

INSPECTION REPORT
Sedimentation Structure
KM-D
Kayenta Mine
Navajo County, Arizona
for
PEABODY COAL COMPANY



Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure KM-D 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-D is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure KM-D. 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-D was inspected on September 5, 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 KM-D 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 KM-D has a 19.1-acre tributary drainage area and is located near Coal Mine Wash at the Kayenta Mine. The watershed is classified as 65% disturbed and 35% Pinion/Juniper.

EMBANKMENT

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

Structure KM-D

Embankment	Residual Sandstone Soils
Foundation	Residual Sandstone Soils
Right Abutment	Residual Sandstone Soils
Left Abutment	Residual Sandstone Soils
Height	8.1 ft
Crest Width	12 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-D, A-A'. Grass provides erosion protection on the upstream and downstream slopes of the embankment.

ANALYSES

STABILITY

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

The following parameters were used in the hydrologic analysis:

1. Water Course length, L	0.356	mi
2. Elevation Difference, H	124	ft
3. Time of Concentration, T	0.123	h
4. Lag time, $0.6T_c$	0.074	h
5. SCS Curve Number	89	
6. Rainfall Depth, 10-year, 24-hour storm .	2.1	in.
25-year, 6-hour storm. .	1.9	in.
7. Drainage Area	19.1	acres

HYDRAULICS

Structure KM-D does not have a spillway. Therefore, the hydraulic analysis is presented in the remedial compliance plan.

Spillway Channel

The structure does not have a spillway channel.

Outflow Channel

The structure presently has no outflow channel.

STORAGE CAPACITY

Analysis of the storage capacity is presented in the remedial compliance plan.

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure KM-D indicated that the only geotechnical problem is rill erosion on the upstream slope. Correction of erosion is considered a periodic maintenance task and does not require remedial action.

HYDRAULICS

Structure KM-D has sufficient storage capacity but it does not have a spillway or outflow channel. A trapezoidal spillway channel should be constructed at elevation 6545.0 feet. The embankment crest elevation should be raised to elevation 6547.60 feet. The outflow channel and stilling basin should be constructed along the alignment shown in Plate 1. The spillway channel, outflow channel, and stilling basin profile is shown in Plate 4 and the required dimensions are shown in Plate 5. The spillway, outflow channel, and stilling basin should be protected against erosion using geotextile and riprap 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-C and into Structure KM-D. The initial conditions and results of the analysis are summarized in the following table.

KM-D HYDRAULICS

	Units	10-year 24-hour Storm	25-year 6-hour Storm
<hr/>			
Initial Reservoir Volume			
Condition		Empty	Full to the spillway elevation
Inflow			
Peak Flow	cfs	35	85
Volume	acre-ft	1.78*	1.48*
Storage			
Peak Stage	ft	6543.33	6546.59
Spillway Elevation . .	ft	6545.00	—
Peak Storage	acre-ft	2.21	—
Storage Capacity . . .	acre-ft	3.23	—
Outflow			
Peak Flow	cfs	0	49
Embankment Crest			
Elevation	ft	—	6547.60
Peak Stage	ft	—	6546.59
Freeboard	ft	—	1.01
Spillway Channel			
Flow Depth	ft	—	1.59
Critical Velocity . .	fps	—	4.4
Manning's "n"		—	0.040
Outflow Channel			
			<u>Section I</u> <u>Section II</u>
Slope	%	—	6 24
Normal Velocity . . .	fps	—	5.6 8.7
Normal Depth	ft	—	0.53 0.35
Manning's "n"		—	0.040 0.040

*Inflow volume for tributary drainage area between Structures
KM-C and KM-D.

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-D.

The calculations for the sediment load entering Structure KM-D 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 3.00
4. Cover Factor, C 0.70
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. Structure KM-D is located downstream from Structure KM-C and receives excess flow from KM-C during the 10-year, 24-hour storm. Therefore, the storage capacity of the two structures must be combined to determine the available sediment storage life. The 10-year, 24-hour storm was routed through KM-C and into KM-D. The results of this analysis are summarized below.

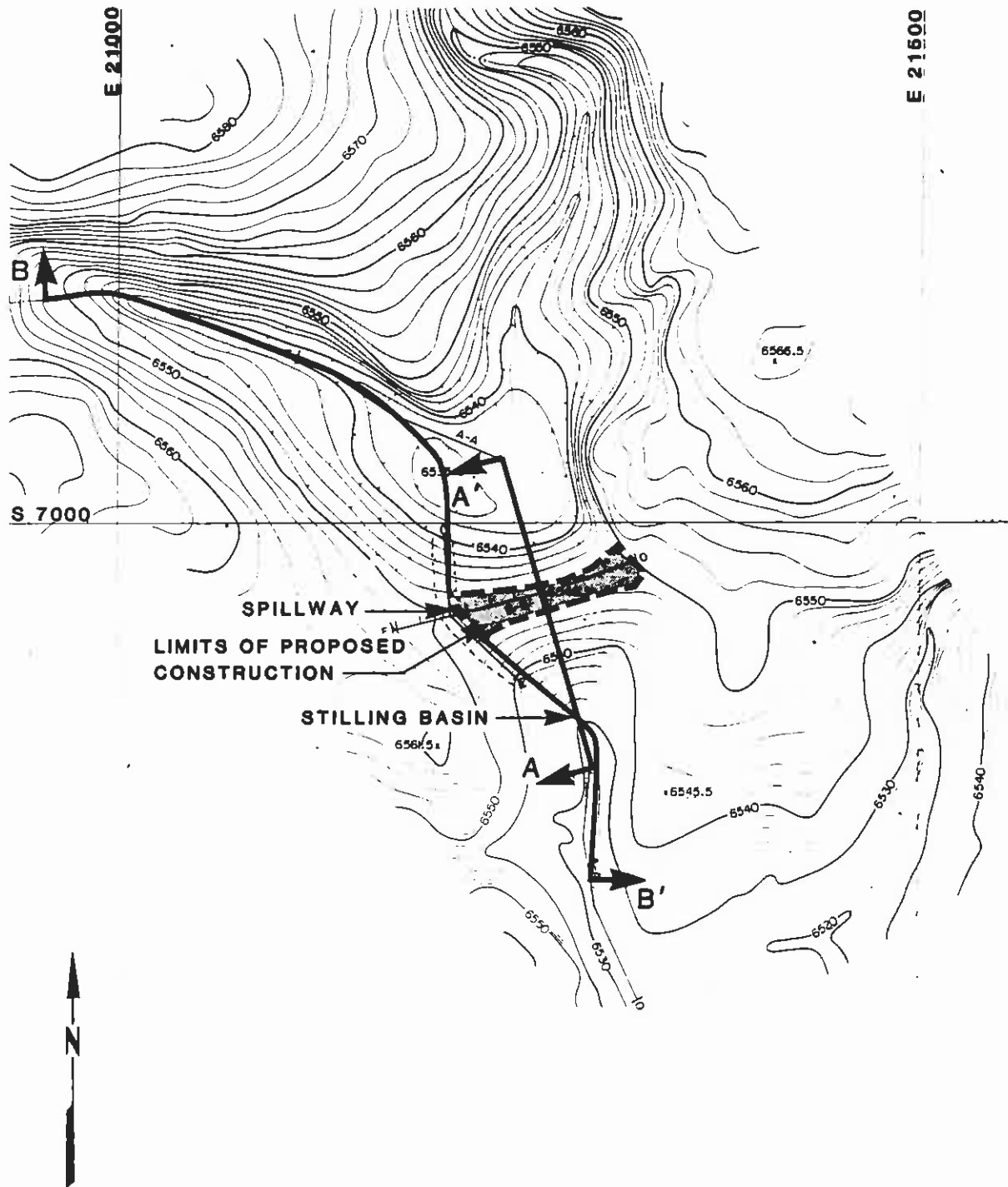
KM-C AND KM-D COMBINED STORAGE

	<u>KM-C</u>	<u>KM-D</u>	<u>Total</u>	
Total Storage Capacity	2.14	3.23	5.37	acre-ft
10-year, 24-hour Storm Inflow	2.57	1.78	4.35	acre-ft
Available Sediment Storage Capacity	—	—	1.02	acre-ft
Sediment Inflow Rate	0.22	0.164	0.384	acre-ft/yr
Sediment Storage Life	—	—	3	yrs

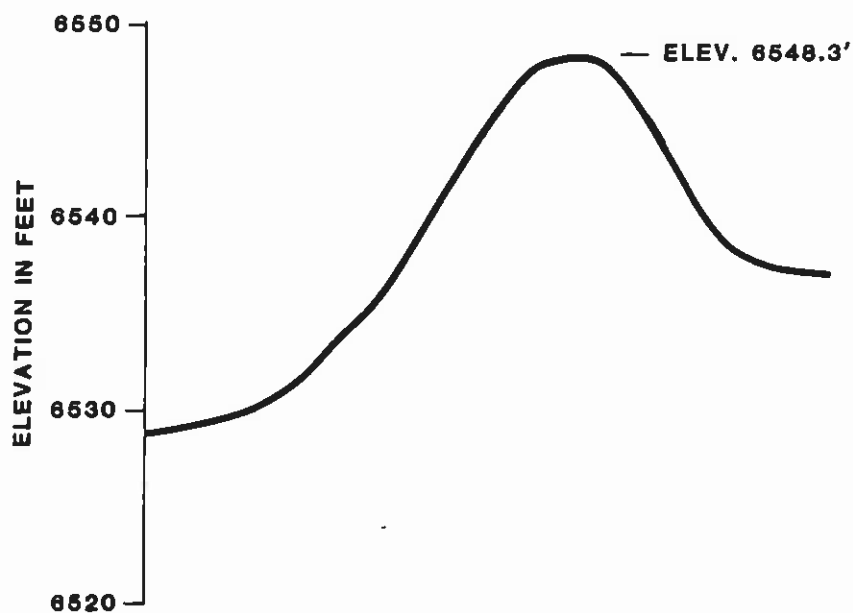
* * *

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

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



SITE PLAN KM-D

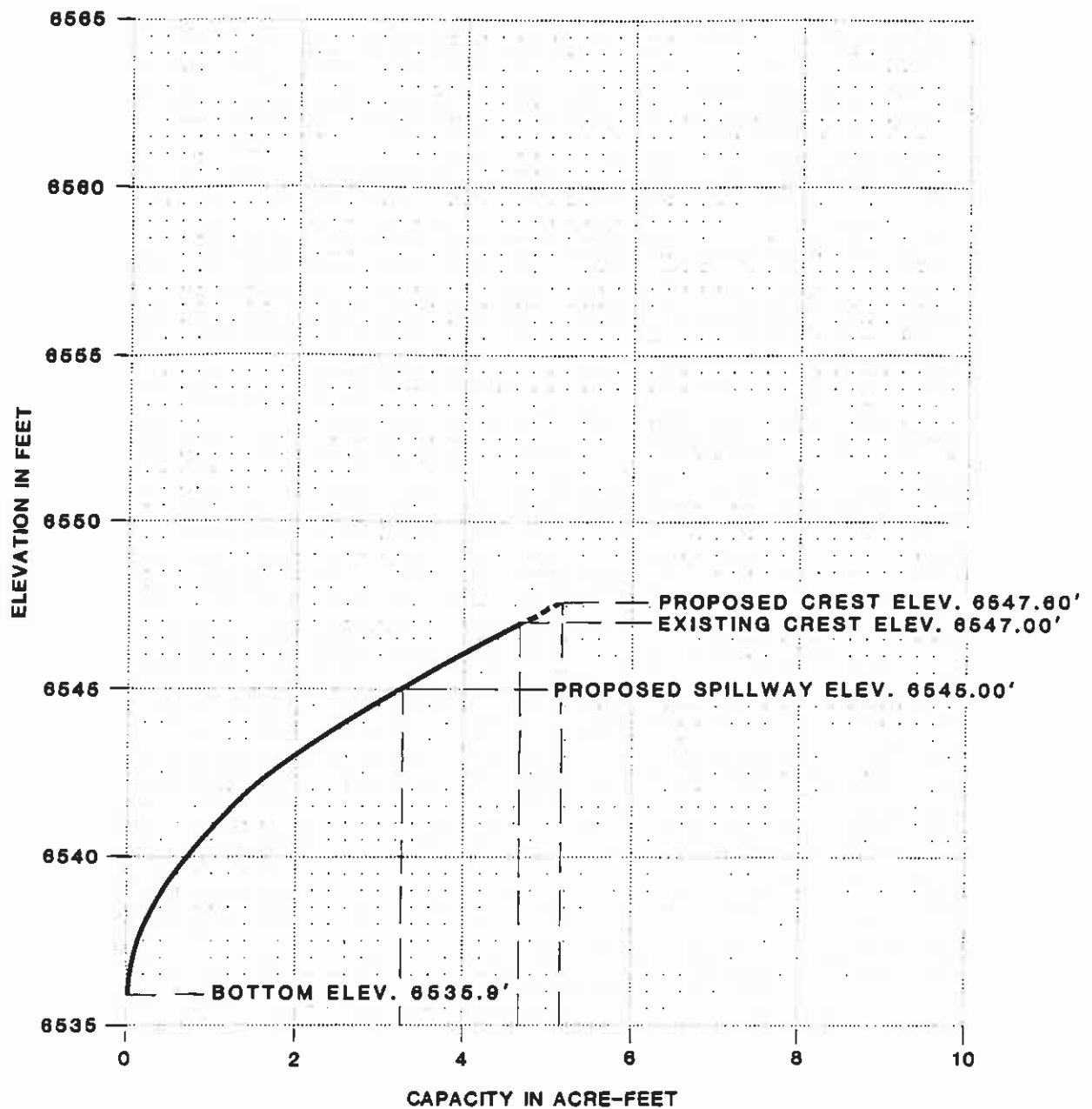


EXISTING
MAXIMUM CROSS-SECTION
A-A'
KM-D

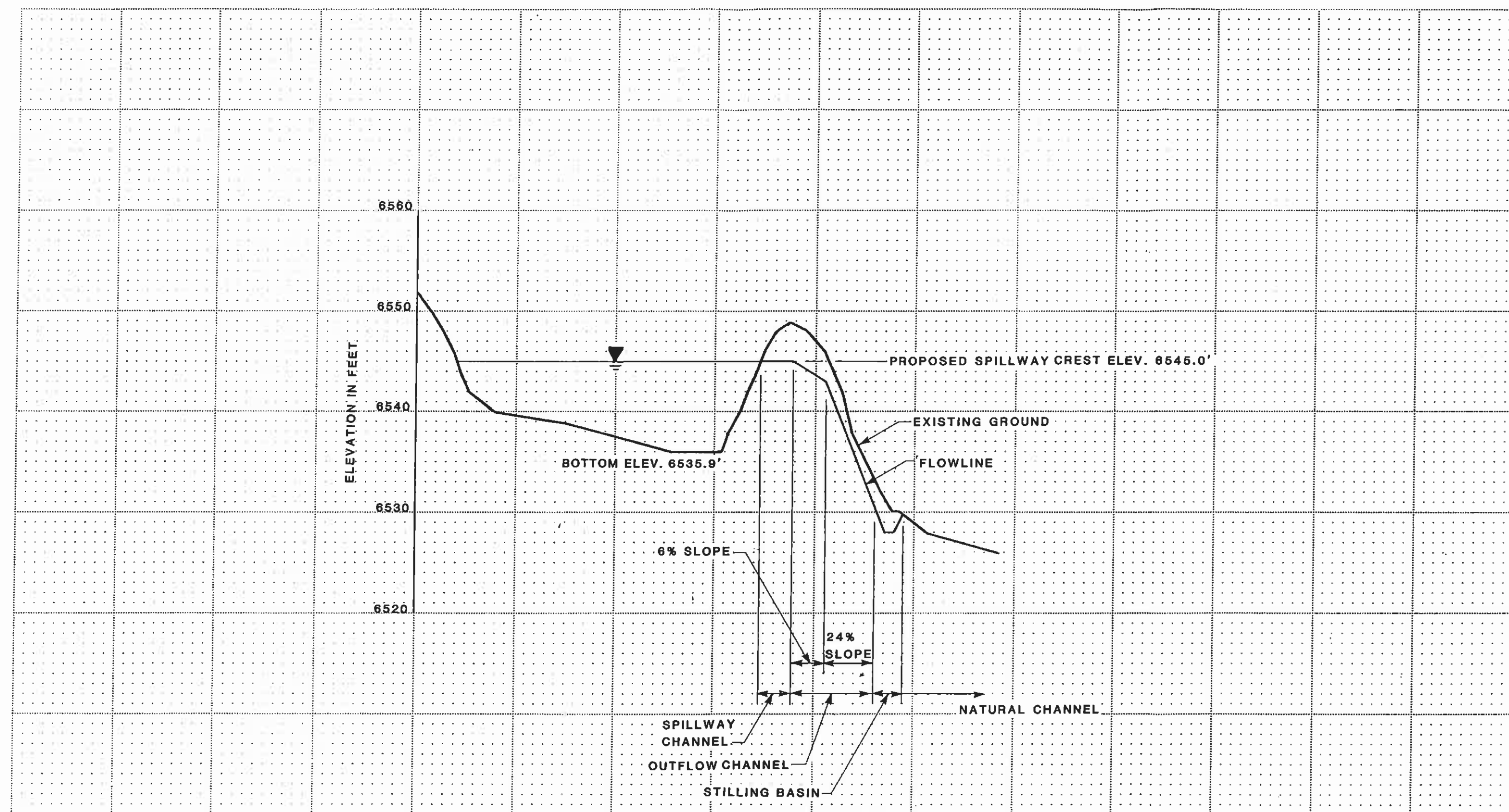
FOR LOCATION SEE PLATE 1

BY **Dames & Moore**

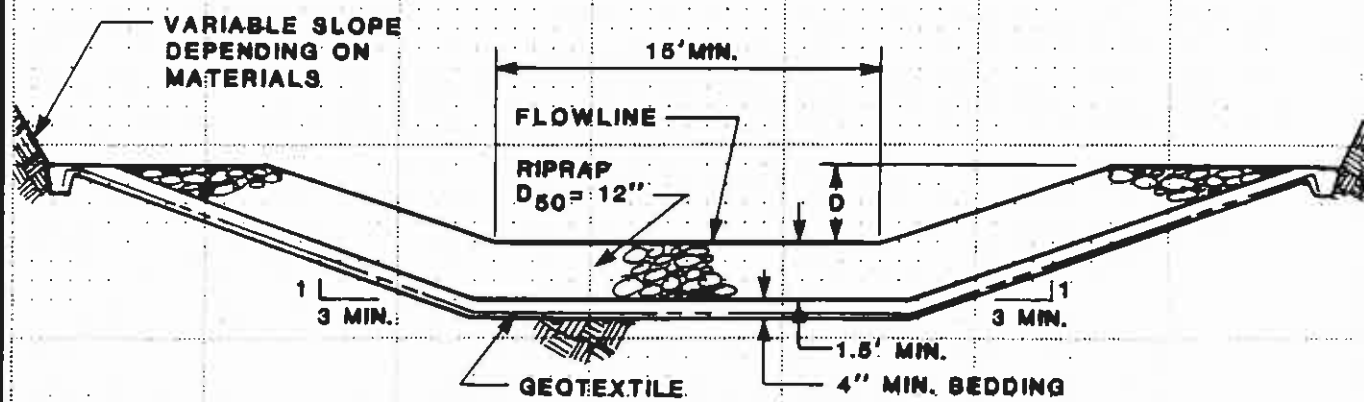
Plate 2



**VOLUME-ELEVATION
CURVE
KM-D**



CHANNEL PROFILE B-B'
KM-D



SPILLWAY CHANNEL

$D = 2.6'$

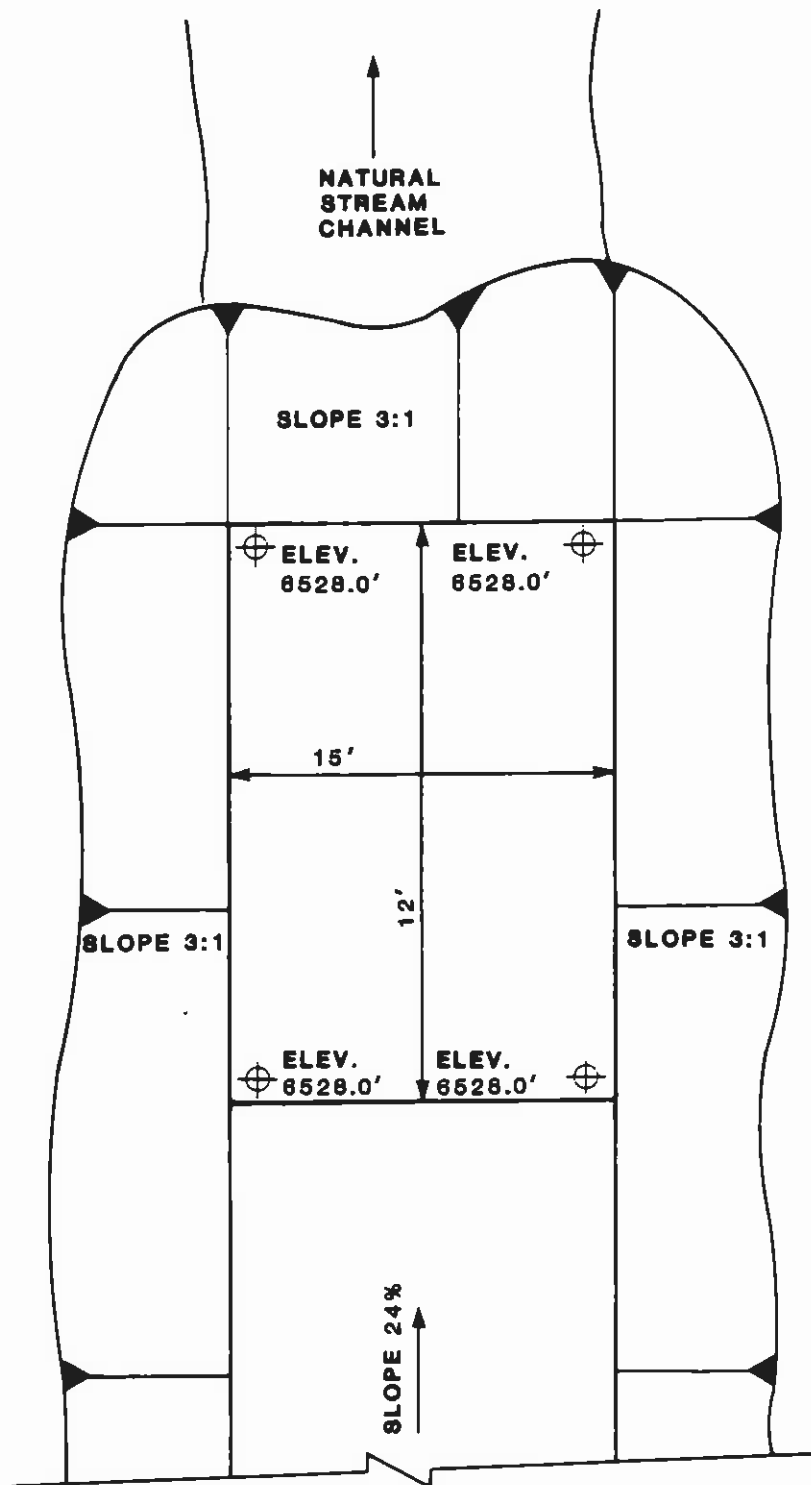
LENGTH = 30'

FLOWLINE ELEV. = 8645.00'

OUTFLOW CHANNEL

$D = 1.5'$

**SPILLWAY AND
OUTFLOW CHANNEL
CROSS SECTION
KM-D**



MINIMUM HEIGHT OF RIPRAP
ALONG SIDEWALLS ABOVE
THE BASIN FLOOR = 3.3'

MINIMUM DEPTH OF BASIN FLOOR
BELOW NATURAL STREAMBED = 1.8'

SPILLWAY STILLING BASIN PLAN

KM-D

APPENDIX A
INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			12'
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			16°
a. Adequate grass cover?	X		70
b. Any erosion?	X		2115
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?	X		Grass
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		70
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	
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			No Spill way See Comment
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?			
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?		<input checked="" type="checkbox"/>	(Elev.) feet
b. Water present?		<input checked="" type="checkbox"/>	(Elev.) feet
c. Siltation?	<input checked="" type="checkbox"/>		
d. Watershed matches soil map?		<input checked="" type="checkbox"/>	

9. GENERAL COMMENTS

No Spill way - should be on embankment towards
 L.A.

APPENDIX B
HYDROLOGY AND HYDRAULIC CALCULATIONS

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6670 - 6546 = 124 ft.

WATER COURSE LENGTH = 4.7 (400) = 1880 ft. = 0.356 mi.

$T_c = \left(\frac{11.9 (0.356)^3}{124} \right)^{0.385} = 0.123 \text{ hr.}$

Lag Time = $0.6 T_c = 0.074 \text{ hr.}$

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
66 (35%)	?-J	ave	D	0.35 (83) = 29.1
12.5 (65%)	Disturbed (Grass Rd)	—	D	0.65 (91) = 59.2
				88.3

50% EH #33

50% EH #25

Use 89

DRAINAGE BASIN AREA

19.1 ACRE 0.030 SQ MILE

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UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

$$R = 40$$

SOIL ERODIBILITY FACTOR

$$\text{SOIL TYPE} = \begin{array}{ll} 50\% & \text{EH \# 33} & .5 (.22) \\ 50\% & \text{EH \# 22} & .5 (.22) \end{array}$$

$$K = .22$$

SLOPE FACTOR

<u>LENGTH (ft.)</u>	<u>Δ ELEV (ft.)</u>	<u>SLOPE (%)</u>	<u>LS</u>
800	50	7%	2.35 (60%)
300	40	14%	3.98 (40%)

use 3.00

COVER FACTOR

<u>AREA (ac)</u>	<u>COVER TYPE</u>	<u>% COVER</u>	<u>CANOPY (%)</u>	<u>WEIGHTED C</u>
35%	P-T	40	25	.35 (.14)
65%	disturbed			.65 (1.0)

$$C = .70$$

EROSION CONTROL FACTOR

$$P = 1.0$$

SEDIMENT INFLOW

$$A = 40 (.22) (3.00) (.70) (1.0) = 18.48 \text{ ton/acre/year}$$

$$A = 18.48 \left(\frac{1}{2047} \right) (19.1) (.95) = .164 \text{ acre-feet/year}$$

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