

APPENDIX E
J7-Jr TEMPORARY DIVERSION

PEABODY WESTERN – KAYENTA MINE

J-19 WEST AREA

TEMPORARY DIVERSION CHANNELS

PURPOSE: To provide runoff control from potential mine disturbance areas and to provide stable temporary diversion channels in the J-19 West area of the Kayenta Mine. The following channels have been included in this design submittal:

J-19 WEST AREA

- J19-E Diversion Channel, (see Exhibit #1, J19-E & J7-Jr Temporary Diversions)
- J7Jr Diversion Channel, (see Exhibit #1, J19-E & J7-Jr Temporary Diversions)

Design Parameters – Channels

To allow construction to be field-fitted for these temporary diversion channels, three alternative trapezoidal or triangular channels (Design A, Design B, or Design C) are recommended. The channel designs will vary based on channel slope and site conditions

The following design parameters are common to all temporary channel designs.

1. All designs are based on the 10-year, 6-hour precipitation event = 1.6 inches.
2. All areas are disturbed (mine, spoil, topsoil piles) or undisturbed. Curve numbers used include; mine = 90, spoil = 86, topsoil piles = 81(temp. reclaimed) and undisturbed = varies.

Note: The following applies to all channel designs:

1. Design selection will be field-fitted to complement the site conditions.
2. Sedcad4 Hydrology and Channel design outputs are attached.
3. If bedrock is encountered during excavation, Design C will not require the installation of riprap.
4. Minimum 20-ft length of ripraped or graveled channel between Design A and Designs B and C.
5. See Chapter 26 for terrace and down drain construction specifications.
6. Maximum slope design for graded spoil-lined channel limited by critical slope.
7. Depth of flow (d) based on minimum slope, Velocity (v) based on maximum slope.
8. Side-slopes will be a minimum of 2H: 1V. or flatter.

Design A: Earth/Graded Spoil-lined trapezoidal or triangular channel. This design will apply to slopes up to the calculated Critical slope.

Design B: Gravel-lined trapezoidal or triangular channel. This design will apply until a velocity of 6.0 fps is exceeded.

Design C: Riprap-lined trapezoidal or triangular channel. This design will apply for all subsequent slopes until a limiting velocity of 10.0 fps is exceeded.

Design summaries for the channels are shown on Table J19-1. Hydrology calculations for the channels are attached as Appendix A. Channel designs and critical slope calculations are attached as Appendix B.

**TABLE J19-1
J-19 Diversion Channel Summary**

Temporary Channel J19-E													
Typical Rip Rap Lined Channel													
Channel	Flow (Q) (cfs)	Slope (%)	Bottom Width (ft)	Side Slope H:1V (ft)	Depth Flow (ft)	Velocity (fps)	Free Board (ft)	Total Depth (ft)	Rip Rap (in)	Watershed (acres)	Time of Concentration (hr)	Curve Number	Design
J19-E	1.8	0.5 - 2.2	0	3	0.6	2.71	1	1.6	N/A	1.9	0.054	86	A
	1.8	2.3 - 18	0	3	0.5	5.96	1	1.5	Gravel				B
Q10/6	1.8	19 - 25	3	3	0.2	3.76	1	1.2	1.5				C

Design Flow: 10-year, 6-hour Storm

Temporary Channel J7Jr - Seg. 1													
Typical Rip Rap Lined Channel													
Channel	Flow (Q) (cfs)	Slope (%)	Bottom Width (ft)	Side Slope H:1V (ft)	Depth Flow (ft)	Velocity (fps)	Free Board (ft)	Total Depth (ft)	Rip Rap (in)	Watershed (acres)	Time of Concentration (hr)	Curve Number	Design
J7-Jr	16.3	0.5 - 1.7	0	3	1.4	4.27	1	2.4	N/A	26.5	0.192	84	A
Seg 1	16.3	1.8 - 4.2	0	3	1.1	5.99	1	2.1	Gravel				B
Q10/6	16.3	4.3 - 8.8	0	3	1.0	6.49	1	2.0	3				C
	16.3	8.9 - 30	0	3	0.9	8.17	1	1.9	6				C

Design Flow: 10-year, 6-hour Storm

Temporary Channel J7Jr - Seg. 2													
Typical Rip Rap Lined Channel													
Channel	Flow (Q) (cfs)	Slope (%)	Bottom Width (ft)	Side Slope H:1V (ft)	Depth Flow (ft)	Velocity (fps)	Free Board (ft)	Total Depth (ft)	Rip Rap (in)	Watershed (acres)	Time of Concentration (hr)	Curve Number	Design
J7-Jr	20	0.5 - 1.6	0	3	1.5	4.39	1	2.5	N/A	39.9	0.950	91	A
Seg 2	20	1.7 - 3.6	0	3	1.2	5.95	1	2.2	Gravel				B
Q10/6	20	3.7 - 7.3	0	3	1.1	6.50	1	2.1	3				C
	20	7.4 - 30	0	3	1.0	8.73	1	2.0	6				C

Design Flow: 10-year, 6-hour Storm

Peabody Western

Pond J7Jr

J19 West Diversion Channel - Seg. 1

10-year, 6-hour

djk

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**PEABODY WESTERN COAL COMPANY
CALCULATED HYDROLOGIC DATA**

PROJECT: J19 AREA

STRUCTURE: J7Jr Diversion Channel

TIME OF CONCENTRATION:

Start Elevation (ft) = 6895
 End Elevation (ft) = 6730
 Elevation Difference, E (ft) = 165

Watercourse Length (ft) = 3038
 Watercourse Length, L (mi) = 0.575

$T_c = (11.9L^3/E)^{0.385} =$ 0.192 hours

ROUTING PARAMETERS:

Between structure routing parameters were calculated using the SCS Upland Method in SEDCAD4. Input and output parameters are shown on the SEDCAD4 printouts in Appendices C.

SCS CURVE NUMBER:

Cover Type	Soil Group	Curve Number	Area (acres)	CN*Area
Pinyon Juniper	B	65	0	0
Pinyon Juniper	D	83	19.2	1593.6
Sagebrush	D	79	0	0
Disturbed - Mine		90	0	0
Disturbed - Spoil		86	7.3	627.8
Disturbed - TS Reclaimed	C	81	0	0
TOTAL:			26.5	2221.4

Weighted CN = Total CN*Area/ Total Area = 84

DRAINAGE BASIN AREA:

26.5 Acres

General Information

Storm Information:

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

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	26.500	26.500	16.30	1.05

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	26.500	0.192	0.000	0.000	84.000	F	16.30	1.051
	Σ	26.500						16.30	1.051

J7Jr Diversion Channel - Seg. 1

Material: Graded Spoil

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	3.0:1	0.5	0.0300	1.00			6.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	16.30 cfs	
Depth:	1.42 ft	2.42 ft
Top Width:	8.52 ft	14.52 ft
Velocity:	2.70 fps	
X-Section Area:	6.04 sq ft	
Hydraulic Radius:	0.673	
Froude Number:	0.56	

J7Jr Diversion Channel - Seg. 1

Material: Graded Spoil

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	3.0:1	1.7	0.0300	1.00			6.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	16.30 cfs	
Depth:	1.13 ft	2.13 ft
Top Width:	6.77 ft	12.77 ft
Velocity:	4.27 fps	
X-Section Area:	3.82 sq ft	
Hydraulic Radius:	0.535	
Froude Number:	1.00	

J7Jr Diversion Critical Slope
Worksheet for Triangular Channel

Project Description	
Project File	untitled.fm2
Worksheet	J19-E Div. Critical Slope
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.030
Channel Slope	0.017000 ft/ft
Left Side Slope	3.000000 H : V
Right Side Slope	3.000000 H : V
Discharge	16.30 cfs

Results	
Depth	1.13 ft
Flow Area	3.83 ft ²
Wetted Perimeter	7.14 ft
Top Width	6.78 ft
Critical Depth	1.13 ft
Critical Slope	0.017022 ft/ft
Velocity	4.26 ft/s
Velocity Head	0.28 ft
Specific Energy	1.41 ft
Froude Number	1.00
Flow is subcritical.	

J7Jr Diversion Channel - Seg. 1

Material: Gravel

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	3.0:1	1.8	0.0300	1.00			6.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	16.30 cfs	
Depth:	1.12 ft	2.12 ft
Top Width:	6.70 ft	12.70 ft
Velocity:	4.36 fps	
X-Section Area:	3.74 sq ft	
Hydraulic Radius:	0.529	
Froude Number:	1.03	

J7Jr Diversion Channel - Seg. 1

Material: Gravel

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	3.0:1	4.2	0.0300	1.00			6.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	16.30 cfs	
Depth:	0.95 ft	1.95 ft
Top Width:	5.71 ft	11.71 ft
Velocity:	5.99 fps	
X-Section Area:	2.72 sq ft	
Hydraulic Radius:	0.452	
Froude Number:	1.53	

J7Jr Diversion Channel - Seg. 1

Material: Riprap

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x. (VxD)
3.0:1	3.0:1	4.3	1.00		

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	16.30 cfs	
Depth:	1.04 ft	2.04 ft
Top Width:	6.21 ft	12.21 ft
Velocity:	5.06 fps	
X-Section Area:	3.22 sq ft	
Hydraulic Radius:	0.491	
Froude Number:	1.24	
Manning's n:	0.0380	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

J7Jr Diversion Channel - Seg. 1

Material: Riprap

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	8.8	1.00		

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	16.30 cfs	
Depth:	0.91 ft	1.91 ft
Top Width:	5.49 ft	11.49 ft
Velocity:	6.49 fps	
X-Section Area:	2.51 sq ft	
Hydraulic Radius:	0.434	
Froude Number:	1.69	
Manning's n:	0.0390	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

J7Jr Diversion Channel - Seg. 1

Material: Riprap

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	8.9	1.00		

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	16.30 cfs	
Depth:	0.91 ft	1.91 ft
Top Width:	5.48 ft	11.48 ft
Velocity:	6.52 fps	
X-Section Area:	2.50 sq ft	
Hydraulic Radius:	0.433	
Froude Number:	1.70	
Manning's n:	0.0390	
Dmin:	3.00 in	
D50:	6.00 in	
Dmax:	9.00 in	

J7Jr Diversion Channel - Seg. 1

Material: Riprap

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	30.0	1.00		

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	16.30 cfs	
Depth:	0.82 ft	1.82 ft
Top Width:	4.89 ft	10.89 ft
Velocity:	8.17 fps	
X-Section Area:	1.99 sq ft	
Hydraulic Radius:	0.387	
Froude Number:	2.26	
Manning's n:	0.0530	
Dmin:	3.00 in	
D50:	6.00 in	
Dmax:	9.00 in	

Peabody Western
Pond J7Jr

J19 West Diversion Channel - Seg. 2

10-year, 6-hour

djk

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**PEABODY WESTERN COAL COMPANY
CALCULATED HYDROLOGIC DATA**

PROJECT: J19 AREA

STRUCTURE: J7Jr Diversion Channel - Seg 2

TIME OF CONCENTRATION:

Start Elevation (ft) = 6825
 End Elevation (ft) = 6715
 Elevation Difference, E (ft) = 110

Watercourse Length (ft) = 1442
 Watercourse Length, L (mi) = 0.273

$T_c = (11.9L^3/E)^{0.385} =$ 0.095 hours

ROUTING PARAMETERS:

Between structure routing parameters were calculated using the SCS Upland Method in SEDCAD4. Input and output parameters are shown on the SEDCAD4 printouts in Appendices C.

SCS CURVE NUMBER:

Cover Type	Soil Group	Curve Number	Area (acres)	CN*Area
Pinyon Juniper	B	65	0	0
Pinyon Juniper	D	83	0	0
Sagebrush	D	79	0	0
Disturbed - Mine		90	0	0
Disturbed - Spill		86	0	0
Disturbed - TS	C	90	13.4	1206
TOTAL:			13.4	1206

Weighted CN = Total CN*Area/ Total Area = 90

DRAINAGE BASIN AREA:

13.4 Acres

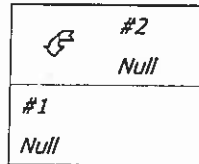
General Information

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	Design Peak Flow
Null	#2	==>	#1	0.077	0.347	



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	7. Paved area and small upland gullies	3.71	40.00	1,078.00	3.87	0.077
#2	Muskingum K:					0.077

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	26.500	26.500	16.30	1.05
#1	13.400	39.900	19.96	1.90

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)
#2	1	26.500	0.192	0.000	0.000	84.000	F	16.30	1.051
	∑	26.500						16.30	1.051
#1	1	13.400	0.950	0.000	0.000	90.000	F	6.76	0.852
	∑	39.900						19.96	1.902

J7Jr Diversion Channel - Seg. 2

Material: Graded Spoil

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	3.0:1	0.5	0.0300	1.00			6.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	20.00 cfs	
Depth:	1.53 ft	2.53 ft
Top Width:	9.19 ft	15.19 ft
Velocity:	2.84 fps	
X-Section Area:	7.04 sq ft	
Hydraulic Radius:	0.727	
Froude Number:	0.57	

J7Jr Diversion Channel - Seg. 2

Material: Graded Spoil

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	3.0:1	1.6	0.0300	1.00			6.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	20.00 cfs	
Depth:	1.23 ft	2.23 ft
Top Width:	7.39 ft	13.39 ft
Velocity:	4.39 fps	
X-Section Area:	4.55 sq ft	
Hydraulic Radius:	0.584	
Froude Number:	0.99	

J7Jr Seg 2 Diversion Critical Slope
Worksheet for Triangular Channel

Project Description	
Project File	untitled.fm2
Worksheet	J7Jr Seg2 Cr Slope
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.030
Channel Slope	0.016565 ft/ft
Left Side Slope	3.000000 H : V
Right Side Slope	3.000000 H : V
Discharge	20.00 cfs

Results	
Depth	1.23 ft
Flow Area	4.50 ft ²
Wetted Perimeter	7.75 ft
Top Width	7.35 ft
Critical Depth	1.23 ft
Critical Slope	0.016565 ft/ft
Velocity	4.44 ft/s
Velocity Head	0.31 ft
Specific Energy	1.53 ft
Froude Number	1.00
Flow is supercritical.	

J7Jr Diversion Channel - Seg. 2

Material: Gravel

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	3.0:1	1.7	0.0300	1.00			6.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	20.00 cfs	
Depth:	1.22 ft	2.22 ft
Top Width:	7.31 ft	13.31 ft
Velocity:	4.49 fps	
X-Section Area:	4.45 sq ft	
Hydraulic Radius:	0.578	
Froude Number:	1.01	

J7Jr Diversion Channel - Seg. 2

Material: Gravel

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	3.0:1	3.6	0.0300	1.00			6.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	20.00 cfs	
Depth:	1.06 ft	2.06 ft
Top Width:	6.35 ft	12.35 ft
Velocity:	5.95 fps	
X-Section Area:	3.36 sq ft	
Hydraulic Radius:	0.502	
Froude Number:	1.44	

J7Jr Diversion Channel - Seg. 2

Material: Riprap

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	3.7	1.00		

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	20.00 cfs	
Depth:	1.14 ft	2.14 ft
Top Width:	6.83 ft	12.83 ft
Velocity:	5.14 fps	
X-Section Area:	3.89 sq ft	
Hydraulic Radius:	0.540	
Froude Number:	1.20	
Manning's n:	0.0370	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

J7Jr Diversion Channel - Seg. 2

Material: Riprap

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	7.3	1.00		

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	20.00 cfs	
Depth:	1.01 ft	2.01 ft
Top Width:	6.08 ft	12.08 ft
Velocity:	6.50 fps	
X-Section Area:	3.08 sq ft	
Hydraulic Radius:	0.480	
Froude Number:	1.61	
Manning's n:	0.0380	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

J7Jr Diversion Channel - Seg. 2

Material: Riprap

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	7.4	1.00		

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	20.00 cfs	
Depth:	1.01 ft	2.01 ft
Top Width:	6.06 ft	12.06 ft
Velocity:	6.53 fps	
X-Section Area:	3.06 sq ft	
Hydraulic Radlus:	0.479	
Froude Number:	1.62	
Manning's n:	0.0380	
Dmin:	3.00 in	
D50:	6.00 in	
Dmax:	9.00 in	

J7Jr Diversion Channel - Seg. 2

Material: Riprap

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	30.0	1.00		

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	20.00 cfs	
Depth:	0.87 ft	1.87 ft
Top Width:	5.24 ft	11.24 ft
Velocity:	8.73 fps	
X-Section Area:	2.29 sq ft	
Hydraulic Radius:	0.415	
Froude Number:	2.33	
Manning's n:	0.0520	
Dmin:	3.00 in	
D50:	6.00 in	
Dmax:	9.00 in	