

INSPECTION REPORT  
Sedimentation Structure  
N1-O  
Kayenta Mine  
Navajo County, Arizona  
for  
PEABODY COAL COMPANY



Dames & Moore  
10139-011-22

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## INTRODUCTION

Sedimentation Structure N1-0 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 N1-0 is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure N1-0. 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 N1-0 was inspected on September 6, 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 N1-0 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 N1-0 has a 116.4-acre tributary drainage area and is located near Coal Mine Wash at the Kayenta Mine. The watershed is classified as 87% reclaimed and 13% disturbed.

### EMBANKMENT

Structure N1-0 is a homogeneous earthen embankment classified as a in-wash embankment. Physical characteristics of the embankment are listed in the following table:

#### Structure N1-0

Embankment . . . . .	Alluvium
Foundation . . . . .	Alluvium
Right Abutment . . . . .	Residual Shale
Left Abutment . . . . .	Alluvium
Height . . . . .	9.1 ft
Crest Width . . . . .	18 ft
Upstream Slope . . . . .	3.1 H : 1 V
Downstream Slope . . . . .	3.1 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section N1-0, A-A'. Grass provides erosion protection on the upstream and downstream slopes of the embankment.

## ANALYSES

### STABILITY

Structure N1-0 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 = 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 N1-0 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 N1-0 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 N1-0 was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L . . . . .	0.318	mi
2.	Elevation Difference, H . . . . .	98	ft
3.	Time of Concentration, $T_c$ . . . . .	0.118	h
4.	Lag time, $0.6T_c$ . . . . .	0.071	h
5.	SCS Curve Number . . . . .	83	
6.	Rainfall Depth, 10-year, 24-hour storm .	2.1	in.
	25-year, 6-hour storm. .	1.9	in.
7.	Drainage Area . . . . .	116.4	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.

# NI-O 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	143	190
Volume . . . . .	acre-ft	7.66	6.11
Storage			
Peak Stage . . . . .	ft	6522.43	6524.99
Spillway Elevation . .	ft	6523.80	--
Peak Storage . . . . .	acre-ft	7.66	--
Storage Capacity . . .	acre-ft	10.88	--
Outflow			
Peak Flow . . . . .	cfs	0	36
Embankment Crest			
Elevation . . . . .	ft	--	6525.80
Peak Stage . . . . .	ft	--	6524.99
Freeboard . . . . .	ft	--	0.81

### Spillway Channel

The existing spillway for N1-0 has a U-shaped channel with the following dimensions:

Channel depth . . . . .	1 ft
Channel width . . . . .	30 ft
Channel length . . . . .	18 ft
Average exit slope . . . . .	0 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, N1-0.



The calculations for the sediment load entering Structure N1-0 were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R . . . . . 40
2. Soil Erodibility Factor, K . . . . . 0.394
3. Slope Factor, LS . . . . . 2.86
4. Cover Factor, C . . . . . 0.261
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 N1-0 and the results of the sediment inflow analysis are summarized in the following table.

#### N1-0 STORAGE

Total Storage Capacity . . . . .	10.88	acre-ft
10-year, 24-hour Storm Inflow . . . . .	7.66	acre-ft
Available Sediment Storage Capacity . .	3.32	acre-ft
Sediment Inflow Rate . . . . .	0.602	acre-ft/yr
Sediment Storage Life . . . . .	5	yrs

#### REMEDIAL COMPLIANCE PLAN

#### GEOTECHNICS

The inspection of Structure N1-0 indicated that there are no geotechnical problems.

## HYDRAULICS

The storage capacity of Structure N1-0 is adequate but the spillway capacity is inadequate. The structure does not have an outflow channel. The bottom elevation of the existing spillway channel should be lowered to elevation 6523.5 feet while maintaining the bottom width of 30 feet as shown on Plate 5. A trapezoidal outflow channel with the same bottom width as the spillway should be constructed along the alignment shown in Plate 1. The channel profile is shown in Plate 4 and required dimensions are shown in Plate 5. Both the spillway and outflow channel should be protected against erosion using geotextile and riprap as shown in Plate 5.

Lowering the spillway elevation to 6523.5 feet decreases the storage capacity and increases the freeboard. The analysis of these conditions is summarized in the following table.

# N1-O HYDRAULICS FOR REDESIGNED SPILLWAY

	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		190
Volume . . . . .	acre-ft		
Storage			
Peak Stage . . . . .	ft	6522.43	6524.72
Spillway Elevation . .	ft	6523.50	--
Peak Storage . . . . .	acre-ft	7.66	--
Storage Capacity . . .	acre-ft	10.21	--
Available Sediment			
Storage Capacity . .	acre-ft	2.55	--
Sediment Inflow Rate .	acre-ft/yr		--
Sediment Storage Life.	yrs	4	--
Outflow			
Peak Flow . . . . .	cfs	--	40
Embankment Crest			
Elevation . . . . .	ft	--	6525.80
Peak Stage . . . . .	ft	--	6524.72
Freeboard . . . . .	ft	--	1.08
Spillway Channel			
Flow Depth . . . . .	ft	--	1.22
Critical Velocity. . .	fps	--	3.4
Manning's "n" . . . .		--	0.040
Outflow Channel			
Slope . . . . .	%	--	33
Normal Velocity. . . .	fps	--	7.0
Normal Depth . . . . .	ft	--	0.19
Manning's "n" . . . .		--	0.040

\* \* \*

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

Plate 1 - Site Plan N1-O

Plate 2 - Existing Maximum Cross Section N1-O, A-A'

Plate 3 - Volume-Elevation Curve N1-O

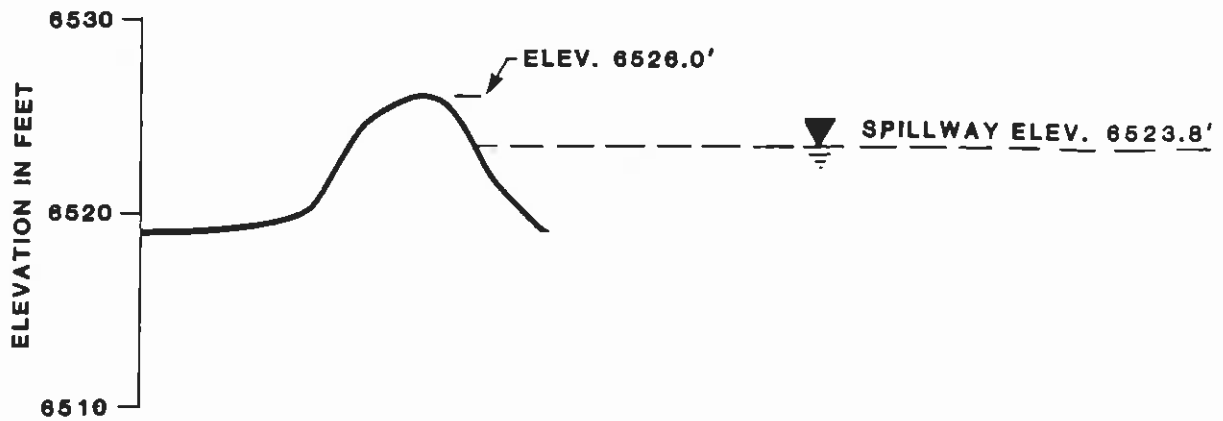
Plate 4 - Channel Profile N1-O, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section N1-O

Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations



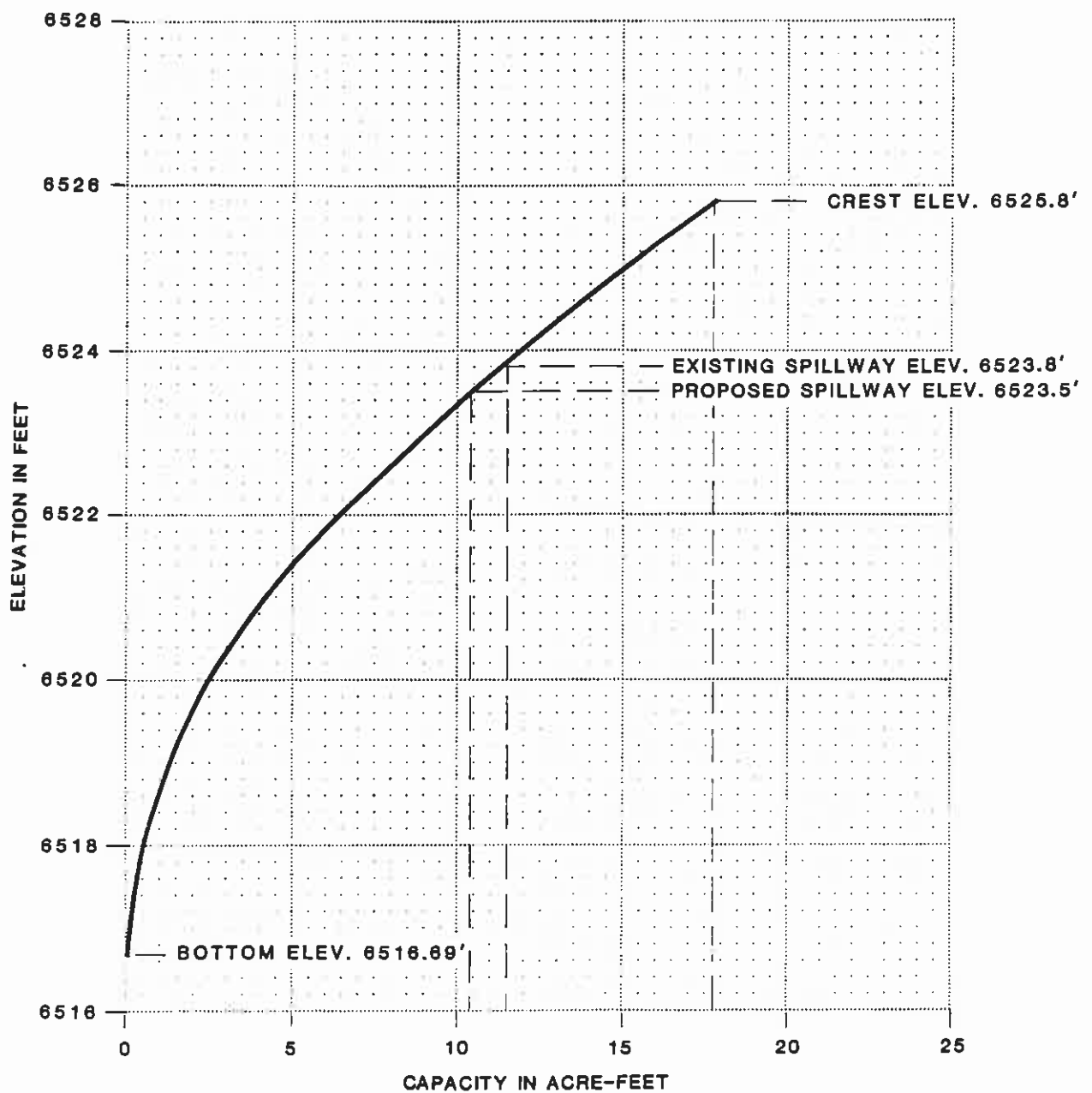


EXISTING  
MAXIMUM CROSS-SECTION  
A-A'  
N1-O

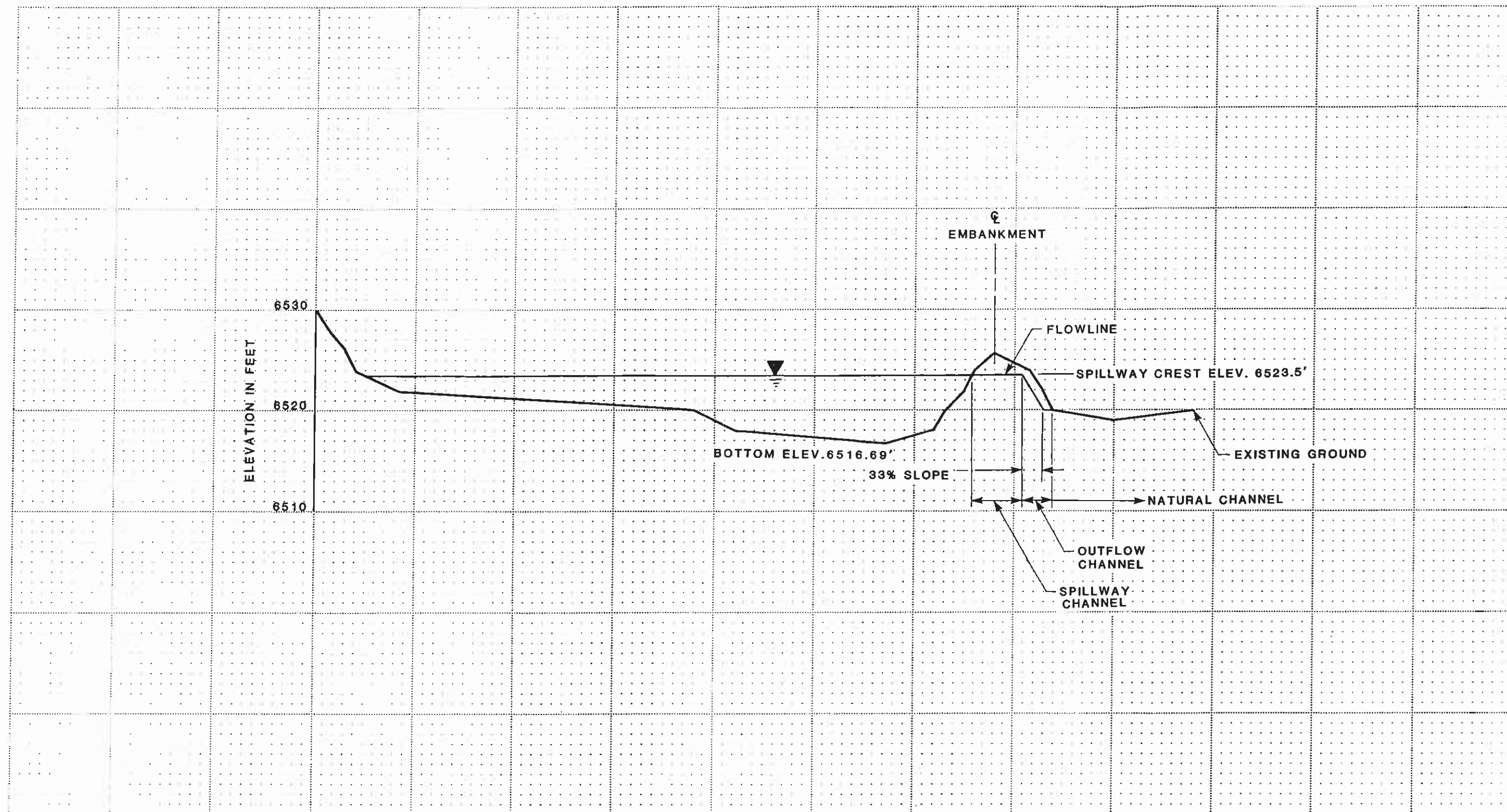
FOR LOCATION SEE PLATE 1

BY **Dames & Moore**

Plate 2

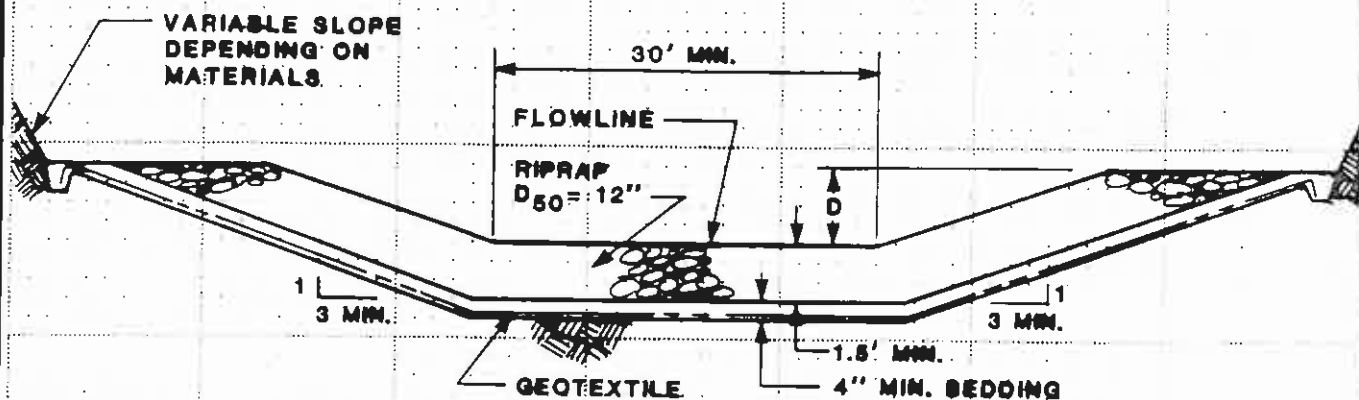


VOLUME-ELEVATION  
CURVE  
N1-O



CHANNEL PROFILE B-B'  
N1-0





SPILLWAY CHANNEL

D = 2.3'  
 LENGTH = 30'  
 FLOWLINE ELEV. = 8523.5'

OUTFLOW CHANNEL

D = 1'

SPILLWAY AND  
 OUTFLOW CHANNEL  
 CROSS SECTION  
 N1-O

APPENDIX A  
INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			18' w
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			18°
a. Adequate grass cover?	X		80
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?	X		Good
g. Any stone deterioration?			N/A
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			18°
a. Adequate grass cover?	X		80
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?			N/A
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?			brwn sil
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?			brwn sil

ITEM	YES	NO	REMARKS
<b>6. SPILLWAY/NORMAL</b>			
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		Not well defined $\approx 1'$ below crest
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
d. Outflow Channel:		X	
Are side slopes eroding?			
Are side slopes sloughing?			NA
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
e. Weir:		X	
Condition?			
<b>7. SPILLWAY/EMERGENCY</b>			
a. Location:			NA
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?			

30' W  
18' L

Slope

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

SPILLWAY POORLY DEFINED - NEEDS WORK - GRADING

Canopy Cover 5 %  
 Ground Cover 80 %

APPENDIX B  
HYDROLOGY AND HYDRAULIC CALCULATIONS

TIME OF CONCENTRATION

ELEVATION DIFFERENCE =  $6623 - 6525 = 98$  ft.

WATER COURSE LENGTH =  $4.2(400) = 1680$  ft. =  $0.318$  mi.

$T_c = \left( \frac{11.9 (0.318)^3}{98} \right)^{0.385} = 0.118$  hr.  $\approx$

Lag Time =  $0.6 T_c = 0.071$  hr.  $\approx$

Note: SEE CALCULATIONS  
ON BACK.

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
(87%)	RECLAIM <sup>post law</sup>	fair	D	(81)(.87)
(13%)	ROAD		D	(91)(.13)
			90% EH #34 - D	82.3
			10% EH #35 - D	

use 83

DRAINAGE BASIN AREA

116.4 ACRE      0.182 SQ MILE

REVISIONS

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UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

$R = 40$

SOIL ERODIBILITY FACTOR

SOIL TYPE = 87% reclaimed .87(.42)  
 13% #34 .13(.22)  
.394

$K = 0.394$

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
1440	90	6.2	2.68 35%
550	40	7.3	2.06 20%
400	80	20.0	8.16 100%
2200	90	4.1	1.33 25%
300	40	13.3	3.68 10%

COVER FACTOR

use 2.86

AREA (ac)	COVER TYPE	% COVER	CAUSER (%)	WEIGHTED C
87%	reclaimed	—	—	.87(.15)
13%	disturbed	—	—	.13(1.0)
				<u><u>C = .261</u></u>

EROSION CONTROL FACTOR

$P = 1.0$

SEDIMENT INFLOW

$A = 40(.394)(2.86)(.261)(1.0) = 11.76$  ton/acre/year

$A = 11.76(116.4)(\frac{.1}{2047})(.9) = .602$  acre-feet/year

REVISIONS

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