improvements to the trapezoidal outflow channel should be made 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.

Lowering the spillway elevation to 6801.00 feet decreases the storage capacity and increases the freeboard. The analysis of these conditions is summarized in the following table.

J28-G 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	85	111	
Volume	acre-ft	4.26	3.47	
Storage				
Peak Stage	ft	6791.76	—	
Spillway Elevation . .	ft	6801.00	--	
Peak Storage	acre-ft	4.26	—	
Storage Capacity . . .	acre-ft	19.22	—	
Available Sediment Storage Capacity . .	acre-ft	14.96	—	
Sediment Inflow Rate .	acre-ft/yr	0.666	--	
Sediment Storage Life.	yrs	22	—	
Outflow				
Peak Flow	cfs	0	6	
Embankment Crest Elevation	ft	—	6805.00	
Peak Stage	ft	--	6801.83	
Freeboard	ft	—	3.17	
Spillway Channel				
Flow Depth	ft	—	0.83	
Critical Velocity. . .	fps	--	2.10	
Manning's "n"		—	0.035	
Outflow Channel			Section I	Section II
Slope	%	--	1.5	6
Normal Velocity. . . .	fps	—	1.6	2.49
Normal Depth	ft	—	0.18	0.12
Manning's "n"		--	0.035	0.035

* * *

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

Plate 1 - Site Plan J28-G

Plate 2 - Existing Maximum Cross Section J28-G, A-A'

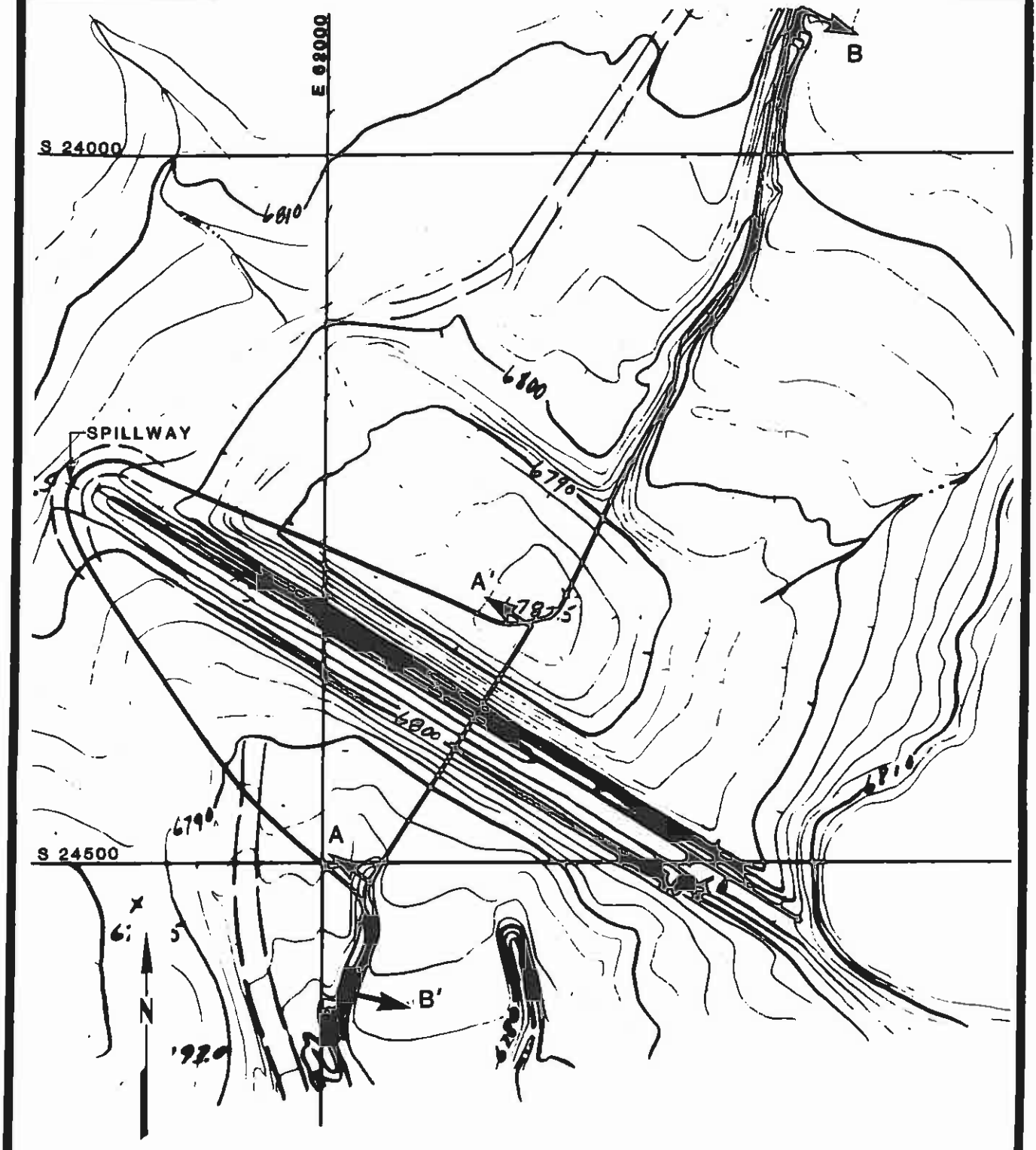
Plate 3 - Volume-Elevation Curve J28-G

Plate 4 - Channel Profile J28-G, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section J28-G

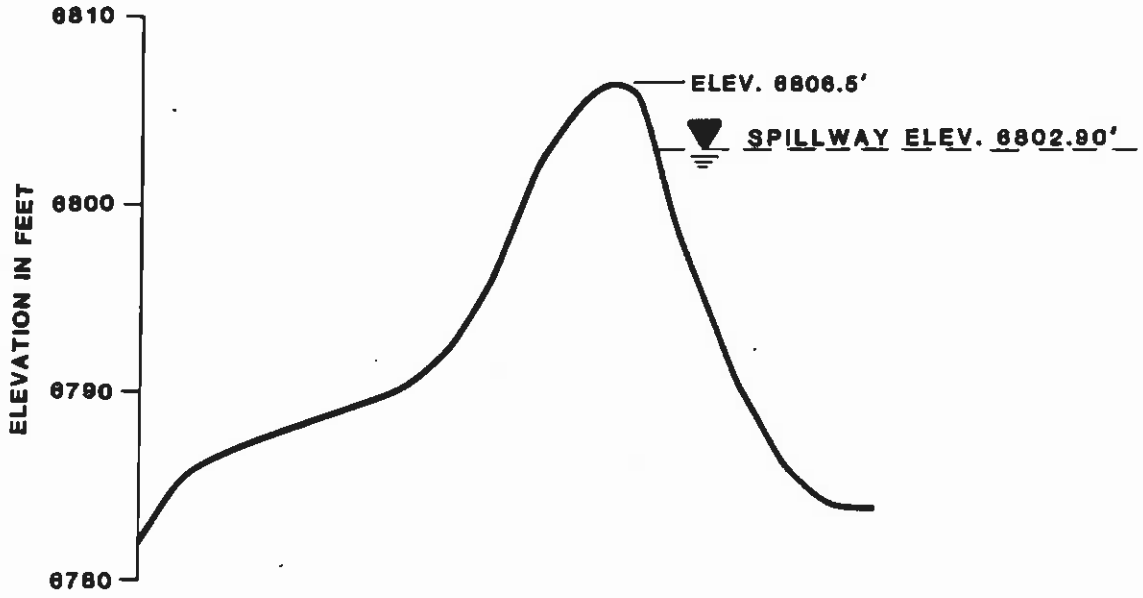
Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations



SITE PLAN
J28-G

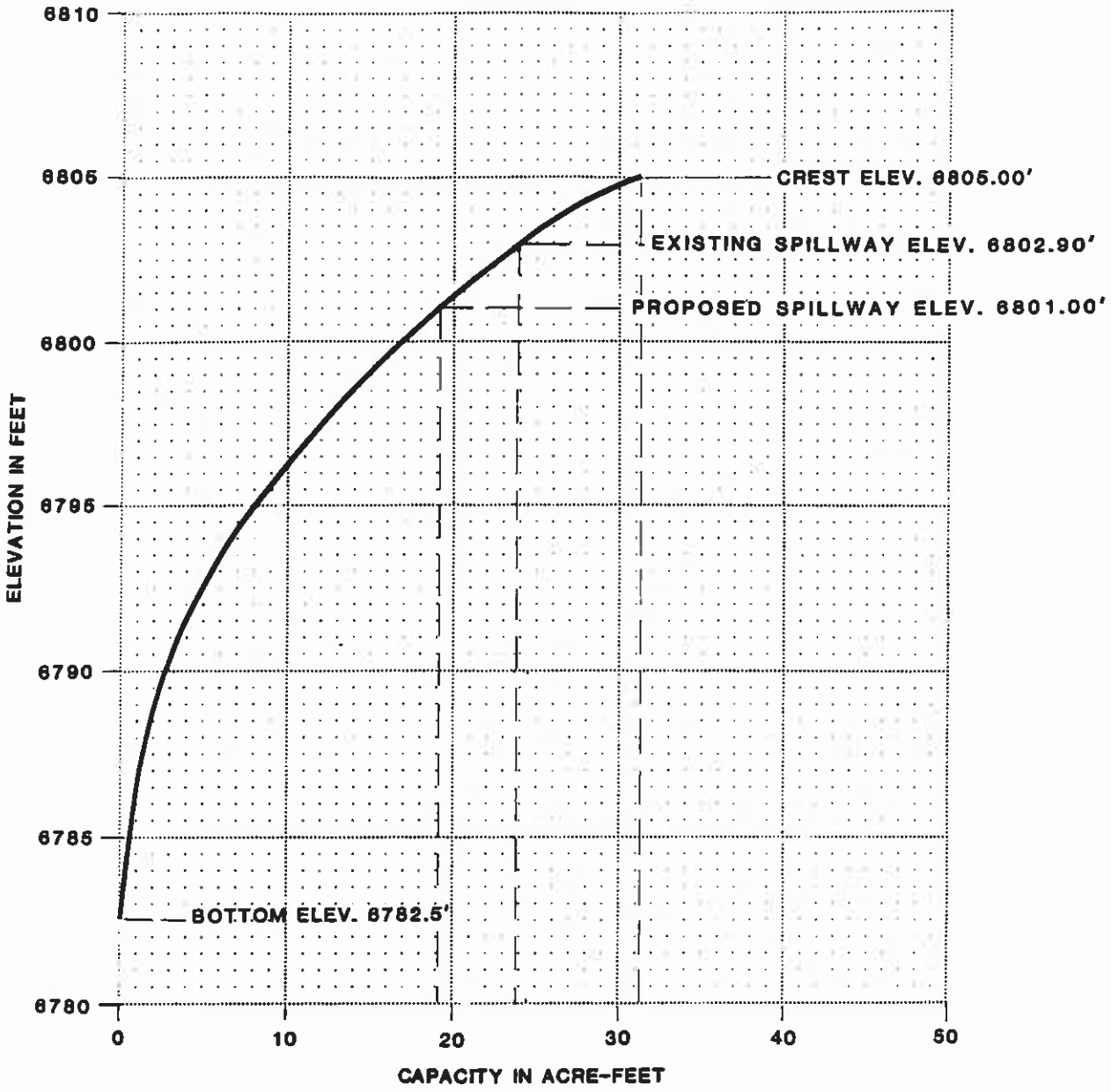
BY **Dames & Moore** Plate 1



SCALE
0 50 100
FEET

EXISTING MAXIMUM CROSS-SECTION A-A' J28-G

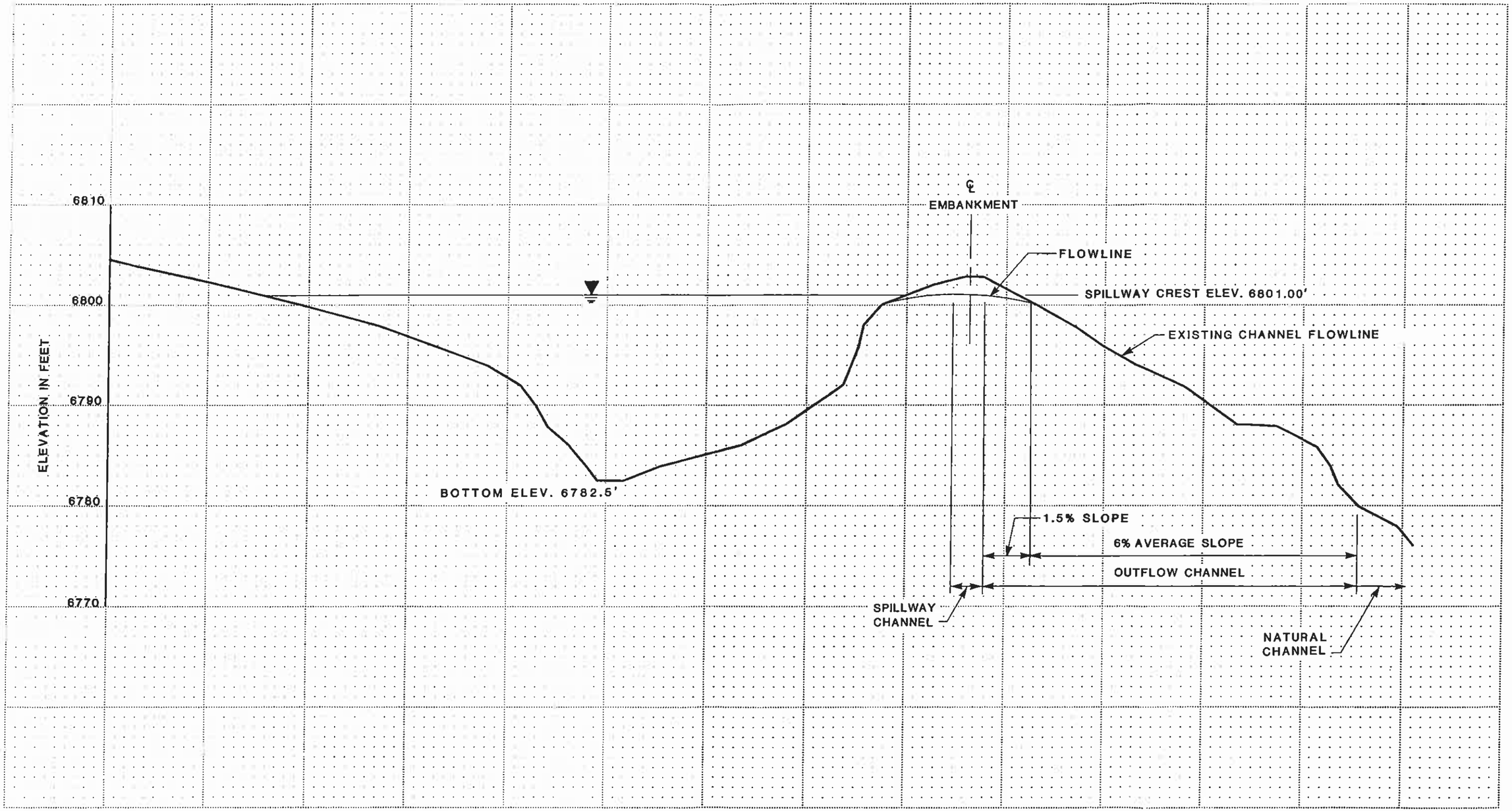
BY **Dames & Moore** Plate 2



VOLUME-ELEVATION CURVE

J28-G

BY **Dames & Moore** Plate 3

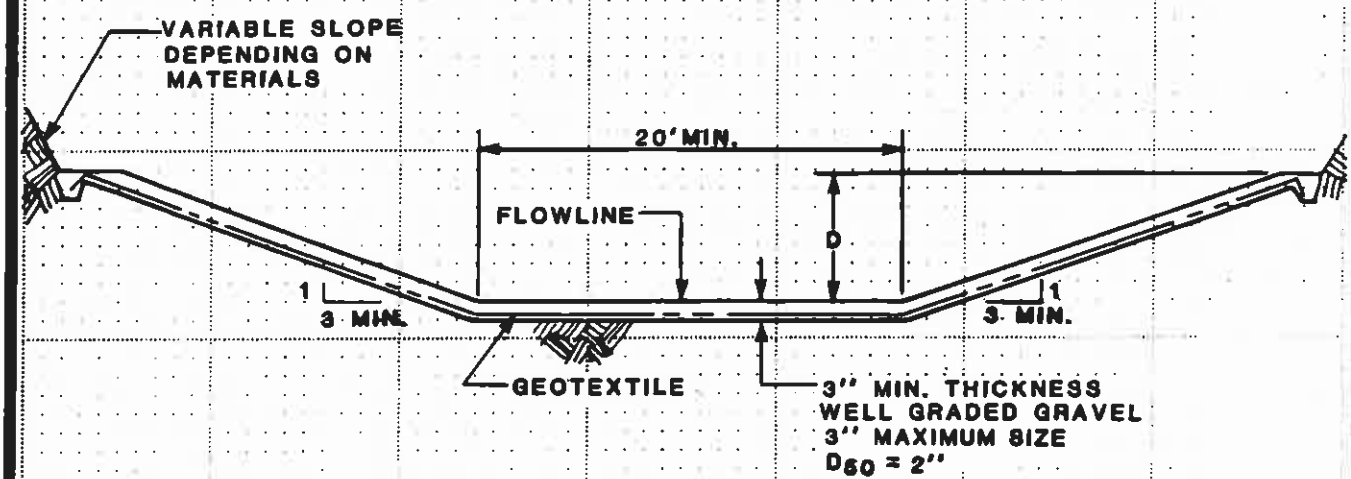


SCALE
0 100 200
FEET

CHANNEL PROFILE B-B'
J28-G

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



SPILLWAY CHANNEL

D = 1.9'

LENGTH = 30'

FLOWLINE ELEV.= 6801.00'

OUTFLOW CHANNEL

D = 1'

SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION J28-G

BY **Dames & Moore** Plate 5

APPENDIX A

INSPECTION CHECK LIST

Sediment Impoundment Name: J28-G
Page: 4

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			Rounded 12' w
a. Any visual settlements?		X	
b. Misalignment?			
c. Cracking?			
2. UPSTREAM SLOPE			21° VERY ROUGH, gauged slope towards LA.
a. Adequate grass cover?		X	
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		Rough see note
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			26°
a. Adequate grass cover?		X	
b. Any erosion?		X	
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		Rills into spillway
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?			Gray SM

ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			
a. Location:			
Left abutment?			
Right abutment?	X		
Crest of Embankments?			
b. Approach Channel:		X	
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:	X		20'W 30'L 0% Slope 4.2' below crest
Are side slopes eroding?	X		Rills from R.A & dam
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
d. Outflow Channel:	X		20'W ≃ 300'+ 8% Slope
Are side slopes eroding?		X	
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

Recently graded, no signs of cracks noted on 3-6-85 by WKW

Canopy 25 %
Ground 35 %

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE PEABODY COAL CO 10139-011-22
SUBJECT SEDIMENT POND HYDROLOGY
J28-G SHEET ___ OF ___

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

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6905 − 6803 = 102 ft.

WATER COURSE LENGTH = 4.0 (400) − 1600 ft. = 0.303 mi.

$$T_c = \left(\frac{11.9\ (0.303)}{102}\right)^{0.385} = 0.110 \text{ hr.}$$

LAG TIME = $0.6\,T_c$ = 0.066 hr.

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
27.3	disturbed	—	C	91 (.46)
25.5	P-J	average	C	78 (.43)
6.6	S-G	average	C	73 (.11)
				83.4

100 % EH #26

use 84

DRAINAGE BASIN AREA

59.4 ACRE 0.093 SQ MILE

BY S. DOLAN DATE 12-2-87
CHECKED BY ___
COPY TO EO ___

FILE FEARLEY GRAVEL CO 10134-011-22
SUBJECT SEDIMENT INFLOW
J2B-G SHEET ___ OF ___

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

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

K = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE = 100% ~~EH~~ #26 = .32

K = .32

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
800	40	5%	1.52 (.3)
500	50	10	3.06 (.35
500	75	15	5.73 (.35
			= 3.53

COVER FACTOR

AREA (ac)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
46%	disturbed	—	—	.46 (1.0)
43%	P-J	40	25	.43 (.1)
11%	S-G	40	25	.11 (.13)
				C = .575

EROSION CONTROL FACTOR

P = 1.0

SEDIMENT INFLOW

$A = 40(.32)(3.53)(.535)(1.0) = 24.17$ ton/acre/year

$A = (24.17)\left(\frac{1}{2047}\right)(59.4)(.95) = .666$ acre-feet/year

BY ___ DATE ___
CHECKED BY ___
COPY TO EO ___

Dames & Moore