APPENDIX 11-Z
Miscellaneous Hydrologic Structures

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BHP Minerals Navajo Mine
Project NM-0003D-I-35 [CP-2 Embankment]
CP-2 Impoundment

1. Proposal

BHP Minerals International, Inc., Navajo Mine hereby submits the proposed installation of a drainage channel from the CP-2 impoundment to the CP-2 culvert. The proposed channel addition will eliminate and detour any water that has collected against the existing railroad embankment to CP-2 culvert.

2. Discussion

2.1 Reason for the proposal

The Office of Surface Mining Albuquerque Field Office (OSM/AFO) did an on-site inspection in June of 1994. The inspection revealed a small impoundment to the N.E. of CP-2 which is now referred to as CP-2 impoundment. The final result of the inspection stated that the total impoundment area was not included within the permit area as required by 30 CFR 773.17(a). A deficiency letter dated June 24, 1994, was sent to BHP from the office of OSM Western Regional Coordinating Center (WRCC) requesting BHP to correct the problem.

2.2 Background to proposal

The propose location of the drainage channel is shown on the attached 8.5" X 11" (copied from EXHIBIT 11-12) drawing. Several concepts were discussed an installing a drainage channel from the impoundment to the culvert CP-2 was agree on with OSM/AFO official and BHP - O.J. Estrada. Additional discussions have been held between the permittee and BHP. All parities are agreeable to the concept. The drainage channel would run parallel with the railroad tracks.

2.3 Drainage

Culvert information for CP-2 is provided on TABLE 11-13 (see CHAPTER 11, page 11-136), and the corresponding watershed are shown in EXHIBIT 11-12 (8.5" X 11" sketch attached). The present watershed configuration for the area of CP-2 will increase from 79.5 acres to 133.5 as noted by the delineation of the watersheds for CP-2.

2.4 Channel Design

The drainage channel will have a gradual slope of approximately .4% from north to south. The grade of channel will come on top of grade at the south end of the channel. The terrain between the impoundment and CP-2 culvert shows signs of sandstone, more so at the south end of the location.

The south end of the proposed drainage channel will stop at approximately 44' from CP-2 culvert, this is due to the elevation change and the existing terrain. Drainage water will have a natural flow atop of sandstone into CP-2 inlet culvert. CP-2 culvert was checked for capacity and adequacy for a peak discharge from a 10-yr, 6-hr event. The peak flow discharge was determined with the SEDCAD+ computer program and also the channel design (attached). Due to the sandstone in the area rip-rap inside the channel will not be required.

3. Reference

Upon approval, the 8.5" X 11" proposed copy will be added to the current EXHIBIT 11-12, "Location of Ponds, Impoundments, and Culverts" and be resubmitted for insertion into the permit.

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP2 CULVERT

by

Name: ET

Company Name: BHP MINERALS
File Name: C:\SEDCAD3\CP2CULV

Date: 08-07-1995

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\SEDCAD3\CP2CULV User: ET
Date: 08-07-1995 Time: 12:24:00
CP2 CULVERT
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

GENERAL INPUT TABLE

STORM #1:

User-Defined Distribution

Label: Type II-60

	Accumulated Time (hrs)	Accumulated Dimensionless Depth
1	0.0	0.000
2	0.5	0.006
3	1.0	0.013
4	1.5	0.021
5	2.0	0.029
6	2.5	0.039
7	3.0	0.049
8	3.5	0.062
9	4.0	0.076
10	4.5	0.094
11	5.0	0.118
12	5.5	0.156
13	6.0	0.672
14	6.5	0.756
15	7.0	0.789
16	7.5	0.810
17	8.0	0.826
18	8.5	0.837
19	9.0	0.849
20	9.5	0.858
21	10.0	0.867
22	10.5	0.874
23	11.0	0.882
24	11.5	0.888
25	12.0	0.895
26	12.5	0.900
27	13.0	0.906
28	13.5	0.911
29	14.0	0.917
30	14.5	0.922
31	15.0	0.927
32	15.5	0.932
33	16.0	0.937
34	16.5	0.941
35	17.0	0.946
36	17.5	0.950
37	18.0	0.955

38	18.5	0.959
39	19.0	0.963
40	19.5	0.967
41	20.0	0.971
42	20.5	0.975
43	21.0	0.978
44	21.5	0.982
45	22.0	0.986
46	22.5	0.990
47	23.0	0.993
48	23.5	0.997
49	24.0	1.000

****

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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\CP2CULV User: ET
Date: 08-07-1995 Time: 12:24:00
CP2 CULVERT
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	54.00	89	M	0.399	0.000	0.000	0.0	2.18	26.29
111	2	79.50	89	M	0.205	0.000	0.000	0.0	3.21	52.21
111 Structure		133.50	Type: Null		Label: cp2 culvert				5.39	
111 Total IN/OUT		133.50							5.39	76.61

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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\CP2CULV User: ET
Date: 08-07-1995 Time: 12:24:00
CP2 CULVERT
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2884.00	4.02	2.01	0.40	0.399		
1	1	1	2	-a	5	2400.00	10.54	3.25	0.21	0.205		

SEDCAD+ CULVERT SIZING UTILITY

cp2 culvert

Design Discharge	=	76.610 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	183.000 feet
Pipe Slope	=	3.200 %
Manning's n	=	0.016
Maximum Headwater	=	8.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 36 inches

PERFORMANCE CURVES:

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	3.00	Inlet (Supercritical)	3
1.60	8.48	Inlet (Supercritical)	3
2.40	15.40	Inlet (Supercritical)	4
3.20	20.73	Inlet	5
4.00	25.01	Inlet	5
4.80	28.64	Inlet	5
5.60	31.87	Inlet	5
6.40	34.81	Inlet	5
7.20	37.49	Inlet	5
8.00	39.52	Outlet	6
8.80	40.80	Outlet	6
9.60	42.04	Outlet	6
10.40	43.25	Outlet	6
11.20	44.42	Outlet	6
12.00	45.56	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	3.75	Inlet (Supercritical)	3
1.60	10.60	Inlet (Supercritical)	3
2.40	19.46	Inlet (Supercritical)	3
3.20	28.89	Inlet	5
4.00	36.21	Inlet	5
4.80	42.29	Inlet	5
5.60	47.60	Inlet	5
6.40	52.37	Inlet	5
7.20	56.75	Inlet	5
8.00	60.81	Inlet	5
8.80	64.61	Inlet	5
9.60	68.20	Inlet	5
10.40	71.62	Inlet	5
11.20	74.88	Inlet	5
12.00	77.55	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	4.50	Inlet (Supercritical)	3
1.60	12.72	Inlet (Supercritical)	3
2.40	23.36	Inlet (Supercritical)	3
3.20	35.96	Inlet (Supercritical)	3
4.00	47.70	Inlet	5
4.80	57.14	Inlet	5
5.60	65.23	Inlet	5
6.40	72.41	Inlet	5
7.20	78.95	Inlet	5
8.00	84.99	Inlet	5
8.80	90.62	Inlet	5
9.60	95.92	Inlet	5
10.40	100.96	Inlet	5
11.20	105.74	Inlet	5
12.00	110.32	Inlet	5

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	5.25	Inlet (Supercritical)	3
1.60	14.83	Inlet (Supercritical)	3
2.40	27.25	Inlet (Supercritical)	3
3.20	41.95	Inlet (Supercritical)	3
4.00	58.63	Inlet (Supercritical)	3
4.80	72.28	Inlet	5
5.60	84.01	Inlet	5
6.40	94.29	Inlet	5
7.20	103.55	Inlet	5
8.00	112.06	Inlet	5
8.80	119.96	Inlet	5
9.60	127.37	Inlet	5
10.40	134.37	Inlet	5
11.20	141.03	Inlet	5
12.00	147.39	Inlet	5

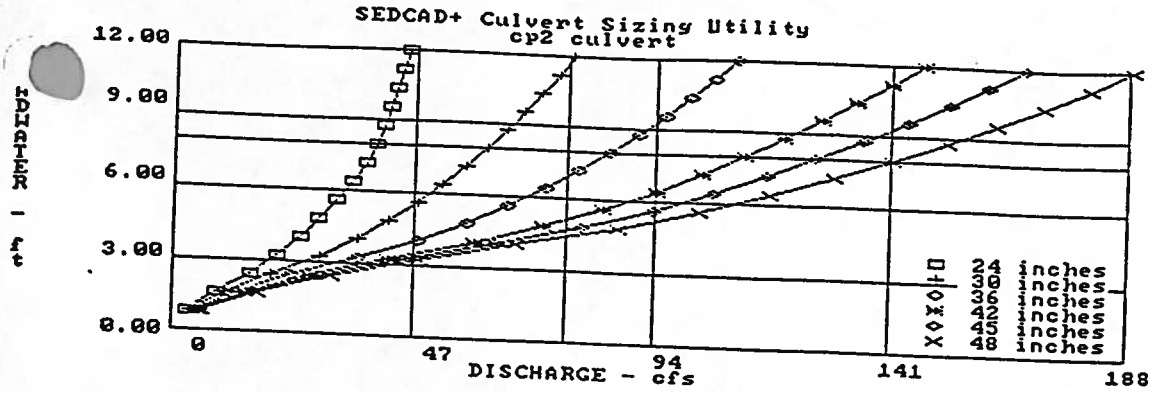
Diameter: 45 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	5.63	Inlet (Supercritical)	3
1.60	15.89	Inlet (Supercritical)	3
2.40	29.20	Inlet (Supercritical)	3
3.20	44.95	Inlet (Supercritical)	3
4.00	62.82	Inlet (Supercritical)	3
4.80	79.63	Inlet	5
5.60	93.58	Inlet	5
6.40	105.70	Inlet	5
7.20	116.57	Inlet	5
8.00	126.51	Inlet	5

8.80	135.72	Inlet	5
9.60	144.35	Inlet	5
10.40	152.48	Inlet	5
11.20	160.21	Inlet	5
12.00	167.58	Inlet	5

Diameter: 48 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	5.99	Inlet (Supercritical)	3
1.60	16.95	Inlet (Supercritical)	3
2.40	31.14	Inlet (Supercritical)	3
3.20	47.95	Inlet (Supercritical)	3
4.00	67.00	Inlet (Supercritical)	3
4.80	86.75	Inlet	5
5.60	103.12	Inlet	5
6.40	117.30	Inlet	5
7.20	129.95	Inlet	5
8.00	141.47	Inlet	5
8.80	152.12	Inlet	5
9.60	162.08	Inlet	5
10.40	171.45	Inlet	5
11.20	180.34	Inlet	5
12.00	188.82	Inlet	5


SEDCAD+ Culvert Sizing Utility
cp2 culvert
HEADWATER - ft
12.00
9.00
6.00
3.00
0.00
0
47
94
141
188
DISCHARGE - cfs
24 inches
30 inches
36 inches
42 inches
45 inches
48 inches

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

RAILROAD SIDE DITCH/CHANNEL AT CP-2

by

Name: ET

Company Name: BHP MINERALS
File Name: C:\SEDCAD\CP2CHAN

Date: 08-07-1995

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\SEDCAD\CP2CHAN User: ET
Date: 08-07-1995 Time: 12:44:01
RAILROAD SIDE DITCH/CHANNEL AT CP-2
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

==========
GENERAL INPUT TABLE
==========

STORM #1:

User-Defined Distribution

Label: Type II-60

	Accumulated Time (hrs)	Accumulated Dimensionless Depth
1	0.0	0.000
2	0.5	0.006
3	1.0	0.013
4	1.5	0.021
5	2.0	0.029
6	2.5	0.039
7	3.0	0.049
8	3.5	0.062
9	4.0	0.076
10	4.5	0.094
11	5.0	0.118
12	5.5	0.156
13	6.0	0.672
14	6.5	0.756
15	7.0	0.789
16	7.5	0.810
17	8.0	0.826
18	8.5	0.837
19	9.0	0.849
20	9.5	0.858
21	10.0	0.867
22	10.5	0.874
23	11.0	0.882
24	11.5	0.888
25	12.0	0.895
26	12.5	0.900
27	13.0	0.906
28	13.5	0.911
29	14.0	0.917
30	14.5	0.922
31	15.0	0.927
32	15.5	0.932
33	16.0	0.937
34	16.5	0.941
35	17.0	0.946
36	17.5	0.950
37	18.0	0.955

38	18.5	0.959
39	19.0	0.963
40	19.5	0.967
41	20.0	0.971
42	20.5	0.975
43	21.0	0.978
44	21.5	0.982
45	22.0	0.986
46	22.5	0.990
47	23.0	0.993
48	23.5	0.997
49	24.0	1.000

****

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Company Name: BHP MINERALS
Filename: C:\SEDCAD\CP2CHAN User: ET
Date: 08-07-1995 Time: 12:44:01
RAILROAD SIDE DITCH/CHANNEL AT CP-2
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	54.00	89	M	0.399	0.000	0.000	0.0	2.18	26.29
		Type: Null			Label: channel					
111	Structure	54.00							2.18	
111	Total IN/OUT	54.00							2.18	26.29

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\SEDCAD\CP2CHAN User: ET
Date: 08-07-1995 Time: 12:44:01
RAILROAD SIDE DITCH/CHANNEL AT CP-2
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2884.00	4.02	2.01	0.40	0.399		

SEDCAD+ ERODIBLE CHANNEL DESIGN

RAILROAD SIDE DITCH/CHANNEL AT CP-2

Limiting Velocity Technique
Sediment-laden Water

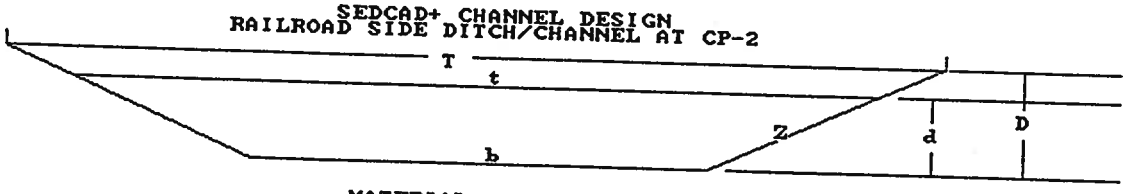
INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	26.30 cfs	
Slope	0.40 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	15.00 ft	
Manning's n	0.025	
Max. Velocity	6.00 fps	
Material	SANDSTONE	
Freeboard	1 ft	

RESULTS:

Actual Discharge	26.30 cfs
Depth	0.62 ft
with Freeboard	1.62 ft
Top Width	17.50 ft
with Freeboard	21.50 ft
Velocity	2.59 fps
Cross Sectional Area	10.15 sq ft
Hydraulic Radius	0.57 ft
Froude Number	0.60

SEDCAD+ CHANNEL DESIGN
RAILROAD SIDE DITCH/CHANNEL AT CP-2



MATERIAL: SANDSTONE
Limiting Variable: Velocity = 6.000 fps
Sediment-laden Water

Discharge	=	26.30 cfs	Depth (d)	=	0.62	(D = 1.62) ft
Bottom (b)	=	15.00 ft	Top width (t)	=	17.50	(T = 21.50) ft
Side slopes (Z)	=	2.0:1(L) 2.0:1(R)	Velocity	=	2.59 fps	
Bed Slope	=	0.40 %	Hydraulic Radius	=	0.57 ft	
Manning's n	=	0.025	Froude number	=	0.60	

w/ Freeboard:

Area III Shop Temporary Diversion

Design:

The temporary diversion ditch is located on the eastern edge of the lease line at the Area III facilities. The ditch is designed for a 2 yr. - 6 hr storm event. The purpose of the berm/embankment is to divert surface runoff from a 602.3 ac watershed that is presently flowing through CP-36 (into the Area III Shop Pond) and route the runoff through CP-35. The combined watershed diverted to CP-35 is 662.4 ac. The ditch is an approximately 3 ft. berm with side slopes ranging from 1.5/1.0 to 3/1. Two additional 24" culverts were added at CP-35 to accommodate the additional flow.

A 3.0 ac watershed associated with the southern end of the diversion is itemized because it represents the amount of runoff to which the southern end of the diversion would be exposed. The diversion channel is not riprapped and a summary of the hydrology and design data is provided below. The design data in conjunction with EXHIBIT 11-116, provide justification for the unarmored channel. The southern end of the ditch from station 0 + 00 to 6 + 00 will have an insignificant amount of flow due to the small watershed, therefore no riprap will be required in this area.

	Channel Slope	Erosive Velocity	Flow Velocity	Riprap Required	Minimum Depth of Channel
Station 4 + 91 to 6 + 71	2.72 %	3.5 fps	2.51 fps	No	0.70 ft
Station 6 + 71 to 7 + 35	2.23 %	3.5 fps	2.24 fps	No	0.68 ft
Station 7 + 35 to 13 + 22	1.00 %	5.0 fps	3.54 fps	No	1.67 ft

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

2YR-6HR FOR BERM FOR CP-36 DITCH

by

Name: bts

Company Name: BHP MINERALS
File Name: C:\BRIAN\TEST

Date: 02-16-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\TEST
User: bts
Date: 02-16-1996 Time: 15:20:51
2yr-6hr for berm for cp-36 ditch
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharg (cfs)
111	1	602.30	89	M	2.787	0.000	0.000	0.0	8.57	26.41
111 Structure		Type: Null 602.30			Label: Area III Temp Div					
111 Total IN/OUT		602.30							8.57	
									8.57	26.41

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\TEST
User: bts
Date: 02-16-1996 Time: 15:20:51
2yr-6hr for berm for cp-36 ditch
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingu K (hr)
1	1	1	1	-a	5	12000.00	1.43	1.20	2.79	2.787	

BHP MINERALS
NAVAJO MINE

22-Apr-96

PROJECT: Area III Shop Temporary Diversion
ENGINEER BTS
FILE NO :
DRWG NO Exhibit 11-116

Channel Design

Precipitation Event:	2yr-6hr		
Design Flow	Q10	26.41	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	3.00	
(Z2:1)	Z2 =	5.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	1.00	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.25	0.12	0.28	1.13
0.50	1.00	0.24	1.80	1.80
0.75	2.25	0.36	5.31	2.36
1.00	4.00	0.48	11.46	2.86
1.25	6.25	0.61	20.79	3.33
1.50	9.00	0.73	33.82	3.76
1.75	12.25	0.85	51.05	4.17
2.00	16.00	0.97	72.91	4.56
2.25	20.25	1.09	99.86	4.93
2.50	25.00	1.21	132.30	5.29
2.75	30.25	1.33	170.64	5.64
3.00	36.00	1.45	215.26	5.98
3.25	42.25	1.57	266.55	6.31
3.50	49.00	1.69	324.87	6.63
3.75	56.25	1.82	390.59	6.94
4.00	64.00	1.94	464.04	7.25
4.25	72.25	2.06	545.57	7.55

Flow Depth at Peak Discharge	1.37 Ft
Minimum Channel Depth Required	1.67 Ft
Critical Depth	1.23 Ft
Flow Type	Subcritical flow
Froude Number	0.53
Flow Velocity	3.54 fps
Soil Type: Clay	
Erosive Velocity	5.00 fps

Flow Velocity Is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

2YR-6HR FOR BERM FOR CP-36 DITCH

by

Name: bts

Company Name: BHP MINERALS
File Name: C:\BRIAN\TEST

Date: 02-16-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\TEST
User: bts
Date: 02-16-1996 Time: 15:18:49
2yr-6hr for berm for cp-36 ditch
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingu K (hr)
1	1	1	1	-a	5	750.00	4.53	2.13	0.10	0.097	

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\TEST
User: bts
Date: 02-16-1996 Time: 15:18:49
2yr-6hr for berm for cp-36 ditch
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharg (cfs)
111 1	3.00	89	M	0.097	0.000	0.000	0.0	0.04	1.29
111 Structure	Type: Null Label: Area III Temp Div 3.00								
111 Total IN/OUT	3.00							0.04	
								0.04	1.29

BHP MINERALS
NAVAJO MINE

22-Apr-96

PROJECT: Area III Shop Temporary Diversion
ENGINEER BTS
FILE NO :
DRWG NO Exhibit 11-116

Channel Design

Precipitation Event:	2yr-6hr		
Design Flow	Q10	1.29	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	1.50	
(Z2:1)	Z2 =	5.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	2.72	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.20	0.12	0.37	1.83
0.50	0.81	0.24	2.37	2.91
0.75	1.83	0.35	6.99	3.82
1.00	3.25	0.47	15.07	4.64
1.25	5.08	0.59	27.34	5.38
1.50	7.31	0.71	44.49	6.08
1.75	9.95	0.82	67.14	6.75
2.00	13.00	0.94	95.90	7.38
2.25	16.45	1.06	131.34	7.98
2.50	20.31	1.18	174.00	8.57
2.75	24.58	1.29	224.43	9.13
3.00	29.25	1.41	283.12	9.68
3.25	34.33	1.53	350.58	10.21
3.50	39.81	1.65	427.29	10.73
3.75	45.70	1.77	513.72	11.24
4.00	52.00	1.88	610.33	11.74
4.25	58.70	2.00	717.56	12.22

Flow Depth at Peak Discharge	0.40	Ft
Minimum Channel Depth Required	0.70	Ft
Critical Depth	0.40	Ft
Flow Type	Subcritical flow	
Froude Number	0.70	
Flow Velocity	2.51	fps
Soil Type: Sandy Clay		
Erosive Velocity	3.50	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

BHP MINERALS
NAVAJO MINE

22-Apr-96

PROJECT: Area III Shop Temporary Diversion
ENGINEER BTS
FILE NO :
DRWG NO Exhibit 11-116

Channel Design

Precipitation Event:	2yr-6hr		
Design Flow	Q10	1.29	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	3.00	
(Z2:1)	Z2 =	5.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	2.23	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.25	0.12	0.42	1.69
0.50	1.00	0.24	2.69	2.69
0.75	2.25	0.36	7.94	3.53
1.00	4.00	0.48	17.11	4.28
1.25	6.25	0.61	31.04	4.97
1.50	9.00	0.73	50.51	5.61
1.75	12.25	0.85	76.23	6.22
2.00	16.00	0.97	108.88	6.81
2.25	20.25	1.09	149.12	7.36
2.50	25.00	1.21	197.56	7.90
2.75	30.25	1.33	254.81	8.42
3.00	36.00	1.45	321.46	8.93
3.25	42.25	1.57	398.05	9.42
3.50	49.00	1.69	485.14	9.90
3.75	56.25	1.82	583.27	10.37
4.00	64.00	1.94	692.96	10.83
4.25	72.25	2.06	814.71	11.28

Flow Depth at Peak Discharge	0.38	Ft
Minimum Channel Depth Required	0.68	Ft
Critical Depth	0.37	Ft
Flow Type	Subcritical flow	
Froude Number	0.64	
Flow Velocity	2.24	fps
Soil Type: Sandy Clay		
Erosive Velocity	3.50	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

Pages 29 – 124 Appendix 11-Z

Blank due to Removal of Area III Dragline Erection Site

BHP MINERALS
NAVAJO MINE

07-Aug-97

PROJECT: A-III TEMPORARY DIVERSION AS-BUILT HYDROLOGY
ENGINEER: BEN HOSKIE
FILE NO :
DRWG NO : EXHIBIT 11-116A
MMD REF:

Channel Design: STA 6+00

Precipitation Event:	2YR 6HR		
Design Flow	Q10	1.29	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	1.50	
(Z2:1)	Z2 =	5.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	2.28	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.20	0.12	0.34	1.68
0.50	0.81	0.24	2.17	2.67
0.75	1.83	0.35	6.40	3.50
1.00	3.25	0.47	13.80	4.24
1.25	5.08	0.59	25.03	4.93
1.50	7.31	0.71	40.73	5.57
1.75	9.95	0.82	61.47	6.18
2.00	13.00	0.94	87.80	6.75
2.25	16.45	1.06	120.25	7.31
2.50	20.31	1.18	159.31	7.84
2.75	24.58	1.29	205.48	8.36
3.00	29.25	1.41	259.21	8.86
3.25	34.33	1.53	320.98	9.35
3.50	39.81	1.65	391.21	9.83
3.75	45.70	1.77	470.34	10.29
4.00	52.00	1.88	558.78	10.75
4.25	58.70	2.00	656.97	11.19

Flow Depth at Peak Discharge	0.42	Ft
Minimum Channel Depth Required	0.72	Ft
Critical Depth	0.40	Ft
Flow Type	Subcritical flow	
Froude Number	0.65	
Flow Velocity	2.37	fps
Soil Type: CLAY		
Erosive Velocity	5.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference:
1. Hydraulic Engineering Circular No. 15;
   Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
   Chapter 3: B.J. Barfield and R.C. Warner
   University of Kentucky

BHP MINERALS
NAVAJO MINE

07-Aug-97

PROJECT: A-III TEMPORARY DIVERSION AS-BUILT HYDROLOGY
ENGINEER: BEN HOSKIE
FILE NO :
DRWG NO : EXHIBIT 11-116A
MMD REF.

Channel Design: @ STA 8+00

Precipitation Event:	2YR-6HR		
Design Flow	Q10	26.41	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	2.00	
(Z2:1)	Z2 =	4.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	1.44	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.19	0.12	0.25	1.33
0.50	0.75	0.24	1.59	2.12
0.75	1.69	0.35	4.70	2.79
1.00	3.00	0.47	10.13	3.38
1.25	4.69	0.59	18.39	3.92
1.50	6.75	0.71	29.92	4.43
1.75	9.19	0.83	45.15	4.91
2.00	12.00	0.94	64.49	5.37
2.25	15.19	1.06	88.32	5.82
2.50	18.75	1.18	117.01	6.24
2.75	22.69	1.30	150.92	6.65
3.00	27.00	1.42	190.39	7.05
3.25	31.69	1.53	235.75	7.44
3.50	36.75	1.65	287.34	7.82
3.75	42.19	1.77	345.46	8.19
4.00	48.00	1.89	410.42	8.55
4.25	54.19	2.00	482.54	8.90

Flow Depth at Peak Discharge	1.44	Ft
Minimum Channel Depth Required	1.74	Ft
Critical Depth	1.37	Ft
Flow Type	Subcritical flow	
Froude Number	0.63	
Flow Velocity	4.31	fps
Soil Type: CLAY		
Erosive Velocity	5.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference:
1. Hydraulic Engineering Circular No. 15;
   Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
   Chapter 3; B.J. Barfield and R.C. Warner
   University of Kentucky

BHP MINERALS
NAVAJO MINE

07-Aug-97

PROJECT: A-III TEMPORARY DIVERSION AS-BUILT HYDROLOGY
ENGINEER: BEN HOSKIE
FILE NO :
DRWG NO : EXHIBIT 11-116A
MMD REF.

Channel Design: @ STA 10+00

Precipitation Event:	2YR-6HR		
Design Flow	Q10	26.41	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	1.50	
(Z2:1)	Z2 =	4.60	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	1.19	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.19	0.12	0.23	1.21
0.50	0.76	0.23	1.47	1.92
0.75	1.72	0.35	4.33	2.52
1.00	3.05	0.47	9.34	3.06
1.25	4.77	0.59	16.94	3.56
1.50	6.86	0.70	27.57	4.02
1.75	9.34	0.82	41.60	4.45
2.00	12.20	0.94	59.42	4.87
2.25	15.44	1.05	81.38	5.27
2.50	19.06	1.17	107.82	5.66
2.75	23.07	1.29	139.07	6.03
3.00	27.45	1.41	175.44	6.39
3.25	32.22	1.52	217.24	6.74
3.50	37.36	1.64	264.77	7.09
3.75	42.89	1.76	318.33	7.42
4.00	48.80	1.87	378.19	7.75
4.25	55.09	1.99	444.64	8.07

Flow Depth at Peak Discharge	1.48	Ft
Minimum Channel Depth Required	1.78	Ft
Critical Depth	1.37	Ft
Flow Type	Subcritical flow	
Froude Number	0.58	
Flow Velocity	3.98	fps
Soil Type: CLAY		
Erosive Velocity	5.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference:
1. Hydraulic Engineering Circular No. 15;
   Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
   Chapter 3; B.J. Barfield and R.C. Warner
   University of Kentucky

BHP MINERALS
NAVAJO MINE

07-Aug-97

PROJECT. A-III TEMPORARY DIVERSION AS-BUILT HYDROLOGY
ENGINEER. BEN HOSKIE
FILE NO :
DRWG NO : EXHIBIT 11-116A
MMD REF.

Channel Design: WORST CASE SCENARIO STA. 6+00 TO 13+23.69

Precipitation Event:	2YR-6HR		
Design Flow	Q10	26.41	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	1.50	
(Z2:1)	Z2 =	4.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	1.44	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.17	0.12	0.23	1.32
0.50	0.69	0.23	1.44	2.10
0.75	1.55	0.35	4.26	2.75
1.00	2.75	0.46	9.19	3.34
1.25	4.30	0.58	16.67	3.88
1.50	6.19	0.70	27.12	4.38
1.75	8.42	0.81	40.93	4.86
2.00	11.00	0.93	58.47	5.32
2.25	13.92	1.04	80.07	5.75
2.50	17.19	1.16	106.09	6.17
2.75	20.80	1.28	136.83	6.58
3.00	24.75	1.39	172.61	6.97
3.25	29.05	1.51	213.74	7.36
3.50	33.69	1.62	260.51	7.73
3.75	38.67	1.74	313.20	8.10
4.00	44.00	1.86	372.10	8.46
4.25	49.67	1.97	437.48	8.81

Flow Depth at Peak Discharge	1.49	Ft
Minimum Channel Depth Required	1.79	Ft
Critical Depth	1.42	Ft
Flow Type	Subcritical flow	
Froude Number	0.63	
Flow Velocity	4.36	fps
Soil Type: CLAY		
Erosive Velocity	5.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference:
1. Hydraulic Engineering Circular No. 15;
   Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
   Chapter 3; B.J. Barfield and R.C. Warner
   University of Kentucky

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-122 BIGHAN RAMP7 ROAD

by

Name: RY

Company Name: BHP MINERALS
File Name: C:\LR\DATA\BHR7_CP1

Date: 10-08-1997

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\LR\DATA\BHR7_CP1 User: RY
Date: 10-08-1997 Time: 14:22:37
CP-122 BIGHAN RAMP7 ROAD
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

BS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
1	1	13.04	78	M	0.293	0.000	0.000	0.0	0.17	2.26
		Type: Null Label: CP-122								
1	Structure	13.04							0.17	
1	Total IN/OUT	13.04							0.17	2.26

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\DATA\BHR7_CP1 User: RY
Date: 10-08-1997 Time: 14:22:37
CP-122 BIGHAN RAMP7 ROAD
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	-a	5	1311.58	1.54	1.24	0.29	0.293		

SEDCAD+ CULVERT SIZING UTILITY

CULVERT CP-122

Design Discharge	=	2.260 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	54.000 feet
Pipe Slope	=	1.000 %
Manning's n	=	0.018
Maximum Headwater	=	4.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 9 inches

PERFORMANCE CURVES:

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.10	Outlet (Subcritical)	1
0.80	0.20	Outlet (Subcritical)	1
1.20	0.30	Outlet (Subcritical)	2
1.60	0.41	Outlet (Subcritical)	2
2.00	0.51	Inlet (Supercritical)	3
2.40	0.61	Inlet (Supercritical)	4
2.80	0.71	Inlet (Supercritical)	4
3.20	0.81	Inlet	5
3.60	0.91	Inlet	5
4.00	1.00	Outlet	6
4.40	1.04	Outlet	6
4.80	1.07	Outlet	6
5.20	1.10	Outlet	6
5.60	1.14	Outlet	6
6.00	1.17	Outlet	6

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.41	Outlet (Subcritical)	2
0.80	0.82	Inlet	5
1.20	1.08	Outlet	6
1.60	1.22	Outlet	6
2.00	1.36	Outlet	6
2.40	1.50	Outlet	6
2.80	1.64	Outlet	6
3.20	1.78	Outlet	6
3.60	1.92	Outlet	6
4.00	2.04	Outlet	6
4.40	2.12	Outlet	6
4.80	2.20	Outlet	6
5.20	2.29	Outlet	6
5.60	2.37	Outlet	6
6.00	2.46	Outlet	6

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.50	Outlet (Subcritical)	1
0.80	1.00	Outlet (Subcritical)	1
1.20	1.28	Outlet (Subcritical)	2
1.60	1.57	Inlet (Supercritical)	4
2.00	1.85	Inlet	5
2.40	2.07	Outlet	6
2.80	2.22	Outlet	6
3.20	2.37	Outlet	6
3.60	2.52	Outlet	6
4.00	2.67	Outlet	6
4.40	2.82	Outlet	6
4.80	2.98	Outlet	6
5.20	3.09	Outlet	6
5.60	3.20	Outlet	6
6.00	3.31	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.01	Outlet (Subcritical)	1
0.80	1.62	Outlet (Subcritical)	1
1.20	2.35	Inlet (Supercritical)	3
1.60	3.14	Outlet	6
2.00	3.58	Outlet	6
2.40	4.02	Outlet	6
2.80	4.36	Outlet	6
3.20	4.70	Outlet	6
3.60	5.04	Outlet	6
4.00	5.32	Outlet	6
4.40	5.60	Outlet	6
4.80	5.88	Outlet	6
5.20	6.14	Outlet	6
5.60	6.37	Outlet	6
6.00	6.61	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.53	Outlet (Subcritical)	1
0.80	2.14	Outlet (Subcritical)	1
1.20	2.98	Outlet (Subcritical)	1
1.60	4.84	Inlet	5
2.00	5.75	Outlet	6
2.40	6.48	Outlet	6
2.80	7.15	Outlet	6
3.20	7.75	Outlet	6
3.60	8.31	Outlet	6
4.00	8.84	Outlet	6

4.40	9.33	Outlet	6
4.80	9.80	Outlet	6
5.20	10.25	Outlet	6
5.60	10.68	Outlet	6
6.00	11.10	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.86	Inlet (Supercritical)	3
0.80	2.26	Inlet (Supercritical)	3
1.20	3.63	Outlet (Subcritical)	2 *
1.60	5.52	Outlet (Subcritical)	1 *
2.00	8.18	Outlet	6
2.40	9.39	Outlet	6
2.80	10.46	Outlet	6
3.20	11.43	Outlet	6
3.60	12.32	Outlet	6
4.00	13.16	Outlet	6
4.40	13.94	Outlet	6
4.80	14.68	Outlet	6
5.20	15.39	Outlet	6
5.60	16.07	Outlet	6
6.00	16.71	Outlet	6

* (Transition Region - Data may need to be smoothed.)

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-123 HYDROLOGY

by

Name: BEN HOSKIE

Company Name: BHP MINERALS
File Name: C:\BEN\VINNEL\CP123\CP_123

Date: 08-19-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\VINNEL\CP123\CP_123 User: BEN HOSKIE
Date: 08-19-1998 Time: 11:41:00
CP-123 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-60
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	187.40	76	M	1.830	0.000	0.000	0.0	1.70	6.32
		Type: Null			Label: CP-123					
111	Structure	187.40							1.70	
111	Total IN/OUT	187.40							1.70	6.32

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\VINNEL\CP123\CP_123 User: BEN HOSKIE
Date: 08-19-1998 Time: 11:41:00
CP-123 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-60
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	1	-a	5	6785.00	1.06	1.03	1.83	1.830		

SEDCAD+ CULVERT SIZING UTILITY

CP-123

Design Discharge	=	6.320 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	50.000 feet
Pipe Slope	=	1.000 %
Manning's n	=	0.018
Maximum Headwater	=	3.300 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.41		0
0.66	0.83	Outlet (Subcritical)	1
0.99	1.14	Outlet (Subcritical)	2
1.32	1.39	Inlet (Supercritical)	3
1.65	1.63	Inlet (Supercritical)	4
1.98	1.88	Inlet	5
2.31	2.07	Outlet	6
2.64	2.20	Outlet	6
2.97	2.33	Outlet	6
3.30	2.46	Outlet	6
3.63	2.59	Outlet	6
3.96	2.72	Outlet	6
4.29	2.86	Outlet	6
4.62	2.99	Outlet	6
4.95	3.08	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.80	Outlet (Subcritical)	1
0.66	1.39	Outlet (Subcritical)	1
0.99	1.91	Outlet (Subcritical)	1
1.32	2.66	Inlet (Supercritical)	4
1.65	3.22	Outlet	6
1.98	3.60	Outlet	6
2.31	3.98	Outlet	6
2.64	4.28	Outlet	6
2.97	4.58	Outlet	6
3.30	4.88	Outlet	6
3.63	5.14	Outlet	6
3.96	5.39	Outlet	6
4.29	5.63	Outlet	6
4.62	5.87	Outlet	6
4.95	6.10	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	1.39	Outlet (Subcritical)	1
0.66	1.88	Outlet (Subcritical)	1
0.99	2.53	Outlet (Subcritical)	1
1.32	3.49	Outlet (Subcritical)	1
1.65	5.05	Outlet	6
1.98	5.75	Outlet	6
2.31	6.39	Outlet	6
2.64	6.98	Outlet	6
2.97	7.50	Outlet	6
3.30	8.02	Outlet	6
3.63	8.47	Outlet	6
3.96	8.93	Outlet	6
4.29	9.34	Outlet	6
4.62	9.75	Outlet	6
4.95	10.14	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.71	Outlet (Subcritical)	2
0.66	1.71	Inlet (Supercritical)	3
0.99	3.06	Inlet (Supercritical)	3
1.32	3.96	Outlet (Subcritical)	1 *
1.65	5.81	Outlet (Subcritical)	1
1.98	8.14	Outlet	6
2.31	9.19	Outlet	6
2.64	10.13	Outlet	6
2.97	11.00	Outlet	6
3.30	11.79	Outlet	6
3.63	12.53	Outlet	6
3.96	13.24	Outlet	6
4.29	13.91	Outlet	6
4.62	14.55	Outlet	6
4.95	15.16	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.78	Outlet (Subcritical)	2
0.66	1.97	Inlet (Supercritical)	3
0.99	3.62	Inlet (Supercritical)	3
1.32	5.56	Inlet (Supercritical)	3
1.65	6.77	Outlet (Subcritical)	1 *
1.98	8.86	Outlet (Subcritical)	1
2.31	12.17	Outlet	6
2.64	13.60	Outlet	6
2.97	14.90	Outlet	6
3.30	16.09	Outlet	6
3.63	17.20	Outlet	6
3.96	18.25	Outlet	6
4.29	19.23	Outlet	6
4.62	20.17	Outlet	6
4.95	21.07	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.86	Inlet (Supercritical)	3
0.66	2.26	Inlet (Supercritical)	3
0.99	4.13	Inlet (Supercritical)	3
1.32	6.36	Inlet (Supercritical)	3
1.65	8.88	Inlet (Supercritical)	3
1.98	9.91	Outlet (Subcritical)	1 *
2.31	12.70	Outlet (Subcritical)	1
2.64	17.11	Inlet	5
2.97	19.07	Outlet	6
3.30	20.77	Outlet	6
3.63	22.34	Outlet	6
3.96	23.81	Outlet	6
4.29	25.20	Outlet	6
4.62	26.51	Outlet	6
4.95	27.76	Outlet	6

* (Transition Region - Data may need to be smoothed.)

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

RAMP 7 ROAD SIDE DITCH - WORSE CASE (SO. SIDE)

by

Name: LR

Company Name: BHP MINERALS
File Name: C:\LR\DATA\R7RDSD

Date: 11-11-1997

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\LR\DATA\R7RDSD User: LR
Date: 11-11-1997 Time: 13:10:48
RAMP 7 ROAD SIDE DITCH - WORSE CASE (SO. SIDE)
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

==========
SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE
==========

-Hydrology-

BS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
11	1	7.85	75	M	0.242	0.000	0.000	0.0	0.07	0.92
		Type: Null			Label: SIDE DITCH-SO. SIDE					
11	Structure	7.85							0.07	
11	Total IN/OUT	7.85							0.07	0.92

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\DATA\R7RDSD User: LR
Date: 11-11-1997 Time: 13:10:48
RAMP 7 ROAD SIDE DITCH - WORSE CASE (SO. SIDE)
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	-a	5	1451.00	2.76	1.66	0.24	0.242		

NAVAJO COAL COMPANY 13-Nov-97
NAVAJO MINE

PROJECT: Ramp 7 Road Realignment (So side ditch)
ENGINEER lr
FILE NO : 17.3.29
DRWG NO Exhibits 11-119 to 119B

Channel Design

Precipitation Event:	10 yr - 6 hr		
Design Flow	Q10	1.00	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	3.00	
(Z2:1)	Z2 =	12.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	6.30	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.47	0.12	1.34	2.85
0.50	1.88	0.25	8.50	4.53
0.75	4.22	0.37	25.09	5.95
1.00	7.50	0.49	54.08	7.21
1.25	11.72	0.62	98.12	8.37
1.50	16.88	0.74	159.66	9.46
1.75	22.97	0.86	240.95	10.49
2.00	30.00	0.99	344.17	11.47
2.25	37.97	1.11	471.36	12.41
2.50	46.88	1.23	624.49	13.32
2.75	56.72	1.36	805.46	14.20
3.00	67.50	1.48	1016.10	15.05
3.25	79.22	1.60	1258.21	15.88
3.50	91.88	1.73	1533.50	16.69
3.75	105.47	1.85	1843.68	17.48
4.00	120.00	1.97	2190.40	18.25
4.25	135.47	2.10	2575.26	19.01

Flow Depth at Peak Discharge	0.23	Ft
Minimum Channel Depth Required	0.53	Ft
Critical Depth	0.26	Ft
Flow Type	Supercritical flow	
Froude Number	0.99	
Flow Velocity	2.69	fps
Soil Type: sandy clay		
Erosive Velocity	3.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

Pages 145 – 156 Appendix 11-Z
Blank due to removal of CP-113 and CP-114, February 2006.

Pages 157 – 162 Appendix 11-Z
Blank due to removal of CP-115, November 2006.

COAL STOCKPILE BERM

WORST CASE SCENARIO

JULY 15, 1998

Coal Stockpile Berm

A worst case hydrological analysis was done to demonstrate that the typical berm shown on Figure 11-7 is adequate to pass the peak discharge from a 10 yr-24 hr storm event. The watersheds at the Hosteen and Lowe Coal Stockpiles were modeled in Sedcad+ to determine the maximum peak discharge. As a worst case, it was assumed that the berm would control the entire surface runoff from the maximum watershed area. The maximum peak discharge occurs at Lowe Coal Stockpile. The berm is capable of safely passing the peak discharge from the design storm. For more details see the attached Sedcad+ runs.

The watersheds for Barber Stockpile Pond #1 and Hosteen Stockpile Pond #1 were used in the analysis. Refer to Exhibit 11-13C and D for the watershed areas used.

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

COAL SROCKPILE BERM - WORST CASE SENARIO (HOSTEEN STOCKPILE)

by

Name: LR

Company Name: BHP MINERALS
File Name: C:\LR\HS_BERM

Date: 07-14-1998

Civil Software Design -- SEDCAD- Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\LR\HS_BERM User: LR
Date: 07-14-1998 Time: 13:58:21
COAL SROCKPILE BERM - WORST CASE SENARIO (HOSTEEN STOCKPILE)
Storm: 1.60 inches, 10 year-24 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	227.00	79	M	0.926	0.000	0.000	0.0	5.79	27.73
			Type: Null			Label: BERM				
111	Structure	227.00							5.79	
111	Total IN/OUT	227.00							5.79	27.73

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Company Name: BHP MINERALS
Filename: C:\LR\HS_BERM User: LR
Date: 07-14-1998 Time: 13:58:21
COAL SROCKPILE BERM - WORST CASE SENARIO (HOSTEEN STOCKPILE)
Storm: 1.60 inches, 10 year-24 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	5600.00	2.82	1.68	0.93	0.926		

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

COAL STOCKPILE BERM - WORST CASE SENARIO (LOWE STOCKPILE)

by

Name: LR

Company Name: BHP MINERALS
File Name: C:\LR\LS_BERM

Date: 07-14-1998

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\LR\LS_BERM User: LR
Date: 07-14-1998 Time: 14:02:32
COAL STOCKPILE BERM - WORST CASE SENARIO (LOWE STOCKPILE)
Storm: 1.60 inches, 10 year-24 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	99.80	89	M	0.792	0.000	0.000	0.0	5.88	39.08
			Type: Null		Label: BERM					
111	Structure	99.80							5.88	
111	Total IN/OUT	99.80							5.88	39.08

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\LS_BERM User: LR
Date: 07-14-1998 Time: 14:02:32
COAL STOCKPILE BERM - WORST CASE SENARIO (LOWE STOCKPILE)
Storm: 1.60 inches, 10 year-24 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	4500.00	2.49	1.58	0.79	0.792		

SEDCAD+ ERODIBLE CHANNEL DESIGN

COAL STOCKPILE BERM - WORST CASE SENARIO

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR
Discharge	39.10 cfs (Lowe Coal Stkp)
Slope	2.00 %
Sideslopes	20.00:1 (L) 1.50:1 (R)
Manning's n	0.025
Max. Velocity	5.00 fps
Material	SPOILS - SHALE AND SANDSTONE
Freeboard	.3 ft

RESULTS:

Actual Discharge	39.10 cfs
Depth	0.87 ft
with Freeboard	1.17 ft
Top Width	18.68 ft
with Freeboard	25.13 ft
Velocity	4.82 fps
Cross Sectional Area	8.11 sq ft
Hydraulic Radius	0.43 ft
Froude Number	1.29

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GORMAN ROAD

DROP STRUCTURE DS-16+04L

THE DROP STRUCTURE LOCATION AND WATERSHED AREA ARE SHOWN ON EXHIBIT 11-12C. THE DESIGN IS PRESENTED ON EXHIBIT 11-87A.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	DS-16+O4L

#1
Chan'l

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	2.340	2.340	2.38	0.09

Structure Detail:

Structure #1 (Riprap Channel)

DS-16+04L

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Multi x (VxD)
5.75	2.0:1	2.0:1	33.3	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.38 cfs	
Depth:	0.03 ft	1.03 ft
Top Width:	5.85 ft	9.85 ft
Velocity*:		
X-Section Area:	0.15 sq ft	
Hydraulic Radius:	0.026	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

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	2.340	0.073	0.000	0.000	89.000	M	2.38	0.094
	Σ	**2.340**						**2.38**	**0.094**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	2.37	29.05	1,224.90	4.610	0.073
#1	**1**	**Time of Concentration:**					**0.073**

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Mason Drainage Along Railroad

The watershed area is presented on a 8 1/2 X 11 sheet attached and on Exhibit 11-12D. The design is presented on Exhibit 11-30 in the PAP.

Updated 10/20/06

LR

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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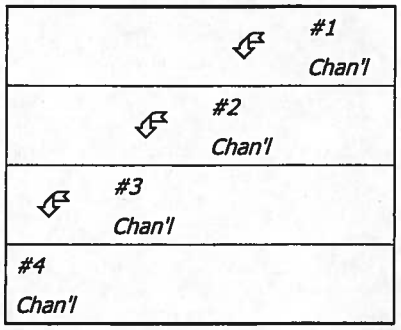
Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#2	0.000	0.000	Max. grade
Channel	#2	==>	#3	0.000	0.000	Riprap A
Channel	#3	==>	#4	0.000	0.000	Riprap B
Channel	#4	==>	End	0.000	0.000	Riprap C



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	5.500	5.500	2.71	0.09
#2	0.000	5.500	2.71	0.09
#3	0.000	5.500	2.71	0.09
#4	0.000	5.500	2.71	0.09

Structure Detail:

Structure #1 (Erodible Channel)

Max. grade

Trapezoidal Erodible Channel Inputs:

Material: Spoils w/sandstone cobbles

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)
5.50	3.0:1	3.0:1	1.8	0.0270	1.00			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.71 cfs	
Depth:	0.19 ft	1.19 ft
Top Width:	6.66 ft	12.66 ft
Velocity:	2.31 fps	
X-Section Area:	1.17 sq ft	
Hydraulic Radius:	0.175	
Froude Number:	0.97	

Structure #2 (Riprap Channel)

Riprap A

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
8.00	3.0:1	3.0:1	12.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.71 cfs	
Depth:	0.07 ft	1.07 ft
Top Width:	8.39 ft	14.39 ft

	w/o Freeboard	w/ Freeboard
Velocity*:		
X-Section Area:	0.54 sq ft	
Hydraulic Radius:	0.064	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #3 (Riprap Channel)

Riprap B

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
5.00	2.0:1	2.0:1	10.9	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.71 cfs	
Depth:	0.09 ft	1.09 ft
Top Width:	5.37 ft	9.37 ft
Velocity*:		
X-Section Area:	0.48 sq ft	
Hydraulic Radius:	0.088	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #4 (Riprap Channel)

Riprap C

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.00	2.0:1	2.0:1	21.3	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.71 cfs	
Depth:	0.06 ft	1.06 ft
Top Width:	4.24 ft	8.24 ft
Velocity*:		
X-Section Area:	0.25 sq ft	
Hydraulic Radius:	0.058	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

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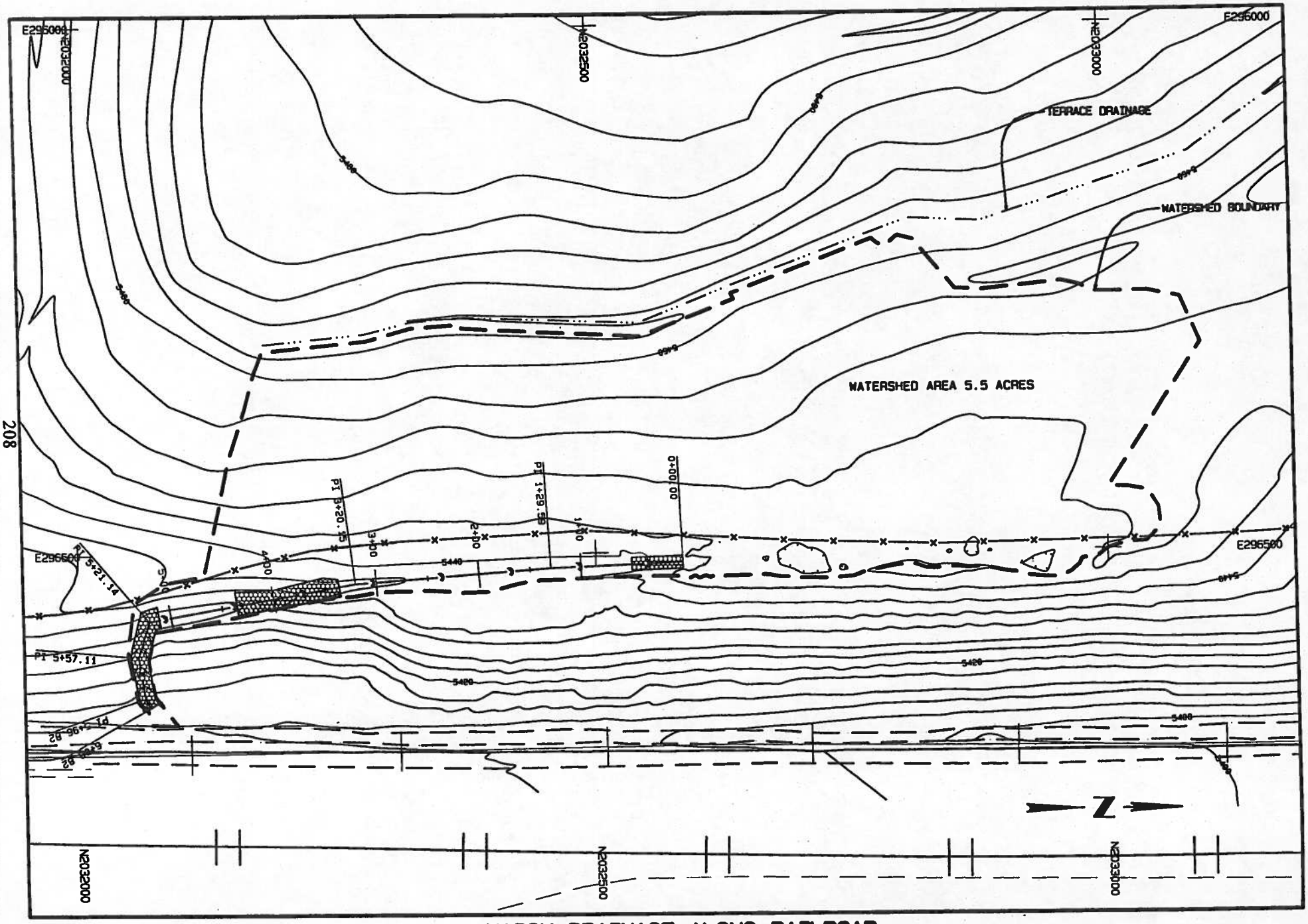
Subwatershed Hydrology Detail:

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	5.500	0.106	0.000	0.000	80.000	M	2.71	0.089
	Σ	**5.500**						**2.71**	**0.089**
#2	Σ	**5.500**						**2.71**	**0.089**
#3	Σ	**5.500**						**2.71**	**0.089**
#4	Σ	**5.500**						**2.71**	**0.089**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	3.31	18.00	543.00	1.820	0.082
		8. Large gullies, diversions, and low flowing streams	5.06	30.00	593.00	6.740	0.024
#1	**1**	**Time of Concentration:**					**0.106**



MASON DRAINAGE ALONG RAILROAD
WATERSHED AREA
NTS

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YAZZIE SPOIL SIDE ROAD EAST RIPRAP DOWNDRAIN AT CP-186

The location of the riprap downdrain is presented on Exhibit 11-95A.

LR

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Networking:

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

#1
Chan'l

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	1.600	1.600	1.74	0.07

Structure Detail:

Structure #1 (Riprap Channel)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.00	1.5:1	1.5:1	34.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.74 cfs	
Depth:	0.03 ft	1.03 ft
Top Width:	4.10 ft	7.10 ft
Velocity*:		
X-Section Area:	0.13 sq ft	
Hydraulic Radius:	0.032	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

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	1.600	0.059	0.000	0.000	90.000	M	1.74	0.071
	Σ	**1.600**						**1.74**	**0.071**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	3.26	38.00	1,165.00	5.410	0.059
#1	**1**	**Time of Concentration:**					**0.059**

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YAZZIE SPOIL SIDE ROAD WEST RIPRAP DOWNDRAIN AT CP-186

The location of the riprap downdrain is presented on Exhibit 11-95A.

LR

BHP Navajo Coal Company
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Fruitland, NM
87416

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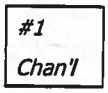
General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#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	1.700	1.700	1.85	0.08

Structure Detail:

Structure #1 (Riprap Channel)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
5.00	1.5:1	1.5:1	34.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.85 cfs	
Depth:	0.03 ft	1.03 ft
Top Width:	5.08 ft	8.08 ft
Velocity*:		
X-Section Area:	0.13 sq ft	
Hydraulic Radius:	0.026	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

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	1.700	0.059	0.000	0.000	90.000	M	1.85	0.075
	Σ	**1.700**						**1.85**	**0.075**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	3.26	38.00	1,165.00	5.410	0.059
#1	**1**	**Time of Concentration:**					**0.059**

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Doby Channel Design

The Doby Drainage is approximately 1,630 acres. The watershed is rough with many small depression and contains NAPI fields. Based on the above criteria about 1,570 acres would meet the slow criteria for the Hydrographic Response.

Shawn Smith

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Fruitland, NM 87414

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	See attached SedCad for Downdrain Riprap sizing

#1
Chan'l

Structure Detail:

Structure #1 (Erodible Channel)

See attached SedCad for Downdrain Riprap sizing

Trapezoidal Erodible Channel Inputs:

Material: Alluvial silts colloidal

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)
25.00	3.0:1	3.0:1	1.5	0.0250				5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	57.46 cfs	
Depth:	0.49 ft	
Top Width:	27.97 ft	
Velocity:	4.39 fps	
X-Section Area:	13.10 sq ft	
Hydraulic Radius:	0.466 ft	
Froude Number:	1.13	

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
16.00	3.0:1	3.0:1	33.0			

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	50.00 cfs	
Depth:	0.43 ft	
Top Width:	18.61 ft	
Velocity:	6.65 fps	
X-Section Area:	7.52 sq ft	
Hydraulic Radius:	0.401 ft	
Froude Number:	1.84	
Manning's n:	0.0700	
Dmin:	3.00 in	
D50:	6.00 in	
Dmax:	9.00 in	

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Area III Facilities
Sandy Hill Drainage Control

Design for the temporary diversion along the Area III Access Road and Parking Area using a 10 year - 6 hour storm event.

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Structure Detail:

Structure #4 (Erodible Channel)

Section S-2

Trapezoidal Erodible Channel Inputs:

Material: Sandy loam noncolloidal

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)
4.80	2.0:1	2.0:1	4.2	0.0200				2.5

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.71 cfs	
Depth:	0.06 ft	
Top Width:	5.05 ft	
Velocity:	2.33 fps	
X-Section Area:	0.30 sq ft	
Hydraulic Radius:	0.060 ft	
Froude Number:	1.68	

Structure #5 (Riprap Channel)

Section S-1

Triangular Riprap Channel Inputs:

Material: Riprap

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.0:1	4.0:1	32.0			

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.71 cfs	
Depth:	0.05 ft	
Top Width:	0.43 ft	
Velocity*:		

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.89 cfs	
Depth:	0.14 ft	
Top Width:	4.65 ft	
Velocity*:		
X-Section Area:	0.62 sq ft	
Hydraulic Radius:	0.132 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #3 (Riprap Channel)

Section N-1A

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.00	3.0:1	2.0:1	24.2			

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.89 cfs	
Depth:	0.04 ft	
Top Width:	4.19 ft	
Velocity*:		
X-Section Area:	0.16 sq ft	
Hydraulic Radius:	0.037 ft	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

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)
#4	1	0.970	0.056	0.000	0.000	82.000	M	0.71	0.020
	Σ	**0.970**						**0.71**	**0.020**
#5	Σ	**0.970**						**0.71**	**0.020**
#1	1	2.580	0.040	0.000	0.000	82.000	M	1.89	0.052
	Σ	**2.580**						**1.89**	**0.052**
#2	Σ	**2.580**						**1.89**	**0.052**
#3	Σ	**2.580**						**1.89**	**0.052**
#6	Σ	**3.550**						**2.61**	**0.072**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	8.00	12.00	150.00	2.820	0.014
		8. Large gullies, diversions, and low flowing streams	2.86	14.00	490.00	5.070	0.026
		8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#1	**1**	**Time of Concentration:**					**0.040**
#4	1	5. Nearly bare and untilled, and alluvial valley fans	9.39	20.00	213.00	3.060	0.019
		8. Large gullies, diversions, and low flowing streams	2.89	18.00	622.00	5.100	0.033
		8. Large gullies, diversions, and low flowing streams	7.81	10.00	128.00	8.380	0.004
#4	**1**	**Time of Concentration:**					**0.056**