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WW-9 POND RECLAMATION WATERSHED 10YR-6HR STORM

Gary Altsisi, P.E.

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.600 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	WW-9A WATERSHED

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	352.900	352.900	42.85	5.91

Structure Detail:

Structure #1 (Null)

WW-9A WATERSHED

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	352.900	0.664	0.000	0.000	77.000	M	42.85	5.907
	Σ	**352.900**						**42.85**	**5.907**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	6. Grassed waterway	9.18	180.00	1,960.00	4.540	0.119
		8. Large gullies, diversions, and low flowing streams	3.12	325.00	10,407.32	5.300	0.545
#1	**1**	**Time of Concentration:**					**0.664**

WW-9 POND WATERSHED CALCULATED CURVE NUMBER

LAND TYPE	SOIL TYPE	AREA	CURVE NUMBER	CN X AREA
PINYON/JUNIPER	D	192.2	83	15952.6
SAGEBRUSH	B	79	60	4740
SAGEBRUSH	D	80	79	6320
DISTURBANCED		1.7	91	154.7
		352.9		27167.3

$$\text{WEIGHTED CN} = \frac{27167.3}{352.9} = 76.98$$

$$= \boxed{77}$$

WW-9 RECLAIMED POND CHANNEL 10YR-6HR

Material: Graded loam to cobbles when noncolloidal

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
20.00	3.0:1	3.0:1	3.5	0.0300	1.00			5.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	42.85 cfs	
Depth:	0.41 ft	1.41 ft
Top Width:	22.46 ft	28.46 ft
Velocity:	4.92 fps	
X-Section Area:	8.71 sq ft	
Hydraulic Radius:	0.385 ft	
Froude Number:	1.39	

WW-9 RECLAIMED POND CHANNEL 10YR-6HR

Material: GRAVEL

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
20.00	3.0:1	3.0:1	6.7	0.0350	1.00			5.5

	w/o Freeboard	w/ Freeboard
Design Discharge:	42.85 cfs	
Depth:	0.37 ft	1.37 ft
Top Width:	22.22 ft	28.22 ft
Velocity:	5.48 fps	
X-Section Area:	7.83 sq ft	
Hydraulic Radius:	0.350 ft	
Froude Number:	1.63	

WW-9 RECLAIMED POND CHANNEL 10YR-6HR

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
20.00	3.0:1	3.0:1	25.0	1.00		

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	42.85 cfs	
Depth:	0.32 ft	1.32 ft
Top Width:	21.90 ft	27.90 ft
Velocity:	6.45 fps	
X-Section Area:	6.64 sq ft	
Hydraulic Radius:	0.302 ft	
Froude Number:	2.06	
Manning's n:	0.0520	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

WW-9 RECLAIMED POND CHANNEL SUMMARY

Channel WW-9 Typical Rip Rap Lined Channel													
Channel	Flow (Q) (cfs)	Slope Range (%)	Min. Bottom Width (ft)	Side Slope H:1 (ft)	Depth Flow (ft)	Velocity (fps)	Free Board (ft)	Total Depth (ft)	Min. Rip Rap (in)	Watershed (acres)	Time of Concentration (hr)	Curve Number	Design
WW-9	42.85	0.0 - 3.5	20	3	0.4	4.92	1	1.4	N/A	352.90	0.664	77	A
		3.6 - 6.7	20	3	0.4	5.48	1	1.4	Gravel				B
Q10/6		6.8 - 25.0	20	3	0.3	6.45	1	1.3	3.0				C
													C
													C

Design Flow: 10-year, 6-hour Storm

WW-9A INLET FROM NAVAJO WELL 9 - 600 GPM (1.4 CFS)

Material: Graded loam to cobbles when noncolloidal

Trapezoidal Channel

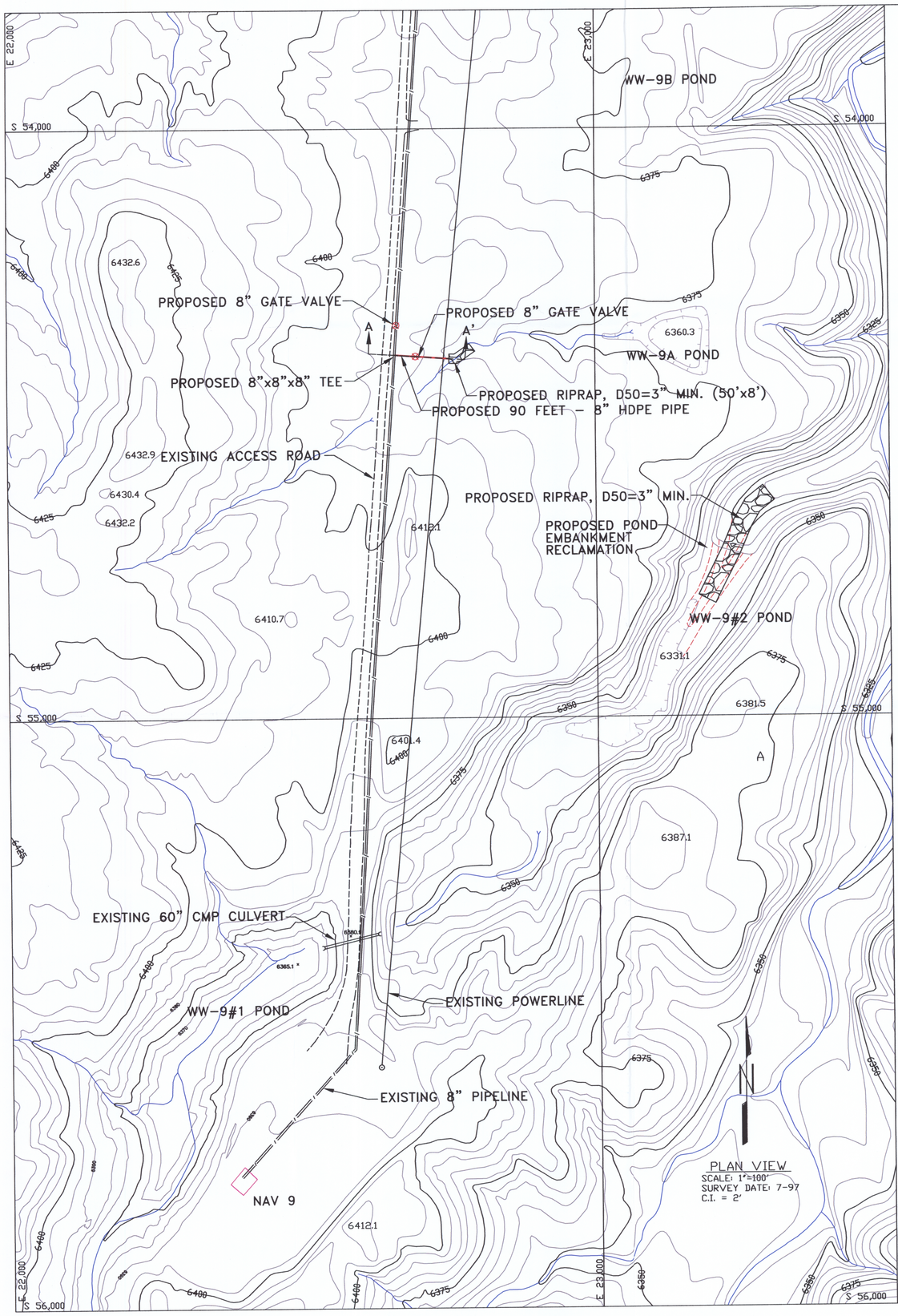
Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	3.0:1	3.0:1	25.0	0.0300	1.00			5.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.40 cfs	
Depth:	0.07 ft	1.07 ft
Top Width:	5.40 ft	11.40 ft
Velocity:	3.98 fps	
X-Section Area:	0.35 sq ft	
Hydraulic Radius:	0.064 ft	
Froude Number:	2.76	

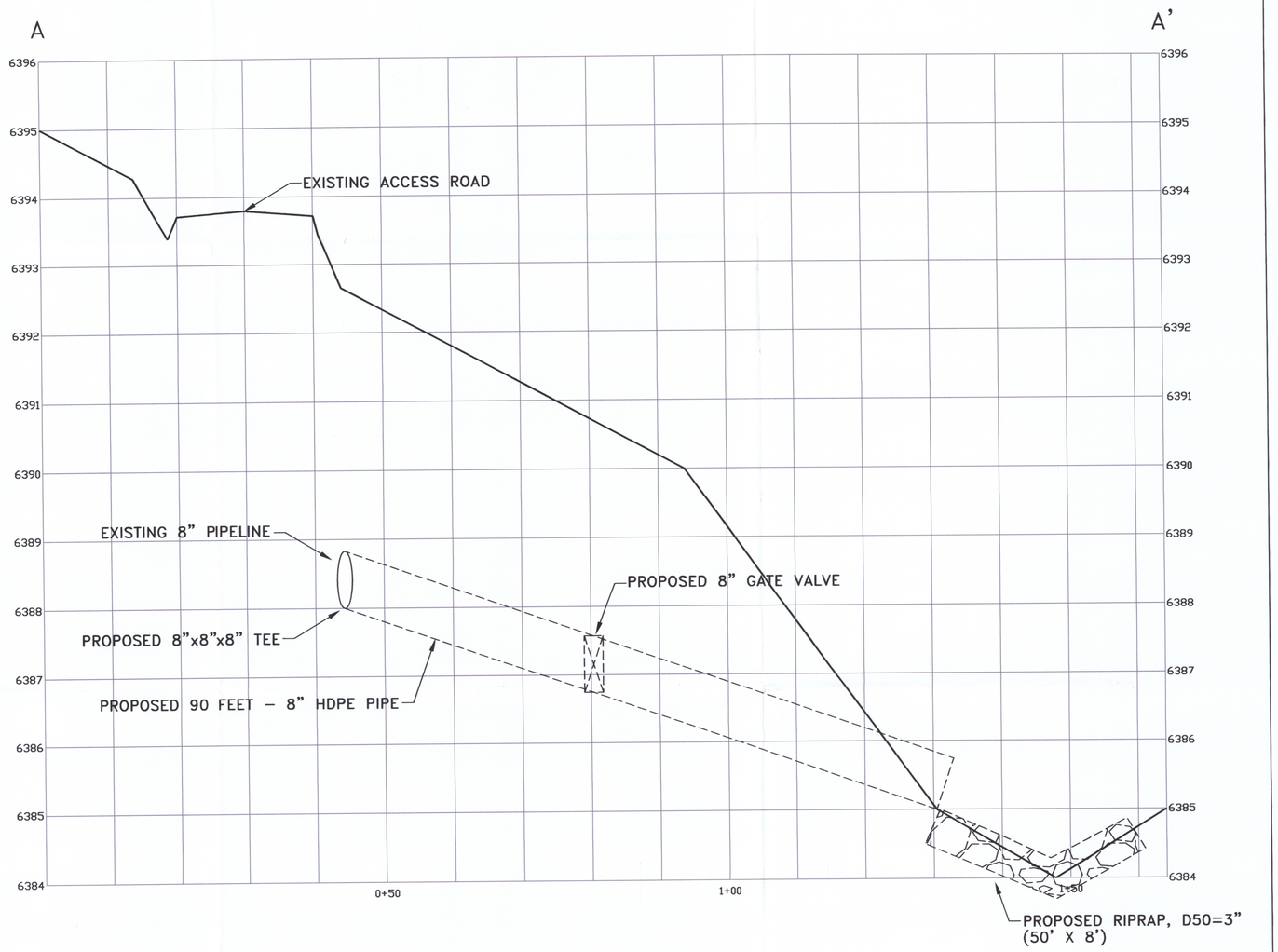
WW-9A POND INLET CHANNEL SUMMARY

Inlet Channel WW-9A Typical Rip Rap Lined Channel													
Channel	Flow (Q) (cfs)	Slope Range (%)	Min. Bottom Width (ft)	Side Slope H:1 (ft)	Depth Flow (ft)	Velocity (fps)	Free Board (ft)	Total Depth (ft)	Min. Rip Rap (in)	Watershed (acres)	Time of Concentration (hr)	Curve Number	Design
WW-9A	1.40	0.0 - 25	5	3	0.1	3.98	1	1.1	N/A Gravel 3.0	0.00	0.000	n/a	A B C C C
Q=600 gpm (1.4 cfs)													

Design Flow: 600 gpm from 8" pipe



PLAN VIEW
SCALE: 1"=100'
SURVEY DATE: 7-97
C.I. = 2'



PROFILE SECTION A-A'
SCALE: HORIZ. 1"=10'
VERT. 1"=1'

ENGINEER'S CERTIFICATION

REGISTERED Professional Engineer CERTIFICATE NO. 37842 GARY ALTSISI Signed: 11/3/12 ARIZONA, USA

EXPIRES: 09/30/2014

Gary Altsisi
Reclamation Supervisor
Peabody Western Coal Company

Arizona P.E. 37842

EXHIBIT #1
WW-9 POND RECLAMATION
AND PROPOSED PIPE SECTION

KAYENTA MINE
PEABODY WESTERN COAL CO. P.O. BOX 650 KAYENTA, AZ 86033

DESIGNED BY: G.A.	SCALE: AS SHOWN
DRAWN BY: G.A.	DRAWING DATE: 11-07-12
CHECKED BY: G.A.	SURVEY DATE: 7-97
CONTOUR INTERVAL: 5'	DWG FILE: WW-9_REMOVAL_PIPELINE_062712.DWG

E 18,000

E 20,000

E 22,000

E 26,000

S 56,000

S 58,000

S 60,000

S 62,000

SEE EXHIBIT #1 "WW-9 POND RECLAMATION AND PROPOSED PIPE SECTION" FOR DESIGN DETAILS.

WW-9A POND

PROPOSED POND RECLAMATION

WW-9#2 POND

WW-9#1 POND

NAV 9

PJ

SB

6975

6825

6830

6650

6400 6450 6500 6550 6600 6650 6700 6750 6800

WW-9 POND WATERSHED
AREA=352.9 AC.
LENGTH=12,367 FT.
ELEV.DIFF.=505 FT.

PLAN VIEW
SCALE: 1"=200'
PHOTO DATE: 3-05
C.I. = 10'

LEGEND

- DRAINAGE
- Tc – CHANNEL FLOW
- UNDISTURBED VEG ID
- WATERSHED BOUNDARY
- RIPRAP
- 6975 ELEVATION POINT ON CHANNEL
- LEASE BOUNDARY

ENGINEER'S CERTIFICATION

Professional Engineer (Civil) CERTIFICATE NO. 37842 GARY ALTSISI Date Signed: 11-13-12 ARIZONA, USA

EXPIRES: 09/30/2014

Gary Altsisi
Reclamation Supervisor
Peabody Western Coal Company

Arizona P.E. 37842

EXHIBIT #2

WW-9 POND RECLAMATION
HYDROLOGY PARAMETERS

KAYENTA MINE

PEABODY WESTERN COAL COMPANY
P.O. BOX 650 KAYENTA, AZ 86033

DESIGNED BY: G.A.	SCALE: AS SHOWN
DRAWN BY: G.A.	DRAWING DATE: 11-07-12
CHECKED BY: G.A.	PHOTO DATE: 5-05
C.I.: 10'	DWG FILE: WW-9_WATERSHED_DESIGN_110712.DWG

DESIGN REPORT

Sedimentation Structure

WW-9B

Black Mesa Mine

Navajo County, Arizona

For

PEABODY WESTERN COAL COMPANY

DEC 17 1999

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APPENDIX A Hydrology, Hydraulic and Sedimentation Calculations
APPENDIX B SEDCAD4 100-Year, 6-Hour Storm Event
EXHIBIT #1 Proposed WW-9B Sedimentation Pond Design

INTRODUCTION

Sedimentation Structure WW-9B is an earthen embankment, designed and constructed in 1983 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 WW-9B and its watershed boundary are shown on Drawing No. 85400 (Sheet K-11) and Drawing No. 85405. The site-specific 1999 design plans are shown on the attached Exhibit 1.

This design report contains information specific to Structure WW-9B. Mine-wide design, construction, and reclamation information is presented in the "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona, for Peabody Western Coal Company", December, 1985 (PAP), Chapter 6, Attachment D, Volume 2, along with the methods and results of analyses used for slope stability, hydrology, and hydraulics, and in Chapter 6, Pages 11 to 42, "Sediment and Water Control Facility Plan".

INSPECTION

The existing structure WW-9B was inspected by a Registered Professional Engineer from Peabody Western Coal Company in July 1999 to assure that the existing structure is stable and no adverse conditions exist. A detailed geotechnical investigation was not performed, rather, the information in Chapter 6, Attachment D was utilized for embankment design to assure that the design embankment configuration would be stable.

SITE DESCRIPTION

LAND USE

The WW-9B structure has a watershed of 12.3 acres and is located near Yucca Flat Wash at the Black Mesa Mine. The 12.3 acre watershed that contributes directly to structure WW-9B is classified as 91% Sagebrush/grass and 9% disturbed.

DESIGN ANALYSES

GENERAL

Structure WW-9B was designed under the supervision of a Registered Professional Engineer from Peabody Western Coal Company. The design was performed in accordance with applicable 30 CFR 780 and 816 regulations of the United States Department of Interior, Office of Surface Mining (OSM) and included a review of available project files. The most current information contained in the Peabody Western Coal Company files includes topographic maps developed from Peabody Western Coal Company field surveys in 1999 and was used in the analyses of the structure.

STABILITY

Structure WW-9B is a category B-5 embankment. A homogenous earthen embankment classified as a sidehill embankment with an approximately 15 feet wide embankment width. An upstream slope of a minimum 2.4:1 (horizontal to vertical) and a downstream slope of 4.2:1 was utilized. Based on the total embankment height of approximately 11 feet, these slopes are equal to or flatter than the recommended "worst case" embankment/foundation condition slopes in Table 3-6, Attachment D, Chapter 6; therefore, the embankment is stable.

HYDROLOGY

The hydrologic analysis was completed using the computer program SEDCAD 4 (see Appendix B). Structure WW-9B is classified as a low hazard structure (see Drawing No. 85408). In addition, the mine area is sparsely populated with no one living in the downstream floodplain. The structure will impound less than 20 acre-feet and be less than 20 vertical feet in height from the upstream toe of the embankment of the natural stream elevation to the top of embankment elevation.

Adequate storage capacity will be maintained in the impoundment above the normal operating level and below the top of the embankment to contain the storm runoff from the 100-year, 6-hour storm event with no discharge over the top of the embankment. To assure that adequate storm water storage capacity is available, the operating water level in the impoundment will be maintained at or below elevation 6372.2. Water level will be controlled and excess stormwater runoff accumulations will be removed by pumping (see Chapter 6 dewatering discussion), as required.

The storage capacity of structure WW-9B was analyzed using the 100-year, 6-hour storm event. The impoundment was verified to completely contain the 100-year, 6-hour storm event, and provide adequate sediment storage volume, without discharging.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.104	mi.
2.	Elevation Difference, H	27 ft	
3.	Time of Concentration, T_c	0.0534 hr	
4.	SCS Curve Number	81	
5.	Rainfall Depth, 100-year, 6-hour storm	2.4 in	
6.	Drainage Area	12.3 acres	

HYDRAULICS

The SEDCAD 4 computer program was used to evaluate inflow to the sedimentation structure. WW-9B does not incorporate an emergency spillway, instead the peak runoff from the 100-yr, 6-hr event will be contained with a minimum of one foot of freeboard. The initial conditions and results of the analysis are summarized in the following table (supporting calculations are presented in Appendix B).

WW-9B SEDIMENTATION POND HYDRAULICS TABLE

	Units	100-Yr, 6-Hr Storm
Initial Reservoir Volume Condition		6372.2
Inflow		
Peak Flow	Cfs	18.13
Volume	ac-ft	0.89
Storage		
Peak Stage	Msl	6373
Max. Operating Elev.	Msl	6372.2
Peak Storage	ac-ft	6.01
Storage Capacity	ac-ft	5.12
Embankment Crest Elev.	Msl	6374
Freeboard	Ft	1.0

Notes: The Storage Capacity figure reflects available pond storage up to the defined Operating Elevation. The Peak Storage figures reflects available pond storage up to the Peak Storage elevation and includes Storage Capacity plus stormwater inflow volume (5.12 + 0. 89).

STORAGE CAPACITY

The impoundment stage-capacity table (see Appendix A) is based on the 1999 topographic mapping conducted by Peabody Western Coal Company. Structure WW-9B is designed to contain approximately 7.18 acre-feet at the top of embankment elevation.

The calculations for the sediment load entering structure WW-9B were made utilizing the Revised Universal Soil Loss Equation with the following parameters:

1.	Rainfall Factor, R	40
2.	Soil Erodibility Factor, K	0.195
3.	Slope Factor, LS	2.5
4.	Cover Factor, C	0.125
5.	Erosion Control Factor, P	1.0

The sediment inflow calculations are included in Appendix A. The hydrologic analysis gives the storage volume required to contain the 100-year, 6-hour storm and the remaining storage volume available for storing sediment. The existing storage capacity of WW-9B and the results of the sediment inflow analysis are summarized in the following table.

Storage for Structure WW-9B

	WW-9B
Total Storage Capacity	7.18 acre-ft
100-Year, 6-Hour Storm Inflow plus 1 ft Freeboard	2.06 acre-ft
Available Sediment Storage Capacity	5.12 acre-ft
Sediment Inflow Rate/Year	0.023 acre-ft /yr
Sediment Storage Life	223 yrs

* * *

The following appendices and drawing are attached and complete this design report.

Appendix A - Hydrology, Hydraulic, and Sedimentation Calculations

Appendix B - SEDCAD4 100-Year, 6-Hour Storm Event

Exhibit #1 - Proposed WW-9B Sedimentation Pond Design

APPENDIX A

Hydrology, Hydraulic, and Sedimentation Calculations

FILE PEABODY COAL CO 10139-011-22
SUBJECT ~~SEDIMENT~~ POND HYDROLOGY
WW9-B SHEET ___ OF ___

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

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6400 - 6373 = 27'

WATER COURSE LENGTH = 550' = 0.104 mi

$T_c = \left(\frac{11.9\ (0.104)^3}{27}\right)^{0.385}$ = 0.0534 hr = 3.2 min

LAG TIME = $0.6\ T_c$ = 0.0321 hr = 1.9 min

SCS CURVE NUMBER

	DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
700'x50'	0.8 (7%)	GRAV RD	—	D	0.08(91) = 7.3
700'x20'	0.3 (2%)	DIRT. RD	—	D	0.02(89) = 1.8
	11.2 (91%)	S-G	ave	D	0.91(79) = 71.9
					81.0

50% EH #23 - D
50% EH #52 - C
Worst case D

Use 81

BY ___ DATE ___
CHECKED BY ___
COPY TO EO ___

DRAINAGE BASIN AREA

12.3 AC. 0.020 SQ. MI.

Dames & Moore

FILE PEABODY COAL CO 10139-011-22
SUBJECT SEDIMENT INFLOW
WW9-B SHEET ___ OF ___

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

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

R = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE = 50% EH # 23 0.5(0.18)
50% EH # 32 0.5(0.21)
~~TEXTURE =~~ Use 0.195

K =

SLOPE FACTOR

LEGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
550	27	5	1.25
750	57	8	2.7
400	37	9	2.3

Use 2.5

COVER FACTOR

AREA (ac.)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
9%	ROADS	—	—	0.09(1.0)
91%	S-G	40	25	0.91(0.13)

C = .208

BY ___ DATE ___
CHECKED BY ___
COPY TO EO ___

APPROVED OCT 2000

EROSION CONTROL FACTOR

P = 1.0

SEDIMENT INFLOW

A = 40(0.195)(25)(.208)(1.0) = 4.056 ton/acre/year

A = 4.056 $\left(\frac{1}{2047}\right)$ (12.3)(0.95) = .023 acre-feet/year

Dames & Moore

LAST REVISION: 7/21/99

WW-9B POND STAGE CAPACITY TABLE

ELEVATION (ft-msl)	STAGE (ft)	AREA (acres)	CAPACITY (ac-ft)	TOTAL CAPACITY (ac-ft)	DESCRIPTION
6361.9	0.0	0.00	0.00	0.00	BOTTOM OF POND
6362.0	0.1	0.01	0.00	0.00	
6364.0	2.1	0.27	0.27	0.27	
6366.0	4.1	0.43	0.69	0.96	
6368.0	6.1	0.56	0.98	1.95	
6370.0	8.1	0.70	1.26	3.20	
6372.0	10.1	0.94	1.64	4.85	
6374.0	12.1	1.39	2.34	7.18	TOP OF EMBANKMENT

APPENDIX B

SEDCAD4 (Input and Output) 100-Year, 6-Hour Storm Event

WW-9B
Design Report

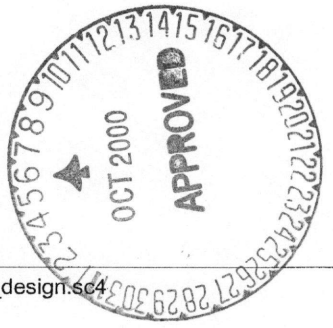
100 yr - 6 hr Design Storm

Christopher Irwin

General Information

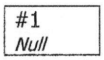
Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 6 hr
Rainfall Depth:	2.400 inches



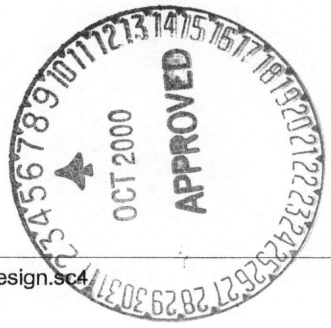
Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	



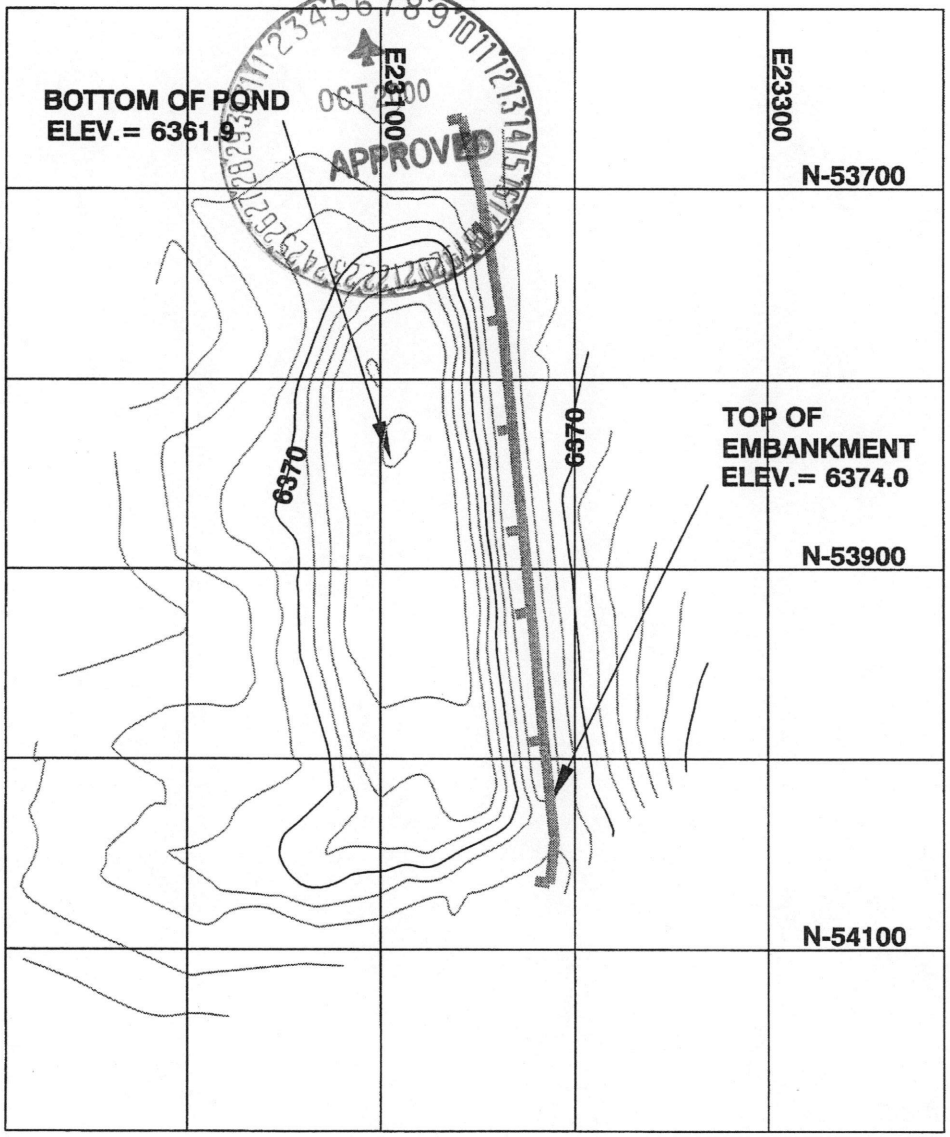
Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	12.300	12.300	18.13	0.89



Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	12.300	0.053	0.000	0.000	81.000	F	18.13	0.89
	Σ	**12.300**						**18.13**	**0.89**



N

PLAN VIEW
SCALE: 1" = 100'
SURVEY DATE: 06-30-99

C.I. = 2'

EXHIBIT 1

WW-9B POND
DESIGN

BLACK MESA MINE
PEABODY WESTERN COAL COMPANY
PO BOX 625 KAYENTA, ARIZONA 86033

DESIGNED BY: PWCC	SCALE: AS SHOWN
DRAWN BY: CI	DRAWING DATE: 07-06-99
CHECKED BY: RL	SURVEY DATE: 06-30-99
CONTOUR INT.: 2'	DWG FILE: WW-9B..D.DWG

DESIGN REPORT

Sedimentation Structure

WW-9A

Black Mesa Mine

Navajo County, Arizona

For

PEABODY WESTERN COAL COMPANY

DEC 17 1999

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APPENDIX A Hydrology, Hydraulic and Sedimentation Calculations
APPENDIX B SEDCAD4 100-Year, 6-Hour Storm Event
EXHIBIT #1 Proposed WW-9A Sedimentation Pond Design

INTRODUCTION

Sedimentation Structure WW-9A is an earthen embankment, designed and constructed in 1983 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 WW-9A and its watershed boundary are shown on Drawing No. 85400 (Sheet K-11) and Drawing No. 85405. The site-specific 1999 design plans are shown on the attached Exhibit 1.

This design report contains information specific to Structure WW-9A. Mine-wide design, construction, and reclamation information is presented in the "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona, for Peabody Western Coal Company", December, 1985 (PAP), Chapter 6, Attachment D, Volume 2, along with the methods and results of analyses used for slope stability, hydrology, and hydraulics, and in Chapter 6, Pages 11 to 42, "Sediment and Water Control Facility Plan".

INSPECTION

The existing structure WW-9A was inspected by a Registered Professional Engineer from Peabody Western Coal Company in July 1999 to assure that the existing structure is stable and no adverse conditions exist. A detailed geotechnical investigation was not performed, rather, the information in Chapter 6, Attachment D was utilized for embankment design to assure that the design embankment configuration would be stable.

SITE DESCRIPTION

LAND USE

The WW-9A structure has a watershed of 12.55 acres and is located near Yucca Flat Wash at the Black Mesa Mine. The 12.55 acre watershed that contributes directly to structure WW-9A is classified as 94% Sagebrush/grass and 6% disturbed.

DESIGN ANALYSES

GENERAL

Structure WW-9A was designed under the supervision of a Registered Professional Engineer from Peabody Western Coal Company. The design was performed in accordance with applicable 30 CFR 780 and 816 regulations of the United States Department of Interior, Office of Surface Mining (OSM) and included a review of available project files. The most current information contained in the Peabody Western Coal Company files includes topographic maps developed from Peabody Western Coal Company field surveys in 1999 and was used in the analyses of the structure.

STABILITY

Structure WW-9A is a category A-5 embankment. A homogenous earthen embankment with an approximately 12 feet wide embankment width. An upstream slope of a minimum 2.3:1 (horizontal to vertical) and a downstream slope of 3.9:1 was utilized. Based on the total embankment height of approximately 14 feet, these slopes are equal to or flatter than the recommended "worst case" embankment/foundation condition slopes in Table 3-6, Attachment D, Chapter 6: therefore, the embankment is stable.

HYDROLOGY

The hydrologic analysis was completed using the computer program SEDCAD 4 (see Appendix B). Structure WW-9A is classified as a low hazard structure (see Drawing No. 85408). In addition, the mine area is sparsely populated with no one living in the downstream floodplain. The structure will impound less than 20 acre-feet and be less than 20 vertical feet in height from the upstream toe of the embankment of the natural stream elevation to the top of embankment elevation.

Adequate storage capacity will be maintained in the impoundment above the normal operating level and below the top of the embankment to contain the storm runoff from the 100-year, 6-hour storm event with no discharge over the top of the embankment. To assure that adequate storm water storage capacity is available, the operating water level in the impoundment will be maintained at or below elevation 6372.4. Water level will be controlled and excess stormwater runoff accumulations will be removed by pumping (see Chapter 6 dewatering discussion), as required.

The storage capacity of structure WW-9A was analyzed using the 100-year, 6-hour storm event. The impoundment was verified to completely contain the 100-year, 6-hour storm event, and provide adequate sediment storage volume, without discharging.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.20	mi.
2.	Elevation Difference, H	50	ft
3.	Time of Concentration, T_c	0.089	hr
4.	SCS Curve Number	80	
5.	Rainfall Depth, 100-year, 6-hour storm	2.4	in
6.	Drainage Area	12.55	acres

HYDRAULICS

The SEDCAD 4 computer program was used to evaluate inflow to the sedimentation structure. WW-9A does not incorporate an emergency spillway, instead the peak runoff from the 100-yr, 6-hr event will be contained with a minimum of one foot of freeboard. The initial conditions and results of the analysis are summarized in the following table (supporting calculations are presented in Appendix B).

WW-9A SEDIMENTATION POND HYDRAULICS TABLE

	Units	100-Yr, 6-Hr Storm
Initial Reservoir Volume Condition		6372.4
Inflow		
Peak Flow	Cfs	17.63
Volume	ac-ft	0.86
Storage		
Peak Stage	Msl	6374
Max. Operating Elev.	Msl	6372.4
Peak Storage	ac-ft	3.48
Storage Capacity	ac-ft	2.62
Embankment Crest Elev.	Msl	6375
Freeboard	Ft	1.0

Notes: The Storage Capacity figure reflects available pond storage up to the defined Operating Elevation. The Peak Storage figures reflects available pond storage up to the Peak Storage elevation and includes Storage Capacity plus stormwater inflow volume (2.62 + 0. 86).

STORAGE CAPACITY

The impoundment stage-capacity table (see Appendix A) is based on the 1999 topographic mapping conducted by Peabody Western Coal Company. Structure WW-9A is designed to contain approximately 4.23 acre-feet at the top of embankment elevation.

The calculations for the sediment load entering structure WW-9A were made utilizing the Revised Universal Soil Loss Equation with the following parameters:

1.	Rainfall Factor, R	40
2.	Soil Erodibility Factor, K	0.18
3.	Slope Factor, LS	2.10
4.	Cover Factor, C	0.096
5.	Erosion Control Factor, P	1.0

The sediment inflow calculations are included in Appendix A. The hydrologic analysis gives the storage volume required to contain the 100-year, 6-hour storm and the remaining storage volume available for storing sediment. The existing storage capacity of WW-9A and the results of the sediment inflow analysis are summarized in the following table.

Storage for Structure WW-9A

	WW-9A
Total Storage Capacity	4.23 acre-ft
100-Year, 6-Hour Storm Inflow plus 1 ft Freeboard	1.61 acre-ft
Available Sediment Storage Capacity	2.62 acre-ft
Sediment Inflow Rate/Year	0.016 acre-ft /yr
Sediment Storage Life	164 yrs

* * *

The following appendices and drawing are attached and complete this design report.

Appendix A - Hydrology, Hydraulic, and Sedimentation Calculations

Appendix B - SEDCAD4 100-Year, 6-Hour Storm Event

Exhibit #1 - Proposed WW-9A Sedimentation Pond Design

APPENDIX A

Hydrology, Hydraulic, and Sedimentation Calculations

FILE [illegible]

SUBJECT SEDIMENT BND HYDROLOGY

WW9-A SHEET ___ OF ___

REVISIONS

BY ___ DATE ___ TO EO ___

BY ___ DATE ___ TO EO ___

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6424 - 6374 = 50'

WATER COURSE LENGTH = 1050' = 0.20 mi

$$T_c = \left(\frac{11.9(0.20)^3}{50}\right)^{0.385} = 0.089 \text{ hr} = 5.4 \text{ min}$$ ME

LAG TIME = $0.6 T_c$ = 0.054 hr = 3.2 min ME

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
0.70 (6%)	Gravel Road	—	D	0.06(91) = 5.5
11.85 (94%)	S-G	ave	D	0.94(79) = 74.3
				79.8

EH #23

Use 80

DATE ___ CHECKED BY ___ COPY TO EO ___

DRAINAGE BASIN AREA

12.55 AC. 0.020 SQ. MI.

APPROVED OCT 2000

Dames & Moore

FILE PEABODY COAL CO [illegible]
SUBJECT SEDIMENT INFLOW
WW9-A SHEET ___ OF ___

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

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

R = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE = EH #23

~~TEXTURE~~ =

K = 0.18

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
700	51	7	2.20
~~850~~	43	6	1.95

USE 2.1

COVER FACTOR

AREA (ac.)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
6%	Gravel Rd.	—	—	0.06 (1.0) = 0.06
94%	S-G	40	25	0.94 (0.13) = .12

C = .18

BY ___ DATE ___ CHECKED BY ___ COPY TO EO ___

EROSION CONTROL FACTOR

P = 1.0

APPROVED OCT 2000

SEDIMENT INFLOW

$A = 40(0.18)(2.1)(0.18)(1.0) = 2.72$ ton/acre/year

$A = 2.72\left(\frac{1}{2047}\right)(125)(0.95) = .016$ acre-feet/year

Dames & Moore

LAST REVISION: 7/19/99

WW-9A POND STAGE CAPACITY TABLE

ELEVATION (ft-msl)	STAGE (ft)	AREA (acres)	CAPACITY (ac-ft)	TOTAL CAPACITY (ac-ft)	DESCRIPTION
6360.4	0.0	0.00	0.00	0.00	BOTTOM OF POND
6362.0	1.6	0.10	0.08	0.08	
6364.0	3.6	0.15	0.25	0.33	
6366.0	5.6	0.18	0.33	0.67	
6368.0	7.6	0.23	0.41	1.08	
6370.0	9.6	0.31	0.54	1.62	
6372.0	11.6	0.44	0.75	2.37	
6374.0	13.6	0.67	1.11	3.48	
6375.0	14.6	0.83	0.75	4.23	TOP OF EMBANKMENT

APPENDIX B

SEDCAD4 (Input and Output) 100-Year, 6-Hour Storm Event

WW-9A
Design Report

100 yr - 6 hr Design Storm

Christopher Irwin

Peabody Western Coal Company
Black Mesa Mine

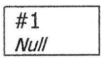
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 6 hr
Rainfall Depth:	2.400 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	

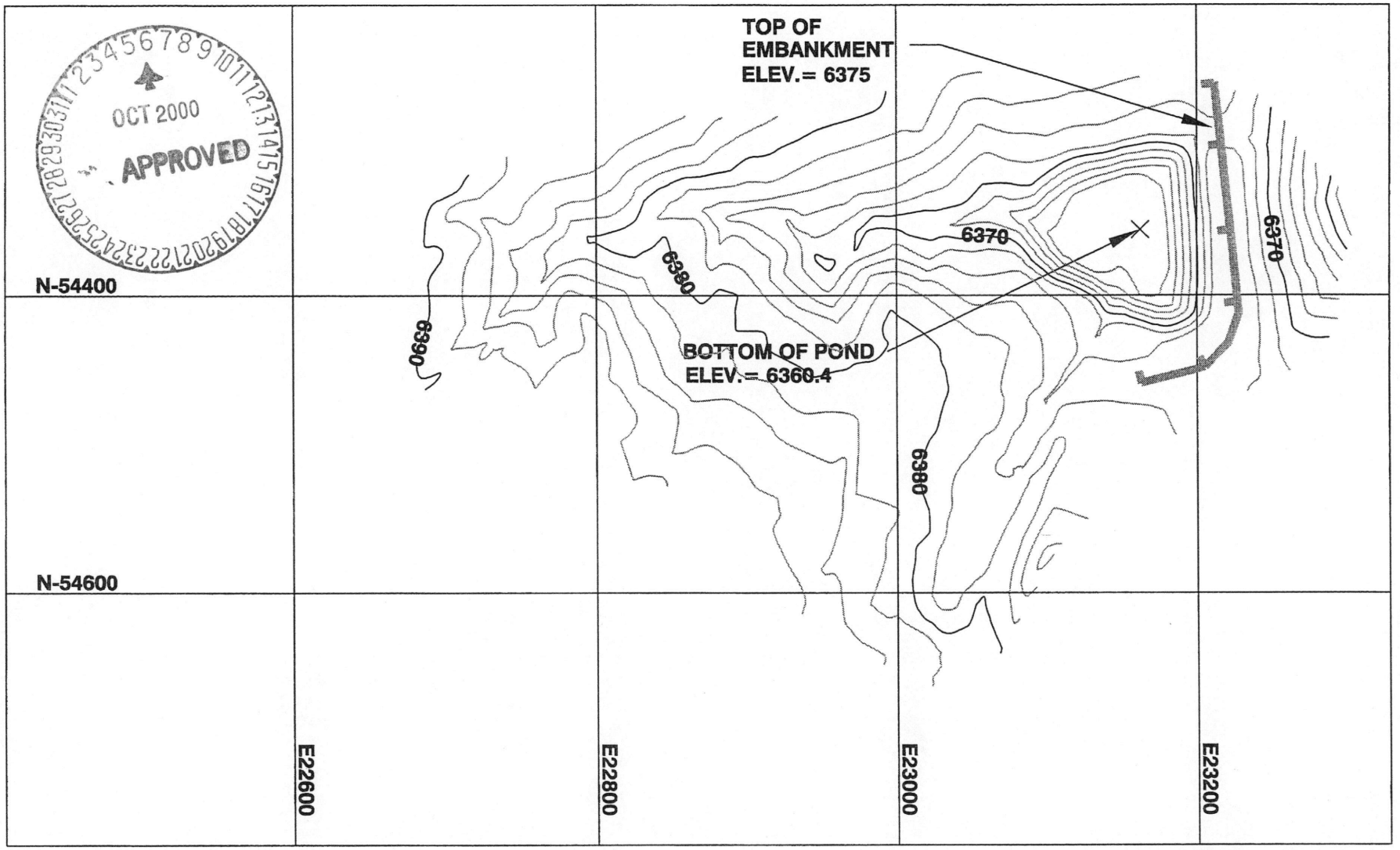


Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	12.550	12.550	17.63	0.86

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	12.550	0.089	0.000	0.000	80.000	F	17.63	0.86
	Σ	**12.550**						**17.63**	**0.86**



PLAN VIEW
SCALE: 1" = 100'
SURVEY DATE: 06-30-99

C.I. = 2'

WW-9A POND
DESIGN

BLACK MESA MINE
PEABODY WESTERN COAL COMPANY
PO BOX 625 KAYENTA, ARIZONA 86033

DESIGNED BY: PWCC	SCALE: AS SHOWN
DRAWN BY: CI	DRAWING DATE: 07-02-99
CHECKED BY: RL	SURVEY DATE: 06-30-99
CONTOUR INT.: 2'	DWG FILE: WW-9A D..9.DWG

EXHIBIT 1

DESIGN REPORT

Sedimentation Structure

WW-9C

Black Mesa Mine

Navajo County, Arizona

For

PEABODY WESTERN COAL COMPANY

DEC 17 1999

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STORAGE CAPACITY 6

APPENDIX A Hydrology, Hydraulic and Sedimentation Calculations
APPENDIX B SEDCAD4 100-Year, 6-Hour Storm Event
EXHIBIT #1 Proposed WW-9C Sedimentation Pond Design

INTRODUCTION

Sedimentation Structure WW-9C is an earthen embankment, designed and constructed in 1983 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 WW-9C and its watershed boundary are shown on Drawing No. 85400 (Sheet K-11) and Drawing No. 85405. The site-specific 1999 design plans are shown on the attached Exhibit 1.

This design report contains information specific to Structure WW-9C. Mine-wide design, construction, and reclamation information is presented in the "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona, for Peabody Western Coal Company", December, 1985 (PAP), Chapter 6, Attachment D, Volume 2, along with the methods and results of analyses used for slope stability, hydrology, and hydraulics, and in Chapter 6, Pages 11 to 42, "Sediment and Water Control Facility Plan".

INSPECTION

The existing structure WW-9C was inspected by a Registered Professional Engineer from Peabody Western Coal Company in July 1999 to assure that the existing structure is stable and no adverse conditions exist. A detailed geotechnical investigation was not performed, rather, the information in Chapter 6, Attachment D was utilized for embankment design to assure that the design embankment configuration would be stable.

SITE DESCRIPTION

LAND USE

The WW-9C structure has a watershed of 12.3 acres and is located near Yucca Flat Wash at the Black Mesa Mine. The 12.3 acre watershed that contributes directly to structure WW-9C is classified as 91% Sagebrush/grass and 9% disturbed.

DESIGN ANALYSES

GENERAL

Structure WW-9C was inspected under the supervision of a Registered Professional Engineer from Peabody Western Coal Company. The design was performed in accordance with applicable 30 CFR 780 and 816 regulations of the United States Department of Interior, Office of Surface Mining (OSM) and included a review of available project files. The most current information contained in the Peabody Western Coal Company files includes topographic maps developed from Peabody Western Coal Company field surveys in 1999 and was used in the analyses of the structure.

STABILITY

Structure WW-9C is a category B-3 embankment. A homogenous earthen embankment classified as an in-wash embankment with an approximately 15 feet wide embankment width. An upstream slope of a minimum 2.0:1 (horizontal to vertical) and a downstream slope of 3.5:1 was utilized. Based on the total embankment height of approximately 14 feet, these slopes are equal to or flatter than the recommended "worst case" embankment/foundation condition slopes in Table 3-6, Attachment D, Chapter 6: therefore, the embankment is stable.

HYDROLOGY

The hydrologic analysis was completed using the computer program SEDCAD 4 (see Appendix B). Structure WW-9C is classified as a low hazard structure (see Drawing No. 85408). In addition, the mine area is sparsely populated with no one living in the downstream floodplain. The structure will impound less than 20 acre-feet and be less than 20 vertical feet in height from the upstream toe of the embankment of the natural stream elevation to the top of embankment elevation.

Adequate storage capacity will be maintained in the impoundment above the normal operating level and below the top of the embankment to contain the storm runoff from the 100-year, 6-hour storm event with no discharge over the top of the embankment. To assure that adequate storm water storage capacity is available, the operating water level in the impoundment will be maintained at or below elevation 6273.2. Water level will be controlled and excess stormwater runoff accumulations will be removed by pumping (see Chapter 6 dewatering discussion), as required.

The storage capacity of structure WW-9C was analyzed using the 100-year, 6-hour storm event. The impoundment was verified to completely contain the 100-year, 6-hour storm event, and provide adequate sediment storage volume, without discharging.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.369	mi.
2.	Elevation Difference, H	106 ft	
3.	Time of Concentration, T_c	0.136 hr	
4.	SCS Curve Number	75	
5.	Rainfall Depth, 100-year, 6-hour storm	2.4 in	
6.	Drainage Area	17.4 acres	

HYDRAULICS

The SEDCAD 4 computer program was used to evaluate inflow to the sedimentation structure. WW-9C does not incorporate an emergency spillway, instead the peak runoff from the 100-yr, 6-hr event will be contained with a minimum of one foot of freeboard. The initial conditions and results of the analysis are summarized in the following table (supporting calculations are presented in Appendix B).

WW-9C SEDIMENTATION POND HYDRAULICS TABLE

	Units	100-Yr, 6-Hr Storm
Initial Reservoir Volume Condition		6273.2
Inflow		
Peak Flow	Cfs	13.98
Volume	ac-ft	0.86
Storage		
Peak Stage	Msl	6274
Max. Operating Elev.	Msl	6273.2
Peak Storage	ac-ft	9.25
Storage Capacity	ac-ft	8.39
Embankment Crest Elev.	Msl	6275
Freeboard	Ft	1.0

Notes: The Storage Capacity figure reflects available pond storage up to the defined Operating Elevation. The Peak Storage figures reflects available pond storage up to the Peak Storage elevation and includes Storage Capacity plus stormwater inflow volume (8.39 + 0. 86).

STORAGE CAPACITY

The impoundment stage-capacity table (see Appendix A) is based on the 1999 topographic mapping conducted by Peabody Western Coal Company. Structure WW-9C is designed to contain approximately 10.41 acre-feet at the top of embankment elevation.

The calculations for the sediment load entering structure WW-9C were made utilizing the Revised Universal Soil Loss Equation with the following parameters:

1.	Rainfall Factor, R	40
2.	Soil Erodibility Factor, K	0.21
3.	Slope Factor, LS	1.5
4.	Cover Factor, C	0.163
5.	Erosion Control Factor, P	1.0

The sediment inflow calculations are included in Appendix A. The hydrologic analysis gives the storage volume required to contain the 100-year, 6-hour storm and the remaining storage volume available for storing sediment. The existing storage capacity of WW-9C and the results of the sediment inflow analysis are summarized in the following table.

Storage for Structure WW-9C

	WW-9C
Total Storage Capacity	10.41 acre-ft
100-Year, 6-Hour Storm Inflow plus 1 ft Freeboard	2.02 acre-ft
Available Sediment Storage Capacity	8.39 acre-ft
Sediment Inflow Rate/Year	0.02 acre-ft /year
Sediment Storage Life	420 years

* * *

The following appendices and drawing are attached and complete this design report.

Appendix A - Hydrology, Hydraulic, and Sedimentation Calculations

Appendix B - SEDCAD4 100-Year, 6-Hour Storm Event

Exhibit #1 - Proposed WW-9C Sedimentation Pond Design

APPENDIX A

Hydrology, Hydraulic, and Sedimentation Calculations

FILE PEABODY COAL CO 10139-011-22
SUBJECT SEDIMENT POND HYDROLOGY
WW9-C SHEET ___ OF ___

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

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6380 - 6274 = 106'

WATER COURSE LENGTH = 1950' = 0.369 mi

$$T_c = \left(\frac{11.9\,(0.369)^3}{106}\right)^{0.385} = 0.136 \text{ hr}$$

LAG TIME = $0.6\,T_c$ = 0.0817 hr

SCS CURVE NUMBER

	DRAINAGE AREA (ac)		COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
1250'x50'	1.4	(8%)	GRAV. RD.	—	C	0.08(89) = 7.1
	16.0	(92%)	S-G	ave.	C	0.92(73) = 67.2
					EH#32-	74.3

Use 75

DRAINAGE BASIN AREA

17.4 AC. 0.027 SQ. MI.

BY GLDavis DATE 1/6/85
CHECKED BY ___
COPY TO EO ___

APPROVED OCT 2000

Dames & Moore

FILE KEABOY COAL CO 1039-011-22
SUBJECT SEDIMENT INFLOW
WW9-C SHEET ___ OF ___

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

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

R = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE = EH ± 32

~~PERCENT~~

K = 0.21

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS	
1450	40	3	0.65	75% area
550	67	12	4.2	25% area

USE 1.5 WEIGHTED

COVER FACTOR

AREA (ac.)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
8%	ROAD	—	—	0.08 (1.0)
92%	S-G	40	25	0.92 (.13)

USE .200

BY ___ DATE ___ CHECKED BY ___ COPY TO EO ___

APPROVED OCT 2000

EROSION CONTROL FACTOR

P = 1.0

SEDIMENT INFLOW

$A = 40(0.21)(1.5)(.200)(1.0) = 2.52$ ton/acre/year

$A = 2.52\left(\frac{1}{2047}\right)(17.4)(0.95) = .020$ acre-feet/year

Dames & Moore

LAST REVISION: 12/16/99

WW-9C POND STAGE CAPACITY TABLE

ELEVATION (ft-msl)	STAGE (ft)	AREA (acres)	CAPACITY (ac-ft)	TOTAL CAPACITY (ac-ft)	DESCRIPTION
6261.3	0.0	0.00	0.00	0.00	BOTTOM OF POND
6262.0	0.7	0.09	0.03	0.03	
6264.0	2.7	0.52	0.61	0.64	
6266.0	4.7	0.69	1.21	1.85	
6268.0	6.7	0.83	1.52	3.37	
6270.0	8.7	0.93	1.76	5.13	
6272.0	10.7	1.03	1.96	7.09	
6274.0	12.7	1.13	2.16	9.25	
6275.0	13.7	1.18	1.16	10.41	TOP OF EMBANKMENT

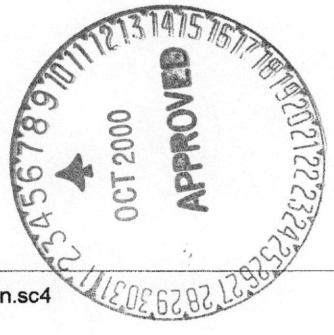
APPENDIX B

SEDCAD4 (Input and Output) 100-Year, 6-Hour Storm Event

WW-9C
Design Report

100 yr - 6 hr Design Storm

Christopher Irwin



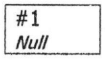
General Information

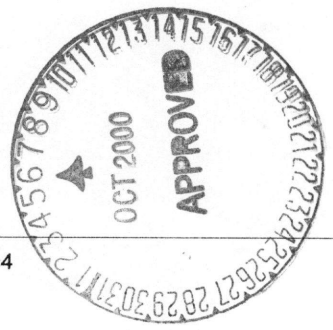
Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 6 hr
Rainfall Depth:	2.400 inches

Structure Networking:

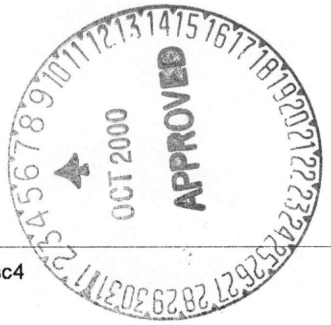
Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	





Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	17.400	17.400	13.98	0.86

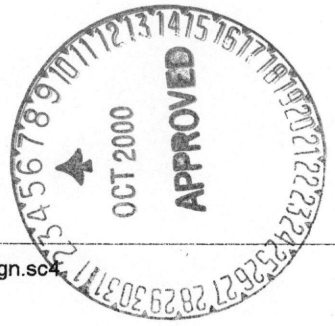


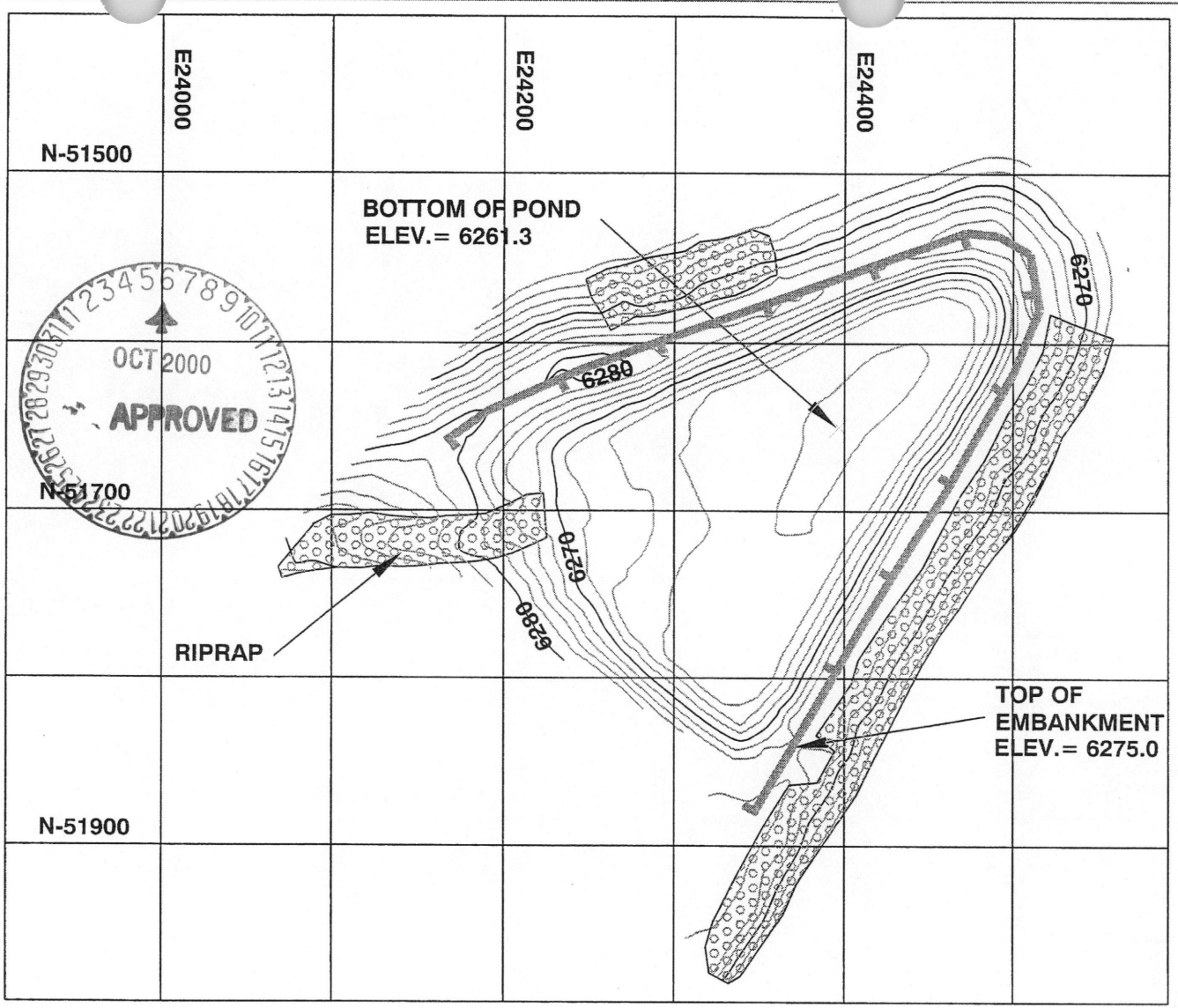
Structure Detail:

Structure #1 (Null)

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	17.400	0.136	0.000	0.000	75.000	F	13.98	0.86
	Σ	**17.400**						**13.98**	**0.86**





N

PLAN VIEW
SCALE: 1" = 100'
SURVEY DATE: 12-15-99

C.I. = 2'

EXHIBIT 1

WW-9C POND
DESIGN

BLACK MESA MINE
PEABODY WESTERN COAL COMPANY
PO BOX 625 KAYENTA, ARIZONA 86033

DESIGNED BY: PWCC	SCALE: AS SHOWN
DRAWN BY: CI	DRAWING DATE: 11-17-99
CHECKED BY: RL	SURVEY DATE: 12-15-99
CONTOUR INT.: 2'	DWG FILE: WW-9C..D.DWG

INSPECTION REPORT

Sedimentation Structure

WW-9D

Black Mesa Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure WW-9D is an earthen embankment, designed and constructed in 1983 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 WW-9D is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure WW-9D. 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 WW-9D was inspected on August 30, 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 WW-9D 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 WW-9D has a 7.67-acre tributary drainage area and is located near the Yucca Flats Wash at the Black Mesa Mine. The watershed is classified as 82% Sagebrush/grass and 18% disturbed.

EMBANKMENT

Structure WW-9D is a homogeneous earthen embankment classified as a in-wash embankment. Physical characteristics of the embankment are listed in the following table:

Structure WW-9D

Embankment	Residual Shale Soils
Foundation	Alluvium
Right Abutment	Residual Shale Soils
Left Abutment	Residual Shale Soils
Height	19.8 ft
Crest Width	15 ft
Upstream Slope	1.8 H : 1 V
Downstream Slope	2.75 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section WW-9D, A-A'. Grass provides erosion protection on the upstream and downstream slopes of the embankment.

ANALYSES

STABILITY

Structure WW-9D is a category B-3 embankment. A standard category B-3 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 WW-9D embankment is lower in height; however, the upstream 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 WW-9D 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 WW-9D was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.123	mi
2.	Elevation Difference, H	106	ft
3.	Time of Concentration, T_c	0.0383	h
4.	Lag time, $0.6T_c$	0.0230	h
5.	SCS Curve Number	82	
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.

WW-9D 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	14	18	
Volume	acre-ft	0.59	0.49	
Storage				
Peak Stage	ft	6255.33	--	
Spillway Elevation . .	ft	6273.80	--	
Peak Storage	acre-ft	0.59	--	
Storage Capacity . . .	acre-ft	15.3	--	
Outflow				
Peak Flow	cfs	0	1	
Embankment Crest Elevation	ft	--	6275.40	
Peak Stage	ft	--	6274.06	
Freeboard	ft	--	1.34	
Spillway Channel				
Flow Depth	ft	--	0.26	
Critical Velocity. . .	fps	--	1.3	
Manning's "n"		--	0.035	
Outflow Channel			Section I	Section II
Slope	%	--	12	34
Normal Velocity. . . .	fps	--	1.7	2.4
Normal Depth	ft	--	0.04	0.03
Manning's "n"		--	0.035	0.035

Spillway Channel

The existing spillway for WW-9D has a trapezoidal channel with the following dimensions:

Channel depth	3 ft
Channel width	12 ft
Channel length	18 ft
Side slopes (horizontal to vertical)	2:1
Average exit slope	0 percent

Rock provides erosion protection for about 50 percent of the channel.

Outflow Channel

The existing outflow channel for WW-9D has a trapezoidal channel with the following dimensions:

Channel depth	3 ft
Channel width	12 ft
Channel length	25 ft
Side slopes (horizontal to vertical)	2:1
Average exit slope	33 percent

Rock provides erosion protection for about 50 percent of 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, WW-9D.

The calculations for the sediment load entering Structure WW-9D were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.189
3. Slope Factor, LS 6.7
4. Cover Factor, C 0.254
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 WW-9D and the results of the sediment inflow analysis are summarized in the following table.

WW-9D STORAGE

Total Storage Capacity	15.3	acre-ft
10-year, 24-hour Storm Inflow	0.59	acre-ft
Available Sediment Storage Capacity . .	14.71	acre-ft
Sediment Inflow Rate	0.052	acre-ft/yr
Sediment Storage Life	283	yrs

Excess storage capacity in Structure WW-9D can be used for storing water produced during maintenance of the nearby water well.

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure WW-9D indicated that the geotechnical problems consist of rill and gulley erosion on the upstream and downstream slopes and on the left abutment; and surface cracks in the crest of

embankment toward the right abutment. Correction of erosion is considered to be a periodic maintenance task and does not require remedial action. The section of the embankment that exhibits the cracks should be reconstructed to eliminate the cracks. The upstream slope should be flattened to 2.0 horizontal to 1 vertical to meet stability requirements.

HYDRAULICS

The storage capacity and spillway capacity of Structure WW-9D are adequate; however, the spillway does not have an adequate 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 WW-9D

Plate 2 - Existing Maximum Cross Section WW-9D, A-A'

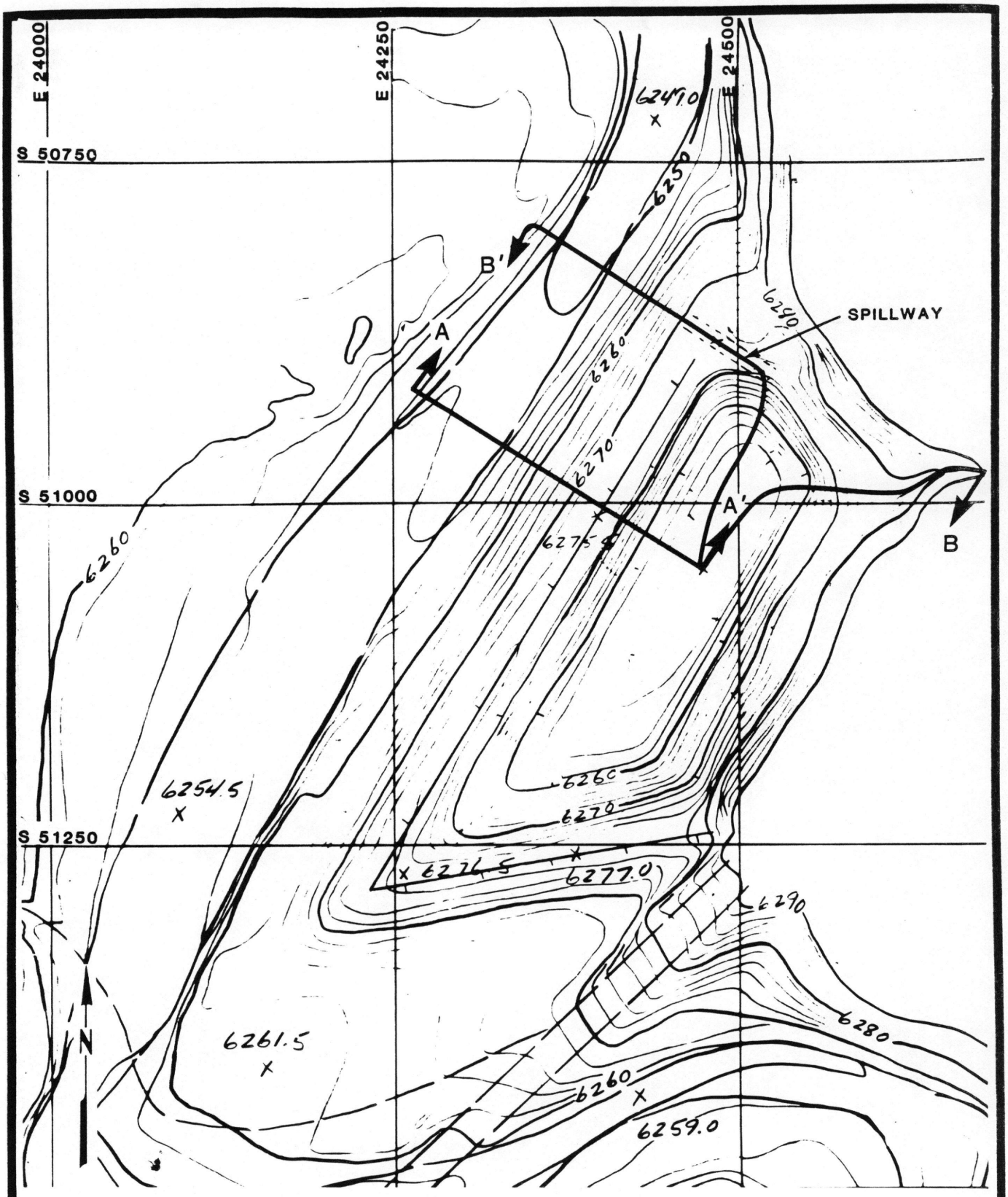
Plate 3 - Volume-Elevation Curve WW-9D

Plate 4 - Channel Profile WW-9D, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section WW-9D

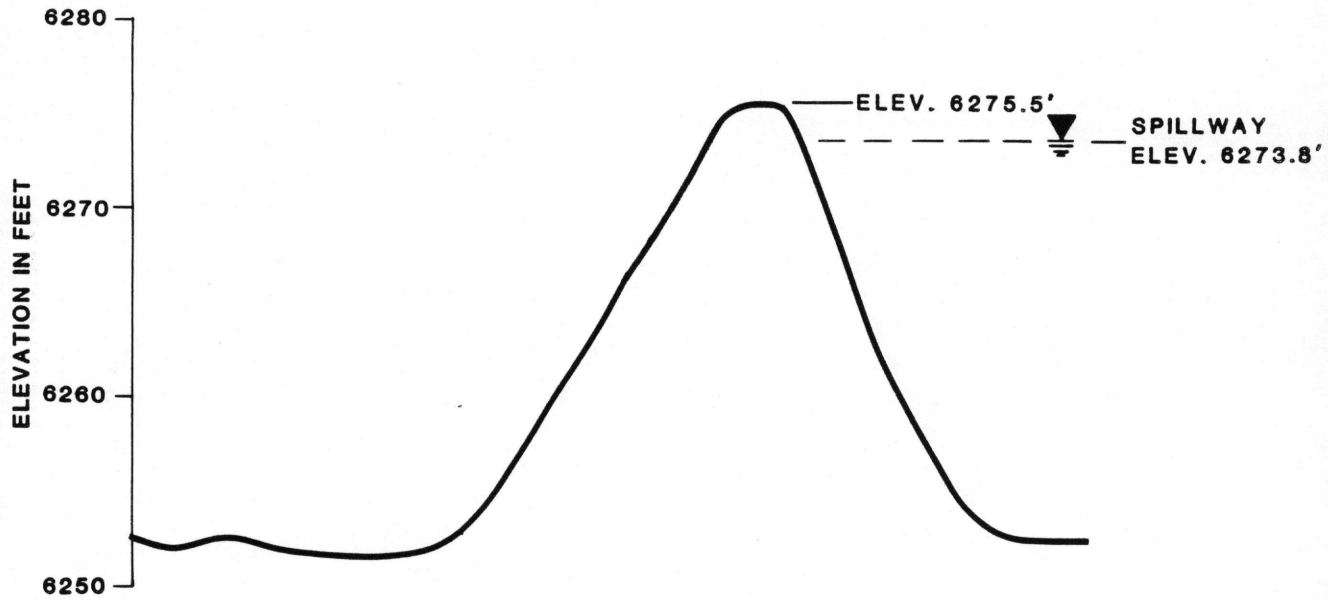
Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations



SITE PLAN
WW-9D

BY **Dames & Moore** Plate 1

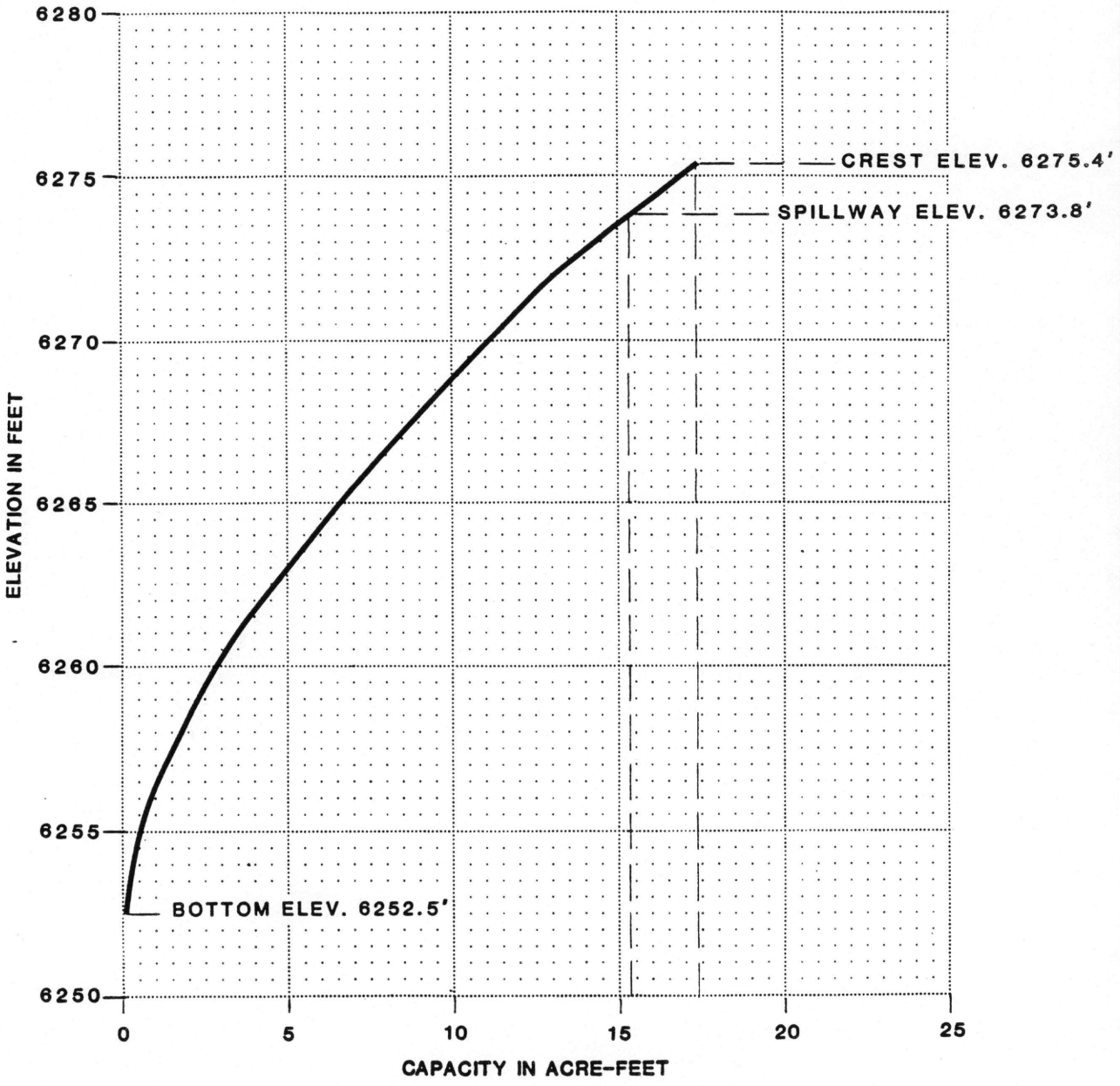


SCALE
0 50 100
FEET

EXISTING MAXIMUM CROSS-SECTION A-A' WW-9D

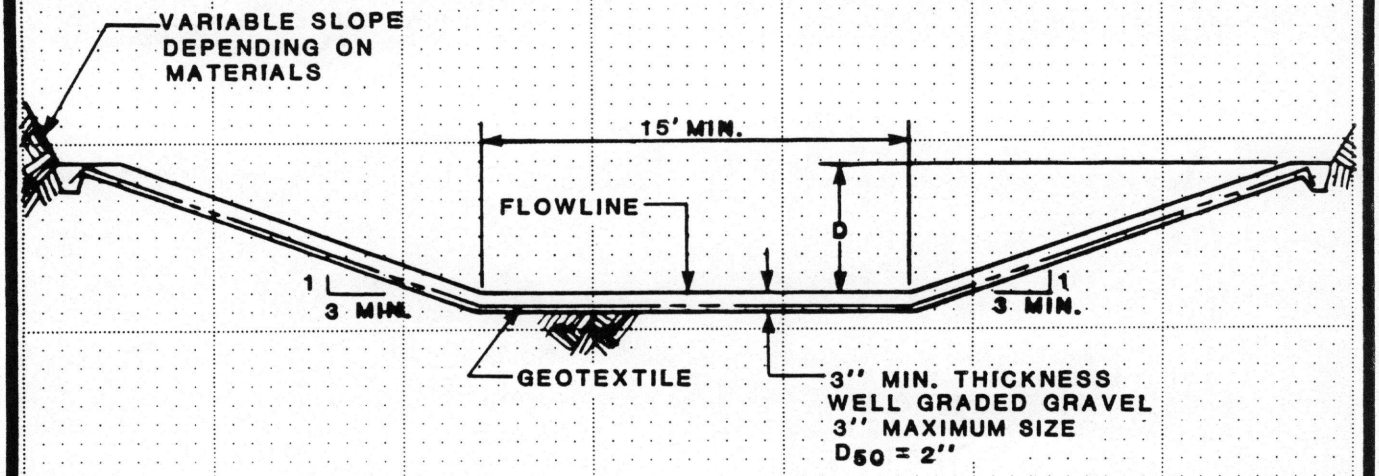
FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 2



VOLUME-ELEVATION CURVE WW-9D

BY **Dames & Moore** Plate 3



SPILLWAY CHANNEL

D = 1.3'

LENGTH = 30'

FLOWLINE ELEV.= 6273.80'

OUTFLOW CHANNEL

D = 1'

SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION WW-9D

BY **Dames & Moore** Plate 5

APPENDIX A

INSPECTION CHECK LIST

Sediment Impoundment Name: WW9-D
Page: 4

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			IRREGULAR SURFACE - humpy from construc 18' wide * rounded sloping to d.s. slop
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?	X	X	transverse cracks ≤ ½" wide
Revised 8-31-85			
2. UPSTREAM SLOPE			29°
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		Gran 75-80%
g. Any stone deterioration?			NA
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			See Comment Section 20°
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?			Rock
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?	X		1 gulley several rills
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Rock & soil

ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			
a. Location:			
Left abutment?			
Right abutment?			
Crest of Embankments?	X		Near Right Abutment
b. Approach Channel:		X	
Are side slopes eroding?			NA
Are side slopes sloughing?			NA
Bottom of channel eroding?			NA
Obstructed?			NA
Erosion protection?	X		some rock on u.s slopes D50/10"
c. Spillway Channel:			
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		80% riprap D 50/10"
d. Outflow Channel:		X	
Are side slopes eroding?			NA
Are side slopes sloughing?			NA
Bottom of channel eroding?			NA
Obstructed?			NA
Erosion protection?	X		Rock on slope D50/24"
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: WW9-D
Page: 6

9 8. GENERAL COMMENTS

Rock on west portion of d.s. slope

24" culvert thru road has started to silt up at entrance
Needs clean out and riprap
outlet need riprap too.

trauverse cracks at crest up to ½" wide
seem to be surface cracks.

8. Impoundment

Sagebrush / grass

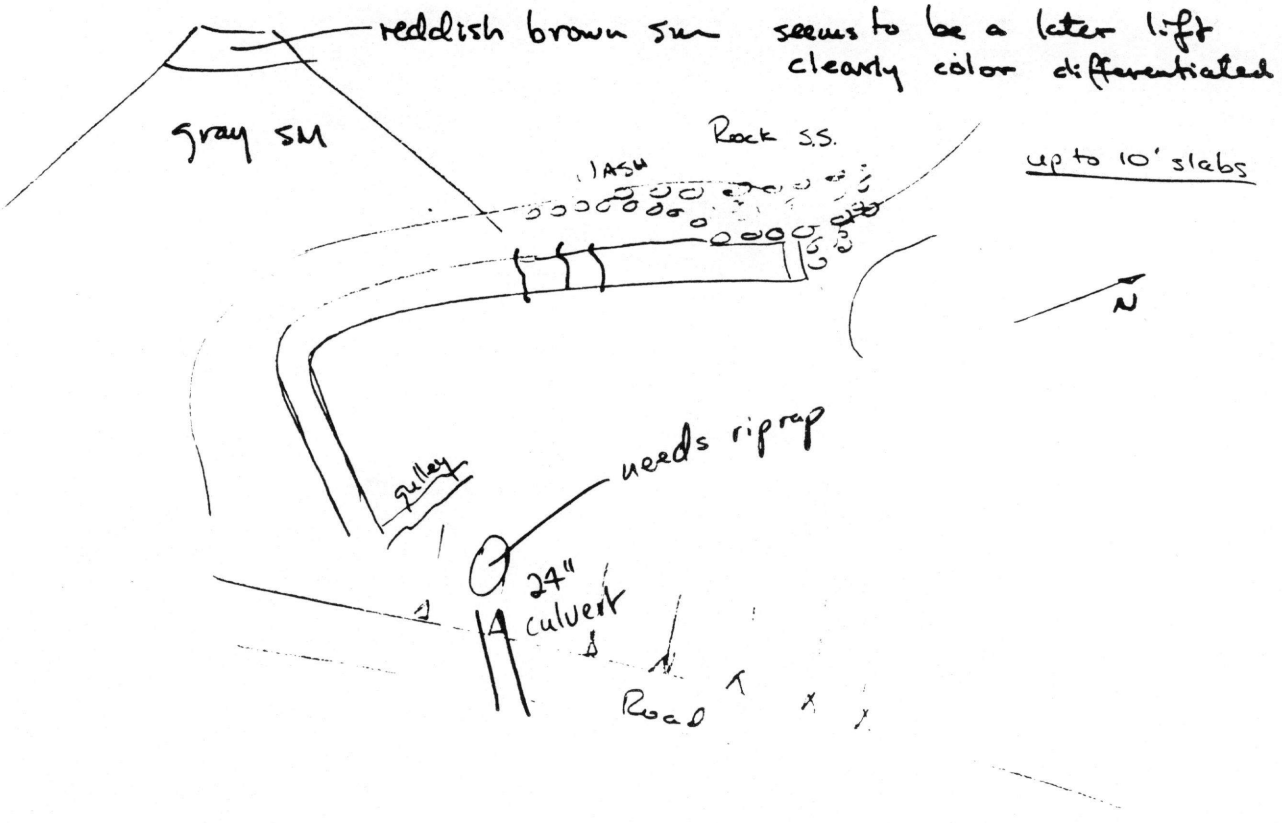
Ground cover 50%

Canopy cover 25%

Watershed same as design

no water in pond

Minor amount of sediment in bottom of pond



APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE [illegible]

SUBJECT SEDIMENT BND HYDROLOGY

WW9-D

SHEET ___ OF ___

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

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6380 - 6274 = 106'

WATER COURSE LENGTH = 650' = 0.123 mi

$$T_c = \left(\frac{11.9\,(0.123)^3}{106}\right)^{0.385} = 0.0383 \text{ hr} = 2.3 \text{ min}$$

LAG TIME = $0.6\,T_c$ = 0.0230 hr = 1.4 min

SCS CURVE NUMBER

	DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
1200' x 50'	1.4 (18%)	GRAV. RD.	—	D	0.18(91) = 16.4
	6.3 (82%)	S-G	ave.	D	0.82(79) = 64.8
					81.2

30% EH #32 - C

70% EH #23 - D

USE 82

Use D

DRAINAGE BASIN AREA

7.67 AC. 0.012 SQ. MI.

BY GDSmith DATE 9/6/85

CHECKED BY ___

COPY TO EO ___

Dames & Moore

FILE [illegible]

SUBJECT SEDIMENT INFLOW

NW9-D SHEET ___ OF ___

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

BY ___ DATE ___ CHECKED BY ___ COPY TO EO ___

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

R = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE = 30% EH #32 0.3 (0.21) = 0.063

70% EH #23 0.7 (0.18) = 0.126

0.189

~~FEATURES~~

K =

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS	
400	35	9	2.4	70% area
200	76	38	16.6	30% area

USE 6.7 WEIGHTED AVG

COVER FACTOR

AREA (ac.)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
18%	Road	—	—	0.18 (1.0)
82%	S-G	40	25	0.82 (.13)

C = .287

EROSION CONTROL FACTOR

P = 1.0

SEDIMENT INFLOW

$A = 40(0.189)(6.7)(0.287)(1.0) = 14.54$ ton/acre/year

$A = 14.54\left(\frac{1}{2047}\right)(7.67)(0.95) = .052$ acre-feet/year

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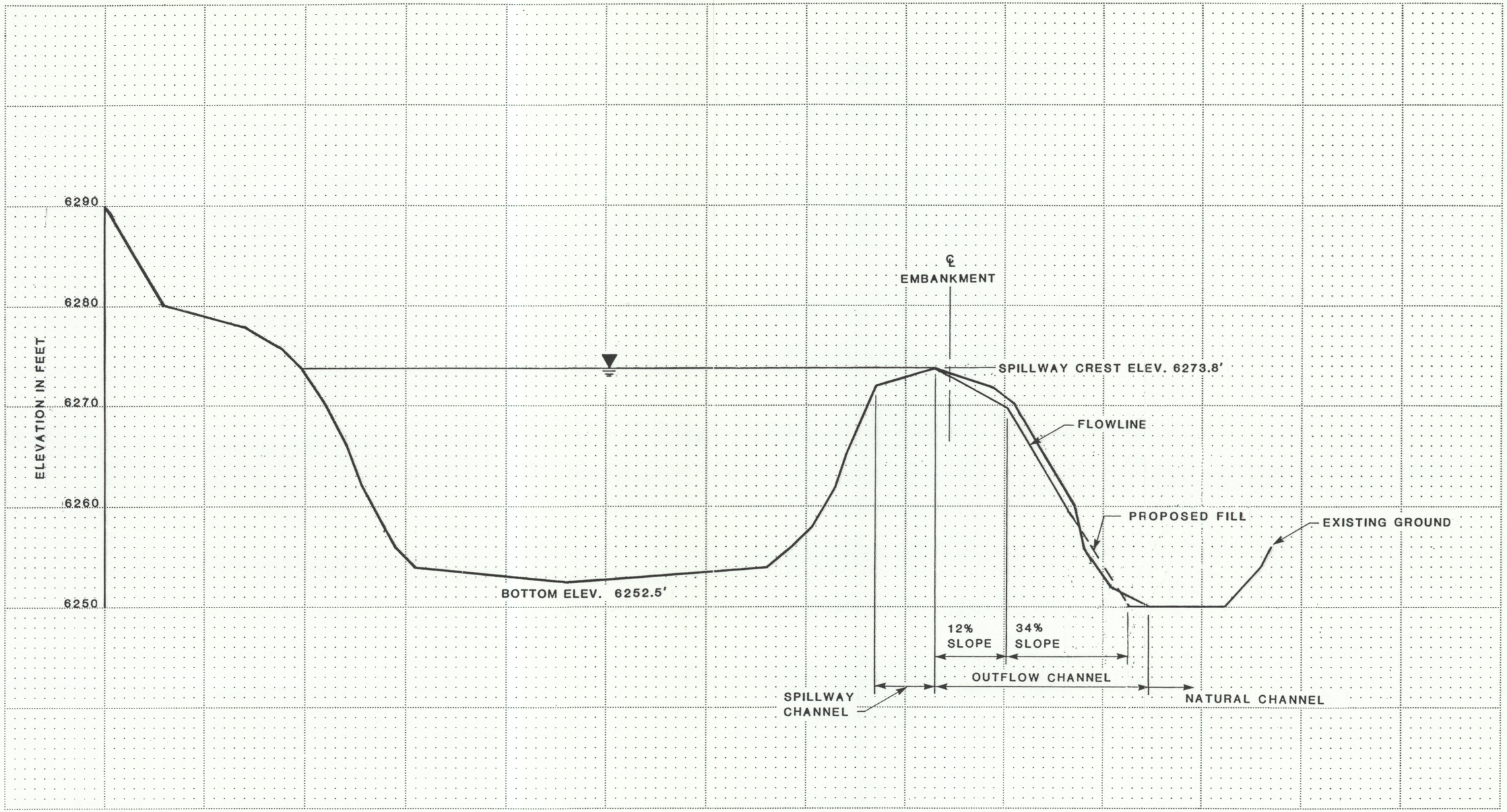

SCALE
0 50 100
FEET

CHANNEL PROFILE B-B'
WW-9D

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4