

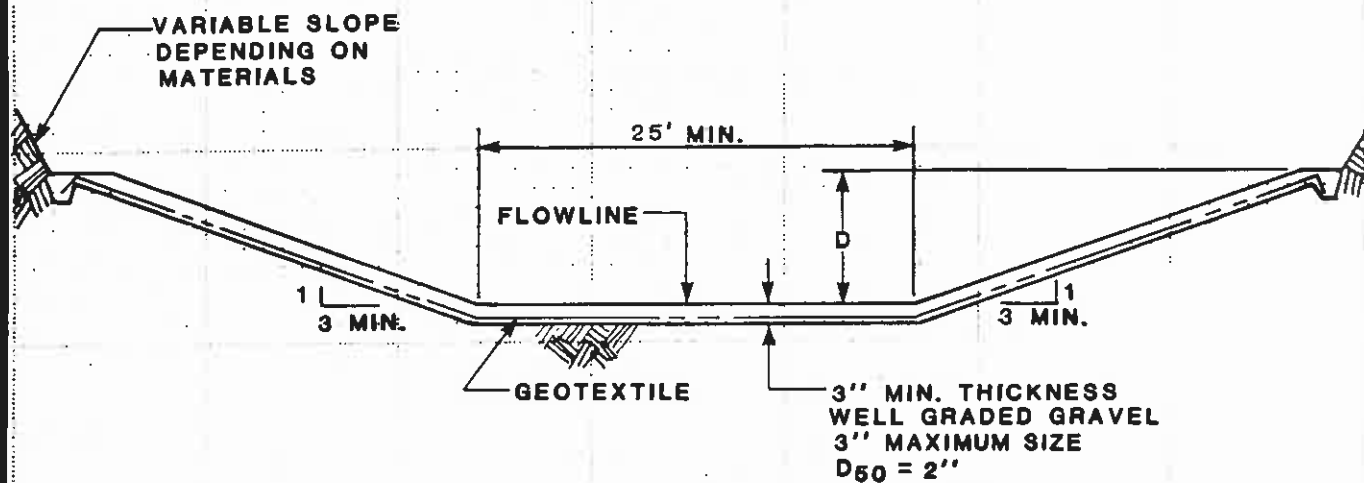
INSPECTION REPORT
Sedimentation Structure
MW-B
Black Mesa Mine
Navajo County, Arizona
for
PEABODY COAL COMPANY



Dames & Moore
10139-011-22

TABLE OF CONTENTS

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



SPILLWAY CHANNEL

D = 1.8'

LENGTH = 30'

FLOWLINE ELEV. = 8313.30'

OUTFLOW CHANNEL

D = 1.0'

**SPILLWAY AND
OUTFLOW CHANNEL
CROSS SECTION
MW-B**

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			
a. Adequate grass cover?		X	20%
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?		X	NA
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			
a. Adequate grass cover?		X	20% sparse
b. Any erosion?	X		gulleys
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Visual depressions or bulges?	X		due to construction - uneven
g. Visual settlements?		X	
h. Is the toe drain dry?		X	NA
i. Are the relief wells flowing?		X	NA
j. Are boils present at the toe?		X	
k. Is seepage present?		X	
l. Animal burrows?		X	
4. ABUTMENT CONTACT. RIGHT			Roadway
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Fill gray sm w/ sm gravel
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/sm

ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			
a. Location:			
Left abutment?			
Right abutment?			
Crest of Embankments?	X		Adjacent to R. Abut
b. Approach Channel:	X		
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
c. Spillway Channel:	X		
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
d. Outflow Channel:		X	ON FACE OF DAM
Are side slopes eroding?			NA
Are side slopes sloughing?			NA
Bottom of channel eroding?	X		
Obstructed?			
Erosion protection?		X	
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"/>		some
d. Watershed matches soil map?		<input checked="" type="checkbox"/>	Reclaimed

9. GENERAL COMMENTS

Downstream slope surface uneven / appears to be due to extra material added surface not trimmed at end of construction

Crest is S shaped.

Gulleys on d.s. face near spillway Hard to tell whether spillway ever ran or due to local run off.

Canopy Cover $\leq 20\%$

Ground cover 75%

APPENDIX B
HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE PEABODY Coal Co 10139-011-22SUBJECT SEDIMENT AND HYDROLOGY

Sheet K-10

MW-8

SHEET OF TIME OF CONCENTRATION

$$\text{ELEVATION DIFFERENCE} = 6555 - 6313 = 242 \text{ ft.}$$

$$\text{WATER COURSE LENGTH} = 2.6(400) = 3040 \text{ ft.} = 0.576 \text{ mi.}$$

$$T_c = \left(\frac{11.9(0.576)^3}{242} \right)^{0.385} = 0.166 \text{ hr.}$$

$$\text{LAG TIME} = 0.6 T_c = 0.099 \text{ hr.}$$

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
259 (54%)	S-G	fair	C-D	66(.54)
20.6 (43%)	P-J	fair	C-D	76(.43)
1.9 (3%)	HAUL RD.	-	D	91(.03)
				<u>71.05</u>
70% EH #22 - C				
30% EH #23 - D				

use 72DRAINAGE BASIN AREA48.0 ACRES 0.075 SQ MILE

REVISIONS

BY DATE TO EO
BY DATE TO EO S. DOLAN DATE 9-9-85CHECKED BY
COPY TO EO

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

$$R = 40$$

SOIL ERODIBILITY FACTOR

$$\begin{array}{lcl} \text{SOIL TYPE} = 30\% \text{ EH \#23} & .3 (.18) \\ 70\% \text{ EH \#32} & .7 (.21) \\ \hline & .201 \end{array}$$

$$K = \underline{\underline{.201}}$$

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
450	140	31.1	17.9 (.50)
500	50	10.0	3.1 (.20)
500	90	18.0	7.7 (.30)

$$\text{use } \underline{\underline{11.88}}$$

COVER FACTOR

AREA (ac.)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
54%	S-G	60	25	.54 (.082)
43%	P-J	60	25	.43 (.085)
3%	disturbed	—	—	.03 (1.0)

$$C = \underline{\underline{.111}}$$

EROSION CONTROL FACTOR

$$P = 1.0$$

SEDIMENT INFLOW

$$A = 40 (.201) (11.88) (.111) (1.0) = 10.60 \quad \text{ton/acre/year}$$

$$A = 10.60 \left(\frac{1}{2047} \right) (48.) (.95) = .236 \quad \text{acre-feet/year}$$

REVISIONS

BY DATE TO EO
 BY DATE TO EO

DATE

CHECKED BY
 COPY TO EO

INTRODUCTION

Sedimentation Structure MW-B 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-B is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure MW-B. 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-B 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-B 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-B has a 48.0-acre tributary drainage area and is located near Moenkopi Wash at the Black Mesa Mine. The watershed is classified as 54% Sagebrush/grass, 43% Pinion/Juniper, and 3% disturbed.

EMBANKMENT

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

Structure MW-B

Embankment	Residual Sandstone Soils
Foundation	Alluvium/Residual Sandstone Soils
Right Abutment	Haul Road Fill
Left Abutment	Sandstone
Height	9.4 ft
Crest Width	11 ft
Upstream Slope	2.25 H : 1 V
Downstream Slope . . .	2 H : 1 V, 1.6 H : 1 V, 1.3 H : 1 V
	left abut. center right abut.

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

ANALYSES

STABILITY

Structure MW-B is a category A-3 embankment. A standard category A-3 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 MW-B 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 MW-B 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-B was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1. Water Course length, L	0.576	mi
2. Elevation Difference, H	242	ft
3. Time of Concentration, T_c	0.166	h
4. Lag time, $0.6T_c$	0.099	h
5. SCS Curve Number	72	
6. Rainfall Depth, 10-year, 24-hour storm .	2.1	in.
25-year, 6-hour storm. .	1.9	in.
7. Drainage Area	48.0	acres

HYDRAULICS

The HEC-1 program was utilized to evaluate inflow, reservoir response and outflow from the sedimentation structure. The initial conditions and results of the analysis are summarized in the following table.

MW-B 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	21	23
Volume	acre-ft	1.44	1.04
Storage			
Peak Stage	ft	6307.57	6313.96
Spillway Elevation . .	ft	6313.30	--
Peak Storage	acre-ft	1.44	--
Storage Capacity . . .	acre-ft	4.79	--
Outflow			
Peak Flow	cfs	0	5
Embankment Crest			
Elevation	ft	--	6315.60
Peak Storage	ft	--	6313.96
Freeboard	ft	--	1.64
Spillway Channel			
Flow Depth	ft	--	0.66
Critical Velocity. . .	fps	--	1.8
Manning's "n"		--	0.040

Approach Channel

The existing approach channel for MW-B has a U-shaped channel with following dimensions:

Channel width	13-14 ft
Channel length	30 ft
Slope	20 percent

Spillway Channel

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

Channel depth	2.3 ft
Channel width	34 ft
Channel length	24 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-B.

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

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.201
3. Slope Factor, LS 11.88
4. Cover Factor, C 0.111
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-B is shown on Plate 3, Volume-Elevation Curve, MW-B, and the results of the analysis are summarized in the following table.

MW-B STORAGE

Total Storage Capacity	4.79	acre-ft
10-year, 24-hour Storm Inflow	1.44	acre-ft
Available Sediment Storage Capacity	3.35	acre-ft
Sediment Inflow Rate	0.236	acre-ft/yr
Sediment Storage Life	14	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure MW-B indicated that the geotechnical problems consist of rill and gully erosion on the downstream slope and a steep and uneven downstream slope. Correction of erosion is considered a periodic maintenance task and does not require remedial action. The downstream slope is uneven due to either lack of fine grading after initial construction or shallow surficial slope failures. The downstream slope should be flattened to 3.25 horizontal to 1 vertical to meet stability requirements. This flatter slope was selected due to a foundation slope greater than 5 percent. The downstream toe of this embankment needs to be riprapped to protect the slope from undercutting by flows in the Moenkopi Wash.

HYDRAULICS

The storage capacity and spillway capacity of Structure MW-B are adequate; however, the spillway does not have an adequate outflow channel or adequate erosion protection. The proposed embankment relocation provides the opportunity to construct a new spillway and outflow channel in a location that minimizes the difficulties in providing adequate erosion protection. A trapezoidal outflow channel constructed along the alignment B-B' shown in Plate 1 will have a much flatter slope than a channel at the existing spillway location. 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.

Relocating the embankment reduces the storage capacity. The analysis of these conditions is summarized in the following table.

MW-B HYDRAULICS FOR RELOCATED EMBANKMENT

	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	21	23
Volume	acre-ft	1.44	1.04
Storage			
Peak Stage	ft	6308.50	--
Spillway Elevation . .	ft	6313.30	--
Peak Storage	acre-ft	1.44	--
Storage Capacity . . .	acre-ft	3.64	--
Available Sediment			
Storage Capacity . .	acre-ft	2.20	--
Sediment Inflow Rate .	acre-ft/yr	0.236	--
Sediment Storage Life.	yr	9	--
Outflow			
Peak Flow	cfs	0	8
Embankment Crest			
Elevation	ft	--	6315.60
Peak Stage	ft	--	6314.10
Freeboard	ft	--	1.50
Spillway Channel			
Flow Depth	ft	--	0.80
Critical Velocity. . .	fps	--	2.2
Manning's "n"		--	0.035
Outflow Channel			
			<u>Section I</u> <u>Section II</u>
Slope	%	--	26 20
Normal Velocity. . . .	fps	--	4.0 3.8
Normal Depth	ft	--	0.08 0.09
Manning's "n"		--	0.035 0.035

* * *

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

Plate 1 - Site Plan MW-B

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

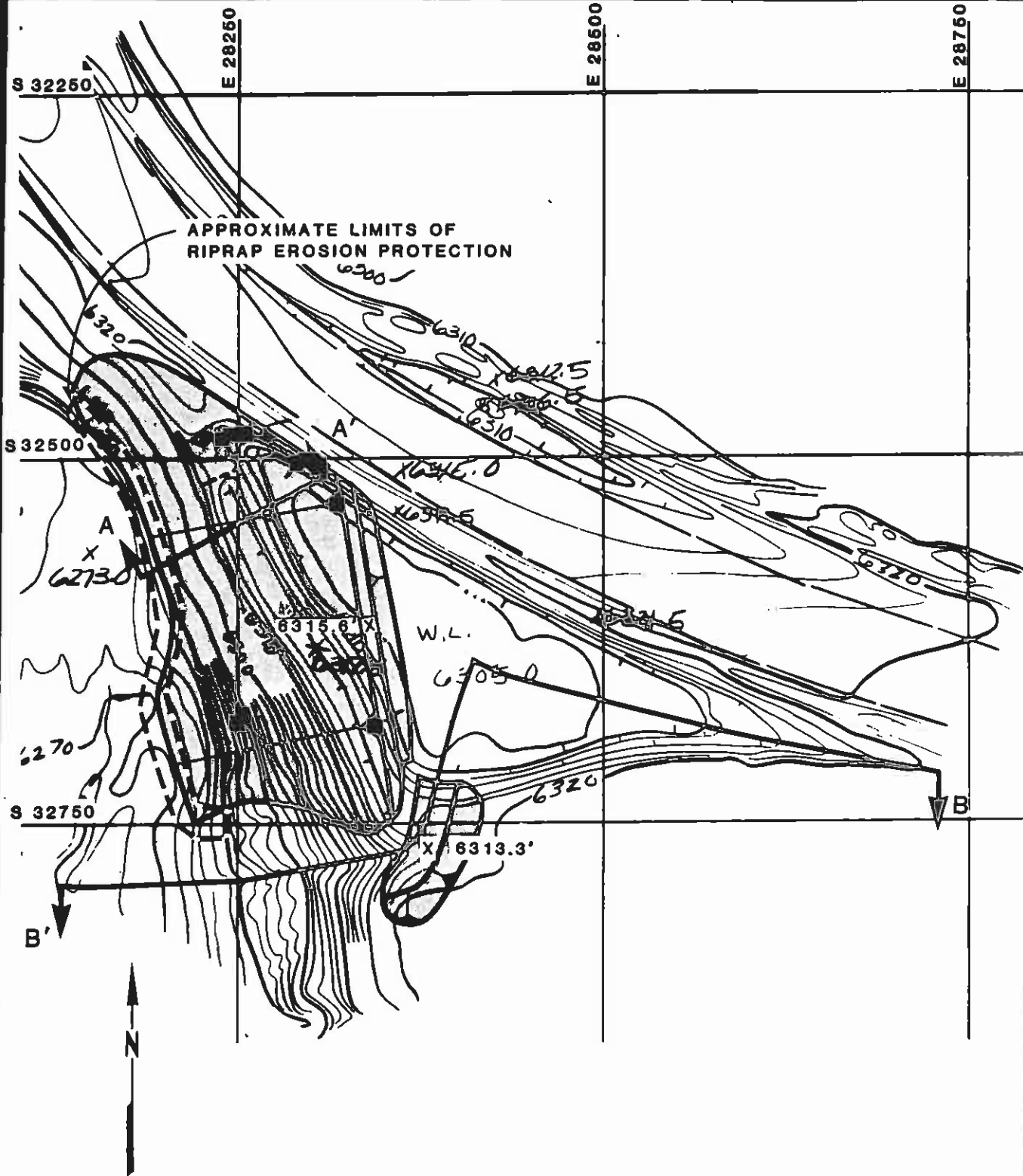
Plate 3 - Volume-Elevation Curve MW-B

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

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

Appendix A - Inspection Check List

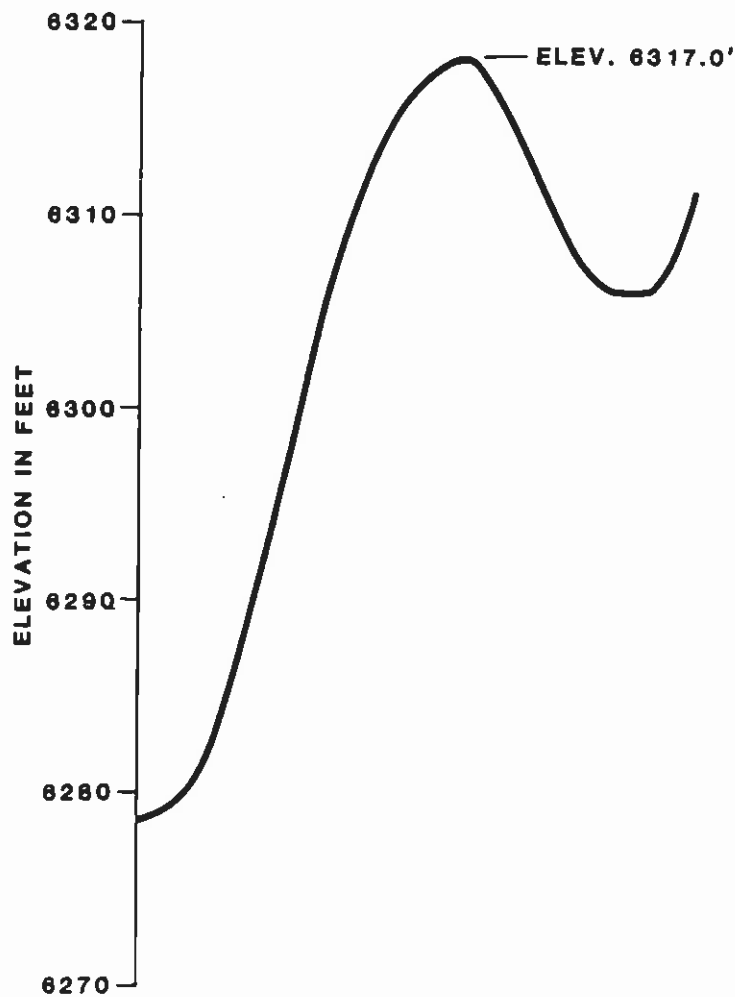
Appendix B - Hydrology and Hydraulic Calculations



SITE PLAN
MW-B

BY **Dames & Moore**

Plate 1

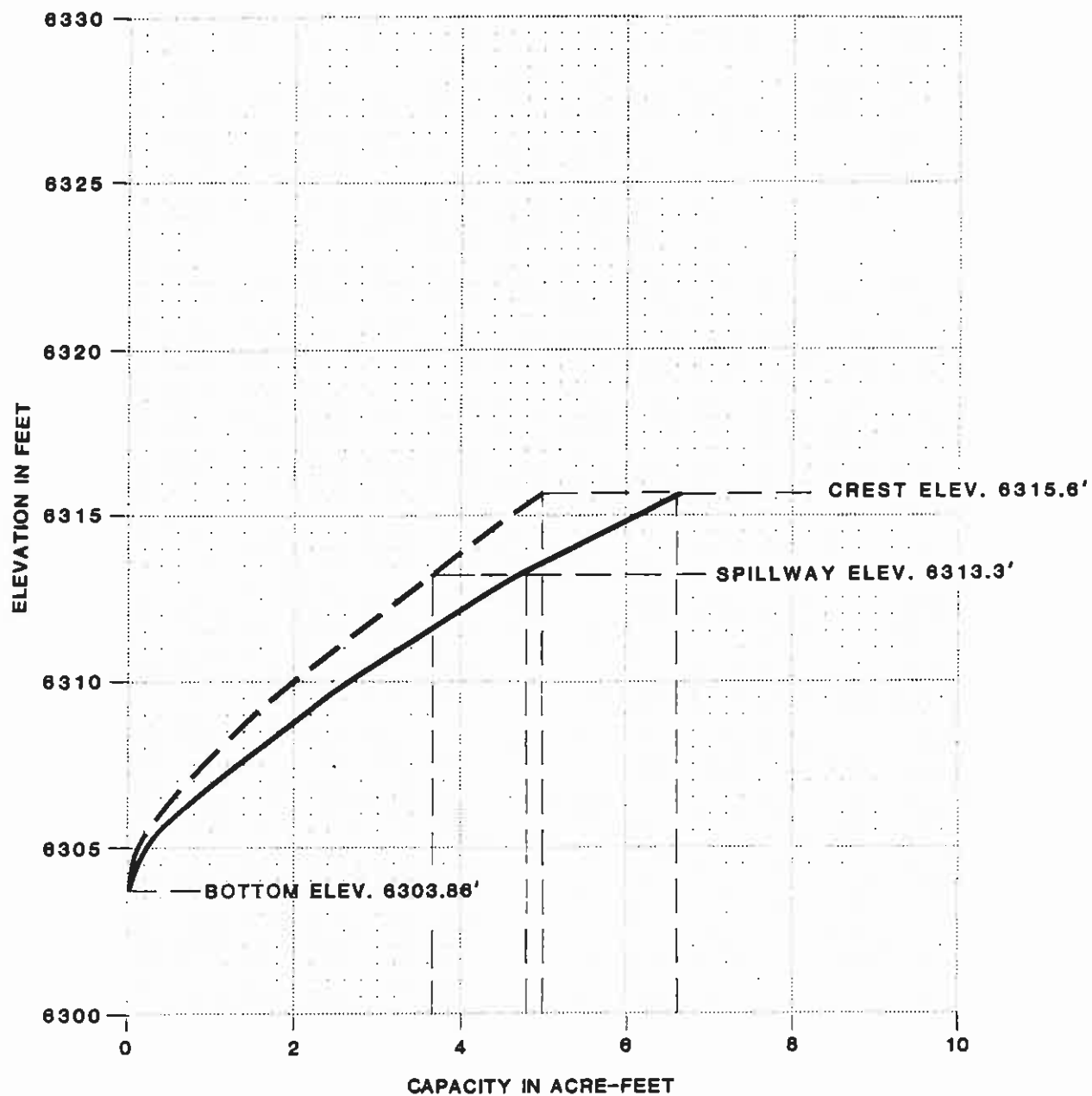


EXISTING
MAXIMUM CROSS-SECTION
A-A'
MW-B

FOR LOCATION SEE PLATE 1

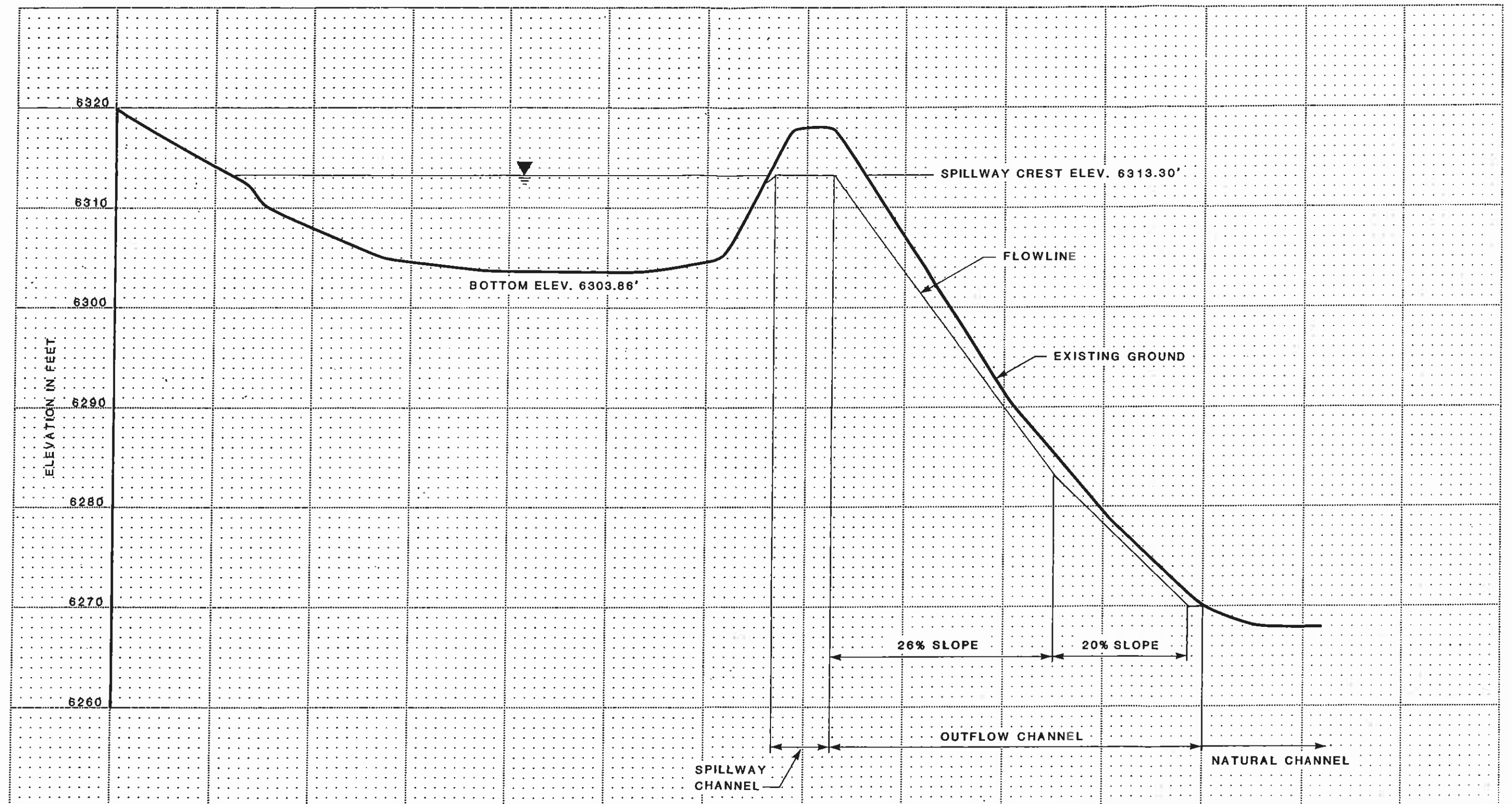
BY **Dames & Moore**

Plate 2



— EXISTING VOLUME
- - PROPOSED VOLUME

VOLUME-ELEVATION CURVE MW-B



CHANNEL PROFILE B-B'
MW-B

