

JZIE

DESIGN REPORT

Temporary Sedimentation Structure

J21-E

Kayenta Mine

Navajo County, Arizona

For

PEABODY WESTERN COAL COMPANY

Registered Professional Engineer (C.E.)
CERTIFICATE NO.
18782
JAMES GARFIELD SCHREINVOGEL
DIE signed
ARIZONA U.S.A.
James G. Schreinvoegel
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INTRODUCTION

Sedimentation Structure J21-E will be an earthen embankment, designed and constructed by Peabody Western Coal Company as a temporary sedimentation structure designed to control runoff and sediment from portions of J21 disturbed surface mining area at the Kayenta Mine. The location of Structure J21-E and its watershed boundary are shown on Drawing No. 85400 (Sheet N-10 and N-11) and Drawing No. 85405. The site-specific general construction plans are shown on the attached Exhibit 1.

This design report contains information specific to Structure J21-E. 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 construction site of the proposed Structure J21-E was inspected in August, 1997 by a Registered Professional Engineer from Peabody Western Coal Company, to assure that the site is suitable and no adverse conditions exist to prevent the successful construction of this structure. A detailed geotechnical investigation was not performed, rather, the information in Chapter 6, Attachment D was utilized for embankment design and will be utilized during construction to construct a stable embankment.

SITE DESCRIPTION

LAND USE

Structure J21-E has a 31.8 -acre tributary drainage area and is located on a tributary to Dinnebito Wash at the Kayenta Mine. The watershed is classified as 23% disturbed, 70% pinyon-juniper, and 7% sagebrush.

DESIGN ANALYSES

GENERAL

Structure J21-E 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 aerial photography flown in 1992 for Peabody Western Coal Company and was used in the analyses of the structure.

STABILITY

Structure J21-E is assumed to be a Category A-3 embankment. The embankment category will be reevaluated during construction under the supervision of a Register Professional Engineer and Table 3-6, Attachment D, Chapter 6 will be utilized as the guidance to construct stable embankment slopes. A homogeneous earthen embankment, compacted in lifts to design specifications, and approximately 15 feet wide on top will be constructed. An upstream slope of 3:1 (horizontal to vertical) or flatter slope and a downstream slope of 3.5:1 or flatter slope is assumed. Based on the total embankment height of approximately 13 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 will be stable. The emergency spillway will be a minimum 15-foot wide riprap-lined trapezoidal channel.

HYDROLOGY

The hydrologic analysis was completed using the computer program SEDCAD+ (see Appendices A, B, and C). Structure J21-E 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 emergency spillway invert elevation. The spillway for the J21-E pond was analyzed using the 25-year, 6-hour storm. Structure J21-E was conservatively assumed to be full to the emergency spillway prior to the time of the 25-year storm event. The storage capacity of structure J21-E was analyzed using the 10-year, 24-hour storm. The pond was verified to completely contain the 10-year, 24-hour storm event, and provide adequate sediment storage volume, without discharging downstream to Dinnebito Wash.

The following parameters were used in the hydrologic analysis:

	<u>J21-E</u>	
1. Water Course length, L	0.341	mi.
2. Elevation Difference, H	150	ft
3. Time of Concentration, T _c	0.109	hr
4. SCS Curve Number	81	
5. Rainfall Depth, 10-year, 24-hour storm	2.1	in
25-year, 6-hour storm	1.9	in
6. Drainage Area	31.8	acres

HYDRAULICS

The SEDCAD+ and Flow Master computer programs were 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 (supporting calculations are presented in Appendices A, B, and C).

J21-E SEDIMENTATION POND HYDRAULICS TABLE

	Units	10-Yr, 24-Hr Storm	25-Yr, 6-Hr Storm
Initial Reservoir Volume Condition		Empty	Full to emergency spillway
Inflow			
Peak Flow	cfs	23.5	29.4
Volume	ac-ft	1.8	1.5
Storage			
Peak Stage	msl	N/A	6895.6
Emerg. Spillway Elev.	msl	6895	6895
Peak Storage	ac-ft	N/A	4.7
Storage Capacity	ac-ft	4.2	4.2
Outflow			
Peak Flow	cfs	N/A	12.8
Spillway Elevation	msl	6895	6895
Embankment Crest Elev.	msl	6897.0	6897.0
Peak Stage	msl	--	6895.6
Freeboard	ft	--	1.4
Emergency Spillway Channel			
Flow Depth	ft	--	0.6
Critical Velocity	fps	--	2.9
Mannings "n"	--	--	.031
Width	ft	--	15
Outflow Channel			
Slope	%	--	30
Normal Velocity	fps	--	4.6
Normal Depth	ft	--	0.2
Mannings "n"	--	--	.056
Riprap D ₅₀	in	--	3.0

EMERGENCY SPILLWAY AND OUTLET CHANNEL

The emergency spillway and outlet channel for J21-E will be a trapezoidal channel with dimensions listed below. The alignment and dimensions are shown on Exhibit 1.

Minimum Channel Depth	(Spillway)	2.0	ft
	(Outflow)	2.0	ft
Channel Width		15	ft
Channel Length	(Spillway)	40	ft
	(Outflow)	200	ft
Sideslopes (Horizontal to Vertical)		3:1	or flatter
Average Slope	(Spillway)	0	%
Maximum Slope	(Outflow)	30	%
Spillway Elevation		6895	ft

A minimum 15-foot long riprap-lined channel will be constructed beyond the toe of the embankment as a transition into the downstream channel.

STORAGE CAPACITY

The impoundment stage-capacity table (see Exhibit 1) is based on the 1992 aerial topographic mapping conducted for Peabody Western Coal Company. Structure J21-E is designed to contain approximately 4.22 acre-feet.

The calculations for the sediment load entering structure J21-E were made utilizing the Revised Universal Soil Loss Equation with the following parameters:

1.	Rainfall Factor, R	40
2.	Soil Erodibility Factor, K	0.24
3.	Slope Factor, LS	7.7
4.	Cover Factor, C	0.40
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 storage capacity for J21-E is shown on Exhibit 1, J21-E Stage Capacity Table, and the results of the sediment inflow analysis are summarized in the following table.

J21-E STORAGE

Total Storage Capacity	4.22	acre-ft
10-year, 24-hour Storm Inflow	1.80	acre-ft
Available Sediment Storage Capacity	2.42	acre-ft
Sediment Inflow Rate	0.42	acre-ft/yr.
Sediment Storage Life	5.7	years

* * *

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

- Appendix A - Hydrology, Hydraulic, and Sedimentation Calculations
- Appendix B - SEDCAD+ (Input and Output) 10-Year, 24-Hour Storm Event
- Appendix C - SEDCAD+ (Input and Output) 25-Year, 6-Hour Storm Event
- Exhibit # 1 - Proposed J21-E Sedimentation Pond Design

APPENDIX A

Hydrology, Hydraulic, and Sedimentation Calculations

**PEABODY WESTERN COAL COMPANY
CALCULATED HYDROLOGIC DATA**

PROJECT: J21 AREA

STRUCTURE: J21-E

TIME OF CONCENTRATION:

Start Elevation (ft) = 7030
 End Elevation (ft) = 6880
 Elevation Difference, E (ft) = 150

Watercourse Length (ft) = 1800
 Watercourse Length, L (mi) = 0.341

$T_c = (11.9L^{0.385}/E)^{0.385} = \underline{\underline{0.109 \text{ hours}}}$

ROUTING PARAMETERS:

Between structure routing parameters were calculated using the SCS Upland Method in SEDCAD+. Input and output parameters are shown on the SEDCAD+ printouts in Appendices B and C.

SCS CURVE NUMBER:

Cover Type	Soil Group	Curve Number	Area (acres)	CN*Area
Sagebrush-Grass	C	73	2.1	153.3
Pinyon Juniper	C	78	22.3	1739.4
Disturbed	C	91	7.4	673.4
TOTAL:			31.8	2566.1

Weighted CN = Total CN*Area/ Total Area = 81

DRAINAGE BASIN AREA:

31.8 Acres

PEABODY WESTERN COAL COMPANY
CALCULATED SEDIMENTOLOGY DATA

PROJECT: J21-E Pond

SOIL ERODIBILITY FACTOR:

Soil Type	Erodibility Factor, K	Area (acres)	K*Area
Disturbed	0.22	7.4	1.63
20	0.25	24.4	6.10
TOTAL:		31.8	7.73

Weighted K = Total K*Area/ Total Area = 0.24

SLOPE FACTOR:

Length (ft)	Elevation Change (ft)	Slope (%)	m	Slope Angle (deg)	LS Factor
400	30	7.5%	0.5	4.3	1.97
250	70	28.0%	0.6	15.6	8.46
250	60	24.0%	0.6	13.5	7.18
400	120	30.0%	0.6	16.7	12.05
500	100	20.0%	0.6	11.3	8.90

Average LS = 7.71

The LS Factor was calculated by:

$LS = (Slope Length / 72.6)^m * (10.8 * \sin(slope\ angle) + 0.03)$ for Slopes < 9%

$LS = (Slope Length / 72.6)^m * (16.8 * \sin(slope\ angle) - 0.5)$ for Slopes > 9%

Where:

Slope < 3%	m = 0.3
Slope = 4%	m = 0.4
5% > Slope < 10%	m = 0.5
Slope > 10%	m = 0.6

COVER AND PRACTICE FACTORS:

Cover Type	Cover (%)	Canopy (%)	Area (acres)	Cover Factor, C	C*Area	Practice Factor, P	P*Area
Sagebrush-Grass	20%	25%	2.1	0.20	0.42	1.00	2.10
Pinyon Juniper	20%	25%	22.3	0.22	4.91	1.00	22.30
Disturbed	0%	0%	7.4	1.00	7.40	1.00	7.40
TOTAL:			31.8		12.73		31.80

Weighted C = Total C*Area/ Total Area = 0.400

Weighted P = Total P*Area/ Total Area = 1.000

RAINFALL FACTOR:

R = 40

PEABODY WESTERN COAL COMPANY
CALCULATED SEDIMENT YIELD

PROJECT: J21-E Pond

The following spreadsheet calculates the predicted sediment yield for the project area. The gross sediment yield is determined according to the Revised Universal Soil Loss Equation.

<u>PARAMETER DESCRIPTION</u>	<u>VALUE</u>
Annual Rainfall Factor	40.00
Soil Erodibility Factor	0.24
Length Slope Factor	7.71
Cover Factor	0.40
Practice Factor	1.00
Gross Annual Sediment Yield	30.00 tons/acre/year
Sediment Density	94.00 pcf
Gross Annual Sediment Yield	0.0147 acre-feet/acre/year
Sediment Delivery Ratio	90%
Estimated Annual Sediment Yield	0.0132 acre-feet/acre/year
Watershed Area	31.8 acres
Watershed Annual Sediment Yield	0.42 acre-feet/year
Number of years	1 years
Calculated Sediment Volume	0.42 acre-feet

J21-E Spillway
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	J21-E Spillway
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.031	
Channel Slope	0.021994	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	15.00	ft
Discharge	12.80	cfs

Results		
Depth	0.28	ft
Flow Area	4.39	ft ²
Wetted Perimeter	16.76	ft
Top Width	16.67	ft
Critical Depth	0.28	ft
Critical Slope	0.021996	ft/ft
Velocity	2.91	ft/s
Velocity Head	0.13	ft
Specific Energy	0.41	ft
Froude Number	1.00	
Flow is subcritical.		

SEDCAD+ RIPRAP CHANNEL DESIGN

J21-E

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	12.80 cfs	
Slope	30.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	15.00 feet	
Freeboard	None	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.18 ft
with Freeboard	0.00 ft
Top Width	16.09 ft
with Freeboard	15.00 ft
Velocity	4.55 fps
Cross Sectional Area	2.81 sq ft
Hydraulic Radius	0.17 ft
Manning's n	0.056
Froude Number	1.92
Dmax	0.313 ft (3.75 in)
D50	0.250 ft (3.00 in)
D10	0.083 ft (1.00 in)

APPENDIX B

SEDCAD+ (Input and Output) 10-Year, 24-Hour Storm Event

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

PEABODY WESTERN COAL COMPANY : POND J21-E (10 YEAR, 24-HR)

by

Name: D. GLEASON

Company Name: ACZ, INC.
File Name: J:\861\0400\J21-E10

Date: 12-17-1997

Company Name: ACZ, INC.

Filename: J:\861\0400\J21-E10 User: D. GLEASON

Date: 12-17-1997 Time: 07:08:39

PEABODY WESTERN COAL COMPANY : POND J21-E (10 YEAR, 24-HR)

Storm: 2.10 inches, 10 year-24 hour, SCS Type II

Hydrograph Convolution Interval: 0.1 hr

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SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

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-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base- Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	31.80	81	F	0.109	0.000	0.000	0.0	1.77	23.47
			Type: Null		Label: J21-E POND					
111	Structure	31.80							1.77	
111	Total IN/OUT	31.80							1.77	23.47

APPENDIX C

SEDCAD+ (Input and Output) 25-Year, 6-Hour Storm Event

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

PEABODY WESTERN COAL COMPANY : POND J21-E (25 YEAR, 6-HR)

by

Name: D. GLEASON

Company Name: ACZ, INC.
File Name: J:\861\0400\J21-E25

Date: 12-17-1997

Company Name: ACZ, INC.
 Filename: J:\861\0400\J21-E25 User: D. GLEASON
 Date: 12-17-1997 Time: 07:08:40
 PEABODY WESTERN COAL COMPANY : POND J21-E (25 YEAR, 6-HR)
 Storm: 1.90 inches, 25 year- 6 hour, SCS Type II
 Hydrograph Convolution Interval: 0.1 hr

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SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

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-Hydrology-

JBS SWS	Area (ac)	CN UHS	Tc (hrs)	K (hrs)	X	Base- Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111 1	31.80	81 F	0.109	0.000	0.000	0.0	1.44	29.39
		Type: Pond	Label: J21-E POND					
111 Structure	31.80						1.44	
111 Total IN	31.80						1.44	29.39
111 Total OUT							1.44	12.81

	Runoff Volume (ac-ft)	Peak Discharge (cfs)
IN	1.44	29.39
OUT	1.44	12.81

Peak Elevation	Hydrograph Detention Time (hrs)
6895.6	0.00

Company Name: ACZ, INC.
 Filename: J:\861\0400\J21-E25 User: D. GLEASON
 Date: 12-17-1997 Time: 07:08:40
 PEABODY WESTERN COAL COMPANY : POND J21-E (25 YEAR, 6-HR)
 Storm: 1.90 inches, 25 year- 6 hour, SCS Type II
 Hydrograph Convolution Interval: 0.1 hr

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 POND INPUT/OUTPUT TABLE
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J1, B1, S1
 J21-E POND

Drainage Area from J1, B1, S1, SWS(s)1: 31.8 acres
 Total Contributing Drainage Area: 31.8 acres

DISCHARGE OPTIONS:

Emergency
 Spillway

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 Riser Diameter (in) -----
 Riser Height (ft) -----
 Barrel Diameter (in) -----
 Barrel Length (ft) -----
 Barrel Slope (%) -----
 Manning's n of Pipe -----
 Spillway Elevation -----

 Lowest Elevation of Holes -----
 Elevation of Holes/Elevation -----

 Entrance Loss Coefficient -----
 Tailwater Depth (ft) -----

 Notch Angle (degrees) -----
 Weir Width (ft) -----

 Siphon Crest Elevation -----
 Siphon Tube Diameter (in) -----
 Siphon Tube Length (ft) -----
 Manning's n of Siphon -----
 Siphon Inlet Elevation -----
 Siphon Outlet Elevation -----

 Emergency Spillway Elevation 6895.0
 Crest Length (ft) 40.0
 Slope: 1 (Left and Right) 3 3
 Bottom Width (ft) 15.0

POND RESULTS:

Permanent
 Pool
 (ac-ft)

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 4.2

	Runoff Volume (ac-ft)	Peak Discharge (cfs)
IN	1.44	29.39
OUT	1.44	12.81

Peak Elevation	Hydrograph Detention Time (hrs)
6895.6	0.00

Company Name: ACZ, INC.

Filename: J:\861\0400\J21-E25 User: D. GLEASON

Date: 12-17-1997 Time: 07:08:40

PEABODY WESTERN COAL COMPANY : POND J21-E (25 YEAR, 6-HR)

Storm: 1.90 inches, 25 year- 6 hour, SCS Type II

Hydrograph Convolution Interval: 0.1 hr

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ELEVATION-AREA-CAPACITY-DISCHARGE TABLE

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J1, B1, S1
 J21-E POND

Drainage Area from J1, B1, S1, SWS(s)1: 31.8 acres
 Total Contributing Drainage Area: 31.8 acres

SW#1: Emergency Spillway

Elev	Stage (ft)	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	
5885.00	0.00	0.18	0.00	0.00	
5886.00	1.00	0.22	0.20	0.00	
5887.00	2.00	0.26	0.44	0.00	
5888.00	3.00	0.30	0.72	0.00	
5889.00	4.00	0.34	1.04	0.00	
5890.00	5.00	0.39	1.40	0.00	
5891.00	6.00	0.45	1.82	0.00	
5892.00	7.00	0.52	2.31	0.00	
5893.00	8.00	0.60	2.87	0.00	
5894.00	9.00	0.68	3.51	0.00	
5895.00	10.00	0.77	4.23	0.00	Stage of SW#1
5895.56	10.56	0.83	4.69	12.81	Peak Stage
5895.70	10.70	0.84	4.79	15.87	
5895.80	10.80	0.85	4.88	20.88	
5895.90	10.90	0.86	4.96	26.41	
5896.00	11.00	0.87	5.05	32.45	
5896.50	11.50	0.92	5.50	73.80	
5897.00	12.00	0.97	5.97	126.65	
5897.50	12.50	1.03	6.47	189.37	
5898.00	13.00	1.09	7.00	273.29	
