INSPECTION REPORT

Sedimentation Structure

N1-L

Kayenta Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY


Dames & Moore
10139-011-22

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## INTRODUCTION

Sedimentation Structure N1-L is an earthen embankment, designed and constructed in 1980 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-L is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure N1-L. 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-L was inspected on September 6, 1985 by an inter-disciplinary 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-L 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-L has a 39.2-acre tributary drainage area and is located near Coal Mine Wash at the Kayenta Mine. The watershed is classified as 55% reclaimed, 36% Pinion/Juniper, and 9% disturbed.

### EMBANKMENT

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

Structure N1-L

| | |
|---|---|
| Embankment | Alluvial Soils |
| Foundation | Alluvium |
| Right Abutment | Alluvium |
| Left Abutment | Scoria |
| Height | 12.6 ft |
| Crest Width | 20 ft |
| Upstream Slope | 3.1 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 N1-L, A-A'.

## ANALYSES

### STABILITY

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

The following parameters were used in the hydrologic analysis:

| | | | |
|---|---|---|---|
| 1. | Water Course length, L | 0.273 | mi |
| 2. | Elevation Difference, H | 83 | ft |
| 3. | Time of Concentration, $T_c$ | 0.106 | h |
| 4. | Lag time, $0.6T_c$ | 0.063 | h |
| 5. | SCS Curve Number | 81 | |
| 6. | Rainfall Depth, 10-year, 24-hour storm | 2.1 | in. |
| | 25-year, 6-hour storm | 1.9 | in. |
| 7. | Drainage Area | 39.2 | 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.

| | 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 | 44 | 55 |
| Volume . . . . . | acre-ft | 2.22 | 1.76 |
| Storage | | | |
| Peak Stage . . . . . | ft | 6497.36 | 6503.09 |
| Spillway Elevation . . | ft | 6501.82 | -- |
| Peak Storage . . . . . | acre-ft | 2.22 | -- |
| Storage Capacity . . . | acre-ft | 5.02 | -- |
| Outflow | | | |
| Peak Flow . . . . . | cfs | 0 | 12 |
| Embankment Crest Elevation . . . . . | ft | -- | 6504.32 |
| Peak Stage . . . . . | ft | -- | 6502.95 |
| Freeboard . . . . . | ft | -- | 1.37 |
| Spillway Channel | | | |
| Flow Depth . . . . . | ft | -- | 1.13 |
| Critical Velocity. . . | fps | -- | 2.9 |
| Manning's "n" . . . . | | -- | 0.035 |
| Outflow Channel | | | |
| Slope . . . . . | % | -- | 1 |
| Normal Velocity. . . . | fps | -- | 2.6 |
| Normal Depth . . . . . | ft | -- | 0.36 |
| Manning's "n" . . . . | | -- | 0.035 |

Approach Channel

The existing approach channel for N1-L has a U-shaped channel with following dimensions:

| | |
|---|---|
| Channel width | 15-25 ft |
| Channel length | 40 ft |
| Slope | 32 percent |

Spillway Channel

The existing spillway for N1-L has a trapezoidal channel with the following dimensions:

| | |
|---|---|
| Channel depth | 2 ft |
| Channel width | 15 ft |
| Channel length | 35 ft |
| Side slopes (horizontal to vertical) | 2:1 |
| 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-L.

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

1. Rainfall Factor, R . . . . . 40
2. Soil Erodibility Factor, K . . . . . 0.35
3. Slope Factor, LS . . . . . 3.95
4. Cover Factor, C . . . . . 0.223
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-L and the results of the sediment inflow analysis are summarized in the following table.

N1-L STORAGE

| | | |
|---|---|---|
| Total Storage Capacity . . . . . | 5.02 | acre-ft |
| 10-year, 24-hour Storm Inflow . . . . . | 2.22 | acre-ft |
| Available Sediment Storage Capacity . . | 2.80 | acre-ft |
| Sediment Inflow Rate . . . . . | 0.224 | acre-ft/yr |
| Sediment Storage Life . . . . . | 12 | yrs |

## REMEDIAL COMPLIANCE PLAN

### GEOTECHNICS

The inspection of Structure N1-L indicated that the only geotechnical problem is rill and gully erosion on the upstream and downstream slopes, the side slopes of the approach and spillway channel; and the bottom of approach channel. The downstream slope should be flattened to 4.0 horizontal to 1 vertical to meet stability requirements. Correction of erosion is considered a periodic maintenance task and does not require remedial action.

### HYDRAULICS

The storage capacity and spillway capacity of Structure N1-L 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 N1-L

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

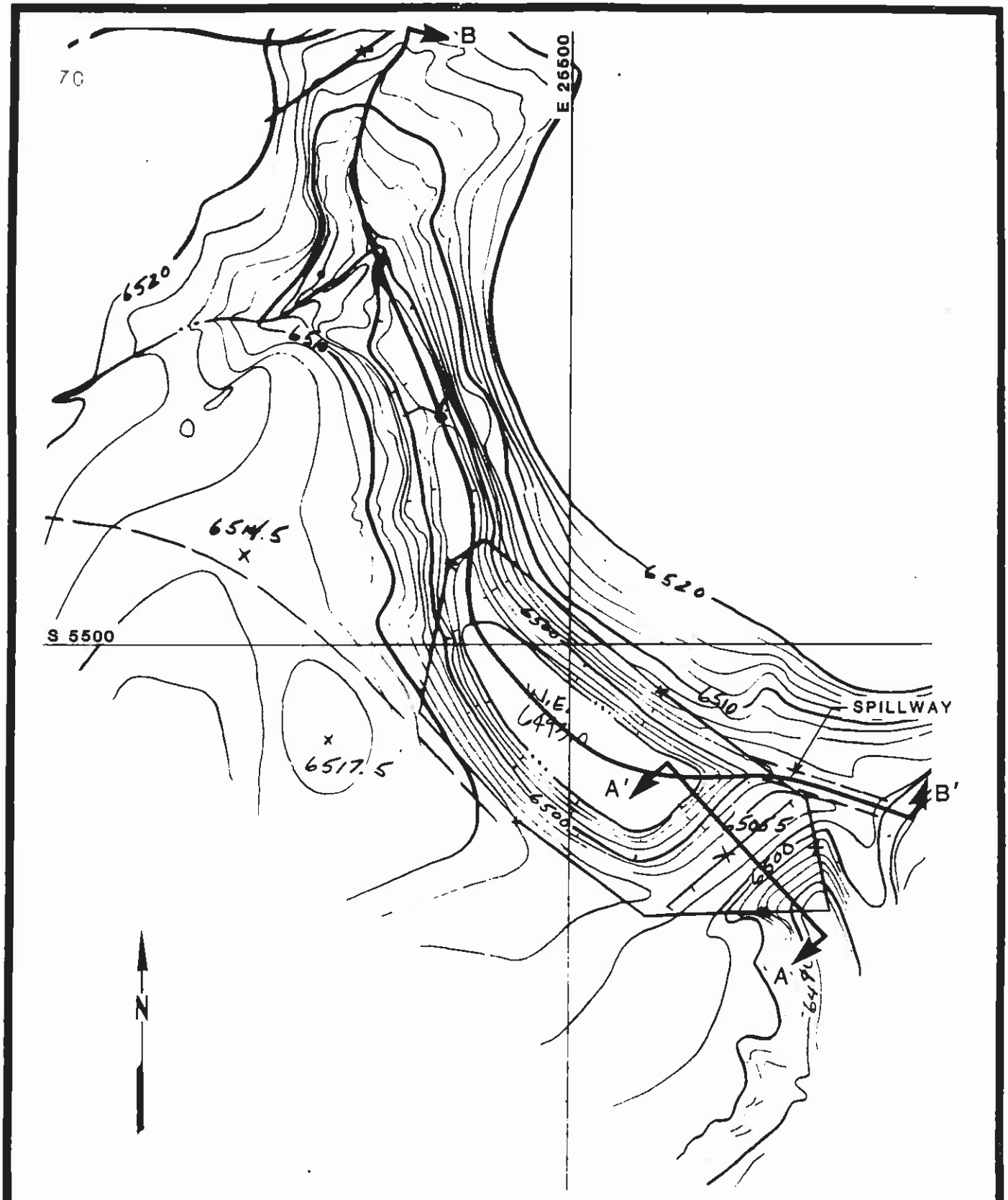
Plate 3 - Volume-Elevation Curve N1-L

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

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

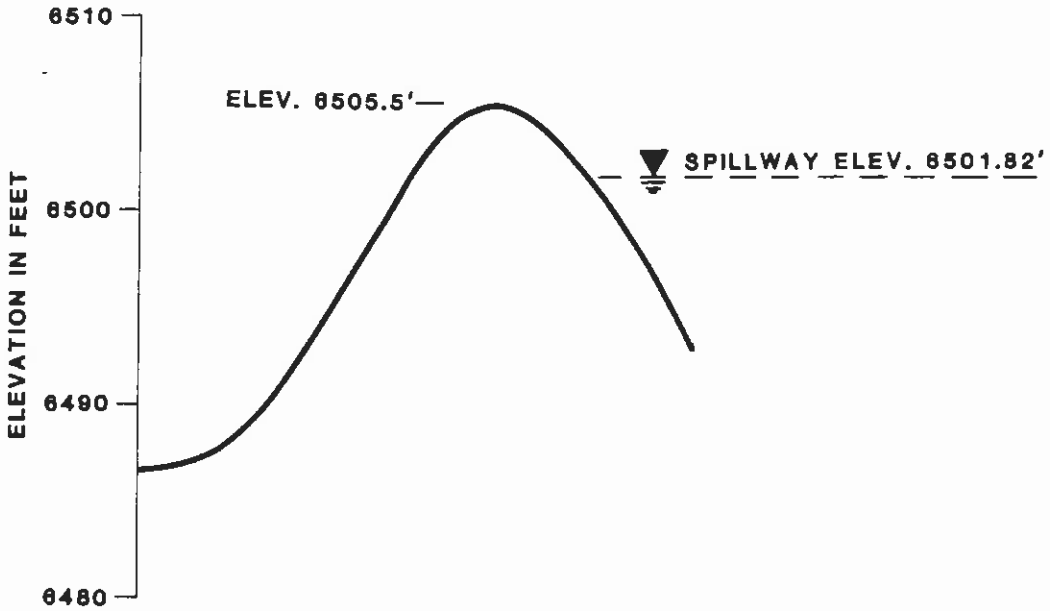
Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations




# SITE PLAN
# N1-L

BY **Dames & Moore** Plate 1



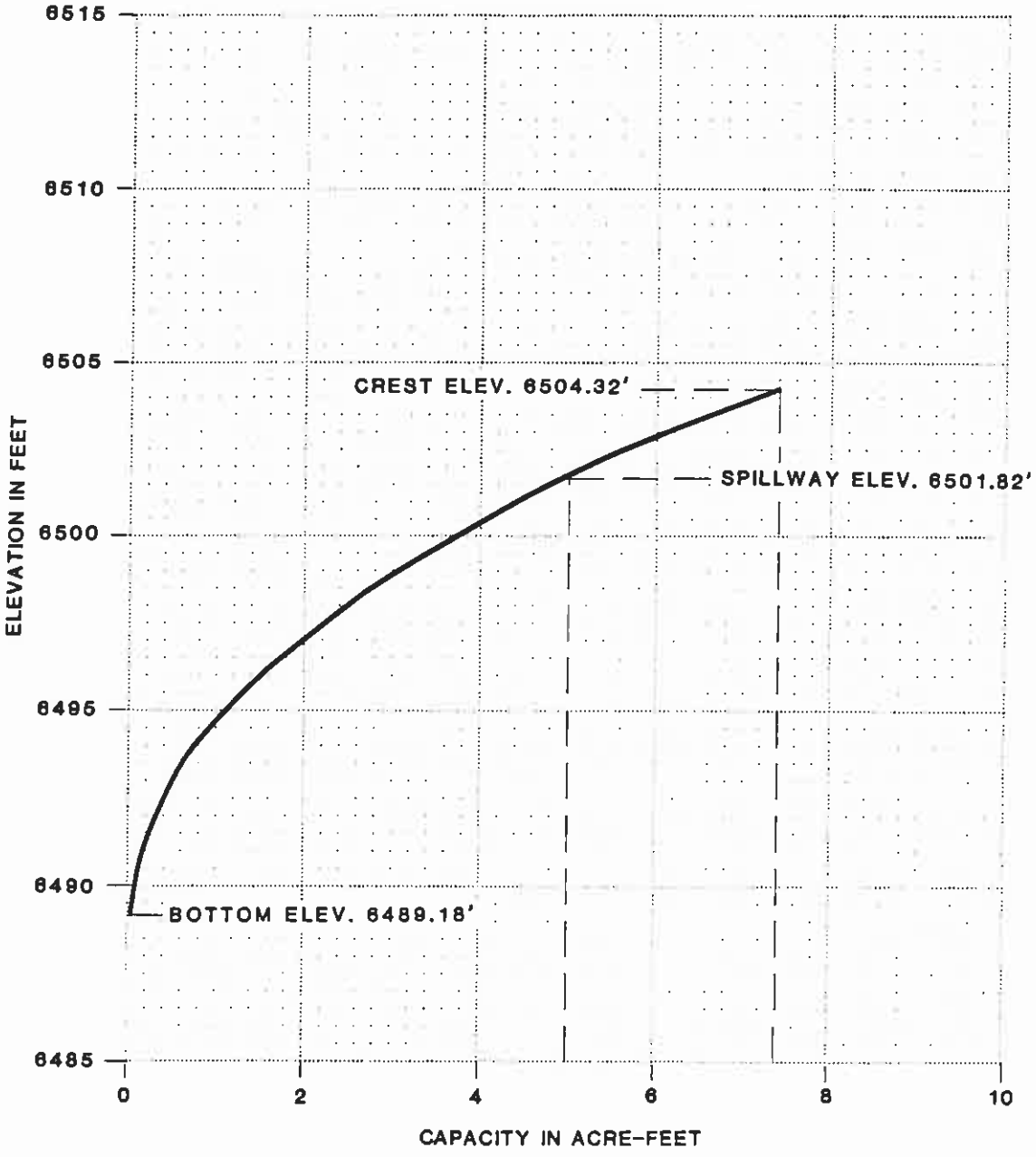

SCALE
0 50 100
FEET

# EXISTING MAXIMUM CROSS-SECTION A-A' N1-L

FOR LOCATION SEE PLATE 1

BY **Dames & Moore**

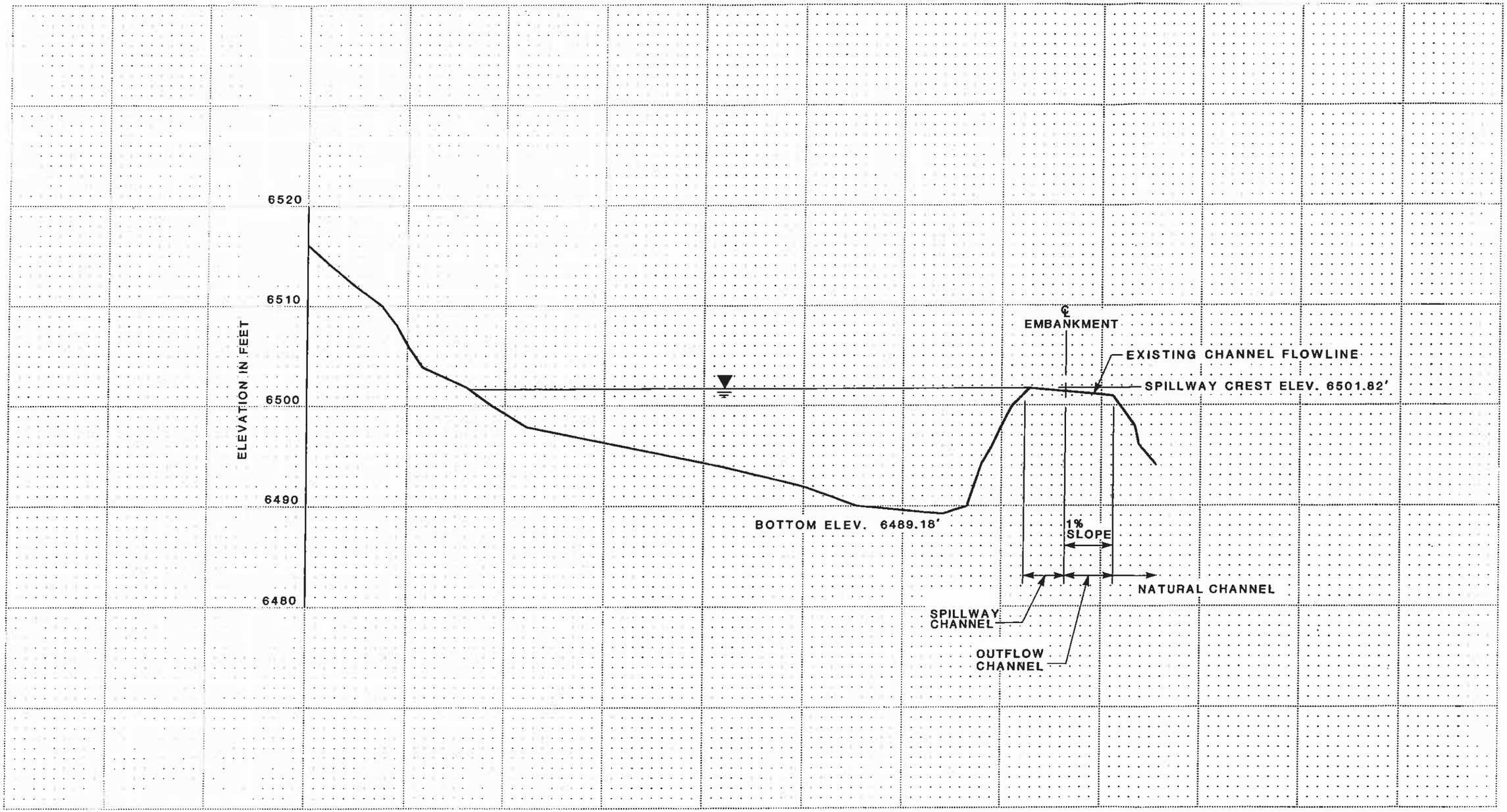
Plate 2




# VOLUME-ELEVATION CURVE

# N1-L

BY **Dames & Moore** Plate 3

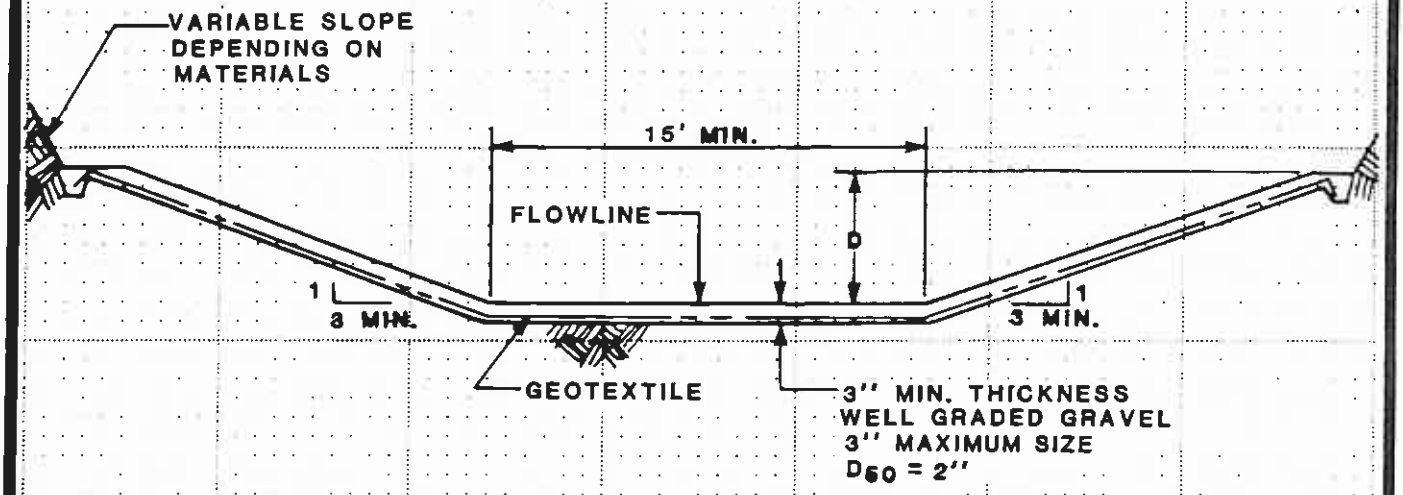



SCALE
0 100 200
FEET

# CHANNEL PROFILE B-B'
# N1-L

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4




**SPILLWAY CHANNEL**

D = 2.2'

LENGTH = 40'

FLOWLINE ELEV.= 6501.82'

**OUTFLOW CHANNEL**

D = 1.5'

# SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION N1-L

BY **Dames & Moore** Plate 5

# APPENDIX A

# INSPECTION CHECK LIST

## INSPECTION CHECK LIST

| ITEM | YES | NO | REMARKS |
|---|---|---|---|
| 1. CREST | | | 20' W |
| a. Any visual settlements? | | X | |
| b. Misalignment? | | X | |
| c. Cracking? | | X | |
| 2. UPSTREAM SLOPE | | | 18° |
| 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 | |
| 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? | | X | brown 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? | X | | |
| Right abutment? | | | |
| Crest of Embankments? | | | |
| b. Approach Channel: | X | | Up Slope of Dam & LA width ~10' |
| Are side slopes eroding? | X | | 1 gulley |
| Are side slopes sloughing? | | X | |
| Bottom of channel eroding? | X | | gulley |
| Obstructed? | | X | |
| Erosion protection? | | X | |
| c. Spillway Channel: | X | | 2' below Crest W 15 L 35 |
| Are side slopes eroding? | X | | Rills from Dam Slope 0° |
| Are side slopes sloughing? | | | |
| Bottom of channel eroding? | | | |
| Obstructed? | | | |
| Erosion protection? | | | |
| d. Outflow Channel: | | | 40' L 15' W Slope 2° then 40 |
| Are side slopes eroding? | | X | |
| Are side slopes sloughing? | | X | |
| Bottom of channel eroding? | X | | at exit gulley |
| Obstructed? | | X | |
| Erosion protection? | | X | |
| 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? | | X | (Elev.) feet |
| b. Water present? | | | (Elev.) feet |
| c. Siltation? | | | |
| d. Watershed matches soil map? | | X | |

**9. GENERAL COMMENTS**

Canopy Cover 5
Ground cover 95

# APPENDIX B

# HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE PEABODY COAL CO 10137-01-??
SUBJECT ~~SEDIMENT~~ POND HYDROLOGY
NI-L
SHEET ___ OF ___

REVISIONS
BY ___ DATE ___ TO EO ___
BY ___ DATE ___ TO EO ___

## TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6585 − 6502 = 83 ft.

WATER COURSE LENGTH = 3.6(400) = 1440 ft. = 0.273 mi

$$T_c = \left(\frac{11.9\,(0.273)^3}{83}\right)^{0.385} = 0.106 \text{ hr.}$$

LAG TIME = $0.6 T_c$ = 0.063 hr.

Note: USE MAX. $T_c$.
SEE BACK.

## SCS CURVE NUMBER

| DRAINAGE AREA (ac) | COVER TYPE | HYDROLOGIC CONDITION | SOIL TYPE | WEIGHTED CURVE NUMBER |
|---|---|---|---|---|
| 14.0 (36%) | Pit | ave | use C | 0.36(78) = 28.1 |
| 21.6 (55%) | Retained (Post law) | - | C | 0.55(81) = 44.6 |
| 3.6 (9%) | Haul Road | — | C | 0.09(89) = 8.0 |
| | | | | 80.7 |

PJ { EH #27 - B
EH #31 - C

USE 81

## DRAINAGE BASIN AREA

39.2 ACRE 0.061 SQ MILE

BY S.T.A.I. DATE 7-12-85
CHECKED BY ___
COPY TO EO ___

Dames & Moore

945 1 (3-72) PRINTED IN U S A

FILE

SUBJECT SEDIMENT INFLOW

NHL SHEET ___ OF ___

REVISIONS BY ___ DATE ___ TO EO ___ BY ___ DATE ___ TO EO ___

# UNIVERSAL SOIL LOSS EQUATION

## RAINFALL FACTOR

R = 40

## SOIL ERODIBILITY FACTOR

SOIL TYPE = 45% EH #21 .45(.27)
55% EH #35 .55(.42)
.35

K = .35

## SLOPE FACTOR

| LENGTH (ft.) | Δ ELEV (ft) | SLOPE (%) | LS |
|---|---|---|---|
| 300 | 90 | 30% | 13.78 (10%) |
| 500 | 50 | 10% | 3.06 (30%) |
| 800 | 60 | 8% | 2.81 (40%) |
| 500 | 45 | 9% | 2.64 (20%) |

use 3.95

## COVER FACTOR

| AREA (ac) | COVER TYPE | % COVER | CANOPY (%) | WEIGHTED C |
|---|---|---|---|---|
| 36% | P-J | 40 | 25 | (.14)(.36) |
| 9% | disturbed | — | — | (1.0)(.09) |
| 55% | reclaimed | — | — | (.55)(.15) |
| | | | | C = .223 |

## EROSION CONTROL FACTOR

P = 1.0

## SEDIMENT INFLOW

$A = 40(.35)(3.95)(.223)(1.0) = 12.33$ ton/acre/year

$A = (12.33)\left(\frac{1}{2047}\right)(39.2)(.95) = .224$ acre-feet/year

BY ___ DATE ___ CHECKED BY ___ COPY TO EO ___

**Dames & Moore**