INSPECTION REPORT

Sedimentation Structure

J16-E

Kayenta Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure J16-E 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 J16-E is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure J16-E. 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 J16-E was inspected on September 10, 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 J16-E 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 J16-E has a 14.4-acre tributary drainage area and is located near Moenkopi Wash at the Kayenta Mine. The watershed is classified as 74% Sagebrush/grass and 26% disturbed.

EMBANKMENT

Structure J16-E is a homogeneous earthen embankment classified as a sidehill embankment. Physical characteristics of the embankment are listed in the following table:

Structure J16-E

```
Embankment . . . . . . Residual Shale Soils
Foundation . . . . . . Residual Shale Soils
Right Abutment . . . . Residual Shale Soils
Left Abutment  . . . . Scoria
Height . . . . . . . . 18.6 ft
Crest Width  . . . . . 18   ft
Upstream Slope . . . . 2.75 H : 1 V
Downstream Slope . . . 2.6 H : 1 V
```

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section J16-E, A-A'. Grass provides erosion protection on the downstream slope of the embankment.

ANALYSES

STABILITY

Structure J16-E 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 J16-E 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 J16-E 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 J16-E was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1. Water Course length, L . . . . 0.182 mi
2. Elevation Difference, H 82   ft
3. Time of Concentration, T_c . . . . 0.066 h
4. Lag time, $0.6T_c$ . . . . 0.040 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 . . . . 14.4 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.

J16-E 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	24	29
Volume	acre-ft	1.00	0.79
Storage			
Peak Stage	ft	6596.42	—
Spillway Elevation	ft	6608.30	--
Peak Storage	acre-ft	1.00	—
Storage Capacity	acre-ft	6.39	—
Outflow			
Peak Flow	cfs	0	5
Embankment Crest			
Elevation	ft	--	6611.50
Peak Stage	ft	--	6608.97
Freeboard	ft	—	2.53
Spillway Channel			
Flow Depth	ft	—	0.67
Critical Velocity.	fps	—	2.0
Manning's "n"		—	0.035
Outflow Channel			
Slope	%	--	31
Normal Velocity.	fps	—	3.8
Normal Depth	ft	--	0.07
Manning's "n"		—	0.035

Spillway Channel

The existing spillway for J16-E has a trapezoidal channel with the following dimensions:

```
Channel depth . . . . . . . . . . . . . .   4.5 ft
Channel width . . . . . . . . . . . . . .  19   ft
Channel length  . . . . . . . . . . . . .  27   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 existing outflow channel for J16-E has a trapezoidal channel with the following dimensions:

```
Channel width . . . . . . . . . . . . . .  19 ft
Channel length  . . . . . . . . . . . . .  80 ft
Side slopes (horizontal to vertical). . 2:1
Average exit slope  . . . . . . . . . . .  29 percent
```

Rock provides 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, J16-E.

The calculations for the sediment load entering Structure J16-E 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 4.25
4. Cover Factor, C 0.356
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 J16-E and the results of the sediment inflow analysis are summarized in the following table.

J16-E STORAGE

Total Storage Capacity . . . . 6.39 acre-ft
10-year, 24-hour Storm Inflow . . . . . 1.00 acre-ft
Available Sediment Storage Capacity . . 5.39 acre-ft
Sediment Inflow Rate . . . . 0.089 acre-ft/yr
Sediment Storage Life . . . . 60 yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure J16-E indicated that the only geotechnical problem is rill erosion on the upstream and downstream slopes and the side slopes of the spillway channel. Correction of erosion is considered a periodic maintenance task and does not require remedial action.
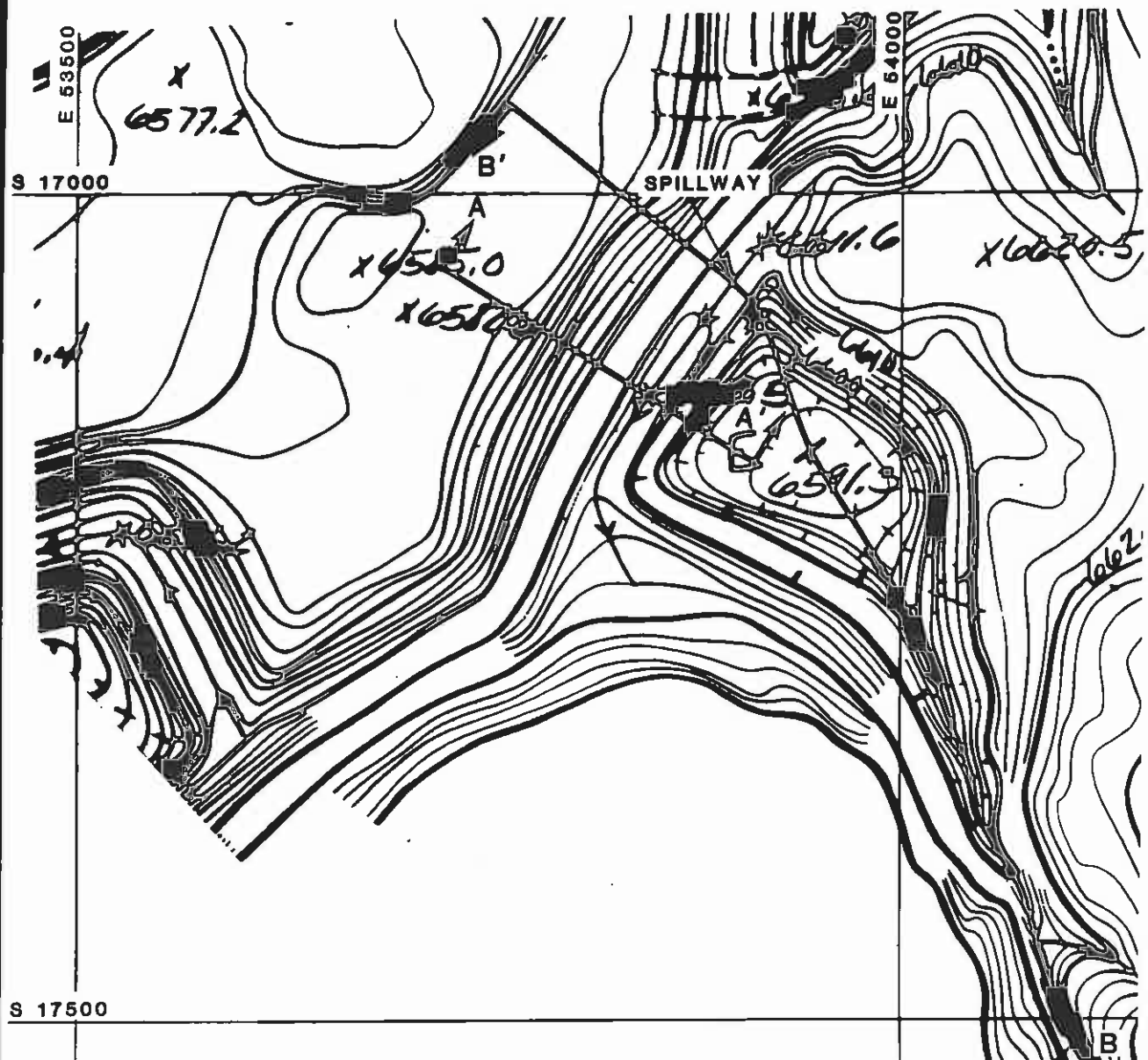
HYDRAULICS

The storage capacity and spillway capacity of Structure J16-E are adequate. The outflow channel is protected with riprap but the spillway channel is not. The spillway channel should be protected against erosion using geotextile and gravel as shown in Plate 5. Plate 4 shows the existing spillway and outflow channel profile and Plate 5 shows the channel dimensions.

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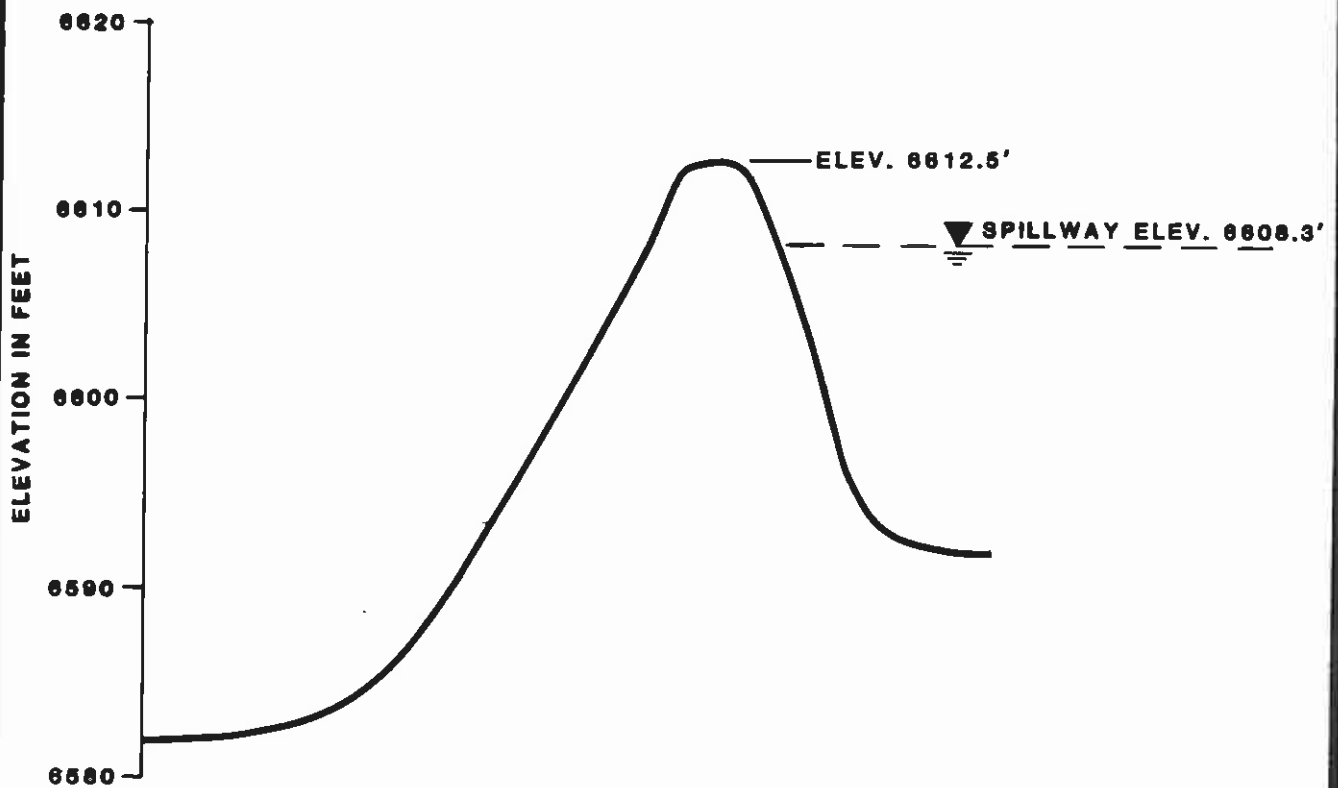
The following plates and appendix are attached and complete this inspection report.

Plate 1   - Site Plan J16-E

Plate 2   - Existing Maximum Cross Section J16-E, A-A'

Plate 3   - Volume-Elevation Curve J16-E

Plate 4   - Channel Profile J16-E, B-B'

Plate 5   - Spillway and Outflow Channel Cross Section J16-E

Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations

S 17000

S 17500

E 53500

E 54000

6577.2

B'

A

SPILLWAY

A'

6591.

N

SCALE
0   100   200
FEET

SITE PLAN
J16-E

BY **Dames & Moore**   Plate 1

ELEV. 6612.5'

▼ SPILLWAY ELEV. 6608.3'

ELEVATION IN FEET

6620

6610

6600

6590

6580

EXISTING
MAXIMUM CROSS-SECTION
A-A'
J16-E

CREST ELEV. 6611.5'

SPILLWAY ELEV. 6608.3'

BOTTOM ELEV. 6589.7'

ELEVATION IN FEET

CAPACITY IN ACRE-FEET

VOLUME-ELEVATION CURVE
J16-E

ELEVATION IN FEET

6620
6610
6600
6590
6580

Ç
EMBANKMENT

SPILLWAY CREST ELEV. 6608.3'

EXISTING CHANNEL FLOWLINE

BOTTOM ELEV. 6589.7'

31% AVERAGE SLOPE

SPILLWAY CHANNEL

OUTFLOW CHANNEL

NATURAL CHANNEL

SCALE
0   100   200
FEET

CHANNEL PROFILE B-B'
J16-E

BY **Dames & Moore**   Plate 4

VARIABLE SLOPE
DEPENDING ON
MATERIALS

20' MIN.

FLOWLINE

D

1
3 MIN.

1
3. MIN.

GEOTEXTILE

3'' MIN. THICKNESS
WELL GRADED GRAVEL
3'' MAXIMUM SIZE
$D_{50} = 2''$
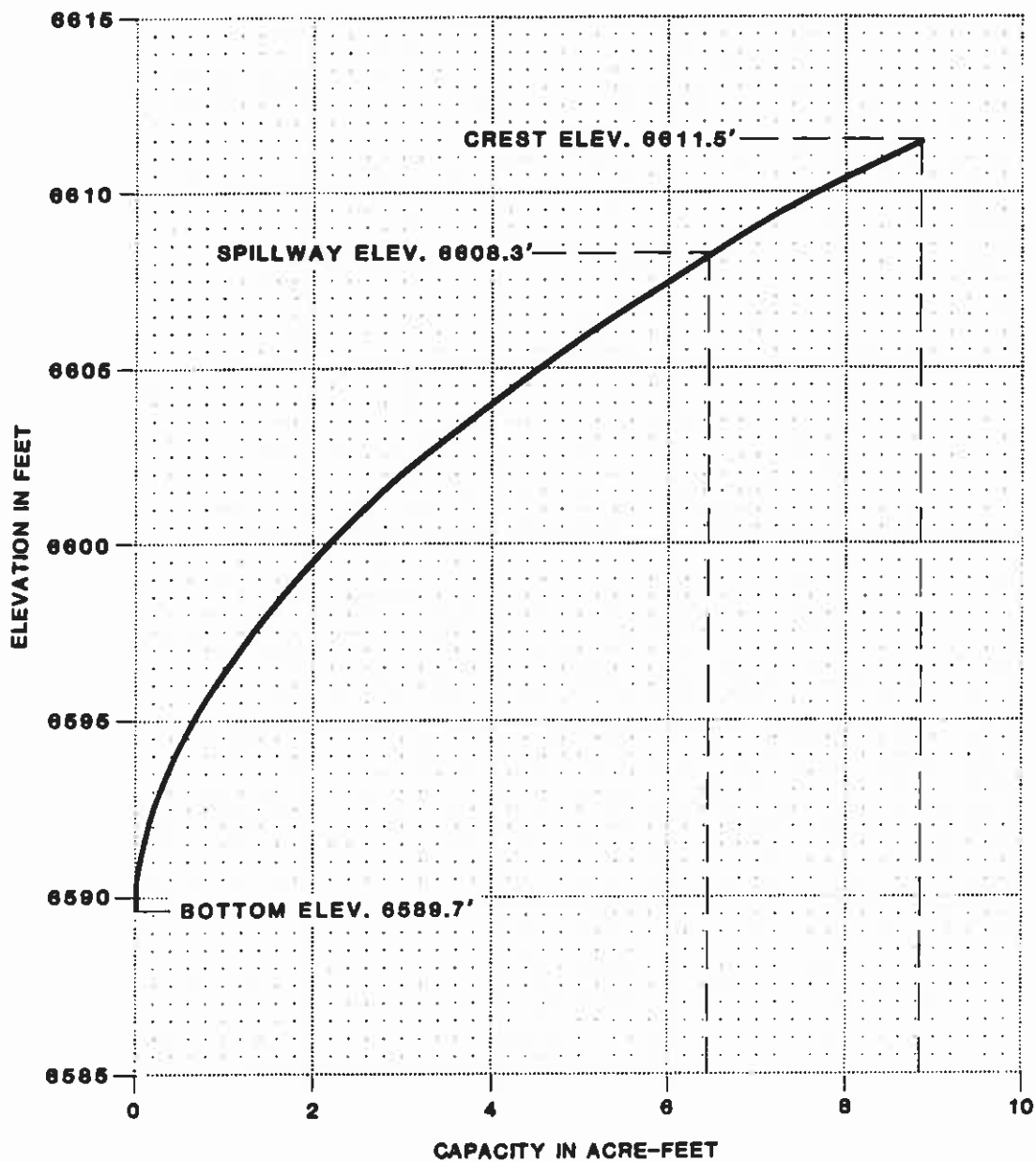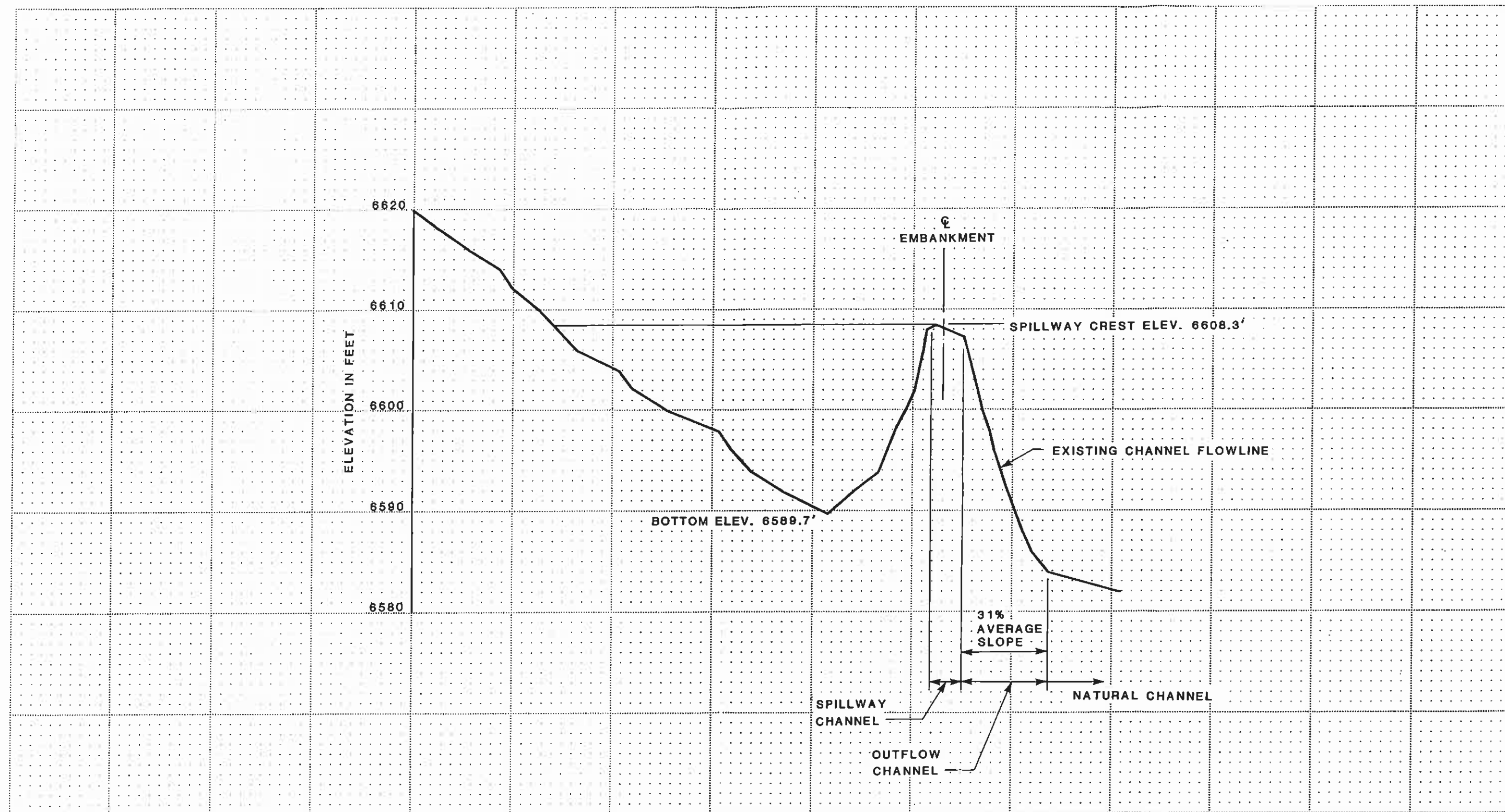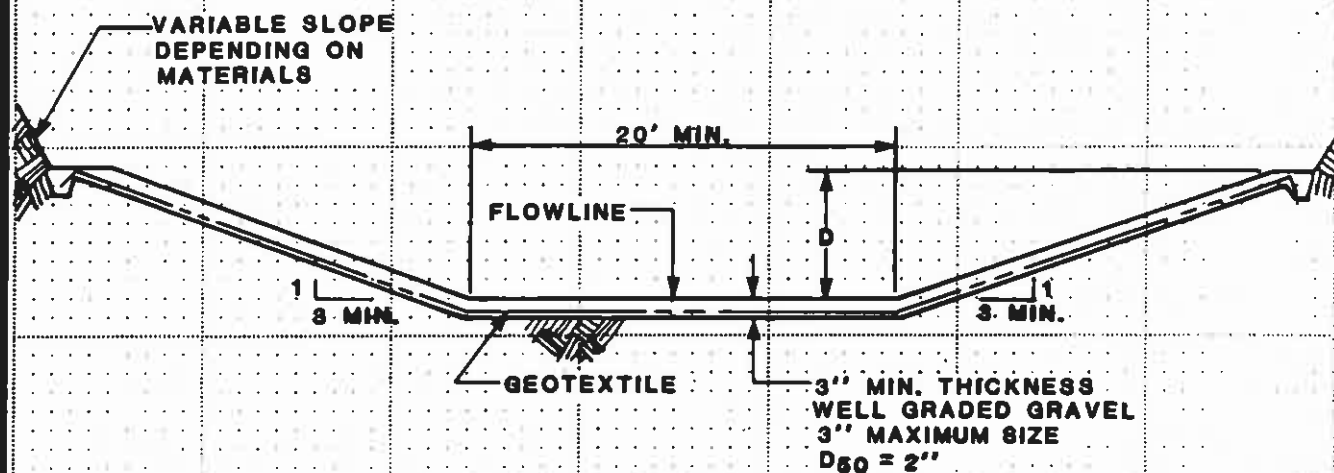
SPILLWAY CHANNEL

D = 1.7'
LENGTH = 30'
FLOWLINE ELEV.= 6608.30'

OUTFLOW CHANNEL

D = 1'

SPILLWAY AND
OUTFLOW CHANNEL
CROSS SECTION
J16-E

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			20° Somewhat uneven
a. Adequate grass cover?		X	
b. Any erosion?	X		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			21°
a. Adequate grass cover?	X		80%
b. Any erosion?	X		Rills
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?			Gray 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?			Rock & brown 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?			NA
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:	X		19'W 27'L, 2% Slope 4.5' below
Are side slopes eroding?	X		Rills Crest
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
d. Outflow Channel:	X		16° Slope 19'W ≈ 80' L
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		D 50 - 18"
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?		✕	(Elev.) feet
b. Water present?	✕		(Elev.) feet
c. Siltation?	✕		
d. Watershed matches soil map?		✕	

9. GENERAL COMMENTS

No Problems

Canopy 10 %
Ground 35 %

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6690 - 6608 = 82 ft.

WATER COURSE LENGTH = 2.4 in. = 960 ft. = 0.182 mi.

$$T_c = \left(\frac{11.9 \ (0.182)^3}{82} \right)^{0.385} = 0.066 \ hr. \ \checkmark$$

LAG TIME = 0.6 T_c = 0.040 hr. $\checkmark$

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
10.6	S-G	average	D	(79) .74
3.8	disturbed		D	(94) .26
		100% EH #22		82.9 $\checkmark$

use 83

DRAINAGE BASIN AREA

__14.4__ ACRE   __0.023__ SQ MILE $\checkmark$

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

BY _S.DOLAN_ DATE _10-2-85_
CHECKED BY _BHM 10/29/85_
COPY TO EO

Dames & Moore

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

$$R = 40$$

SOIL ERODIBILITY FACTOR

SOIL TYPE = 100% EH #22   = .22

$$K = .22$$

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
400	50	12.5	3.8 (.7)
300	50	16.7	5.3 (.3)
			4.25

COVER FACTOR

AREA (ac.)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
74%	S-G	40	25	.74(.13)
26%	disturbed	—	—	.26 (1.0)
				C = .356

EROSION CONTROL FACTOR

$$P = 1.0$$

SEDIMENT INFLOW

$$A = 40(.22)(4.25)(.356)(1.0) = 13.32 \text{ ton/acre/year}$$

$$A = (13.32)\left(\frac{1}{2047}\right)(24.4)(.95) = .089 \text{ acre-feet/year} \checkmark$$

Dames & Moore