INSPECTION REPORT

Sedimentation Structure

MW-A

Black Mesa Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure MW-A 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 Black Mesa Mine. The location of Structure MW-A is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure MW-A. 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 MW-A 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 MW-A 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 MW-A has a 7.67-acre tributary drainage area and is located near Moenkopi Wash at the Black Mesa Mine. The watershed is classified as 100% disturbed.

EMBANKMENT

Structure MW-A is a homogeneous earthen embankment classified as a in-wash embankment. Physical characteristics of the embankment are listed in the following table:

Structure MW-A

Embankment	Alluvial Soils with Residual Sandstone/Shale Soils
Foundation	Alluvial Soils
Right Abutment	Alluvial Soils
Left Abutment	Haul Road Fill
Height	13.8 ft
Crest Width	15 ft
Upstream Slope	2.5 H : 1 V
Downstream Slope . . .	4 H : 1 V

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

ANALYSES

STABILITY

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

1. Maximum height = 20 ft
2. Maximum upstream slope = 2.0 H : 1 V
3. Maximum downstream slope = 4.0 H : 1 V
4. Normal pool with steady seepage saturation conditions

The MW-A 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 MW-A 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 MW-A was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.674	mi
2.	Elevation Difference, H	126	ft
3.	Time of Concentration, T_c	0.330	h
4.	Lag time, $0.6T_c$	0.200	h
5.	SCS Curve Number	91	
6.	Rainfall Depth, 10-year, 24-hour storm .	2.1	in.
	25-year, 6-hour storm. .	1.9	in.
7.	Drainage Area	7.67	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.

MW-A 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	12	15
Volume	acre-ft	0.86	0.75
Storage			
Peak Stage	ft	6277.66	6289.28
Spillway Elevation . .	ft	6288.80	--
Peak Storage	acre-ft	0.86	--
Storage Capacity . . .	acre-ft	9.17	--
Outflow			
Peak Flow	cfs	0	2
Embankment Crest Elevation	ft	--	6290.40
Peak Stage	ft	--	6289.26
Freeboard	ft	--	1.14
Spillway Channel			
Flow Depth	ft	--	0.46
Critical Velocity. . .	fps	--	1.5
Manning's "n"		--	0.035
Outflow Channel			
Slope	%	--	1
Normal Velocity. . . .	fps	--	0.9
Normal Depth	ft	--	0.11
Manning's "n"		--	0.035

Spillway Channel

The existing spillway for MW-A has a trapezoidal channel with the following dimensions:

Channel depth	2.8 ft
Channel width	18 ft
Channel length	50 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 structure presently has no outflow 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, MW-A.

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

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.216
3. Slope Factor, LS 2.40
4. Cover Factor, C 1.0
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 MW-A and the results of the sediment inflow analysis are summarized in the following table.

MW-A STORAGE

Total Storage Capacity	9.17	acre-ft
10-year, 24-hour Storm Inflow	0.86	acre-ft
Available Sediment Storage Capacity . .	8.31	acre-ft
Sediment Inflow Rate	0.074	acre-ft/yr
Sediment Storage Life	112	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure MW-A indicated that the only geotechnical problem is rill and gully erosion on the upstream slope and the right and left abutments. Gully erosion is also undermining the right side slopes of the spillway. Correction of erosion is considered a periodic maintenance task and does not require remedial action.

HYDRAULICS

The storage capacity and spillway capacity of Structure MW-A are adequate; however, the spillway does not have an 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 MW-A

Plate 2 - Existing Maximum Cross Section MW-A, A-A'

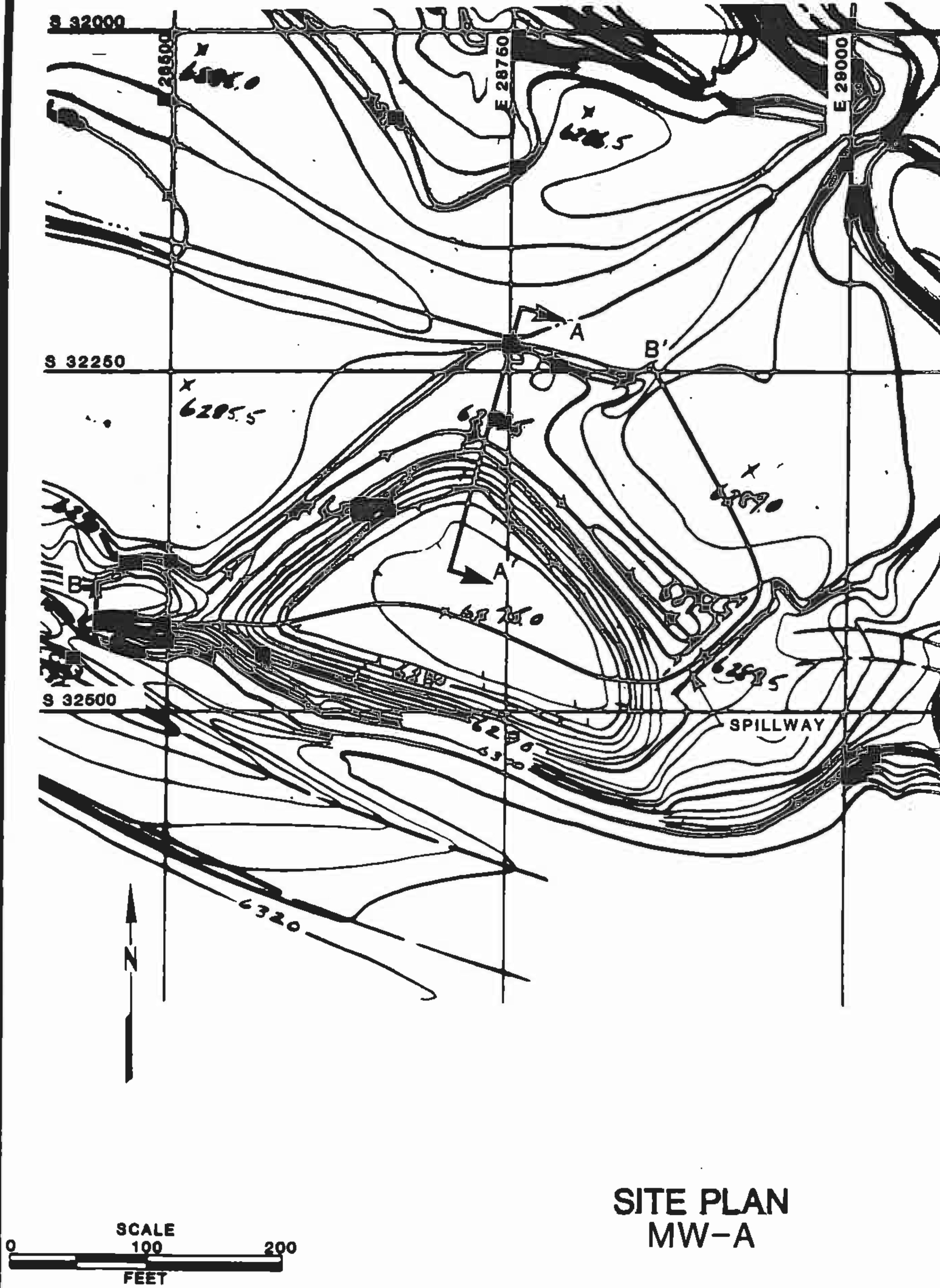
Plate 3 - Volume-Elevation Curve MW-A

Plate 4 - Channel Profile MW-A, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section MW-A

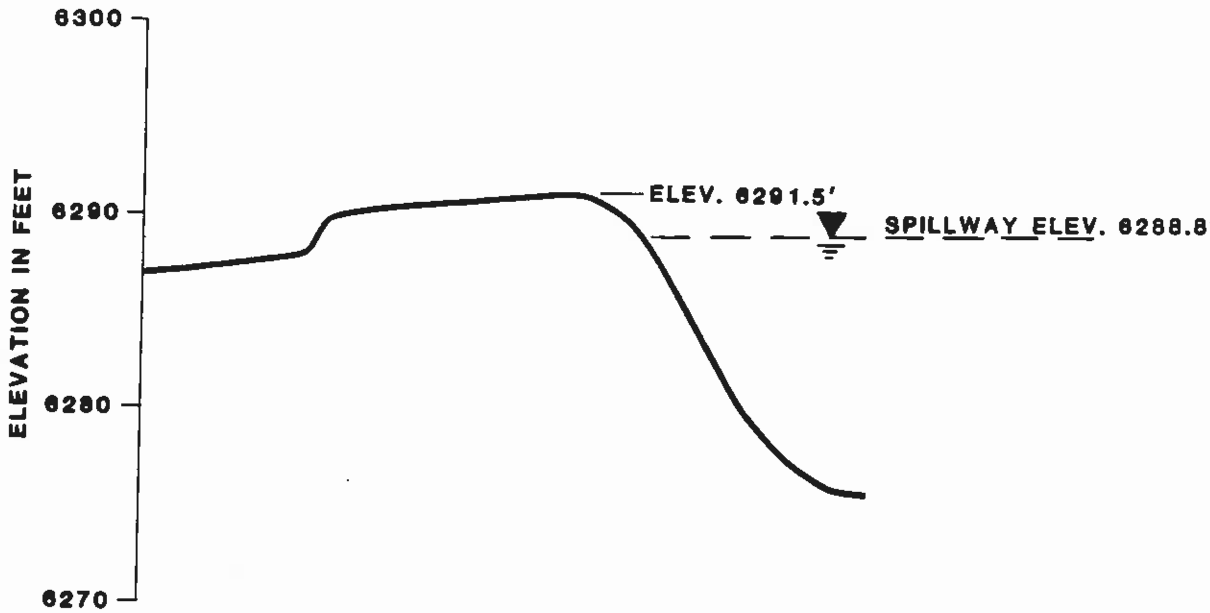
Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations



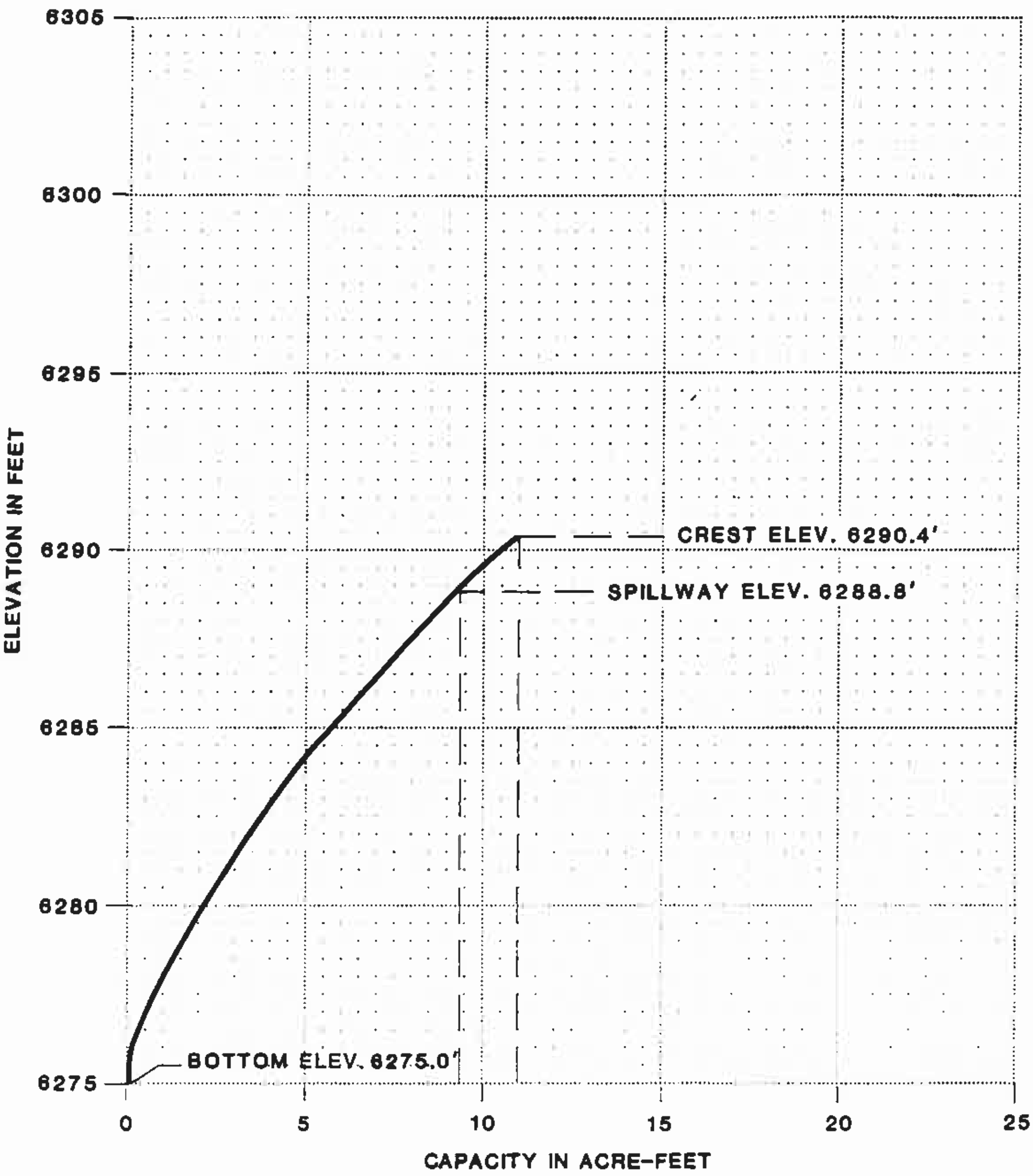
SITE PLAN
MW-A

BY **Dames & Moore** Plate 1



EXISTING
MAXIMUM CROSS-SECTION
A-A'
MW-A

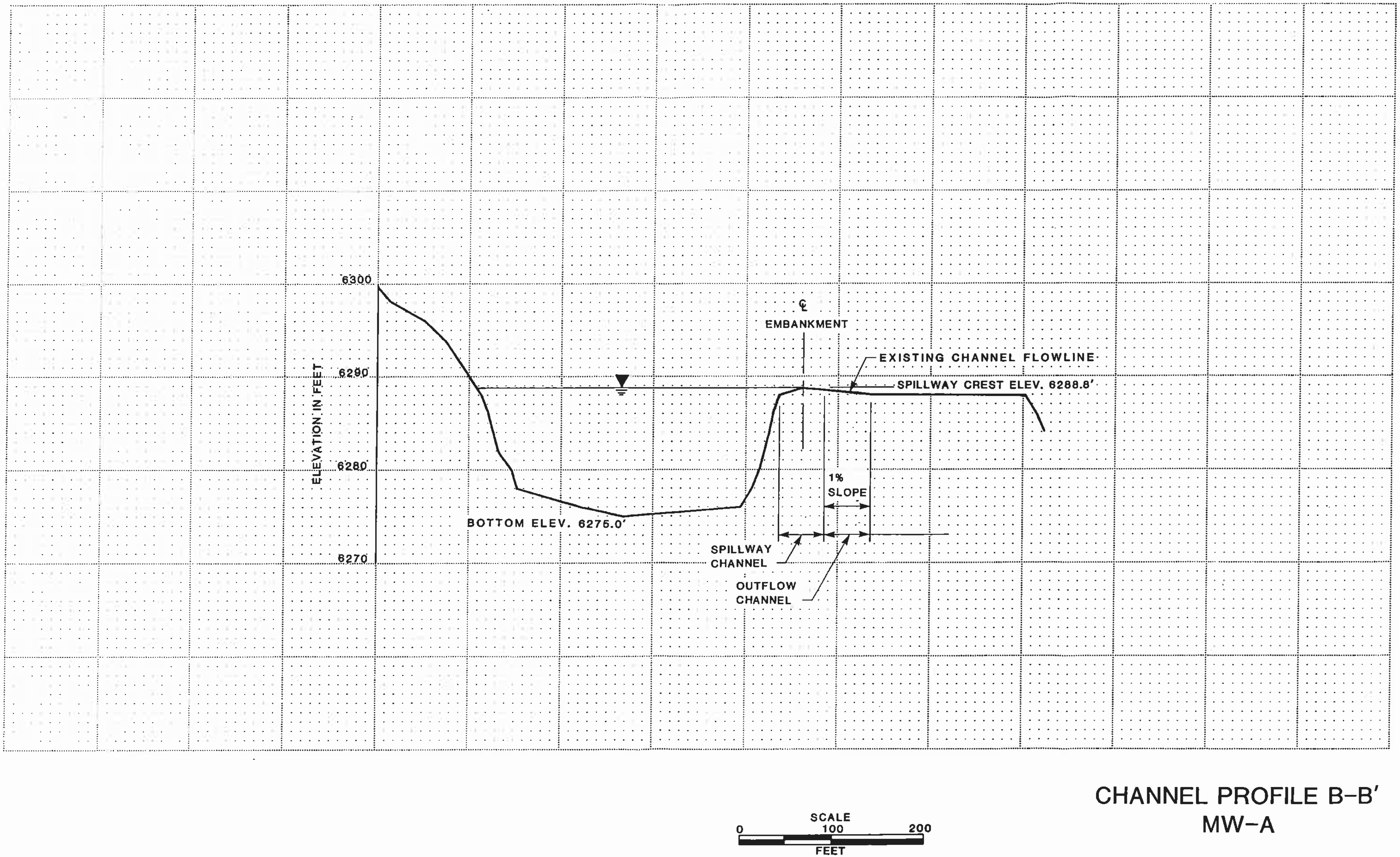
BY Dames & Moore Plate 2



VOLUME-ELEVATION CURVE

MW-A

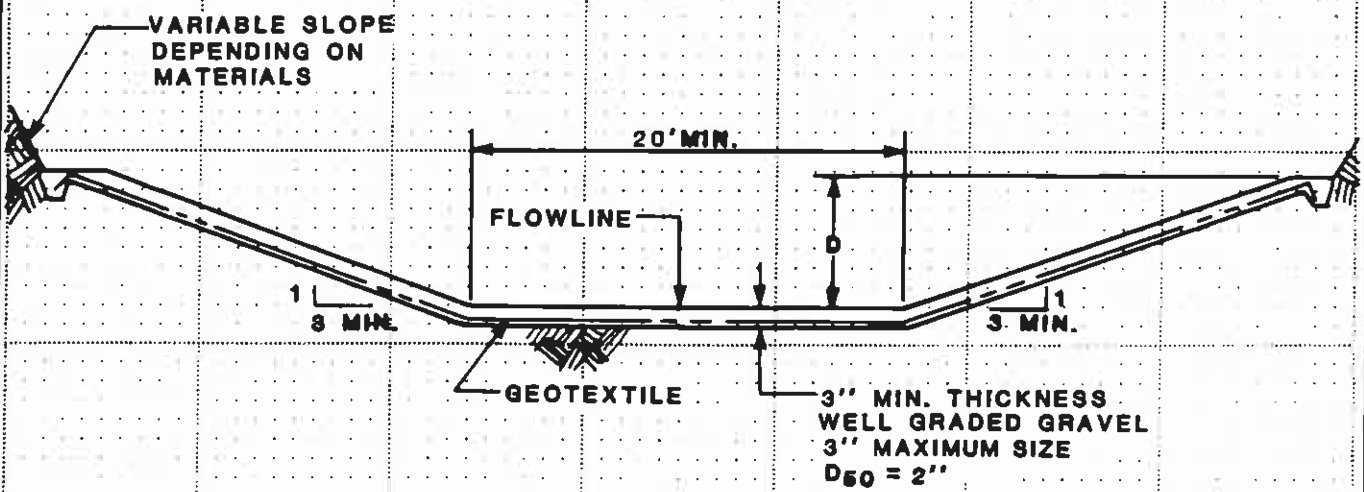
BY **Dames & Moore** Plate 3



CHANNEL PROFILE B-B'
MW-A

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



SPILLWAY CHANNEL

D = 1.5'

LENGTH = 50'

FLOWLINE ELEV.= 6288.80'

OUTFLOW CHANNEL

D = 1'

SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION MW-A

BY Dames & Moore Plate 5

APPENDIX A

INSPECTION CHECK LIST

Sediment Impoundment Name: MW-A
Page: 4

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			
a. Adequate grass cover?	X		
b. Any erosion?	X		minor 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			
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		gulleys
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			SM brown
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?	X		gulleys
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Fill / Road

ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			
a. Location:			
Left abutment?			
Right abutment?			
Crest of Embankments?	X		Towards R.A.
b. Approach Channel:		X	NA – Face of U.S. dam
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?	X		gulley
Obstructed?			
Erosion protection?		X	
c. Spillway Channel:		X	
Are side slopes eroding?		X	Right slope low See sketch
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
d. Outflow Channel:		X	
Are side slopes eroding?			NA
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?			

Sediment Impoundment Name: MW - A
Page: 6

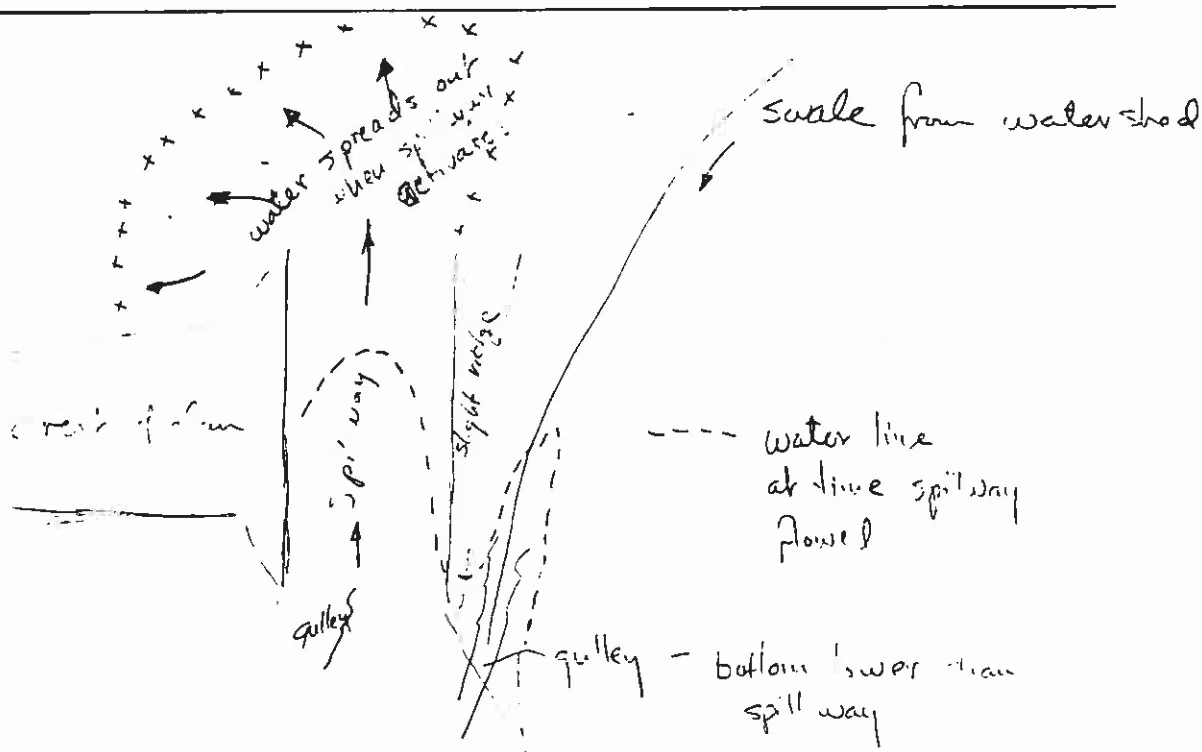
ITEM	YES	NO	REMARKS
8. IMPOUNDMENT			
a. Sinkholes?		X	(Elev.) feet
b. Water present?	X		(Elev.) feet
c. Siltation?	X		
d. Watershed matches soil map?		X	disturbed bare ?

9. GENERAL COMMENTS

More sediment inflow from Haul road than from watershed

ground cover 20%

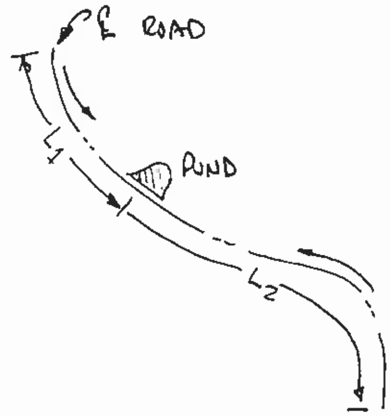
Canopy cover ≤40 %



APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

MW-A DRAINS A PORTION OF A HAUL ROAD



$L_1 = 1660'$

Δ ELEV = 6390 − 6314 = 76'

SLOPE = 4.6%

$L_2 = 3560'$

Δ ELEV = 6440 − 6314 = 126'

SLOPE = 3.5%

TIME OF CONCENTRATION:

ASSUME OVERLAND FLOW VELOCITY OF 3 FT/SEC FOR 4% SLOPE

$T_c = 3560/3 = 1187$ sec. = 19.8 min = 0.33 hr.

LAG TIME = $0.6\,T_c$ = 0.20 hr.

SCS CURVE NUMBER:

WATERSHED IS 100% GRAVEL ROAD

HYDROLOGIC CONDITION D (SOIL TYPE EH #23)

CN = 91

DRAINAGE BASIN AREA:

7.67 acres = 0.012 mi^2

REVISIONS BY ____ DATE ____ TO EO ____
BY ____ DATE ____ TO EO ____

BY G Dewitt DATE 9/10/86
CHECKED BY ____
COPY TO EO ____

Dames & Moore

Purpose: A time of concentration from which a lag time can be computed must be obtained for hydrograph construction representing runoff from a watershed. Various methods of estimating time of concentration, T_c, are as follo[illegible]

A. ESTIMATING T_c FROM STREAM HYDRAULICS (SCS GUIDE)

1. Obtain stream reaches and channel cross-sections from field surveys
2. Find approximate channel bankfull discharge for each reach.
3. Compute average velocity for the bankfull discharge of each reach.
4. Use the average velocity and the valley length of the reach to compute travel time through each reach.
5. Add travel times of reaches to get T_c.

Note: Appendix B "Hydraulic Computations" presents methods of computing flows in natural channels.

B. ESTIMATING T_c FROM VELOCITY ESTIMATES AND WATERCOURSE LENGTHS

Velocity Estimate Guide

[illegible]S Navy - Technical Publication Navdocks TP-PW-5 Table 88, March 1953

Average slope of channel from farthest point to outlet, in percent	Average velocity, feet per second
1 to 2	2.0
2 to 4	3.0
4 to 6	4.0
6 to 10	5.0

Texas Highway Department Rational Design of Culverts and Bridges, October [illegible]

Slope in percent	Average velocity, feet per sec[illegible]		
	Woodlands (upper portion watershed)	Pastures (upper portion watershed)	Natu[illegible] channe[illegible] well de[illegible]
0 - 3	1.0	1.5	1 [illegible]
4 - 7	2.0	3.0	[illegible]
8 - 11	3.0	4.0	[illegible]
12 - 15	3.5	4.5	8 [illegible]

Figure 30. Time of concentration estimates. (Sheet 1 of 2.) 288-D-2461.

Universal Soil Loss Equation

Rainfall Factor

R = 40

Soil Erodibility Factor

Soil Type = 80% EH #23, 20% EH #27

.8(.18)
.2(.36)
.216

K = .216

Slope Factor

Length (ft.)	Δ Elev (ft.)	Slope (%)	LS
1750	40	2.3	.53 (.40)
1200	100	8.3	3.64 (.60)

use 2.40

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

$A = 40(.216)(2.4)(1.0)(1.0) = 20.74$ ton/acre/year

$A = 20.74\left(\frac{1}{2047}\right)(7.67)(.95) = .074$ acre-feet/year