APPENDIX 11-U

NAVAJO MINE RAILROAD
SEDIMENT AND DRAINAGE CONTROL STRUCTURES

DESIGN DATA

MAY 1998

NAVAJO MINE RAILROAD
SEDIMENT AND DRAINAGE CONTROL STRUCTURES

To comply with the EPA Storm Water Regulation, BHP has verified the performance of all drainage control structures along the railroad. In cases where the flow velocity exceeded the erosive velocity and erosion was visible, structures were designed to control and minimize the contribution of sediment to surface runoff outside the permit area.

The drainage control structures along the railroad were evaluated per the procedure and criteria outlined in Chapter 11, Section 11.5.6.2.2 of the mine permit. All watersheds and existing drainage control structures were surveyed to identify the following; the locations of structures, watershed areas and structure dimensions (see Table A attached) for all drainage structures. After completing the field survey, the watersheds and structures were modeled with SEDCAD+ computer software to determine the adequacy of the existing structures and where new structures need to be placed. There are numerous small watershed areas ranging from 0.1 to 8 acres. Instead of making a separate analysis for each individual watershed, a worst case hydrology analysis was done for 0.5, 1.0, 2.0, 4.0, 6.0 and 8.0 acres watersheds. The peak discharges from the worst case hydrology analysis were used in the hydraulic analysis of ditches/channels having watersheds of equivalent or smaller size. For the worst case hydrology runs, the time of concentration (T_c) was assumed to be zero, giving conservative peak discharges which will be used to design the drainage/erosion control structures. Utilizing the data from the worst case runs, all structures were modeled with the SEDCAD+ channel utility. If the watershed for any structure was larger than 8.0 acres, the watershed was modeled separately.

The constructed flow paths associated with the railroad, including side ditches, berms/ditch combinations and relief ditches were hydraulically evaluated. The SEDCAD+ channel design utility was used to check the flow velocities in the ditches or channels. The procedures and criteria outlined in Chapter 11, Section 11.5.6.2.2 of the mine permit were followed to determine the type of structure or BMP to be applied. Table A "Drainage Control Structures" summarizes the type of BMP's applied or needed to be installed. See schedules on Exhibit 11-14J for the type of structures that need to be installed.

At the north end of the Big Fill, on the west side, there are five straw bale barriers (check dams) placed in series in the ditch along the toe of the embankment. The watershed area for the ditch is small, approximately 1.7 acres. The straw bale barriers appear to be functioning effectively. The section of ditch containing the straw bale barriers does not receive water from the railroad side ditch immediately upstream. The surface runoff collected by the side ditch is diverted into a downdrain pipe, which runs along the toe of the embankment parallel to the ditch. The downdrain pipe terminates and releases the flow into the ditch downstream of the straw bale barriers at a point where the ditch grade shallows out. These straw bale barriers will be retained and maintained. No technical evaluation was done on the straw bale barriers.

The railroad utilizes a large number of downdrains, several of which are fed by lengthy drainage paths running along the side of the railroad access route. During the survey, three downdrain pipes and four culverts were found that were not included in Appendix 11-V for culverts and downdrains. A downdrain pipe was also added on the Barber Stockpile Spur. The designs for these are included in this submittal package and the appropriate exhibits and tables were updated.

The surface runoff at the coal preparation plant and the North Facilities which includes the section of railroad within that vicinity, is collected and retained in either the North Cells (Cells A, A2, B, and C) or Pond 5. The surface runoff from these areas is primary sheet flow on flat surfaces with low grades. The runoff is collected in low gradient swales that divert the runoff into culverts going to Cell A or Pond 5. No erosion was observed in this area during the survey. Not all ditches were checked in this area, since the runoff and sediment is retained.

Three surface disturbances along the railroad were identified during the surveys. It appears that the disturbance was made in efforts to maintain the berms and silt fences nearby. These areas will be seeded, mulched and crimped to stabilize the surface and improve hydrologic conditions.

During the survey several storage areas for the railroad track maintenance supplies were noted and are shown on Exhibits 11-14A through 11-14H. These storage areas contain rails, rail ties, and railroad ballast.

TABLE A
NAVAJO MINE RAILROAD
DRAINAGE CONTROL STRUCTURES

Name/Station[3]	Structure Type	Watershed (Acres)	Slope (%)		Length (ft)	BMP[1] or BTCA[2] Applied	Comments:
			Min	Max			
CH-5L	RR. S. Ditch	0.5	1.0	1.0	1,000	Shallow grade	No erosion visible. Sta. 0 to 10
CH-5R	RR. S. Ditch	0.5	1.0	1.0	1,000	Shallow grade	No erosion visible. Sta. 0 to 10
CH-22L	RR. S. Ditch	0.3	0.5	0.5	1,200	Shallow grade	No erosion visible. Sta. 16 to 28
CH-22R	RR. S. Ditch	0.3	0.5	0.5	1,200	Shallow grade	No erosion visible. Sta. 16 to 28
CH-65L	RR. S. Ditch	1.0	0.5	0.5	2,000	Shallow grade	No erosion visible. Sta. 70 to 58
CH-65R	RR. S. Ditch	1.0	0.5	0.5	1,000	Shallow grade	No erosion visible. Sta. 70 to 50
CH-77L	Rd. S. Ditch	2.3	1.0	2.0	1,000	Shallow grade	No erosion visible. Sta. 82 to 72 leading to CP-37.
CH-80L	RR. S. Ditch	2.0	0.5	0.6	1,750	Shallow grade	No erosion visible. Sta. 88 to 71
CH-80R	RR. S. Ditch	2.0	0.5	0.6	1,750	Shallow grade	No erosion visible. Sta. 88 to 71
CH-87L	Rd. S. Ditch	3.2	2.0	3.0	1,100	Shallow grade	No erosion visible. Sta. 82 to 93 leading to CP-1.
RD-91R	Relief Ditch	0.6	2.0	2.0	220	Not Req'd	No erosion visible.
DS-94L	Relief Ditch	0.4	5.0	7.0	40	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-141 for more details.
DS-95L	Relief Ditch	2.8	6.0	6.0	75	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-141 for more details.
CH-99L	RR. S. Ditch	1.0	0.5	1.0	500	Shallow grade	No erosion visible. Sta. 101 to 96 leading to DS-95L
CH-103L	Berm/RR S. Dit.	1.8	0.5	1.0	1,300	Shallow grade	No erosion visible. Sta. 108 to 95 leading to DS-95L.
DS-110L	Relief Ditch	See Exh. 11-65 for details.				Rip-rapped drop str.	Channel bottom is on bed rock at the inlet to CP-2. Rip-rap embk. toe only.
DS-110R	Relief Ditch	0.4	2.0	10.0	115	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-141 for more details.
RD-111L	Relief Ditch	0.8	5.0	7.0	100	Not Req'd	No erosion visible.
113L to 116L	n/a	0.8	n/a	n/a	100	Mulch and crimp	Disturb area will rills and gullies. Seed, mulch and crimp to stablize slopes.
CH-127R	RR. S. Ditch	2.4	1.0	1.0	1,200	Shallow grade	No erosion visible. Sta. 122 to 134 leading to DS-134R.
CH-129L	RR. S. Ditch	2.4	1.0	1.0	2,100	Shallow grade	No erosion visible. Sta. 119 to 140 merges w/CH-142L
CH-130L	Berm	7.4	2.0	4.0	850	Not Req'd	No erosion visible. Sta 126to 135 upper portion of CH-142L
DS-134R	Relief Ditch	2.5	15.0	15.0	45	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-141 for more details.
CH-142L	Channel	32.4	2.0	4.0	950	Not Req'd	Sta. 135 to 144 leading to CP3. Sandstone channel bed.
RD-143R	Relief Ditch	0.2	2.0	8.0	150	Not Req'd	No erosion visible.
SB-144L	Check Dam	1.9	3.0	4.0	175	Straw bale ck. dam	See Exh. 11-141 for typical details.
CH-147L	Ditch/Berm	0.7	1.0	2.0	500	Not Req'd	No erosion visible. Sta. 149 to 144 leading to SB-144L.
RD-149R	Relief Ditch	1.0	3.0	16.7	100	Not Req'd	No erosion visible.
CH-150L	RR. S. Ditch	1.5	1.0	1.0	900	Shallow grade	No erosion visible. Sta. 154 to 144 leading to SB-144L.
CH-151R	RR. S. Ditch	1.0	1.0	1.0	550	Shallow grade	No erosion visible. Sta. 155 to 149 leading to RD-149R.
CH-156L	Ditch/Berm	1.8	2.0	4.0	1,350	Not Req'd	No erosion visible. Sta. 151 to 165 leading to DS-165L and CH-166L.
CH-158L	RR. S. Ditch	0.9	1.0	1.0	1,050	Shallow grade	No erosion visible. Sta. 154 to 165 leading to DS-165L andCH-166L.
CH-159R	RR. S. Ditch	1.6	1.0	1.5	1,000	Shallow grade	No erosion visible. Ditch leading to DS-165R.
DS-165L	Relief Ditch	2.7	4.0	10.0	20	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-141 for more details.
DS-165R	Relief Ditch	1.6	1.0	3.0	100	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-141 for more details.
CH-166L	Channel	4.0	1.0	2.5	250	Not Req'd	No erosion visible. Sta. 165 to 168 leading to CP-4.
CH-170L	Channel	7.0	0.5	1.0	600	Shallow grade	No erosion visible. Sta. 174 to 168 leading to CP-4.
CH-195L	RR. S. Ditch	5.8	0.5	1.0	4,000	Shallow grade	No erosion visible. Sta. 175 to 215 merges w/CH-212L.
CH-212L	Rd. S. Ditch	5.8	2.0	4.0	750	Not Req'd	No erosion visible. Ditch along Big Fill Road (north side).

TABLE A
NAVAJO MINE RAILROAD
DRAINAGE CONTROL STRUCTURES

Name/Station[3]	Structure Type	Watershed (Acres)	Slope (%)		Length (ft)	BMP[1] or BTCA[2] Applied	Comments:
			Min	Max			
CH-215L	Rd. S. Ditch	1.8	2.0	4.0	750	Not Req'd	No erosion visible. Ditch along Big Fill Road (south side).
CH-215R	RR. S. Ditch	47.5	1.0	1.0	4,900	Shallow grade	No erosion visible. Sta. 190 to 239 leading to DD-7.
CH-229L	RR. S. Ditch	3.7	0.5	1.0	2,000	Shallow grade	No erosion visible. Sta. 219 to 239 leading to DD-13.
SB-241R	Check Dam	1.8	1.0	24.0	300	Straw bale ck. dam	Existing straw bale barriers to be retained. No erosion visible.
CH-242L	RR. S. Ditch	15.0	0.5	1.0	700	Shallow grade	Sta. 218 to 246, leading to DD-14.
DS-249L	Relief Ditch	8.4	5.0	10.0	20	Rip-rapped drop str.	Drop str. into Chinde Temp. Div. Rip-rap req'd. See Exh. 11-14I for more details.
DS-251L	Relief Ditch	4.9	5.0	10.0	20	Rip-rapped drop str.	Drop str. into Chinde Temp. Div. Rip-rap req'd. See Exh. 11-14I for more details.
DS-258R	Relief Ditch	2.1	4.0	8.0	500	Rip-rapped drop str.	Existing check dams to be removed. Rip-rap req'd. See Exh. 11-14I for more details.
CH-265R	RR. S. Ditch	2.1	0.5	1.0	1,300	Shallow grade	No erosion visible. Sta. 268 to 261 leading to DS-258R.
DS-267L	Relief Ditch	7.0	4.0	10.0	20	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
SF-268R	Silt Fence	1.8	8.0	11.0	n/a	Silt Fence	See Exh. 11-14I for typical details.
CH-275L	RR. S. Ditch	50.0	0.5	1.0	4,900	Shallow grade	No erosion visible. Sta. 306 to 275 leading to DD-18.
CH-275R	RR. S. Ditch	1.8	0.5	1.0	1,000	Shallow grade	No erosion visible. Sta. 278 to 268 leading to SF-268R.
SF-280R	Silt Fence	0.9	10.0	10.0	n/a	Silt Fence	See Exh. 11-14I for typical details.
CH-285R	RR. S. Ditch	0.9	0.5	1.0	1,300	Shallow grade	No erosion visible. Sta. 293 to 280 leading to SF-280R.
DS-294R	Relief Ditch	1.4	2.0	8.0	160	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
CH-300R	RR. S. Ditch	1.4	0.5	1.0	1,200	Shallow grade	No erosion visible. Sta. 306 to 294 leading to DS-294.
CH-319R	RR. S. Ditch	1.9	0.5	1.0	2,700	Shallow grade	No erosion visible. Sta. 306 to 333 leading to DS-333R.
CH-320L	RR. S. Ditch	57.0	0.5	1.0	2,400	Shallow grade	No erosion visible. Sta. 306 to 330 leading to DS-330L.
DS-330L	Relief Ditch	57.0	5.0	5.0	25	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
DS-333R	Relief Ditch	1.9	10.0	10.0	100	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
CH-334R	RR. S. Ditch	0.2	0.5	1.0	300	Shallow grade	No erosion visible. Sta. 333 to 336 leading to DD-23.
CH-337R	RR. S. Ditch	0.2	0.5	1.0	300	Shallow grade	No erosion visible. Sta. 336 to 339 leading to DD-24.
CH-337L	RR. S. Ditch	2.2	0.5	1.0	1,400	Shallow grade	No erosion visible. Sta. 330 to 6 H. Spur leading to DS-6L H. Spur.
DS-338L	Relief Ditch	7.0	10.0	10.0	100	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
CH-343R	RR. S. Ditch	0.6	0.5	1.0	500	Shallow grade	No erosion visible. Sta. 339 to 344 leading to RD-345R.
RD-345R	Relief Ditch	1.0	2.0	5.0	150	Not Req'd	No erosion visible.
DS-6L H. Spur	Relief Ditch	2.8	7.0	10.0	50	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
CH-8L H. Spur	RR. S. Ditch	0.6	0.5	1.0	400	Shallow grade	No erosion visible. Sta. 10 to 6 on H. Spur leading to DS-6L H. Spur.
CH-10L H. Spur	Channel	7.0	1.7	3.0	1500	Not Req'd	Sta. 15 to 0 on H. Spur leading to DS-338L.
CH-354L	RR. S. Ditch	1.7	0.5	1.0	1,000	Shallow grade	No erosion visible. Sta. 348 to 358 leading to CP-103.
CH-354R	RR. S. Ditch	0.7	0.5	1.0	800	Shallow grade	No erosion visible. Sta. 350 to 358 leading to RD-358.
RD-358R	Relief Ditch	0.7	1.0	3.0	150	Not Req'd	No erosion visible.
RD-361R	Relief Ditch	0.5	1.0	25.0	40	Not Req'd	No erosion visible.
CH-364R	RR. S. Ditch	0.5	0.5	1.0	700	Shallow grade	No erosion visible. Sta. 368 to 361 leading to RD-361.
CH-8L B. Spur	RR. S. Ditch	17.3	0.5	1.0	2,400	Shallow grade	No erosion visible. Sta. 20 B. Spur to 359 leading to CP-103.
CH-10R B. Spur	RR. S. Ditch	0.4	0.5	1.0	600	Shallow grade	No erosion visible. Sta. 13 to 7 on B. Spur merges w/CH-374L.
CH-17R B. Spur	RR. S. Ditch	0.4	0.5	1.0	650	Shallow grade	No erosion visible. Sta. 20 to 14 on B. Spur leading to DD-27.
CH-374L	Rd. Ditch	3.0	0.5	3.0	1,038	Not Req'd	No erosion visible. Sta. 366 to 376 leading to DS-375L.

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Name/Station[3]	Structure Type	Watershed (Acres)	Slope (%)		Length (ft)	BMP[1] or BTCA[2] Applied	Comments:
			Min	Max			
CH-375L	Rd. Ditch	6.3	0.5	1.0	3,062	Shallow grade	No erosion visible. Sta. 403 to 374 leading to DS-375L.
DS-375L	Relief Ditch	9.6	1.0	9.0	65	Rip-rapped drop str.	Erosion visible. Rip-rap req'd. See Exh. 11-14I for more details.
RD-382R	Relief Ditch	0.7	1.0	9.0	150	Not Req'd	No erosion visible. Ditch is on sandstone bedrock.
CH-384R	RR. S. Ditch	0.7	0.5	1.0	1,000	Shallow grade	No erosion visible. Sta. 392 to 382 leading to RD-382R
CH-385L	RR. S. Ditch	2.3	0.5	1.0	1,238	Shallow grade	No erosion visible. Sta. 392 to 380 merges w/CH-375.
DS-393L	Relief Ditch	4.4	0.5	5.0	45	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details. Leads to CP-9.
RD-393R	Relief Ditch	0.2	0.5	11.0	45	Not Req'd	No erosion visible.
RD-394R	Relief Ditch	0.5	0.5	11.0	45	Not Req'd	No erosion visible.
RD-397R	Relief Ditch	0.2	0.5	15.0	100	Not Req'd	No erosion visible.
CH-405R	RR. S. Ditch	0.7	0.5	1.0	662	Shallow grade	No erosion visible. Sta. 408 to 402 leading to RD-405R.
RD-405R	Relief Ditch	0.7	0.5	6.0	50	Not Req'd	No erosion visible.
CH-410L	RR. S. Ditch	4.4	0.5	1.0	3,592	Shallow grade	No erosion visible. Sta. 429 to 393 leading to DS-393L.
CH-411L	Rd. Ditch	0.6	0.5	1.2	730	Shallow grade	No erosion visible. Sta. 403 to 411 leading to RD- 411L.
RD-411L	Relief Ditch	0.6	0.5	4.0	45	Not Req'd	No erosion visible.
RD-412L	Relief Ditch	0.5	0.5	4.2	40	Not Req'd	No erosion visible.
CH-415L	Rd. Ditch	0.5	0.5	1.0	724	Shallow grade	No erosion visible. Sta. 418 to 411 leading to RD-412L.
DS-418R	Relief Ditch	0.3	0.5	8.0	40	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
DS-419L	Relief Ditch	1.1	0.5	5.0	45	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
RD-419R	Relief Ditch	0.7	0.5	4.0	40	Not Req'd	No erosion visible.
CH-425L	Rd. Ditch	1.1	0.5	1.0	1,015	Shallow grade	No erosion visible. Sta 429 to 419 leading to DS-419L.
CH-425R	RR. S. Ditch	0.7	0.5	1.7	1,022	Shallow grade	No erosion visible. Sta 429 to 419 leading to RD-419L.
CH-435L	Rd. Ditch	1.4	0.5	1.5	881	Shallow grade	No erosion visible. Sta. 429 to 438 leading to DS-438L.
CH-435R	RR. S. Ditch	0.6	0.5	1.5	895	Shallow grade	No erosion visible. Sta. 429 to 438 leading to DS-438R.
DS-438L	Relief Ditch	1.4	0.5	4.0	40	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
DS-438R	Relief Ditch	0.6	0.5	4.0	40	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
DS-439L	Relief Ditch	0.9	0.5	5.0	40	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
DS-439R	Relief Ditch	0.7	0.5	4.0	40	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
CH-442L	Rd. Ditch	0.9	0.5	1.0	910	Shallow grade	No erosion visible. Sta 448 to 439 leading to DS-439L.
CH-442R	RR. S. Ditch	0.7	0.5	1.0	652	Shallow grade	No erosion visible. Sta. 445 to 439 leading to DS-439R.
CH-444L	Rd. Ditch	0.3	0.5	3.2	215	Not Req'd	No erosion visible.
CH-445L	Rd. Ditch	0.4	0.5	3.0	340	Not Req'd	No erosion visible.
RD-447L	Relief Ditch	2.9	0.5	4.0	350	Not Req'd	No erosion visible. Leading to CP-13.
RD-447R	Relief Ditch	1.6	0.5	4.0	100	Not Req'd	No erosion visible. Leading to CP-14.
RD-450R	Relief Ditch	2.4	0.5	2.7	400	Not Req'd	No erosion visible. Leading to CP-14.
CH-460L	Rd. Ditch	2.4	0.5	1.0	2,650	Shallow grade	No erosion visible. Sta.475 to 448 leading to RD-447L.
CH-460R	RR. S. Ditch	2.4	0.5	1.0	2,760	Shallow grade	No erosion visible. Sta. 477 to 449 leading to RD-450R.
DS-471L	Relief Ditch	2.6	0.5	9.0	50	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
RD-472 R	Relief Ditch	0.2	0.5	6.7	300	Not Req'd	No erosion visible.
DS-474L	Relief Ditch	0.9	0.5	12.0	80	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.

TABLE A
NAVAJO MINE RAILROAD
DRAINAGE CONTROL STRUCTURES

Name/Station[3]	Structure Type	Watershed (Acres)	Slope (%)		Length (ft)	BMP[1] or BTCA[2] Applied	Comments:
			Min	Max			
RD-475R	Relief Ditch	0.1	0.5	10.0	75	Not Req'd	No erosion visible.
DS-478L	Relief Ditch	0.8	0.5	15.0	45	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
RD-478R	Relief Ditch	0.3	0.5	20.0	350	Not Req'd	No erosion visible.
CH-479L	RR. S. Ditch	0.4	0.5	1.0	620	Shallow grade	No erosion visible. Sta. 483 to 477 leading to DS-478L.
DS-481L	Relief Ditch	8.1	0.5	18.0	60	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
DS-484L	Relief Ditch					Rip-rapped drop str.	Spur D East Channel see Exh. 11-53 thru 11-56 for details.
DS-484R	Relief Ditch					Rip-rapped drop str.	Spur D West Channel see Exh. 11-53 thru 11-56 for details.
CH-487L	RR. S. Ditch	21.0	0.5	1.0	6,140	Shallow grade	No erosion visible. Sta. 549 to 487 leading to DS-484L.
CH-487R	RR. S. Ditch	31.0	0.5	1.0	6,080	Shallow grade	No erosion visible. Sta. 548 to 487 leading to DS-484R.
547R to 551R		1.0	n/a	n/a	100	Mulch and crimp	Disturb area will rills and gullies. Seed, mulch and crimp to stablize slopes.
DS-550+00R	Relief Ditch	3.9	7.0	16.0	300	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
CH-550+10L	RR. S. Ditch	0.1	0.5	1.0	180	Shallow grade	No Erosion visible. Leading to DD-25.
SB-551L	Check Dam	<0.1	15.0	15.0	n/a	Straw bale ck. dam	Existing Straw bale barrier to be retained.
DS-551L	Relief Ditch	5.2	0.5	20.0	50	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
SB-552L	Check Dam	5.2	2.0	7.0	150	Straw bale ck. dam	See Exh. 11-14I for typical details.
SB-553L	Check Dam	1.2	22.0	33.0	180	Straw bale ck. dam	See Exh. 11-14I for typical details.
SF-553R	Silt Fence	<0.2	15.0	25.0	n/a	Silt fence	See Exh. 11-14I for typical details.
SB-554R	Check Dam	1.2	0.5	15.0	180	Straw bale ck. dam	See Exh. 11-14I for typical details.
RD-555+60R	Relief Ditch	0.4	0.5	22.0	230	Not Req'd	No erosion visible.
CH-558+25L	RR. S. Ditch	0.8	0.5	1.0	1,450	Not Req'd	No erosion visible. Sta. 565 to 551 leading to DD-25.
556R to 559R	n/a	0.8	n/a	n/a	130	Mulch and crimp	Disturb area will rills and gullies. Seed, mulch and crimp to stablize slopes.
RD-561+00R	Relief Ditch	0.8	0.5	30.0	150	Not Req'd	No erosion visible.
RD-562R	Relief Ditch	0.2	0.5	45.0	150	Not Req'd	No erosion visible.
CH-562+50R	RR. S. Ditch	0.2	0.5	1.0	350	Shallow grade	No erosion visible. Leading to RD-562R.
SB-563L	Check Dam	0.5	15.0	26.0	250	Straw bale ck. dam	See Exh. 11-14I for typical details.
SB-563+50R	Check Dam	0.3	35.0	46.0	120	Straw bale ck. dam	See Exh. 11-14I for typical details.
RD-564+50R	Relief Ditch	0.2	0.5	32.0	150	Not Req'd	No erosion visible.
SF-565R	Silt Fence	0.2	0.5	32.0	n/a	Silt fence	See Exh. 11-14I for typical details.
DS-565+00L	Relief Ditch	1.5	0.5	25.0	200	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
SB-565+50R	Check Dam	0.7	0.5	30.0	130	Straw bale ck. dam	See Exh. 11-14I for typical details.
CH-568+85L	RR. S. Ditch	1.5	0.5	1.0	600	Shallow grade	No erosion visible. Sta. 571 to 565 leading to DS-565+00L.
RD-570+00R	Relief Ditch	0.3	0.5	40.0	125	Not Req'd	No erosion visible.
DS-570+80R	Relief Ditch	0.1	0.5	19.0	110	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
CH-572+50R	RR. S. Ditch	0.2	0.5	1.0	350	Shallow grade	No erosion visible. Sta. 565 to 562 leading to RD-562.
CH-584+55R	RR. S. Ditch	5.4	0.5	1.0	3,900	Shallow grade	No erosion visible. Sta. 572 to 611 leading to RD-616R.
CH-592+45L	RR. S. Ditch	5.9	0.5	1.0	4,160	Shallow grade	No erosion visible. Sta. 572 to 613 leading to DS-613+50L.
CH-611R	Rd. Ditch	6.9	2.0	5.0	150	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details. Powerline service road.
DS-613+50L	Relief Ditch	5.9	0.5	20.0	100	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
RD-616R	Relief Ditch	12.0	0.5	3.0	1,200	Not Req'd	No erosion visible. Vegetated drainway. Sta. 611 to 623.

TABLE A
NAVAJO MINE RAILROAD
DRAINAGE CONTROL STRUCTURES

Name/Station[3]	Structure Type	Watershed (Acres)	Slope (%)		Length (ft)	BMP[1] or BTCA[2] Applied	Comments:
			Min	Max			
CH-635+45L	RR. S. Ditch	2.5	0.5	1.0	4,590	Shallow grade	No erosion visible. Sta. 614 to 657 leading to DD-4.
RD-645+90R	Relief Ditch	0.9	0.5	3.0	70	Not Req'd	No erosion visible.
RD-648+20R	Relief Ditch	0.2	0.5	3.0	100	Not Req'd	No erosion visible.
CH-650+95R	Channel	2.9	0.5	4.0	290	Not Req'd	No erosion visible. Leads to DS- 652+90R.
DS-652+90R	Relief Ditch	2.9	6.0	24.0	42	Rip-rapped drop str.	Rip-rap req'd. See Exh. 11-14I for more details.
CH-663+90L	Rd. Ditch	3.1	0.5	1.0	1,340	Shallow grade	No erosion visible. Sta. 670 to 657 leading to DD-4.
CP-98	Culvert	2.0	1.0	1.0	80		Verified diameter of culvert.
CP-99	Culvert	2.0	1.0	1.0	80		Verified diameter of culvert.
CP-100	Culvert	0.2	2.0	2.0	60		Verified diameter of culvert.
CP-101	Culvert	2.0	1.8	1.0	40		Verified diameter of culvert.
CP-102	Culvert	1.0	1.0	1.0	50		Verified diameter of culvert.
DD-23	D. Drain Pipe	0.1	68.0	68.0	48	(4)	All downdrain pipes will be rip-rapped at the outlet. See Exh. 11-14A thru 11-14G
DD-24	D. Drain Pipe	0.1	50.0	50.0	45	(4)	for locations of other downdrain pipes and Table 11-12C for design data.
DD-25	D. Drain Pipe	0.9	n/a	25.0	67	(4)	
DD-27	D. Drain Pipe	0.4	n/a	65.0	25	(4)	Add a 16 inch diameter downdrain pipe on Barber Spur (Sta. 11+75R B. Spur)

(1) BMP = Best Management Practice
(2) BTCA = Best Technology Currently Available
(3) CH = Channel, RD = Relief Ditch, DS = Drop Structure, SB = Straw Bale Barrier or Check Dam, CP = Culvert, DD = Downdrain Pipe
(4) Downdrain pipes prevents the formation of gullies and rills on the embankment slopes by collecting runoff at the crest and diverting it to the toe of the embank.

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

STD_05A

by

Name: RH

Company Name: BHP MINERALS
File Name: C:\RUSSELL\STD_05A

Date: 09-06-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: EHP MINERALS
Filename: C:\RUSSELL\STD_05A User: RH
Date: 09-06-1996 Time: 14:09:56
STD_05A
Storm: 1.30 inches, 10 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	0.50	89	M	0.000	0.000	0.000	0.0	0.02	**0.54**
		Type: Null			Label: STD_05A					
111	Structure	0.50							0.02	
111	Total IN/OUT	0.50							0.02	0.54

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

STD_1AC

by

Name: RH

Company Name: BHP MINERALS
File Name: C:\RUSSELL\STD_1AC

Date: 09-06-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\RUSSELL\STD_1AC User: RH
Date: 09-06-1996 Time: 14:07:24
STD_1AC
Storm: 1.30 inches, 10 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	1.00	89	M	0.000	0.000	0.000	0.0	0.04	1.08
		Type: Null			Label: STD_1AC					
111	Structure	1.00							0.04	
111	Total IN/OUT	1.00							0.04	1.08

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

STD_2AC

by

Name: RH

Company Name: BHP MINERALS
File Name: C:\RUSSELL\STD_2AC

Date: 09-06-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\RUSSELL\STD_2AC User: RH
Date: 09-06-1996 Time: 13:59:10
STD_2AC
Storm: 1.30 inches, 10 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	2.00	89	M	0.000	0.000	0.000	0.0	0.08	2.16
		Type: Null			Label: STD_2AC					
111	Structure	2.00							0.08	
111	Total IN/OUT	2.00							0.08	2.16

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

4 ACRE STANDARD RUN FOR WORST CASE SENARIO

by

Name: DJR

Company Name: BHP MINERALS
File Name: C:\RUSSELL\STD_4AC

Date: 09-06-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\RUSSELL\STD_4AC User: DJR
Date: 09-06-1996 Time: 13:45:19
4 ACRE STANDARD RUN FOR WORST CASE SENARIO
Storm: 1.30 inches, 10 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	4.00	89	M	0.000	0.000	0.000	0.0	0.16	4.31
		Type: Null			Label: 4 ACRE STANDARD					
111	Structure	4.00							0.16	
111	Total IN/OUT	4.00							0.16	4.31

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

STD_6AC

by

Name: RH

Company Name: BHP MINERALS
File Name: C:\RUSSELL\STD_6AC

Date: 09-06-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\RUSSELL\STD_6AC User: RH
Date: 09-06-1996 Time: 14:13:16
STD_6AC
Storm: 1.30 inches, 10 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	6.00	89	M	0.000	0.000	0.000	0.0	0.24	6.47
		Type: Null			Label: STD_6AC					
111	Structure	6.00							0.24	
111	Total IN/OUT	6.00							0.24	6.47

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

STD_8AC

by

Name: RH

Company Name: BHP MINERALS
File Name: C:\RUSSELL\STD_8AC

Date: 09-06-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\RUSSELL\STD_8AC User: RH
Date: 09-06-1996 Time: 14:14:21
STD_8AC
Storm: 1.30 inches, 10 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 Discharge (cfs)
111	1	8.00	89	M	0.000	0.000	0.000	0.0	0.32	8.62
		Type: Null			Label: STD_8AC					
111	Structure	8.00							0.32	
111	Total IN/OUT	8.00							0.32	8.62

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-5L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	8.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.06 ft
with Freeboard	0.56 ft
Top Width	8.24 ft
with Freeboard	10.24 ft
Velocity	1.12 fps
Cross Sectional Area	0.48 sq ft
Hydraulic Radius	0.06 ft
Froude Number	0.82

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-5R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	10.00:1 (R)
Bottom Width	4.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.09 ft
with Freeboard	0.59 ft
Top Width	5.05 ft
with Freeboard	11.05 ft
Velocity	1.36 fps
Cross Sectional Area	0.40 sq ft
Hydraulic Radius	0.08 ft
Froude Number	0.86

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CH275L

by

Name: rh

Company Name: BHP MINERALS
File Name: C:\SEDCAD3\DD18

Date: 01-10-1997

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-267L

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	8.62 cfs	
Slope	10.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	3.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.43 ft	
with Freeboard	0.93 ft	
Top Width	5.57 ft	
with Freeboard	8.57 ft	
Velocity	4.70 fps	
Cross Sectional Area	1.83 sq ft	
Hydraulic Radius	0.32 ft	
Manning's n	0.047	
Froude Number	1.44	
Dmax	0.313 ft	(3.75 in)
D50	0.250 ft	(3.00 in)
D10	0.083 ft	(1.00 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-265R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL
Discharge	4.31 cfs
Slope	1.00 %
Sideslopes	2.00:1 (L) 10.00:1 (R)
Bottom Width	0.10 ft
Manning's n	0.025
Max. Velocity	5.00 fps
Material	SHALE W/RAILROAD BALLAST
Freeboard	.5 ft

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.53 ft
with Freeboard	1.03 ft
Top Width	6.48 ft
with Freeboard	12.48 ft
Velocity	2.47 fps
Cross Sectional Area	1.75 sq ft
Hydraulic Radius	0.27 ft
Froude Number	0.84

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-258R

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	3.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	1.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADEP Method

Depth	0.30 ft
with Freeboard	0.80 ft
Top Width	2.81 ft
with Freeboard	5.81 ft
Velocity	3.76 fps
Cross Sectional Area	0.57 sq ft
Hydraulic Radius	0.20 ft
Manning's n	0.038
Froude Number	1.47
Dmax	0.156 ft (1.88 in)
D50	0.125 ft (1.50 in)
D10	0.042 ft (0.50 in)

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-251L DS INTO CHINDE DIV. SOUTH SIDE

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	6.47 cfs	
Slope	10.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	5.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.25 ft
with Freeboard	0.75 ft
Top Width	6.52 ft
with Freeboard	9.52 ft
Velocity	4.42 fps
Cross Sectional Area	1.46 sq ft
Hydraulic Radius	0.22 ft
Manning's n	0.039
Froude Number	1.65
Dmax	0.156 ft (1.88 in)
D50	0.125 ft (1.50 in)
D10	0.042 ft (0.50 in)

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-249L DS INTO CHINDE DIV. NORTH SIDE

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	8.62 cfs	
Slope	10.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	5.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.32 ft
with Freeboard	0.82 ft
Top Width	6.90 ft
with Freeboard	9.90 ft
Velocity	4.57 fps
Cross Sectional Area	1.89 sq ft
Hydraulic Radius	0.27 ft
Manning's n	0.043
Froude Number	1.54
Dmax	0.313 ft (3.75 in)
D50	0.250 ft (3.00 in)
D10	0.083 ft (1.00 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-242L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	11.63 cfs	
Slope	1.00 %	
Sideslopes	3.00:1 (L)	5.00:1 (R)
Bottom Width	1.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE W/RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	11.63 cfs
Depth	0.80 ft
with Freeboard	1.30 ft
Top Width	7.40 ft
with Freeboard	11.40 ft
Velocity	3.46 fps
Cross Sectional Area	3.36 sq ft
Hydraulic Radius	0.44 ft
Froude Number	0.90

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\DD14 User: rh
Date: 01-10-1997 Time: 09:00:32
CH242L
Storm: 1.30 inches. 10 year- 6 hour. type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS (hrs)	Base-Tc (hrs)	Runoff K (cfs)	Runoff X (ac-ft)	Peak Flow (cfs)	Volume	Discharge
111	1	15.00	89	M	0.158	0.000	0.000	0.0	0.61	11.63
		Type: Null			Label: dd14					
111	Structure	15.00					0.61			
111	Total IN/OUT	15.00						0.61	11.63	

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CH242L

by

Name: rh

Company Name: BHP MINERALS
File Name: C:\SEDCAD3\DD14

Date: 01-10-1997

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-229L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	5.00:1 (R)
Bottom Width	6.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.24 ft
with Freeboard	0.74 ft
Top Width	7.67 ft
with Freeboard	11.17 ft
Velocity	2.64 fps
Cross Sectional Area	1.63 sq ft
Hydraulic Radius	0.21 ft
Froude Number	1.01

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-215R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	10.90 cfs	
Slope	1.00 %	
Sideslopes	4.00:1 (L)	1.00:1 (R)
Bottom Width	5.00 ft	
Manning's n	0.025	
Max. Velocity	3.00 fps	
Material	SHALE AND RAILRAOD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	10.90 cfs
Depth	0.52 ft
with Freeboard	1.02 ft
Top Width	7.59 ft
with Freeboard	10.09 ft
Velocity	3.34 fps
Cross Sectional Area	3.27 sq ft
Hydraulic Radius	0.42 ft
Froude Number	0.90

Civil Software Design -- SEDCAD- Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\CH215R User: LR
Date: 05-10-1998 Time: 15:05:47
CH-215R
Storm: 1.30 inches, 10 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 Discharge (cfs)
111	1	47.50	89	M	1.361	0.000	0.000	0.0	1.92	10.87
		Type: Null			Label: CH-215R					
111	Structure	47.50							1.92	
111	Total IN/OUT	47.50							1.92	10.87

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

-

CH-215R

by

-

Name: LR

Company Name: BHP MINERALS
File Name: C:\LR\CH215R

Date: 05-10-1998

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-215L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	4.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	6.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	2.16 cfs
Depth	0.11 ft
with Freeboard	0.61 ft
Top Width	6.43 ft
with Freeboard	8.43 ft
Velocity	3.26 fps
Cross Sectional Area	0.66 sq ft
Hydraulic Radius	0.10 ft
Froude Number	1.79

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-212L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	6.47 cfs	
Slope	4.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	6.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE AND GRAVEL	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	6.47 cfs
Depth	0.23 ft
with Freeboard	0.73 ft
Top Width	6.94 ft
with Freeboard	8.94 ft
Velocity	4.28 fps
Cross Sectional Area	1.51 sq ft
Hydraulic Radius	0.21 ft
Froude Number	1.61

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-195L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	6.47 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	10.00:1 (R)
Bottom Width	10.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	6.47 cfs
Depth	0.22 ft
with Freeboard	0.72 ft
Top Width	12.69 ft
with Freeboard	18.69 ft
Velocity	2.55 fps
Cross Sectional Area	2.54 sq ft
Hydraulic Radius	0.20 ft
Froude Number	1.00

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-170L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	8.62 cfs	
Slope	1.00 %	
Sideslopes	10.00:1 (L)	1.00:1 (R)
Bottom Width	12.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	8.62 cfs
Depth	0.24 ft
with Freeboard	0.74 ft
Top Width	14.64 ft
with Freeboard	20.14 ft
Velocity	2.70 fps
Cross Sectional Area	3.20 sq ft
Hydraulic Radius	0.22 ft
Froude Number	1.02

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-166L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	2.50 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	4.00 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.26 ft
with Freeboard	0.76 ft
Top Width	8.57 ft
with Freeboard	8.57 ft
Velocity	3.45 fps
Cross Sectional Area	1.25 sq ft
Hydraulic Radius	0.22 ft
Froude Number	1.28

SEDCAD+ ERODIBLE CHANNEL DESIGN

DS-165R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	3.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	4.00 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	2.16 cfs
Depth	0.17 ft
with Freeboard	0.67 ft
Top Width	5.00 ft
with Freeboard	8.00 ft
Velocity	2.89 fps
Cross Sectional Area	0.75 sq ft
Hydraulic Radius	0.15 ft
Froude Number	1.32

Note: Although not required, rip-rap (D50 = 0.25 ft.) will be placed.

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-165L

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	10.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	3.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.26 ft
with Freeboard	0.76 ft
Top Width	4.58 ft
with Freeboard	7.58 ft
Velocity	4.32 fps
Cross Sectional Area	1.00 sq ft
Hydraulic Radius	0.21 ft
Manning's n	0.039
Froude Number	1.63
Dmax	0.156 ft (1.88 in)
D50	0.125 ft (1.50 in)
D10	0.042 ft (0.50 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-159R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	1.50 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	4.00 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	2.16 cfs
Depth	0.21 ft
with Freeboard	0.71 ft
Top Width	4.83 ft
with Freeboard	6.83 ft
Velocity	2.37 fps
Cross Sectional Area	0.91 sq ft
Hydraulic Radius	0.19 ft
Froude Number	0.96

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-158L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	4.00:1 (R)
Bottom Width	6.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.11 ft
with Freeboard	0.61 ft
Top Width	6.64 ft
with Freeboard	9.64 ft
Velocity	1.61 fps
Cross Sectional Area	0.67 sq ft
Hydraulic Radius	0.10 ft
Froude Number	0.89

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-156L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	4.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	5.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	2.16 cfs
Depth	0.12 ft
with Freeboard	0.62 ft
Top Width	5.47 ft
with Freeboard	7.47 ft
Velocity	3.47 fps
Cross Sectional Area	0.62 sq ft
Hydraulic Radius	0.11 ft
Froude Number	1.81

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-151R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	1.00 %	
Sideslopes	5.00:1 (L)	1.00:1 (R)
Bottom Width	5.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.12 ft
with Freeboard	0.62 ft
Top Width	5.71 ft
with Freeboard	8.71 ft
Velocity	1.71 fps
Cross Sectional Area	0.63 sq ft
Hydraulic Radius	0.11 ft
Froude Number	0.91

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-150L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	1.00 %	
Sideslopes	1.00:1 (L)	5.00:1 (R)
Bottom Width	5.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	2.16 cfs
Depth	0.18 ft
with Freeboard	0.68 ft
Top Width	6.07 ft
with Freeboard	9.07 ft
Velocity	2.20 fps
Cross Sectional Area	0.98 sq ft
Hydraulic Radius	0.16 ft
Froude Number	0.96

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-149R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	17.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	2.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALES AND HARDPANS	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.10 ft
with Freeboard	0.60 ft
Top Width	2.40 ft
with Freeboard	4.40 ft
Velocity	4.92 fps
Cross Sectional Area	0.22 sq ft
Hydraulic Radius	0.09 ft
Froude Number	2.87

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-147L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	2.00 %	
Sideslopes	1.00:1 (L)	2.00:1 (R)
Bottom Width	5.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.10 ft
with Freeboard	0.60 ft
Top Width	5.29 ft
with Freeboard	6.79 ft
Velocity	2.17 fps
Cross Sectional Area	0.50 sq ft
Hydraulic Radius	0.09 ft
Froude Number	1.24

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-143R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	6.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	3.00 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.06 ft
with Freeboard	0.56 ft
Top Width	3.39 ft
with Freeboard	6.39 ft
Velocity	2.60 fps
Cross Sectional Area	0.21 sq ft
Hydraulic Radius	0.06 ft
Froude Number	1.86

SEDCAD+ RIPRAP CHANNEL DESIGN

CH-142L

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	20.52 cfs	
Slope	4.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	5.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.65 ft
with Freeboard	1.15 ft
Top Width	8.89 ft
with Freeboard	11.89 ft
Velocity	4.55 fps
Cross Sectional Area	4.51 sq ft
Hydraulic Radius	0.50 ft
Manning's n	0.041
Froude Number	1.13
Dmax	0.313 ft (3.75 in)
D50	0.250 ft (3.00 in)
D10	0.083 ft (1.00 in)

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Company Name: BHP MINERALS
Filename: C:\LR\CH142L User: LR
Date: 05-10-1998 Time: 14:04:52
CH-142L
Storm: 1.30 inches, 10 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 Discharge (cfs)
111	1	39.80	80	M	0.044	0.000	0.000	0.0	1.64	20.52
		Type: Null			Label: CH-142L					
111	Structure	39.80							1.64	
111	Total IN/OUT	39.80							1.64	20.52

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CH-142L

by

Name: LR

Company Name: BHP MINERALS
File Name: C:\LR\CH142L

Date: 05-10-1998

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-134R

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	15.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	4.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.21 ft
with Freeboard	0.71 ft
Top Width	5.26 ft
with Freeboard	8.26 ft
Velocity	4.42 fps
Cross Sectional Area	1.97 sq ft
Hydraulic Radius	0.18 ft
Manning's n	0.042
Froude Number	1.81
Dmax	0.156 ft (1.88 in)
D50	0.125 ft (1.50 in)
D10	0.042 ft (0.50 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	8.63 cfs	
Slope	4.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	6.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	CLAY, COLLOIDAL	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	8.63 cfs
Depth	0.28 ft
with Freeboard	0.78 ft
Top Width	7.11 ft
with Freeboard	9.11 ft
Velocity	4.75 fps
Cross Sectional Area	1.82 sq ft
Hydraulic Radius	0.25 ft
Froude Number	1.65

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-129L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	1.00 %	
Sideslopes	1.00:1 (L)	4.00:1 (R)
Bottom Width	6.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	4.32 cfs
Depth	0.24 ft
with Freeboard	0.74 ft
Top Width	7.21 ft
with Freeboard	9.71 ft
Velocity	2.70 fps
Cross Sectional Area	1.60 sq ft
Hydraulic Radius	0.22 ft
Froude Number	1.01

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-127R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	1.00 %	
Sideslopes	5.00:1 (L)	1.00:1 (R)
Bottom Width	6.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.24 ft
with Freeboard	0.74 ft
Top Width	7.44 ft
with Freeboard	10.44 ft
Velocity	2.67 fps
Cross Sectional Area	1.61 sq ft
Hydraulic Radius	0.21 ft
Froude Number	1.01

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-111L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	1.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	4.00 ft	
Manning's n	1.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	1.09 ft
with Freeboard	0.59 ft
Top Width	4.52 ft
with Freeboard	7.52 ft
Velocity	1.94 fps
Cross Sectional Area	1.37 sq ft
Hydraulic Radius	1.08 ft
Froude Number	1.32

DS-110R

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.00	3.0:1	3.0:1	23.0	1.00		

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.54 cfs	
Depth:	0.05 ft	1.05 ft
Top Width:	2.30 ft	8.30 ft
Velocity*:		
X-Section Area:	0.11 sq ft	
Hydraulic Radius:	0.046	
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.

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-103L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	5.00 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	2.16 cfs
Depth	0.20 ft
with Freeboard	0.70 ft
Top Width	5.82 ft
with Freeboard	7.82 ft
Velocity	1.95 fps
Cross Sectional Area	1.11 sq ft
Hydraulic Radius	0.19 ft
Froude Number	0.79

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-99L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	2.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	5.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.10 ft
with Freeboard	0.60 ft
Top Width	5.39 ft
with Freeboard	7.39 ft
Velocity	2.15 fps
Cross Sectional Area	0.50 sq ft
Hydraulic Radius	0.09 ft
Froude Number	1.24

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-95L

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	6.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	3.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.30 ft
with Freeboard	0.80 ft
Top Width	4.80 ft
with Freeboard	7.80 ft
Velocity	3.69 fps
Cross Sectional Area	1.17 sq ft
Hydraulic Radius	0.24 ft
Manning's n	0.038
Froude Number	1.32
Dmax	0.156 ft (1.88 in)
D50	0.125 ft (1.50 in)
D10	0.042 ft (0.50 in)

DS-94L

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.00	4.0:1	4.0:1	19.0	1.00		

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.54 cfs	
Depth:	0.06 ft	1.06 ft
Top Width:	3.49 ft	11.49 ft
Velocity*:		
X-Section Area:	0.20 sq ft	
Hydraulic Radius:	0.056	
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.

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-91R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	2.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	2.00 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.18 ft
with Freeboard	0.68 ft
Top Width	3.09 ft
with Freeboard	6.09 ft
Velocity	2.34 fps
Cross Sectional Area	0.46 sq ft
Hydraulic Radius	0.15 ft
Froude Number	1.07

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-87L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	3.00 %	
Sideslopes	2.00:1 (L)	3.00:1 (R)
Bottom Width	10.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	4.30 cfs
Depth	0.13 ft
with Freeboard	0.63 ft
Top Width	10.65 ft
with Freeboard	13.15 ft
Velocity	3.22 fps
Cross Sectional Area	1.33 sq ft
Hydraulic Radius	0.12 ft
Froude Number	1.60

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-80R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	0.60 %	
Sideslopes	10.00:1 (L)	0.50:1 (R)
Bottom Width	10.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.21 ft
with Freeboard	0.71 ft
Top Width	12.16 ft
with Freeboard	17.41 ft
Velocity	1.89 fps
Cross Sectional Area	2.28 sq ft
Hydraulic Radius	0.19 ft
Froude Number	0.77

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-80L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	0.60 %	
Sideslopes	0.50:1 (L)	10.00:1 (R)
Bottom Width	15.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.16 ft
with Freeboard	0.66 ft
Top Width	16.72 ft
with Freeboard	21.97 ft
Velocity	1.66 fps
Cross Sectional Area	2.59 sq ft
Hydraulic Radius	0.15 ft
Froude Number	0.74

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-77L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	2.00 %	
Sideslopes	2.00:1 (L)	3.00:1 (R)
Bottom Width	6.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.20 ft
with Freeboard	0.70 ft
Top Width	6.98 ft
with Freeboard	9.48 ft
Velocity	3.37 fps
Cross Sectional Area	1.28 sq ft
Hydraulic Radius	0.18 ft
Froude Number	1.39

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-65R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	0.50 %	
Sideslopes	1.00:1 (L)	2.00:1 (R)
Bottom Width	10.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.10 ft
with Freeboard	0.60 ft
Top Width	10.29 ft
with Freeboard	11.79 ft
Velocity	1.10 fps
Cross Sectional Area	0.98 sq ft
Hydraulic Radius	0.10 ft
Froude Number	0.63

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-65L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	0.50 %	
Sideslopes	2.00:1 (L)	1.00:1 (R)
Bottom Width	10.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.10 ft
with Freeboard	0.60 ft
Top Width	10.29 ft
with Freeboard	11.79 ft
Velocity	1.10 fps
Cross Sectional Area	0.98 sq ft
Hydraulic Radius	0.10 ft
Froude Number	0.63

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-22R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	0.50 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	2.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.16 ft
with Freeboard	0.66 ft
Top Width	2.66 ft
with Freeboard	4.66 ft
Velocity	1.42 fps
Cross Sectional Area	0.38 sq ft
Hydraulic Radius	0.14 ft
Froude Number	0.66

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-22L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	0.50 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	2.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.16 ft
with Freeboard	0.66 ft
Top Width	2.66 ft
with Freeboard	4.66 ft
Velocity	1.42 fps
Cross Sectional Area	0.38 sq ft
Hydraulic Radius	0.14 ft
Froude Number	0.66

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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\DD18 User: rh
Date: 01-10-1997 Time: 08:54:09
CH275L
Storm: 1.30 inches. 10 year- 6 hour. type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS (hrs)	Tc (hrs)	Base-K (cfs)	Runoff X (ac-ft)	Peak Flow (cfs)	Volume	Discharge
111	1	50.00	89	M	1.250	0.000	0.000	0.0	2.02	12.21
		Type: Null			Label: dd18					
111	Structure	50.00						2.02		
111	Total IN/OUT	50.00						2.02	12.21	

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-275L LEADING TO DD-18

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	12.21 cfs	
Slope	1.00 %	
Sideslopes	3.00:1 (L)	5.00:1 (R)
Bottom Width	1.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE AND RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	12.21 cfs
Depth	0.82 ft
with Freeboard	1.32 ft
Top Width	7.53 ft
with Freeboard	11.53 ft
Velocity	3.50 fps
Cross Sectional Area	3.49 sq ft
Hydraulic Radius	0.45 ft
Froude Number	0.91

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-275R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	1.00 %	
Sideslopes	50.00:1 (L)	2.00:1 (R)
Bottom Width	8.00 ft	
Manning's n	0.025	
Max. Velocity	3.00 fps	
Material	SANDY CLAY WITH RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	2.16 cfs
Depth	0.14 ft
with Freeboard	0.64 ft
Top Width	15.23 ft
with Freeboard	41.23 ft
Velocity	1.34 fps
Cross Sectional Area	1.62 sq ft
Hydraulic Radius	0.11 ft
Froude Number	0.72

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-285R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	1.00 %	
Sideslopes	50.00:1 (L)	2.00:1 (R)
Bottom Width	8.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SANDY CLAY WITH RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.10 ft
with Freeboard	0.60 ft
Top Width	12.96 ft
with Freeboard	38.96 ft
Velocity	1.08 fps
Cross Sectional Area	1.00 sq ft
Hydraulic Radius	0.08 ft
Froude Number	0.69

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-294R

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	8.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	2.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.24 ft
with Freeboard	0.74 ft
Top Width	3.41 ft
with Freeboard	6.41 ft
Velocity	3.39 fps
Cross Sectional Area	0.64 sq ft
Hydraulic Radius	0.18 ft
Manning's n	0.040
Froude Number	1.38
Dmax	0.156 ft (1.88 in)
D50	0.125 ft (1.50 in)
D10	0.042 ft (0.50 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-300R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL
Discharge	2.16 cfs
Slope	1.00 %
Sideslopes	2.00:1 (L) 10.00:1 (R)
Bottom Width	0.10 ft
Manning's n	0.025
Max. Velocity	5.00 fps
Material	SHALE W/RAILROAD BALLAST
Freeboard	.5 ft

RESULTS:

Actual Discharge	2.16 cfs
Depth	0.41 ft
with Freeboard	0.91 ft
Top Width	5.00 ft
with Freeboard	11.00 ft
Velocity	2.07 fps
Cross Sectional Area	1.04 sq ft
Hydraulic Radius	0.21 ft
Froude Number	0.80

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-319R LEADS TO DS-333R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	8.00 %	
Sideslopes	10.00:1 (L)	2.00:1 (R)
Bottom Width	8.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SANDY CLAY WITH RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	2.16 cfs
Depth	0.08 ft
with Freeboard	0.58 ft
Top Width	8.99 ft
with Freeboard	14.99 ft
Velocity	3.08 fps
Cross Sectional Area	0.70 sq ft
Hydraulic Radius	0.08 ft
Froude Number	1.94

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

-

RR SIDE DITCH AT STA 320L (STA 306 TO 330)

by

-

Name: LR

Company Name: BHP MINERALS
File Name: C:\LR\CH320L

Date: 05-11-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\CH320L User: LR
Date: 05-11-1998 Time: 10:55:03
RR SIDE DITCH AT STA 320L (STA 306 TO 330)
Storm: 1.30 inches, 10 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 Discharge (cfs)
111	1	57.00	82	M	0.326	0.000	0.000	0.0	1.15	15.90
		Type: Null			Label: CH-320L					
111	Structure	57.00							1.15	
111	Total IN/OUT	57.00							1.15	15.90

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\CH320L User: LR
Date: 05-11-1998 Time: 10:55:03
RR SIDE DITCH AT STA 320L (STA 306 TO 330)
Storm: 1.30 inches, 10 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)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2400.00	4.17	2.04	0.33	0.326		

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-320L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	15.90 cfs	
Slope	1.00 %	
Sideslopes	3.00:1 (L)	5.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE W/RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	15.90 cfs
Depth	1.02 ft
with Freeboard	1.52 ft
Top Width	8.24 ft
with Freeboard	12.24 ft
Velocity	3.75 fps
Cross Sectional Area	4.24 sq ft
Hydraulic Radius	0.50 ft
Froude Number	0.92

SEDCAD+ RIPRAP CHANNEL DESIGN

DS330L - RIP RAP DESIGN FOR DROP STRUCTURE

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	14.85 cfs	
Slope	5.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	6.00 feet	
Freeboard	0.5 ft	

RESULTS:

Steep Slope Design - Simons/OSM Method

Depth	0.26 ft
with Freeboard	0.76 ft
Top Width	7.59 ft
with Freeboard	10.59 ft
Velocity	8.27 fps
Cross Sectional Area	1.80 sq ft
Hydraulic Radius	0.23 ft
Manning's n	0.032
Froude Number	3.00
Dmax	0.625 ft (7.50 in)
D50	0.500 ft (6.00 in)
D10	0.167 ft (2.00 in)

DS-333R

Material: Riprap

Trapezoidal Channel

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	3.0:1	15.0	1.00		

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.16 cfs	
Depth:	0.08 ft	1.08 ft
Top Width:	4.51 ft	10.51 ft
Velocity*:		
X-Section Area:	0.36 sq ft	
Hydraulic Radius:	0.080	
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.

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-334R AND CH-337R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL
Discharge	0.54 cfs
Slope	1.00 %
Sideslopes	2.00:1 (L) 10.00:1 (R)
Bottom Width	0.10 ft
Manning's n	0.025
Max. Velocity	5.00 fps
Material	SHALE W/RAILROAD BALLAST
Freeboard	.5 ft

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.24 ft
with Freeboard	0.74 ft
Top Width	2.97 ft
with Freeboard	8.97 ft
Velocity	1.47 fps
Cross Sectional Area	0.37 sq ft
Hydraulic Radius	0.12 ft
Froude Number	0.73

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-337L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	10.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE W/RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.53 ft
with Freeboard	1.03 ft
Top Width	6.48 ft
with Freeboard	12.48 ft
Velocity	2.47 fps
Cross Sectional Area	1.75 sq ft
Hydraulic Radius	0.27 ft
Froude Number	0.84

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-338L

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	8.62 cfs	
Slope	10.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	3.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.43 ft
with Freeboard	0.93 ft
Top Width	5.57 ft
with Freeboard	8.57 ft
Velocity	4.70 fps
Cross Sectional Area	1.83 sq ft
Hydraulic Radius	0.32 ft
Manning's n	0.047
Froude Number	1.44
Dmax	0.313 ft (3.75 in)
D50	0.250 ft (3.00 in)
D10	0.083 ft (1.00 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-343R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	1.00 %	
Sideslopes	10.00:1 (L)	2.00:1 (R)
Bottom Width	2.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SANDY CLAY W/RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.20 ft
with Freeboard	0.70 ft
Top Width	4.43 ft
with Freeboard	10.43 ft
Velocity	1.65 fps
Cross Sectional Area	0.65 sq ft
Hydraulic Radius	0.15 ft
Froude Number	0.76

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-345R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	5.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE (BADLANDS)	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.34 ft
with Freeboard	0.84 ft
Top Width	1.47 ft
with Freeboard	3.47 ft
Velocity	4.01 fps
Cross Sectional Area	0.27 sq ft
Hydraulic Radius	0.17 ft
Froude Number	1.65

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-6L H. SPUR

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	10.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	2.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.32 ft
with Freeboard	0.82 ft
Top Width	3.93 ft
with Freeboard	6.93 ft
Velocity	4.51 fps
Cross Sectional Area	0.96 sq ft
Hydraulic Radius	0.24 ft
Manning's n	0.040
Froude Number	1.61
Dmax	0.313 ft (3.75 in)
D50	0.250 ft (3.00 in)
D10	0.083 ft (1.00 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-8L H. SPUR

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	10.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE W/RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.31 ft
with Freeboard	0.81 ft
Top Width	3.86 ft
with Freeboard	9.86 ft
Velocity	1.75 fps
Cross Sectional Area	0.62 sq ft
Hydraulic Radius	0.16 ft
Froude Number	0.77

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-10L H. SPUR

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	8.62 cfs	
Slope	3.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	4.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE AND CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	8.62 cfs
Depth	0.37 ft
with Freeboard	0.87 ft
Top Width	6.21 ft
with Freeboard	9.21 ft
Velocity	4.59 fps
Cross Sectional Area	1.88 sq ft
Hydraulic Radius	0.30 ft
Froude Number	1.47

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-354L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	10.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE W/RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	2.16 cfs
Depth	0.41 ft
with Freeboard	0.91 ft
Top Width	5.00 ft
with Freeboard	11.00 ft
Velocity	2.07 fps
Cross Sectional Area	1.04 sq ft
Hydraulic Radius	0.21 ft
Froude Number	0.80

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-354R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL
Discharge	1.08 cfs
Slope	1.00 %
Sideslopes	2.00:1 (L) 10.00:1 (R)
Bottom Width	0.10 ft
Manning's n	0.025
Max. Velocity	5.00 fps
Material	SHALE W/RAILROAD BALLAST
Freeboard	.5 ft

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.31 ft
with Freeboard	0.81 ft
Top Width	3.86 ft
with Freeboard	9.86 ft
Velocity	1.75 fps
Cross Sectional Area	0.62 sq ft
Hydraulic Radius	0.16 ft
Froude Number	0.77

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-358R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	3.00 %	
Sideslopes	5.00:1 (L)	5.00:1 (R)
Bottom Width	0.50 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.24 ft
with Freeboard	0.74 ft
Top Width	2.85 ft
with Freeboard	7.85 ft
Velocity	2.73 fps
Cross Sectional Area	0.39 sq ft
Hydraulic Radius	0.14 ft
Froude Number	1.29

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-361R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	25.00 %	
Sideslopes	2.00:1 (L)	5.00:1 (R)
Bottom Width	1.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.53 cfs
Depth	0.08 ft
with Freeboard	0.58 ft
Top Width	1.59 ft
with Freeboard	5.09 ft
Velocity	4.93 fps
Cross Sectional Area	0.11 sq ft
Hydraulic Radius	0.07 ft
Froude Number	3.32

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-364R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	10.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE W/RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.24 ft
with Freeboard	0.74 ft
Top Width	2.97 ft
with Freeboard	8.97 ft
Velocity	1.47 fps
Cross Sectional Area	0.37 sq ft
Hydraulic Radius	0.12 ft
Froude Number	0.73

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CH-8L B. SPUR LEADS TO CP-103

by

Name: LR

Company Name: BHP MINERALS
File Name: C:\LR\CH8LBSPU

Date: 05-13-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\CH8LBSPU User: LR
Date: 05-13-1998 Time: 12:28:38
CH-8L B. SPUR LEADS TO CP-103
Storm: 1.30 inches, 10 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 Discharge (cfs)
111	1	17.30	83	M	0.258	0.000	0.000	0.0	0.39	6.16
		Type: Null			Label: CH-8L B. SPUR					
111	Structure	17.30			-				0.39	
111	Total IN/OUT	17.30							0.39	6.16

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Company Name: BHP MINERALS
Filename: C:\LR\CH8LBSPU User: LR
Date: 05-13-1998 Time: 12:28:38
CH-8L B. SPUR LEADS TO CP-103
Storm: 1.30 inches, 10 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)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1575.00	2.86	1.69	0.26	0.258		

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-8L B. SPUR

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	6.16 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	0.50 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALES (SPOILS @ TOE OF REGRADE)	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	6.16 cfs
Depth	0.84 ft
with Freeboard	1.34 ft
Top Width	3.85 ft
with Freeboard	5.85 ft
Velocity	3.39 fps
Cross Sectional Area	1.82 sq ft
Hydraulic Radius	0.43 ft
Froude Number	0.87

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-10R B. SPUR AND CH-17R B. SPUR

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	10.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE W/RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.24 ft
with Freeboard	0.74 ft
Top Width	2.97 ft
with Freeboard	8.97 ft
Velocity	1.47 fps
Cross Sectional Area	0.37 sq ft
Hydraulic Radius	0.12 ft
Froude Number	0.73

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-374L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	4.31 cfs	
Slope	3.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE WITH RAILROAD BALLAST	
Freeboard	1 ft	

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.68 ft
with Freeboard	1.68 ft
Top Width	2.72 ft
with Freeboard	6.72 ft
Velocity	4.67 fps
Cross Sectional Area	0.92 sq ft
Hydraulic Radius	0.30 ft
Froude Number	1.41

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-375L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	8.62 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE WITH SANDSTONE COBBLES	
Freeboard	1 ft	

RESULTS:

Actual Discharge	8.62 cfs
Depth	1.08 ft
with Freeboard	2.08 ft
Top Width	4.33 ft
with Freeboard	8.33 ft
Velocity	3.68 fps
Cross Sectional Area	2.35 sq ft
Hydraulic Radius	0.48 ft
Froude Number	0.88

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-375L

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	10.78 cfs	
Slope	9.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	2.00 feet	
Freeboard	0.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.55 ft
with Freeboard	1.05 ft
Top Width	5.31 ft
with Freeboard	8.31 ft
Velocity	5.34 fps
Cross Sectional Area	2.02 sq ft
Hydraulic Radius	0.37 ft
Manning's n	0.043
Froude Number	1.53
Dmax	0.313 ft (3.75 in)
D50	0.250 ft (3.00 in)
D10	0.083 ft (1.00 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-384R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	1.08 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	RAILROAD BALLAST	
Freeboard	1 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.50 ft
with Freeboard	1.50 ft
Top Width	1.99 ft
with Freeboard	5.99 ft
Velocity	2.19 fps
Cross Sectional Area	0.49 sq ft
Hydraulic Radius	0.22 ft
Froude Number	0.77

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-385L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	4.31 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	3.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE WITH RAILROAD BALLAST	
Freeboard	1 ft	

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.76 ft
with Freeboard	1.76 ft
Top Width	3.80 ft
with Freeboard	8.80 ft
Velocity	2.98 fps
Cross Sectional Area	1.45 sq ft
Hydraulic Radius	0.35 ft
Froude Number	0.85

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-393L

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	6.47 cfs	
Slope	5.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	2.00 feet	
Freeboard	0.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.45 ft
with Freeboard	0.95 ft
Top Width	4.67 ft
with Freeboard	7.67 ft
Velocity	4.35 fps
Cross Sectional Area	1.49 sq ft
Hydraulic Radius	0.31 ft
Manning's n	0.035
Froude Number	1.36
Dmax	0.156 ft (1.88 in)
D50	0.125 ft (1.50 in)
D10	0.042 ft (0.50 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-393R AND RD-394R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	11.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	2.00 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.53 cfs
Depth	0.07 ft
with Freeboard	0.57 ft
Top Width	2.44 ft
with Freeboard	5.44 ft
Velocity	3.24 fps
Cross Sectional Area	0.16 sq ft
Hydraulic Radius	0.07 ft
Froude Number	2.21

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-397R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	15.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	0.50 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE (BADLANDS)	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.14 ft
with Freeboard	0.64 ft
Top Width	1.06 ft
with Freeboard	3.06 ft
Velocity	4.89 fps
Cross Sectional Area	0.11 sq ft
Hydraulic Radius	0.10 ft
Froude Number	2.68

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-405R

Limiting Velocity Technique
Sediment-Laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	1.08 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	RAILROAD BALLAST	
Freeboard	1 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.50 ft
with Freeboard	1.50 ft
Top Width	1.99 ft
with Freeboard	5.99 ft
Velocity	2.19 fps
Cross Sectional Area	0.49 sq ft
Hydraulic Radius	0.22 ft
Froude Number	0.77

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-405R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	6.00 %	
Sideslopes	6.00:1 (L)	2.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE WITH RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.26 ft
with Freeboard	0.76 ft
Top Width	2.15 ft
with Freeboard	6.15 ft
Velocity	3.75 fps
Cross Sectional Area	0.29 sq ft
Hydraulic Radius	0.13 ft
Froude Number	1.80

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-410L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	6.47 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	6.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE WITH RAILROAD BALLAST	
Freeboard	1 ft	

RESULTS:

Actual Discharge	6.47 cfs
Depth	0.73 ft
with Freeboard	1.73 ft
Top Width	5.88 ft
with Freeboard	13.88 ft
Velocity	3.00 fps
Cross Sectional Area	2.16 sq ft
Hydraulic Radius	0.36 ft
Froude Number	0.87

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-411L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	1.08 cfs	
Slope	1.20 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	ALLUVIAL SILTS NONCOLLOIDAL	
Freeboard	1 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.48 ft
with Freeboard	1.48 ft
Top Width	1.92 ft
with Freeboard	5.92 ft
Velocity	2.34 fps
Cross Sectional Area	0.46 sq ft
Hydraulic Radius	0.21 ft
Froude Number	0.84

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-411L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	4.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	2.00 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.15 ft
with Freeboard	0.65 ft
Top Width	2.89 ft
with Freeboard	5.89 ft
Velocity	2.96 fps
Cross Sectional Area	0.37 sq ft
Hydraulic Radius	0.12 ft
Froude Number	1.47

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-412L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	4.20 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.27 ft
with Freeboard	0.77 ft
Top Width	1.18 ft
with Freeboard	3.18 ft
Velocity	3.16 fps
Cross Sectional Area	0.17 sq ft
Hydraulic Radius	0.13 ft
Froude Number	1.46

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-415L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	0.54 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	ALLUVIAL SILTS NONCOLLOIDAL	
Freeboard	1 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.38 ft
with Freeboard	1.38 ft
Top Width	1.53 ft
with Freeboard	5.53 ft
Velocity	1.84 fps
Cross Sectional Area	0.29 sq ft
Hydraulic Radius	0.17 ft
Froude Number	0.74

SEDCAD+ ERODIBLE CHANNEL DESIGN

DS-418R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	8.00 %	
Sideslopes	2.00:1 (L)	3.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALES W\RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.53 cfs
Depth	0.22 ft
with Freeboard	0.72 ft
Top Width	1.18 ft
with Freeboard	3.68 ft
Velocity	3.86 fps
Cross Sectional Area	0.14 sq ft
Hydraulic Radius	0.11 ft
Froude Number	1.99

Note: Although not required, rip-rap (D50 = 0.25 ft.) will be placed.

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-419L

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	5.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	2.00 feet	
Freeboard	0.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.26 ft
with Freeboard	0.76 ft
Top Width	3.58 ft
with Freeboard	6.58 ft
Velocity	2.93 fps
Cross Sectional Area	0.74 sq ft
Hydraulic Radius	0.20 ft
Manning's n	0.039
Froude Number	1.14
Dmax	0.156 ft (1.88 in)
D50	0.125 ft (1.50 in)
D10	0.042 ft (0.50 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-419R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	4.00 %	
Sideslopes	2.00:1 (L)	4.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.31 ft
with Freeboard	0.81 ft
Top Width	1.95 ft
with Freeboard	4.95 ft
Velocity	3.42 fps
Cross Sectional Area	0.32 sq ft
Hydraulic Radius	0.15 ft
Froude Number	1.50

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-425L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	2.16 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	ALLUVIAL SILTS NONCOLLOIDAL	
Freeboard	1 ft	

RESULTS:

Actual Discharge	2.16 cfs
Depth	0.64 ft
with Freeboard	1.64 ft
Top Width	2.58 ft
with Freeboard	6.58 ft
Velocity	2.60 fps
Cross Sectional Area	0.83 sq ft
Hydraulic Radius	0.29 ft
Froude Number	0.81

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-425R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	1.08 cfs	
Slope	1.70 %	
Sideslopes	2.00:1 (L)	4.00:1 (R)
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	ALLUVIAL SILTS NONCOLLIODAL	
Freeboard	1 ft	

RESULTS:

Actual Discharge	1.07 cfs
Depth	0.38 ft
with Freeboard	1.38 ft
Top Width	2.28 ft
with Freeboard	8.28 ft
Velocity	2.48 fps
Cross Sectional Area	0.43 sq ft
Hydraulic Radius	0.18 ft
Froude Number	1.00

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-435L

Limiting Velocity Technique
Sediment-Laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	2.16 cfs	
Slope	1.50 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	ALLUVIAL SILTS NONCOLLOIDAL	
Freeboard	1 ft	

RESULTS:

Actual Discharge	2.16 cfs
Depth	0.60 ft
with Freeboard	1.60 ft
Top Width	2.39 ft
with Freeboard	6.39 ft
Velocity	3.03 fps
Cross Sectional Area	0.71 sq ft
Hydraulic Radius	0.27 ft
Froude Number	0.98

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-435R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	1.08 cfs	
Slope	1.50 %	
Sideslopes	2.00:1 (L)	4.00:1 (R)
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	ALLUVIAL SILTS NONCOLLOIDAL	
Freeboard	1 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.39 ft
with Freeboard	1.39 ft
Top Width	2.34 ft
with Freeboard	8.34 ft
Velocity	2.37 fps
Cross Sectional Area	0.46 sq ft
Hydraulic Radius	0.19 ft
Froude Number	0.95

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-438L

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	4.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	2.00 feet	
Freeboard	0.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.28 ft
with Freeboard	0.78 ft
Top Width -	3.66 ft
with Freeboard	6.66 ft
Velocity	2.76 fps
Cross Sectional Area	0.78 sq ft
Hydraulic Radius	0.21 ft
Manning's n	0.038
Froude Number	1.05
Dmax	0.156 ft (1.88 in)
D50	0.125 ft (1.50 in)
D10	0.042 ft (0.50 in)

DS-438R

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
5.00	3.0:1	3.0:1	12.0	1.00		

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.08 cfs	
Depth:	0.07 ft	1.07 ft
Top Width:	5.40 ft	11.40 ft
Velocity*:		
X-Section Area:	0.34 sq ft	
Hydraulic Radius:	0.063	
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.

SEDCAD+ ERODIBLE CHANNEL DESIGN

DS-439L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	5.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE WITH SANDSTONE COBBLES	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.29 ft
with Freeboard	0.79 ft
Top Width	1.87 ft
with Freeboard	4.87 ft
Velocity	3.72 fps
Cross Sectional Area	0.29 sq ft
Hydraulic Radius	0.15 ft
Froude Number	1.67

Note: Although not required, rip-rap (D50 = 0.25 ft.) will be placed.

DS-439R

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
5.00	3.0:1	3.0:1	10.0	1.00		

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.08 cfs	
Depth:	0.07 ft	1.07 ft
Top Width:	5.44 ft	11.44 ft
Velocity*:		
X-Section Area:	0.38 sq ft	
Hydraulic Radius:	0.070	
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.

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-442L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR
Discharge	1.08 cfs
Slope	1.00 %
Sideslopes	2.00:1 (L) 100.00:1 (R)
Manning's n	0.025
Max. Velocity	5.00 fps
Material	SHALE WITH RAILROAD BALLAST
Freeboard	1 ft

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.14 ft
with Freeboard	1.14 ft
Top Width	14.63 ft
with Freeboard	116.63 ft
Velocity	1.03 fps
Cross Sectional Area	1.05 sq ft
Hydraulic Radius	0.07 ft
Froude Number	0.68

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-442R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	1.08 cfs	
Slope	1.00 %	
Sideslopes	8.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE WITH RAILROAD BALLAST	
Freeboard	1 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.34 ft
with Freeboard	1.34 ft
Top Width	3.44 ft
with Freeboard	13.44 ft
Velocity	1.82 fps
Cross Sectional Area	0.59 sq ft
Hydraulic Radius	0.17 ft
Froude Number	0.77

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-444L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	0.54 cfs	
Slope	3.20 %	
Sideslopes	2.00:1 (L)	3.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE WITH SANDSTONE COBBLES	
Freeboard	1 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.28 ft
with Freeboard	1.28 ft
Top Width	1.40 ft
with Freeboard	6.40 ft
Velocity	2.74 fps
Cross Sectional Area	0.20 sq ft
Hydraulic Radius	0.13 ft
Froude Number	1.29

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-445L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	0.54 cfs	
Slope	3.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE WITH SANDSTONE COBBLES	
Freeboard	1 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.31 ft
with Freeboard	1.31 ft
Top Width	1.24 ft
with Freeboard	5.24 ft
Velocity	2.77 fps
Cross Sectional Area	0.19 sq ft
Hydraulic Radius	0.14 ft
Froude Number	1.24

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-447L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	4.00 %	
Sideslopes	2.00:1 (L)	50.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.24 ft
with Freeboard	0.74 ft
Top Width	12.45 ft
with Freeboard	38.45 ft
Velocity	2.89 fps
Cross Sectional Area	1.49 sq ft
Hydraulic Radius	0.12 ft
Froude Number	1.47

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-447R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	4.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	3.00 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	2.16 cfs
Depth	0.18 ft
with Freeboard	0.68 ft
Top Width	4.08 ft
with Freeboard	7.08 ft
Velocity	3.42 fps
Cross Sectional Area	0.63 sq ft
Hydraulic Radius	0.15 ft
Froude Number	1.53

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-450R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	2.70 %	
Sideslopes	4.00:1 (L)	6.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	3.00 fps	
Material	SHALE WITH SANDSTONE COBBLES	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.47 ft
with Freeboard	0.97 ft
Top Width	4.80 ft
with Freeboard	9.80 ft
Velocity	3.74 fps
Cross Sectional Area	1.15 sq ft
Hydraulic Radius	0.24 ft
Froude Number	1.34

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-460L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	4.31 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	3.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE WITH RAILROAD BALLAST	
Freeboard	1 ft	

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.76 ft
with Freeboard	1.76 ft
Top Width	3.80 ft
with Freeboard	8.80 ft
Velocity	2.98 fps
Cross Sectional Area	1.45 sq ft
Hydraulic Radius	0.35 ft
Froude Number	0.85

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-460R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR
Discharge	4.31 cfs
Slope	1.00 %
Sideslopes	2.00:1 (L) 3.00:1 (R)
Manning's n	0.025
Max. Velocity	3.00 fps
Material	SHALE WITH RAILROAD BALLAST
Freeboard	1 ft

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.76 ft
with Freeboard	1.76 ft
Top Width	3.80 ft
with Freeboard	8.80 ft
Velocity	2.98 fps
Cross Sectional Area	1.45 sq ft
Hydraulic Radius	0.35 ft
Froude Number	0.85

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-471L

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	9.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	2.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.32 ft
with Freeboard	0.82 ft
Top Width	3.93 ft
with Freeboard	6.93 ft
Velocity	4.50 fps
Cross Sectional Area	0.96 sq ft
Hydraulic Radius	0.24 ft
Manning's n	0.038
Froude Number	1.61
Dmax	0.313 ft (3.75 in)
D50	0.250 ft (3.00 in)
D10	0.083 ft (1.00 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-472R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL
Discharge	0.54 cfs
Slope	6.70 %
Sideslopes	2.00:1 (L) 50.00:1 (R)
Bottom Width	0.10 ft
Manning's n	0.025
Max. Velocity	5.00 fps
Material	SHALE WITH SANDSTONE COBBLES
Freeboard	.5 ft

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.10 ft
with Freeboard	0.60 ft
Top Width	5.18 ft
with Freeboard	31.18 ft
Velocity	2.09 fps
Cross Sectional Area	0.26 sq ft
Hydraulic Radius	0.05 ft
Froude Number	1.65

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-474L

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	12.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	2.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.16 ft
with Freeboard	0.66 ft
Top Width	2.94 ft
with Freeboard	5.94 ft
Velocity	2.80 fps
Cross Sectional Area	0.39 sq ft
Hydraulic Radius	0.13 ft
Manning's n	0.047
Froude Number	1.36
Dmax	0.156 ft (1.88 in)
D50	0.125 ft (1.50 in)
D10	0.042 ft (0.50 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-475R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL
Discharge	[illegible].54 cfs
Slope	[illegible].00 %
Sideslopes	2.[illegible]:1 (L) 50.00:1 (R)
Bottom Width	[illegible].10 ft
Manning's n	[illegible].025
Max. Velocity	[illegible].00 fps
Material	SHALE WITH SANDSTONE COBBLES
Freeboard	.5 ft

RESULTS:

Actual Discharge	[illegible].53 cfs
Depth	[illegible].09 ft
with Freeboard	0.[illegible] ft
Top Width	[illegible].77 ft
with Freeboard	30.[illegible] ft
Velocity	[illegible].41 fps
Cross Sectional Area	[illegible].22 sq ft
Hydraulic Radius	[illegible].05 ft
Froude Number	[illegible].99

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-478L

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	15.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	1.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.19 ft
with Freeboard	0.69 ft
Top Width	2.15 ft
with Freeboard	5.15 ft
Velocity	3.56 fps
Cross Sectional Area	0.30 sq ft
Hydraulic Radius	0.14 ft
Manning's n	0.043
Froude Number	1.67
Dmax	0.156 ft (1.88 in)
D50	0.125 ft (1.50 in)
D10	0.042 ft (0.50 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-478R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	20.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	1.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE (BADLANDS)	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.53 cfs
Depth	0.09 ft
with Freeboard	0.59 ft
Top Width	1.54 ft
with Freeboard	4.54 ft
Velocity	4.66 fps
Cross Sectional Area	0.11 sq ft
Hydraulic Radius	0.07 ft
Froude Number	3.01

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-479L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	1.08 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	3.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE WITH RAILROAD BALLAST	
Freeboard	1 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.45 ft
with Freeboard	1.45 ft
Top Width	2.26 ft
with Freeboard	7.26 ft
Velocity	2.11 fps
Cross Sectional Area	0.51 sq ft
Hydraulic Radius	0.21 ft
Froude Number	0.78

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-481L

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	8.62 cfs	
Slope	18.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	3.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.37 ft
with Freeboard	0.87 ft
Top Width	5.24 ft
with Freeboard	8.24 ft
Velocity	5.61 fps
Cross Sectional Area	1.54 sq ft
Hydraulic Radius	0.29 ft
Manning's n	0.049
Froude Number	1.83
Dmax	0.313 ft (3.75 in)
D50	0.250 ft (3.00 in)
D10	0.083 ft (1.00 in)

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

MAX FLOW FOR CH-487L

by

Name: DJR

Company Name: BHP MINERALS
File Name: C:\RUSSELL CH487L

Date: 09-09-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\RUSSELL\CH487L User: DJR
Date: 09-09-1996 Time: 13:14:31
MAX FLOW FOR CH-487L
Storm: 1.30 inches, 10 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	21.00	89	M	0.000	0.000	0.000	0.0	0.85	22.64
		Type: Null			Label: CH-487L					
111	Structure	21.00							0.85	
111	Total IN/OUT	21.00							0.85	22.64

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-4871

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	22.68 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	4.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE WITH RAILROAD BALLAST	
Freeboard	1 ft	

RESULTS:

Actual Discharge	22.68 cfs
Depth	1.32 ft
with Freeboard	2.32 ft
Top Width	7.90 ft
with Freeboard	13.90 ft
Velocity	4.36 fps
Cross Sectional Area	5.21 sq ft
Hydraulic Radius	0.62 ft
Froude Number	0.95

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

MAX FLOW FOR CH-487R

by

Name: DJR

Company Name: BHP MINERALS
File Name: C:\RUSSELL CH487R

Date: 09-09-1996

Civil Software Design -- SEDCAD- Version 3.1
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Company Name: BHP MINERALS
Filename: C:\RUSSELL\CH487R User: DJR
Date: 09-09-1996 Time: 13:14:27
MAX FLOW FOR CH-487R
Storm: 1.30 inches, 10 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	31.00	89	M	0.000	0.000	0.000	0.0	1.25	33.42
		Type: Null			Label: CH-487R					
111	Structure	31.00							1.25	
111	Total IN/OUT	31.00							1.25	33.42

SEDCAD- ERODIBLE CHANNEL DESIGN

CH-487R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	33.48 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	4.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE WITH RAILROAD BALLAST	
Freeboard	1 ft	

RESULTS:

Actual Discharge	33.48 cfs
Depth	1.52 ft
with Freeboard	2.52 ft
Top Width	9.15 ft
with Freeboard	15.15 ft
Velocity	4.80 fps
Cross Sectional Area	6.97 sq ft
Hydraulic Radius	0.72 ft
Froude Number	0.97

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-550+00 RIGHT

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	16.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	5.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.18 ft
with Freeboard	0.68 ft
Top Width	6.11 ft
with Freeboard	9.11 ft
Velocity	4.20 fps
Cross Sectional Area	1.03 sq ft
Hydraulic Radius	0.17 ft
Manning's n	0.043
Froude Number	1.80
Dmax	0.156 ft (1.88 in)
D50	0.125 ft (1.50 in)
D10	0.042 ft (0.50 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-550+10L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL
Discharge	1.54 cfs
Slope	1.00 %
Sideslopes	2.00:1 (L) 10.00:1 (R)
Bottom Width	1.00 ft
Manning's n	1.025
Max. Velocity	3.00 fps
Material	SHALE WITH RAILROAD BALLAST
Freeboard	.5 ft

RESULTS:

Actual Discharge	1.54 cfs
Depth	1.18 ft
with Freeboard	0.68 ft
Top Width	3.18 ft
with Freeboard	9.18 ft
Velocity	1.44 fps
Cross Sectional Area	1.38 sq ft
Hydraulic Radius	1.12 ft
Froude Number	1.73

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-555+60R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	22.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	2.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE (BADLANDS)	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.06 ft
with Freeboard	0.56 ft
Top Width	2.36 ft
with Freeboard	5.36 ft
Velocity	4.06 fps
Cross Sectional Area	0.13 sq ft
Hydraulic Radius	0.06 ft
Froude Number	3.03

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-558+25L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL
Discharge	1.08 cfs
Slope	1.00 %
Sideslopes	2.00:1 (L) 10.00:1 (R)
Bottom Width	0.10 ft
Manning's n	0.025
Max. Velocity	5.00 fps
Material	SHALE W/RAILROAD BALLAST
Freeboard	.5 ft

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.31 ft
with Freeboard	0.81 ft
Top Width	3.86 ft
with Freeboard	9.86 ft
Velocity	1.75 fps
Cross Sectional Area	0.62 sq ft
Hydraulic Radius	0.16 ft
Froude Number	0.77

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-561+00R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	30.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	3.00 ft	
Manning's n	1.025	
Max. Velocity	3.00 fps	
Material	SHALE (BADLANDS)	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	1.05 ft
with Freeboard	0.55 ft
Top Width	3.29 ft
with Freeboard	8.29 ft
Velocity	4.28 fps
Cross Sectional Area	1.25 sq ft
Hydraulic Radius	1.05 ft
Froude Number	3.46

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-562R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	45.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	3.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE (BADLANDS)	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.55 cfs
Depth	0.04 ft
with Freeboard	0.54 ft
Top Width	3.16 ft
with Freeboard	5.16 ft
Velocity	4.54 fps
Cross Sectional Area	0.12 sq ft
Hydraulic Radius	0.04 ft
Froude Number	4.08

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-562+50R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL
Discharge	0.54 cfs
Slope	1.00 %
Sideslopes	2.00:1 (L) 10.00:1 (R)
Bottom Width	0.10 ft
Manning's n	0.025
Max. Velocity	5.00 fps
Material	SHALE W/RAILROAD BALLAST
Freeboard	.5 ft

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.24 ft
with Freeboard	0.74 ft
Top Width	2.97 ft
with Freeboard	8.97 ft
Velocity	1.47 fps
Cross Sectional Area	0.37 sq ft
Hydraulic Radius	0.12 ft
Froude Number	0.73

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-564+50R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	32.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	2.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE (BADLANDS)	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.05 ft
with Freeboard	0.55 ft
Top Width	2.33 ft
with Freeboard	5.33 ft
Velocity	4.58 fps
Cross Sectional Area	0.12 sq ft
Hydraulic Radius	0.05 ft
Froude Number	3.59

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-565+00L

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.16 cfs	
Slope	13.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	3.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	1.15 ft
with Freeboard	0.65 ft
Top Width	3.91 ft
with Freeboard	6.91 ft
Velocity	4.12 fps
Cross Sectional Area	1.52 sq ft
Hydraulic Radius	1.13 ft
Manning's n	1.047
Froude Number	1.98
Dmax	1.156 ft (1.88 in)
D50	1.125 ft (1.50 in)
D10	1.042 ft (0.50 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-568+85L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	2.16 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	10.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE W/RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	2.16 cfs
Depth	0.41 ft
with Freeboard	0.91 ft
Top Width	5.00 ft
with Freeboard	11.00 ft
Velocity	2.07 fps
Cross Sectional Area	1.04 sq ft
Hydraulic Radius	0.21 ft
Froude Number	0.80

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-570+00R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	40.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	1.50 ft	
Manning's n	0.025	
Max. Velocity	5.50 fps	
Material	SHALE (BADLANDS)	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.53 cfs
Depth	0.06 ft
with Freeboard	0.56 ft
Top Width	1.86 ft
with Freeboard	4.86 ft
Velocity	5.34 fps
Cross Sectional Area	0.10 sq ft
Hydraulic Radius	0.05 ft
Froude Number	4.05

SEDCAD+ ERODIBLE CHANNEL DESIGN

DS-570+80R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Slope	19.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	2.00 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	BADLANDS	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.06 ft
with Freeboard	0.56 ft
Top Width	2.25 ft
with Freeboard	4.25 ft
Velocity	3.95 fps
Cross Sectional Area	0.14 sq ft
Hydraulic Radius	0.06 ft
Froude Number	2.84

Note: Although not required, rip-rap (D50 = 0.25 ft.) will be placed.

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-584+55R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL
Discharge	6.47 cfs
Slope	1.00 %
Sideslopes	2.00:1 (L) 10.00:1 (R)
Bottom Width	0.10 ft
Manning's n	0.025
Max. Velocity	5.00 fps
Material	SHALE W/RAILROAD BALLAST
Freeboard	.5 ft

RESULTS:

Actual Discharge	6.47 cfs
Depth	0.62 ft
with Freeboard	1.12 ft
Top Width	7.54 ft
with Freeboard	13.54 ft
Velocity	2.73 fps
Cross Sectional Area	2.37 sq ft
Hydraulic Radius	0.31 ft
Froude Number	0.86

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-592+45L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL
Discharge	6.47 cfs
Slope	1.00 %
Sideslopes	2.00:1 (L) 10.00:1 (R)
Bottom Width	0.10 ft
Manning's n	0.025
Max. Velocity	5.00 fps
Material	SHALE W/RAILROAD BALLAST
Freeboard	.5 ft

RESULTS:

Actual Discharge	6.47 cfs
Depth	0.62 ft
with Freeboard	1.12 ft
Top Width	7.54 ft
with Freeboard	13.54 ft
Velocity	2.73 fps
Cross Sectional Area	2.37 sq ft
Hydraulic Radius	0.31 ft
Froude Number	0.86

SEDCAD+ RIPRAP CHANNEL DESIGN

CH-611R

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	8.67 cfs	
Slope	5.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	3.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.44 ft
with Freeboard	0.94 ft
Top Width	5.65 ft
with Freeboard	8.65 ft
Velocity	4.54 fps
Cross Sectional Area	1.91 sq ft
Hydraulic Radius	0.33 ft
Manning's n	0.035
Froude Number	1.38
Dmax	0.313 ft (3.75 in)
D50	0.250 ft (3.00 in)
D10	0.083 ft (1.00 in)

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-613+50 LEFT

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	6.47 cfs	
Slope	20.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	5.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.25 ft
with Freeboard	0.75 ft
Top Width	6.49 ft
with Freeboard	9.49 ft
Velocity	4.54 fps
Cross Sectional Area	1.43 sq ft
Hydraulic Radius	0.22 ft
Manning's n	0.053
Froude Number	1.71
Dmax	0.313 ft (3.75 in)
D50	0.250 ft (3.00 in)
D10	0.083 ft (1.00 in)

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

-

RELIEF DITCH AT STA 616R (STA 611 TO 623)

by

-

Name: LR

Company Name: BHP MINERALS
File Name: C:\LR\RD616R

Date: 05-11-1998

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

Company Name: BHP MINERALS
Filename: C:\LR\RD616R User: LR
Date: 05-11-1998 Time: 10:13:48
RELIEF DITCH AT STA 616R (STA 611 TO 623)
Storm: 1.30 inches, 10 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 Discharge (cfs)
111	1	12.00	89	M	0.173	0.000	0.000	0.0	0.48	9.18
		Type: Null			Label: CH-616R					
111	Structure	12.00							0.48	
111	Total IN/OUT	12.00							0.48	9.18

Civil Software Design -- SEDCAD- Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\RD616R User: LR
Date: 05-11-1998 Time: 10:13:48
RELIEF DITCH AT STA 616R (STA 611 TO 623)
Storm: 1.30 inches, 10 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)	Muskingum X (hr)	X
1	1	1	1	-a	5	1400.00	5.00	2.24	0.17	0.173		

SEDCAD+ VEGETATED CHANNEL DESIGN

RD-616R

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	9.18 cfs	
Slope	3.00 %	
Sideslopes	6.00:1 (L)	6.00:1 (R)
Bottom Width	3.00 feet	
Max. Velocity	5.000fps	
Material	GRASS MIXTURE	
Freeboard	.5 ft	

RESULTS:

	STABILITY CLASS E	CAPACITY CLASS E	w/ FREEBOARD
Actual Discharge	9.06	9.06 cfs	
Depth	0.47	0.47	0.97 ft
Top Width	8.69	8.69	14.69 ft
Velocity	3.27	3.27 fps	
Cross Sectional Area	2.77	2.77 sq ft	
Hydraulic Radius	0.32	0.32 ft	
Manning's n	0.037	0.037	
Froude Number	1.02	1.02	

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-635+45 LEFT

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	1.10 %	
Sideslopes	3.00:1 (L)	2.00:1 (R)
Bottom Width	25.00 ft	
Manning's n	0.020	
Max. Velocity	5.00 fps	
Material	RAIL ROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.10 ft
with Freeboard	0.60 ft
Top Width	25.31 ft
with Freeboard	28.01 ft
Velocity	1.68 fps
Cross Sectional Area	2.56 sq ft
Hydraulic Radius	0.10 ft
Froude Number	0.94

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-645+90R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	3.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	2.50 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDYCLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.08 cfs
Depth	0.14 ft
with Freeboard	0.64 ft
Top Width	3.36 ft
with Freeboard	6.36 ft
Velocity	2.56 fps
Cross Sectional Area	0.42 sq ft
Hydraulic Radius	0.12 ft
Froude Number	1.28

SEDCAD+ ERODIBLE CHANNEL DESIGN

RD-648+20R

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	0.54 cfs	
Slope	3.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	2.00 ft	
Manning's n	0.025	
Max. Velocity	3.50 fps	
Material	SANDY CLAY	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	0.54 cfs
Depth	0.11 ft
with Freeboard	0.61 ft
Top Width	2.65 ft
with Freeboard	5.65 ft
Velocity	2.13 fps
Cross Sectional Area	0.25 sq ft
Hydraulic Radius	0.09 ft
Froude Number	1.22

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-650+95 RIGHT

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	1.08 cfs	
Slope	4.00 %	
Sideslopes	3.00:1 (L)	2.00:1 (R)
Bottom Width	2.00 ft	
Manning's n	0.020	
Max. Velocity	3.50 fps	
Material	SANDY LOAM NONCOLLOIDAL	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	1.07 cfs
Depth	0.13 ft
with Freeboard	0.63 ft
Top Width	2.66 ft
with Freeboard	5.16 ft
Velocity	3.48 fps
Cross Sectional Area	0.31 sq ft
Hydraulic Radius	0.11 ft
Froude Number	1.81

SEDCAD+ RIPRAP CHANNEL DESIGN

DS-652+90 RIGHT

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	24.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	2.00 feet	
Freeboard	.5 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.30 ft
with Freeboard	0.80 ft
Top Width	3.78 ft
with Freeboard	6.78 ft
Velocity	5.03 fps
Cross Sectional Area	0.86 sq ft
Hydraulic Radius	0.22 ft
Manning's n	0.053
Froude Number	1.86
Dmax	0.313 ft (3.75 in)
D50	0.250 ft (3.00 in)
D10	0.083 ft (1.00 in)

SEDCAD+ ERODIBLE CHANNEL DESIGN

CH-663+90L

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	4.31 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	10.00:1 (R)
Bottom Width	0.10 ft	
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	SHALE W/RAILROAD BALLAST	
Freeboard	.5 ft	

RESULTS:

Actual Discharge	4.31 cfs
Depth	0.53 ft
with Freeboard	1.03 ft
Top Width	6.48 ft
with Freeboard	12.48 ft
Velocity	2.47 fps
Cross Sectional Area	1.75 sq ft
Hydraulic Radius	0.27 ft
Froude Number	0.84

SEDCAD+ CULVERT SIZING UTILITY

CP-98

Design Discharge	=	2.160 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	80.000 feet
Pipe Slope	=	1.000 %
Manning's n	=	0.015
Maximum Headwater	=	1.600 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 12 inches

PERFORMANCE CURVES:

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.20	Outlet (Subcritical)	1
0.32	0.39	Outlet (Subcritical)	2
0.48	0.59	Inlet (Supercritical)	3
0.64	0.79	Inlet (Supercritical)	4
0.80	0.99	Inlet	5
0.96	1.05	Inlet	5
1.12	1.11	Inlet	5
1.28	1.16	Inlet	5
1.44	1.22	Inlet	5
1.60	1.28	Inlet	5
1.76	1.33	Inlet	5
1.92	1.39	Inlet	5
2.08	1.45	Inlet	5
2.24	1.50	Outlet	6
2.40	1.56	Outlet	6

Diameter: 9 inches

Headwater	Discharge	Flow

(ft)	(cfs)	Control	Type
0.16	0.19		0
0.32	0.39		0
0.48	0.58	Outlet (Subcritical)	1
0.64	0.78	Outlet (Subcritical)	1
0.80	0.97	Outlet (Subcritical)	1
0.96	1.11	Outlet (Subcritical)	2
1.12	1.25	Outlet (Subcritical)	2
1.28	1.39	Inlet (Supercritical)	3
1.44	1.52	Inlet (Supercritical)	4
1.60	1.66	Inlet (Supercritical)	4
1.76	1.80	Inlet	5
1.92	1.93	Outlet	6
2.08	2.03	Outlet	6
2.24	2.09	Outlet	6
2.40	2.15	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.26	Outlet (Subcritical)	1
0.32	0.52	Outlet (Subcritical)	2
0.48	0.79	Outlet (Subcritical)	2
0.64	1.08	Inlet (Supercritical)	3
0.80	1.53	Inlet (Supercritical)	3
0.96	1.97	Inlet (Supercritical)	3
1.12	2.44	Inlet (Supercritical)	4
1.28	2.91	Inlet	5
1.44	3.15	Inlet	5
1.60	3.34	Inlet	5
1.76	3.53	Outlet	6
1.92	3.72	Outlet	6
2.08	3.91	Outlet	6
2.24	4.07	Outlet	6
2.40	4.20	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.30	Outlet (Subcritical)	1
0.32	0.61	Outlet (Subcritical)	2
0.48	0.91	Inlet (Supercritical)	3
0.64	1.37	Inlet (Supercritical)	3
0.80	1.88	Inlet (Supercritical)	3
0.96	2.48	Inlet (Supercritical)	3
1.12	3.11	Inlet (Supercritical)	3
1.28	3.80	Inlet (Supercritical)	3
1.44	4.46	Inlet (Supercritical)	4
1.60	5.09	Inlet	5
1.76	5.60	Outlet	6
1.92	6.06	Outlet	6
2.08	6.33	Outlet	6
2.24	6.60	Outlet	6
2.40	6.87	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.34	Outlet (Subcritical)	1
0.32	0.69	Outlet (Subcritical)	2
0.48	1.05	Inlet (Supercritical)	3
0.64	1.63	Inlet (Supercritical)	3
0.80	2.26	Inlet (Supercritical)	3
0.96	2.96	Inlet (Supercritical)	3
1.12	3.73	Inlet (Supercritical)	3
1.28	4.56	Inlet (Supercritical)	3
1.44	5.43	Inlet (Supercritical)	3
1.60	6.36	Inlet (Supercritical)	3
1.76	7.27	Inlet (Supercritical)	4
1.92	8.06	Inlet	5
2.08	8.78	Inlet	5
2.24	9.43	Inlet	5
2.40	10.03	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.38	Outlet (Subcritical)	1
0.32	0.76	Outlet (Subcritical)	2
0.48	1.24	Inlet (Supercritical)	3
0.64	1.89	Inlet (Supercritical)	3
0.80	2.64	Inlet (Supercritical)	3
0.96	3.46	Inlet (Supercritical)	3
1.12	4.35	Inlet (Supercritical)	3
1.28	5.31	Inlet (Supercritical)	3
1.44	6.34	Inlet (Supercritical)	3
1.60	7.42	Inlet (Supercritical)	3
1.76	8.56	Inlet (Supercritical)	3
1.92	9.75	Inlet (Supercritical)	3
2.08	10.84	Inlet	5
2.24	11.84	Inlet	5
2.40	12.77	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

CP-99

Design Discharge	=	2.160	cfs
Entrance Loss Coefficient	=	0.9	
Pipe Length	=	80.000	feet
Pipe Slope	=	1.000	%
Manning's n	=	0.015	
Maximum Headwater	=	1.600	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 12 inches

PERFORMANCE CURVES:

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.20	Outlet (Subcritical)	1
0.32	0.39	Outlet (Subcritical)	2
0.48	0.59	Inlet (Supercritical)	3
0.64	0.79	Inlet (Supercritical)	4
0.80	0.99	Inlet	5
0.96	1.05	Inlet	5
1.12	1.11	Inlet	5
1.28	1.16	Inlet	5
1.44	1.22	Inlet	5
1.60	1.28	Inlet	5
1.76	1.33	Inlet	5
1.92	1.39	Inlet	5
2.08	1.45	Inlet	5
2.24	1.50	Outlet	6
2.40	1.56	Outlet	6

Diameter: 9 inches

Headwater	Discharge	Flow

(ft)	(cfs)	Control	Type
0.16	0.19		0
0.32	0.39		0
0.48	0.58	Outlet (Subcritical)	1
0.64	0.78	Outlet (Subcritical)	1
0.80	0.97	Outlet (Subcritical)	1
0.96	1.11	Outlet (Subcritical)	2
1.12	1.25	Outlet (Subcritical)	2
1.28	1.39	Inlet (Supercritical)	3
1.44	1.52	Inlet (Supercritical)	4
1.60	1.66	Inlet (Supercritical)	4
1.76	1.80	Inlet	5
1.92	1.93	Outlet	6
2.08	2.03	Outlet	6
2.24	2.09	Outlet	6
2.40	2.15	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.26	Outlet (Subcritical)	1
0.32	0.52	Outlet (Subcritical)	2
0.48	0.79	Outlet (Subcritical)	2
0.64	1.08	Inlet (Supercritical)	3
0.80	1.53	Inlet (Supercritical)	3
0.96	1.97	Inlet (Supercritical)	3
1.12	2.44	Inlet (Supercritical)	4
1.28	2.91	Inlet	5
1.44	3.15	Inlet	5
1.60	3.34	Inlet	5
1.76	3.53	Outlet	6
1.92	3.72	Outlet	6
2.08	3.91	Outlet	6
2.24	4.07	Outlet	6
2.40	4.20	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.30	Outlet (Subcritical)	1
0.32	0.61	Outlet (Subcritical)	2
0.48	0.91	Inlet (Supercritical)	3
0.64	1.37	Inlet (Supercritical)	3
0.80	1.88	Inlet (Supercritical)	3
0.96	2.48	Inlet (Supercritical)	3
1.12	3.11	Inlet (Supercritical)	3
1.28	3.80	Inlet (Supercritical)	3
1.44	4.46	Inlet (Supercritical)	4
1.60	5.09	Inlet	5
1.76	5.60	Outlet	6
1.92	6.06	Outlet	6
2.08	6.33	Outlet	6
2.24	6.60	Outlet	6
2.40	6.87	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.34	Outlet (Subcritical)	1
0.32	0.69	Outlet (Subcritical)	2
0.48	1.05	Inlet (Supercritical)	3
0.64	1.63	Inlet (Supercritical)	3
0.80	2.26	Inlet (Supercritical)	3
0.96	2.96	Inlet (Supercritical)	3
1.12	3.73	Inlet (Supercritical)	3
1.28	4.56	Inlet (Supercritical)	3
1.44	5.43	Inlet (Supercritical)	3
1.60	6.36	Inlet (Supercritical)	3
1.76	7.27	Inlet (Supercritical)	4
1.92	8.06	Inlet	5
2.08	8.78	Inlet	5
2.24	9.43	Inlet	5
2.40	10.03	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.38	Outlet (Subcritical)	1
0.32	0.76	Outlet (Subcritical)	2
0.48	1.24	Inlet (Supercritical)	3
0.64	1.89	Inlet (Supercritical)	3
0.80	2.64	Inlet (Supercritical)	3
0.96	3.46	Inlet (Supercritical)	3
1.12	4.35	Inlet (Supercritical)	3
1.28	5.31	Inlet (Supercritical)	3
1.44	6.34	Inlet (Supercritical)	3
1.60	7.42	Inlet (Supercritical)	3
1.76	8.56	Inlet (Supercritical)	3
1.92	9.75	Inlet (Supercritical)	3
2.08	10.84	Inlet	5
2.24	11.84	Inlet	5
2.40	12.77	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

CP-100

Design Discharge	=	0.540 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	60.000 feet
Pipe Slope	=	2.000 %
Manning's n	=	0.015
Maximum Headwater	=	1.600 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 6 inches

PERFORMANCE CURVES:

Diameter: 2 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.00		0
0.32	0.00		0
0.48	0.00		0
0.64	0.00		0
0.80	0.00		0
0.96	0.00		0
1.12	0.00		0
1.28	0.00		0
1.44	0.00		0
1.60	0.00	-	0
1.76	0.00		0
1.92	0.00		0
2.08	0.00		0
2.24	0.00		0
2.40	0.00		0

Diameter: 4 inches

Headwater	Discharge	Flow

(ft)	(cfs)	Control	Type
0.16	0.01		0
0.32	0.01		0
0.48	0.02		0
0.64	0.03		0
0.80	0.03		0
0.96	0.04		0
1.12	0.04		0
1.28	0.05		0
1.44	0.06		0
1.60	0.06		0
1.76	0.07		0
1.92	0.08		0
2.08	0.08		0
2.24	0.09	Outlet (Subcritical)	1
2.40	0.10	Outlet (Subcritical)	1

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.06		0
0.32	0.13	Outlet (Subcritical)	1
0.48	0.19	Outlet (Subcritical)	1
0.64	0.25	Outlet (Subcritical)	2
0.80	0.32	Outlet (Subcritical)	2
0.96	0.38	Outlet (Subcritical)	2
1.12	0.44	Inlet (Supercritical)	3
1.28	0.51	Inlet (Supercritical)	3
1.44	0.57	Inlet (Supercritical)	3
1.60	0.63	Inlet (Supercritical)	4
1.76	0.70	Inlet (Supercritical)	4
1.92	0.76	Inlet	5
2.08	0.82	Inlet	5
2.24	0.89	Inlet	5
2.40	0.95	Outlet	6

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.20	Outlet (Subcritical)	1
0.32	0.39	Outlet (Subcritical)	2
0.48	0.59	Inlet (Supercritical)	3
0.64	0.79	Inlet (Supercritical)	4
0.80	0.99	Inlet	5
0.96	1.09	Inlet	5
1.12	1.18	Inlet	5
1.28	1.27	Inlet	5
1.44	1.37	Inlet	5
1.60	1.46	Inlet	5
1.76	1.55	Outlet	6
1.92	1.65	Outlet	6
2.08	1.74	Outlet	6
2.24	1.83	Outlet	6
2.40	1.93	Outlet	6

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.22	Outlet (Subcritical)	1
0.32	0.43	Outlet (Subcritical)	1
0.48	0.65	Outlet (Subcritical)	2
0.64	0.86	Inlet (Supercritical)	3
0.80	1.10	Inlet (Supercritical)	3
0.96	1.35	Inlet (Supercritical)	4
1.12	1.61	Inlet (Supercritical)	4
1.28	1.86	Inlet	5
1.44	2.04	Inlet	5
1.60	2.11	Inlet	5
1.76	2.19	Inlet	5
1.92	2.27	Inlet	5
2.08	2.35	Inlet	5
2.24	2.42	Inlet	5
2.40	2.50	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.26	Outlet (Subcritical)	1
0.32	0.52	Outlet (Subcritical)	2
0.48	0.79	Outlet (Subcritical)	2
0.64	1.08	Inlet (Supercritical)	3
0.80	1.53	Inlet (Supercritical)	3
0.96	1.97	Inlet (Supercritical)	3
1.12	2.44	Inlet (Supercritical)	4
1.28	2.91	Inlet	5
1.44	3.28	Inlet	5
1.60	3.63	Inlet	5
1.76	3.98	Inlet	5
1.92	4.23	Inlet	5
2.08	4.48	Inlet	5
2.24	4.72	Outlet	6
2.40	4.97	Outlet	6

SEDCAD+ CULVERT SIZING UTILITY

CP-101

Design Discharge	=	2.160	cfs
Entrance Loss Coefficient	=	0.9	
Pipe Length	=	40.000	feet
Pipe Slope	=	1.000	%
Manning's n	=	0.015	
Maximum Headwater	=	1.600	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 12 inches

PERFORMANCE CURVES:

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.20	Outlet (Subcritical)	1
0.32	0.39	Outlet (Subcritical)	2
0.48	0.59	Inlet (Supercritical)	3
0.64	0.79	Inlet (Supercritical)	4
0.80	0.99	Inlet	5
0.96	1.08	Inlet	5
1.12	1.17	Inlet	5
1.28	1.26	Inlet	5
1.44	1.35	Inlet	5
1.60	1.44	Inlet	5
1.76	1.53	Outlet	6
1.92	1.62	Outlet	6
2.08	1.71	Outlet	6
2.24	1.80	Outlet	6
2.40	1.89	Outlet	6

Diameter: 9 inches

Headwater	Discharge		Flow

(ft)	(cfs)	Control	Type
0.16	0.19		0
0.32	0.39		0
0.48	0.58	Outlet (Subcritical)	1
0.64	0.78	Outlet (Subcritical)	1
0.80	0.97	Outlet (Subcritical)	1
0.96	1.17	Outlet (Subcritical)	2
1.12	1.37	Inlet (Supercritical)	3
1.28	1.57	Inlet (Supercritical)	4
1.44	1.77	Inlet	5
1.60	1.97	Outlet	6
1.76	2.08	Outlet	6
1.92	2.17	Outlet	6
2.08	2.27	Outlet	6
2.24	2.36	Outlet	6
2.40	2.45	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.26	Outlet (Subcritical)	1
0.32	0.52	Outlet (Subcritical)	2
0.48	0.79	Outlet (Subcritical)	2
0.64	1.08	Inlet (Supercritical)	3
0.80	1.53	Inlet (Supercritical)	3
0.96	1.97	Inlet (Supercritical)	3
1.12	2.44	Inlet (Supercritical)	4
1.28	2.91	Inlet	5
1.44	3.23	Inlet	5
1.60	3.50	Outlet	6
1.76	3.78	Outlet	6
1.92	4.04	Outlet	6
2.08	4.24	Outlet	6
2.24	4.44	Outlet	6
2.40	4.63	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.30	Outlet (Subcritical)	1
0.32	0.61	Outlet (Subcritical)	2
0.48	0.91	Inlet (Supercritical)	3
0.64	1.37	Inlet (Supercritical)	3
0.80	1.88	Inlet (Supercritical)	3
0.96	2.48	Inlet (Supercritical)	3
1.12	3.11	Inlet (Supercritical)	3
1.28	3.80	Inlet (Supercritical)	3
1.44	4.46	Inlet (Supercritical)	4
1.60	5.10	Inlet	5
1.76	5.64	Inlet	5
1.92	6.14	Inlet	5
2.08	6.56	Outlet	6
2.24	6.98	Outlet	6
2.40	7.31	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.34	Outlet (Subcritical)	1
0.32	0.69	Outlet (Subcritical)	2
0.48	1.05	Inlet (Supercritical)	3
0.64	1.63	Inlet (Supercritical)	3
0.80	2.26	Inlet (Supercritical)	3
0.96	2.96	Inlet (Supercritical)	3
1.12	3.73	Inlet (Supercritical)	3
1.28	4.56	Inlet (Supercritical)	3
1.44	5.43	Inlet (Supercritical)	3
1.60	6.36	Inlet (Supercritical)	3
1.76	7.27	Inlet (Supercritical)	4
1.92	8.06	Inlet	5
2.08	8.78	Inlet	5
2.24	9.46	Inlet	5
2.40	10.10	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.38	Outlet (Subcritical)	1
0.32	0.76	Outlet (Subcritical)	2
0.48	1.24	Inlet (Supercritical)	3
0.64	1.89	Inlet (Supercritical)	3
0.80	2.64	Inlet (Supercritical)	3
0.96	3.46	Inlet (Supercritical)	3
1.12	4.35	Inlet (Supercritical)	3
1.28	5.31	Inlet (Supercritical)	3
1.44	6.34	Inlet (Supercritical)	3
1.60	7.42	Inlet (Supercritical)	3
1.76	8.56	Inlet (Supercritical)	3
1.92	9.75	Inlet (Supercritical)	3
2.08	10.84	Inlet	5
2.24	11.84	Inlet	5
2.40	12.77	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

CP-102

Design Discharge	=	1.080	cfs
Entrance Loss Coefficient	=	0.9	
Pipe Length	=	50.000	feet
Pipe Slope	=	1.000	%
Manning's n	=	0.015	
Maximum Headwater	=	2.400	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 8 inches

PERFORMANCE CURVES:

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.24	0.01		0
0.48	0.02		0
0.72	0.03		0
0.96	0.04		0
1.20	0.05		0
1.44	0.07		0
1.68	0.08		0
1.92	0.09	Outlet (Subcritical)	1
2.16	0.10	Outlet (Subcritical)	1
2.40	0.11	Outlet (Subcritical)	1
2.64	0.12	Outlet (Subcritical)	1
2.88	0.13	Outlet (Subcritical)	1
3.12	0.14	Outlet (Subcritical)	1
3.36	0.15	Outlet (Subcritical)	1
3.60	0.16	Outlet (Subcritical)	1

Diameter: 6 inches

Headwater	Discharge		Flow

(ft)	(cfs)	Control	Type
0.24	0.09	Outlet (Subcritical)	1
0.48	0.17	Outlet (Subcritical)	1
0.72	0.26	Outlet (Subcritical)	2
0.96	0.34	Outlet (Subcritical)	2
1.20	0.43	Inlet (Supercritical)	3
1.44	0.51	Inlet (Supercritical)	3
1.68	0.60	Inlet (Supercritical)	4
1.92	0.68	Inlet (Supercritical)	4
2.16	0.77	Inlet	5
2.40	0.86	Inlet	5
2.64	0.94	Outlet	6
2.88	1.01	Outlet	6
3.12	1.04	Outlet	6
3.36	1.06	Outlet	6
3.60	1.09	Outlet	6

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.24	0.30	Outlet (Subcritical)	1
0.48	0.59	Inlet (Supercritical)	3
0.72	0.89	Inlet (Supercritical)	4
0.96	1.07	Inlet	5
1.20	1.19	Inlet	5
1.44	1.31	Inlet	5
1.68	1.42	Inlet	5
1.92	1.54	Outlet	6
2.16	1.66	Outlet	6
2.40	1.78	Outlet	6
2.64	1.89	Outlet	6
2.88	2.01	Outlet	6
3.12	2.07	Outlet	6
3.36	2.14	Outlet	6
3.60	2.21	Outlet	6

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.24	0.29		0
0.48	0.58	Outlet (Subcritical)	1
0.72	0.87	Outlet (Subcritical)	1
0.96	1.15	Outlet (Subcritical)	2
1.20	1.42	Inlet (Supercritical)	3
1.44	1.69	Inlet (Supercritical)	4
1.68	1.96	Outlet	6
1.92	2.10	Outlet	6
2.16	2.23	Outlet	6
2.40	2.35	Outlet	6
2.64	2.47	Outlet	6
2.88	2.59	Outlet	6
3.12	2.71	Outlet	6
3.36	2.83	Outlet	6
3.60	2.95	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.24	0.39	Outlet (Subcritical)	1
0.48	0.79	Outlet (Subcritical)	2
0.72	1.30	Inlet (Supercritical)	3
0.96	1.97	Inlet (Supercritical)	3
1.20	2.68	Inlet (Supercritical)	4
1.44	3.20	Inlet	5
1.68	3.57	Outlet	6
1.92	3.95	Outlet	6
2.16	4.23	Outlet	6
2.40	4.49	Outlet	6
2.64	4.76	Outlet	6
2.88	5.02	Outlet	6
3.12	5.24	Outlet	6
3.36	5.45	Outlet	6
3.60	5.67	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.24	0.46	Outlet (Subcritical)	1
0.48	0.91	Inlet (Supercritical)	3
0.72	1.63	Inlet (Supercritical)	3
0.96	2.48	Inlet (Supercritical)	3
1.20	3.45	Inlet (Supercritical)	3
1.44	4.46	Inlet (Supercritical)	4
1.68	5.37	Inlet	5
1.92	6.12	Inlet	5
2.16	6.67	Outlet	6
2.40	7.18	Outlet	6
2.64	7.63	Outlet	6
2.88	8.07	Outlet	6
3.12	8.46	Outlet	6
3.36	8.86	Outlet	6
3.60	9.23	Outlet	6

SEDCAD+ CULVERT SIZING UTILITY

DD23 - CHECK TO SEE IF EXISTING 1.3 FEET DIAMETER PIPE IS CAPABLE OF HANDLING CURRENT WATERSHED

Design Discharge	=	0.540 cfs
Entrance Loss Coefficient	=	0.2
Pipe Length	=	48.000 feet
Pipe Slope	=	68.000 %
Manning's n	=	0.014
Maximum Headwater	=	1.600 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 6 inches

PERFORMANCE CURVES:

Diameter: 2 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.00		0
0.32	0.00		0
0.48	0.00		0
0.64	0.00		0
0.80	0.00		0
0.96	0.00		0
1.12	0.00		0
1.28	0.00		0
1.44	0.00		0
1.60	0.00		0
1.76	0.00		0
1.92	0.00		0
2.08	0.00		0
2.24	0.00		0
2.40	0.00		0

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.03		0

0.32	0.06	0	
0.48	0.09	0	
0.64	0.12	Outlet (Subcritical)	1
0.80	0.14	Outlet (Subcritical)	1
0.96	0.17	Outlet (Subcritical)	1
1.12	0.20	Outlet (Subcritical)	1
1.28	0.23	Outlet (Subcritical)	1
1.44	0.26	Outlet (Subcritical)	1
1.60	0.29	Outlet (Subcritical)	1
1.76	0.32	Outlet (Subcritical)	2
1.92	0.35	Outlet (Subcritical)	2
2.08	0.38	Outlet (Subcritical)	2
2.24	0.40	Outlet (Subcritical)	2
2.40	0.43	Outlet (Subcritical)	2

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.11	Outlet (Subcritical)	1
0.32	0.23	Outlet (Subcritical)	1
0.48	0.34	Outlet (Subcritical)	2
0.64	0.45	Outlet (Subcritical)	2
0.80	0.57	Inlet (Supercritical)	3
0.96	0.68	Inlet (Supercritical)	3
1.12	0.80	Inlet (Supercritical)	4
1.28	0.91	Inlet	5
1.44	1.01	Inlet	5
1.60	1.06	Inlet	5
1.76	1.11	Inlet	5
1.92	1.16	Inlet	5
2.08	1.21	Inlet	5
2.24	1.26	Inlet	5
2.40	1.32	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.20	Outlet (Subcritical)	1
0.32	0.39	Outlet (Subcritical)	2
0.48	0.59	Inlet (Supercritical)	3

0.64	0.79	Inlet (Supercritical)	4
0.80	0.99	Inlet	5
0.96	1.15	Inlet	5
1.12	1.31	Inlet	5
1.28	1.47	Inlet	5
1.44	1.63	Inlet	5
1.60	1.79	Inlet	5
1.76	1.95	Inlet	5
1.92	2.07	Inlet	5
2.08	2.17	Inlet	5
2.24	2.26	Inlet	5
2.40	2.36	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.22	Outlet (Subcritical)	1
0.32	0.43	Outlet (Subcritical)	1
0.48	0.65	Outlet (Subcritical)	2
0.64	0.86	Inlet (Supercritical)	3
0.80	1.10	Inlet (Supercritical)	3
0.96	1.35	Inlet (Supercritical)	4
1.12	1.61	Inlet (Supercritical)	4
1.28	1.86	Inlet	5
1.44	2.07	Inlet	5
1.60	2.22	Inlet	5
1.76	2.38	Inlet	5
1.92	2.53	Inlet	5
2.08	2.69	Inlet	5
2.24	2.84	Inlet	5
2.40	3.00	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.16	0.26	Outlet (Subcritical)	1
0.32	0.52	Outlet (Subcritical)	2
0.48	0.79	Outlet (Subcritical)	2
0.64	1.08	Inlet (Supercritical)	3
0.80	1.53	Inlet (Supercritical)	3

0.96	1.97	Inlet (Supercritical)	3
1.12	2.44	Inlet (Supercritical)	4
1.28	2.91	Inlet	5
1.44	3.28	Inlet	5
1.60	3.63	Inlet	5
1.76	3.98	Inlet	5
1.92	4.26	Inlet	5
2.08	4.53	Inlet	5
2.24	4.80	Inlet	5
2.40	5.06	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

DD24 - CHECK TO SEE IF EXISTING 10 INCH DIAMETER PIPE IS CAPABLE OF HANDLING CURRENT WATERSHED.

Design Discharge	=	0.540 cfs
Entrance Loss Coefficient	=	0.2
Pipe Length	=	34.000 feet
Pipe Slope	=	50.000 %
Manning's n	=	0.014
Maximum Headwater	=	1.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 6 inches

PERFORMANCE CURVES:

Diameter: 2 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.00		0
0.20	0.00		0
0.30	0.00		0
0.40	0.00		0
0.50	0.00		0
0.60	0.00		0
0.70	0.00		0
0.80	0.00		0
0.90	0.00		0
1.00	0.00		0
1.10	0.00		0
1.20	0.00		0
1.30	0.00		0
1.40	0.00		0
1.50	0.00		0

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.02		0

0.20	0.04	0	
0.30	0.05	0	
0.40	0.07	0	
0.50	0.09	0	
0.60	0.11	Outlet (Subcritical)	1
0.70	0.13	Outlet (Subcritical)	1
0.80	0.14	Outlet (Subcritical)	1
0.90	0.16	Outlet (Subcritical)	1
1.00	0.18	Outlet (Subcritical)	1
1.10	0.20	Outlet (Subcritical)	1
1.20	0.22	Outlet (Subcritical)	1
1.30	0.23	Outlet (Subcritical)	1
1.40	0.25	Outlet (Subcritical)	1
1.50	0.27	Outlet (Subcritical)	1

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.07	0	
0.20	0.14	Outlet (Subcritical)	1
0.30	0.21	Outlet (Subcritical)	1
0.40	0.28	Outlet (Subcritical)	1
0.50	0.36	Outlet (Subcritical)	2
0.60	0.43	Outlet (Subcritical)	2
0.70	0.50	Outlet (Subcritical)	2
0.80	0.57	Inlet (Supercritical)	3
0.90	0.64	Inlet (Supercritical)	3
1.00	0.71	Inlet (Supercritical)	4
1.10	0.78	Inlet (Supercritical)	4
1.20	0.85	Inlet (Supercritical)	4
1.30	0.92	Inlet	5
1.40	0.99	Inlet	5
1.50	1.03	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.12	Outlet (Subcritical)	1
0.20	0.25	Outlet (Subcritical)	1
0.30	0.37	Outlet (Subcritical)	2

0.40	0.49	Outlet (Subcritical)	2
0.50	0.62	Inlet (Supercritical)	3
0.60	0.74	Inlet (Supercritical)	4
0.70	0.86	Inlet (Supercritical)	4
0.80	0.99	Inlet	5
0.90	1.09	Inlet	5
1.00	1.19	Inlet	5
1.10	1.29	Inlet	5
1.20	1.39	Inlet	5
1.30	1.49	Inlet	5
1.40	1.59	Inlet	5
1.50	1.69	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.14		0
0.20	0.27	Outlet (Subcritical)	1
0.30	0.41	Outlet (Subcritical)	1
0.40	0.54	Outlet (Subcritical)	2
0.50	0.68	Outlet (Subcritical)	2
0.60	0.81	Outlet (Subcritical)	2
0.70	0.95	Inlet (Supercritical)	3
0.80	1.10	Inlet (Supercritical)	3
0.90	1.25	Inlet (Supercritical)	4
1.00	1.41	Inlet (Supercritical)	4
1.10	1.57	Inlet (Supercritical)	4
1.20	1.73	Inlet (Supercritical)	4
1.30	1.89	Inlet	5
1.40	2.03	Inlet	5
1.50	2.13	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.16		0
0.20	0.33	Outlet (Subcritical)	1
0.30	0.49	Outlet (Subcritical)	1
0.40	0.65	Outlet (Subcritical)	2
0.50	0.82	Outlet (Subcritical)	2

0.60	0.98	Inlet (Supercritical)	3
0.70	1.25	Inlet (Supercritical)	3
0.80	1.53	Inlet (Supercritical)	3
0.90	1.81	Inlet (Supercritical)	3
1.00	2.09	Inlet (Supercritical)	3
1.10	2.38	Inlet (Supercritical)	4
1.20	2.68	Inlet (Supercritical)	4
1.30	2.97	Inlet	5
1.40	3.20	Inlet	5
1.50	3.42	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

DD-25

Design Discharge	=	1.080 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	66.700 feet
Pipe Slope	=	25.000 %
Manning's n	=	0.013
Maximum Headwater	=	0.900 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 8 inches

PERFORMANCE CURVES:

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.09	0.02		0
0.18	0.03		0
0.27	0.05		0
0.36	0.06		0
0.45	0.08		0
0.54	0.10		0
0.63	0.11	Outlet (Subcritical)	1
0.72	0.13	Outlet (Subcritical)	1
0.81	0.15	Outlet (Subcritical)	1
0.90	0.16	Outlet (Subcritical)	1
0.99	0.18	Outlet (Subcritical)	1
1.08	0.19	Outlet (Subcritical)	1
1.17	0.21	Outlet (Subcritical)	1
1.26	0.23	Outlet (Subcritical)	1
1.35	0.24	Outlet (Subcritical)	1

Diameter: 6 inches

Headwater	Discharge	Flow

(ft)	(cfs)	Control	Type
0.09	0.06		0
0.18	0.13	Outlet (Subcritical)	1
0.27	0.19	Outlet (Subcritical)	1
0.36	0.26	Outlet (Subcritical)	1
0.45	0.32	Outlet (Subcritical)	2
0.54	0.38	Outlet (Subcritical)	2
0.63	0.45	Outlet (Subcritical)	2
0.72	0.51	Inlet (Supercritical)	3
0.81	0.58	Inlet (Supercritical)	3
0.90	0.64	Inlet (Supercritical)	3
0.99	0.70	Inlet (Supercritical)	4
1.08	0.77	Inlet (Supercritical)	4
1.17	0.83	Inlet (Supercritical)	4
1.26	0.90	Inlet (Supercritical)	4
1.35	0.96	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.09	0.11	Outlet (Subcritical)	1
0.18	0.22	Outlet (Subcritical)	1
0.27	0.33	Outlet (Subcritical)	2
0.36	0.44	Outlet (Subcritical)	2
0.45	0.55	Inlet (Supercritical)	3
0.54	0.67	Inlet (Supercritical)	3
0.63	0.78	Inlet (Supercritical)	4
0.72	0.89	Inlet (Supercritical)	4
0.81	1.00	Inlet	5
0.90	1.09	Inlet	5
0.99	1.18	Inlet	5
1.08	1.27	Inlet	5
1.17	1.36	Inlet	5
1.26	1.45	Inlet	5
1.35	1.54	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.09	0.12		0
0.18	0.24	Outlet (Subcritical)	1
0.27	0.36	Outlet (Subcritical)	1
0.36	0.49	Outlet (Subcritical)	1
0.45	0.61	Outlet (Subcritical)	2
0.54	0.73	Outlet (Subcritical)	2
0.63	0.85	Inlet (Supercritical)	3
0.72	0.97	Inlet (Supercritical)	3
0.81	1.11	Inlet (Supercritical)	3
0.90	1.25	Inlet (Supercritical)	4
0.99	1.40	Inlet (Supercritical)	4
1.08	1.54	Inlet (Supercritical)	4
1.17	1.68	Inlet (Supercritical)	4
1.26	1.83	Inlet	5
1.35	1.97	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.09	0.15		0
0.18	0.29	Outlet (Subcritical)	1
0.27	0.44	Outlet (Subcritical)	1
0.36	0.59	Outlet (Subcritical)	2
0.45	0.74	Outlet (Subcritical)	2
0.54	0.88	Inlet (Supercritical)	3
0.63	1.05	Inlet (Supercritical)	3
0.72	1.30	Inlet (Supercritical)	3
0.81	1.55	Inlet (Supercritical)	3
0.90	1.81	Inlet (Supercritical)	3
0.99	2.06	Inlet (Supercritical)	3
1.08	2.32	Inlet (Supercritical)	4
1.17	2.59	Inlet (Supercritical)	4
1.26	2.85	Inlet	5
1.35	3.09	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.09	0.17	Outlet (Subcritical)	1
0.18	0.34	Outlet (Subcritical)	1
0.27	0.51	Outlet (Subcritical)	2
0.36	0.68	Outlet (Subcritical)	2
0.45	0.85	Inlet (Supercritical)	3
0.54	1.04	Inlet (Supercritical)	3
0.63	1.33	Inlet (Supercritical)	3
0.72	1.63	Inlet (Supercritical)	3
0.81	1.92	Inlet (Supercritical)	3
0.90	2.25	Inlet (Supercritical)	3
0.99	2.59	Inlet (Supercritical)	3
1.08	2.94	Inlet (Supercritical)	3
1.17	3.32	Inlet (Supercritical)	3
1.26	3.71	Inlet (Supercritical)	3
1.35	4.10	Inlet (Supercritical)	3

SEDCAD+ CULVERT SIZING UTILITY

DD-27

Design Discharge	=	0.540 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	25.000 feet
Pipe Slope	=	65.000 %
Manning's n	=	0.017
Maximum Headwater	=	1.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 6 inches

PERFORMANCE CURVES:

Diameter: 2 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.00		0
0.20	0.00		0
0.30	0.00		0
0.40	0.00		0
0.50	0.00		0
0.60	0.00		0
0.70	0.00		0
0.80	0.00		0
0.90	0.00		0
1.00	0.00		0
1.10	0.00		0
1.20	0.00		0
1.30	0.00		0
1.40	0.00		0
1.50	0.00		0

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.02		0

0.20	0.04		0
0.30	0.05		0
0.40	0.07		0
0.50	0.09		0
0.60	0.11	Outlet (Subcritical)	1
0.70	0.13	Outlet (Subcritical)	1
0.80	0.14	Outlet (Subcritical)	1
0.90	0.16	Outlet (Subcritical)	1
1.00	0.18	Outlet (Subcritical)	1
1.10	0.20	Outlet (Subcritical)	1
1.20	0.22	Outlet (Subcritical)	1
1.30	0.23	Outlet (Subcritical)	1
1.40	0.25	Outlet (Subcritical)	1
1.50	0.27	Outlet (Subcritical)	1

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.07		0
0.20	0.14	Outlet (Subcritical)	1
0.30	0.21	Outlet (Subcritical)	1
0.40	0.28	Outlet (Subcritical)	1
0.50	0.36	Outlet (Subcritical)	2
0.60	0.43	Outlet (Subcritical)	2
0.70	0.50	Outlet (Subcritical)	2
0.80	0.57	Inlet (Supercritical)	3
0.90	0.64	Inlet (Supercritical)	3
1.00	0.71	Inlet (Supercritical)	4
1.10	0.78	Inlet (Supercritical)	4
1.20	0.85	Inlet (Supercritical)	4
1.30	0.92	Inlet	5
1.40	0.99	Inlet	5
1.50	1.03	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.12	Outlet (Subcritical)	1
0.20	0.25	Outlet (Subcritical)	1
0.30	0.37	Outlet (Subcritical)	2
0.40	0.49	Outlet (Subcritical)	2

0.50	0.62	Inlet (Supercritical)	3
0.60	0.74	Inlet (Supercritical)	4
0.70	0.86	Inlet (Supercritical)	4
0.80	0.99	Inlet	5
0.90	1.09	Inlet	5
1.00	1.19	Inlet	5
1.10	1.29	Inlet	5
1.20	1.39	Inlet	5
1.30	1.49	Inlet	5
1.40	1.59	Inlet	5
1.50	1.69	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.14		0
0.20	0.27	Outlet (Subcritical)	1
0.30	0.41	Outlet (Subcritical)	1
0.40	0.54	Outlet (Subcritical)	2
0.50	0.68	Outlet (Subcritical)	2
0.60	0.81	Outlet (Subcritical)	2
0.70	0.95	Inlet (Supercritical)	3
0.80	1.10	Inlet (Supercritical)	3
0.90	1.25	Inlet (Supercritical)	4
1.00	1.41	Inlet (Supercritical)	4
1.10	1.57	Inlet (Supercritical)	4
1.20	1.73	Inlet (Supercritical)	4
1.30	1.89	Inlet	5
1.40	2.03	Inlet	5
1.50	2.13	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.16		0
0.20	0.33	Outlet (Subcritical)	1
0.30	0.49	Outlet (Subcritical)	1
0.40	0.65	Outlet (Subcritical)	2
0.50	0.82	Outlet (Subcritical)	2
0.60	0.98	Inlet (Supercritical)	3
0.70	1.25	Inlet (Supercritical)	3

SEDCAD+ CULVERT SIZING UTILITY

DD-25

Design Discharge	=	1.080 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	66.700 feet
Pipe Slope	=	25.000 %
Manning's n	=	0.013
Maximum Headwater	=	0.900 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 8 inches

PERFORMANCE CURVES:

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.09	0.02		0
0.18	0.03		0
0.27	0.05		0
0.36	0.06		0
0.45	0.08		0
0.54	0.10		0
0.63	0.11	Outlet (Subcritical)	1
0.72	0.13	Outlet (Subcritical)	1
0.81	0.15	Outlet (Subcritical)	1
0.90	0.16	Outlet (Subcritical)	1
0.99	0.18	Outlet (Subcritical)	1
1.08	0.19	Outlet (Subcritical)	1
1.17	0.21	Outlet (Subcritical)	1
1.26	0.23	Outlet (Subcritical)	1
1.35	0.24	Outlet (Subcritical)	1

Diameter: 6 inches

Headwater	Discharge	Flow

(ft)	(cfs)	Control	Type
0.09	0.06		0
0.18	0.13	Outlet (Subcritical)	1
0.27	0.19	Outlet (Subcritical)	1
0.36	0.26	Outlet (Subcritical)	1
0.45	0.32	Outlet (Subcritical)	2
0.54	0.38	Outlet (Subcritical)	2
0.63	0.45	Outlet (Subcritical)	2
0.72	0.51	Inlet (Supercritical)	3
0.81	0.58	Inlet (Supercritical)	3
0.90	0.64	Inlet (Supercritical)	3
0.99	0.70	Inlet (Supercritical)	4
1.08	0.77	Inlet (Supercritical)	4
1.17	0.83	Inlet (Supercritical)	4
1.26	0.90	Inlet (Supercritical)	4
1.35	0.96	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.09	0.11	Outlet (Subcritical)	1
0.18	0.22	Outlet (Subcritical)	1
0.27	0.33	Outlet (Subcritical)	2
0.36	0.44	Outlet (Subcritical)	2
0.45	0.55	Inlet (Supercritical)	3
0.54	0.67	Inlet (Supercritical)	3
0.63	0.78	Inlet (Supercritical)	4
0.72	0.89	Inlet (Supercritical)	4
0.81	1.00	Inlet	5
0.90	1.09	Inlet	5
0.99	1.18	Inlet	5
1.08	1.27	Inlet	5
1.17	1.36	Inlet	5
1.26	1.45	Inlet	5
1.35	1.54	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.09	0.12		0
0.18	0.24	Outlet (Subcritical)	1
0.27	0.36	Outlet (Subcritical)	1
0.36	0.49	Outlet (Subcritical)	1
0.45	0.61	Outlet (Subcritical)	2
0.54	0.73	Outlet (Subcritical)	2
0.63	0.85	Inlet (Supercritical)	3
0.72	0.97	Inlet (Supercritical)	3
0.81	1.11	Inlet (Supercritical)	3
0.90	1.25	Inlet (Supercritical)	4
0.99	1.40	Inlet (Supercritical)	4
1.08	1.54	Inlet (Supercritical)	4
1.17	1.68	Inlet (Supercritical)	4
1.26	1.83	Inlet	5
1.35	1.97	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.09	0.15		0
0.18	0.29	Outlet (Subcritical)	1
0.27	0.44	Outlet (Subcritical)	1
0.36	0.59	Outlet (Subcritical)	2
0.45	0.74	Outlet (Subcritical)	2
0.54	0.88	Inlet (Supercritical)	3
0.63	1.05	Inlet (Supercritical)	3
0.72	1.30	Inlet (Supercritical)	3
0.81	1.55	Inlet (Supercritical)	3
0.90	1.81	Inlet (Supercritical)	3
0.99	2.06	Inlet (Supercritical)	3
1.08	2.32	Inlet (Supercritical)	4
1.17	2.59	Inlet (Supercritical)	4
1.26	2.85	Inlet	5
1.35	3.09	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.09	0.17	Outlet (Subcritical)	1
0.18	0.34	Outlet (Subcritical)	1
0.27	0.51	Outlet (Subcritical)	2
0.36	0.68	Outlet (Subcritical)	2
0.45	0.85	Inlet (Supercritical)	3
0.54	1.04	Inlet (Supercritical)	3
0.63	1.33	Inlet (Supercritical)	3
0.72	1.63	Inlet (Supercritical)	3
0.81	1.92	Inlet (Supercritical)	3
0.90	2.25	Inlet (Supercritical)	3
0.99	2.59	Inlet (Supercritical)	3
1.08	2.94	Inlet (Supercritical)	3
1.17	3.32	Inlet (Supercritical)	3
1.26	3.71	Inlet (Supercritical)	3
1.35	4.10	Inlet (Supercritical)	3

SEDCAD+ CULVERT SIZING UTILITY

DD-27

Design Discharge	=	0.540 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	25.000 feet
Pipe Slope	=	65.000 %
Manning's n	=	0.017
Maximum Headwater	=	1.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 6 inches

PERFORMANCE CURVES:

Diameter: 2 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.00		0
0.20	0.00		0
0.30	0.00		0
0.40	0.00		0
0.50	0.00		0
0.60	0.00		0
0.70	0.00		0
0.80	0.00		0
0.90	0.00		0
1.00	0.00		0
1.10	0.00		0
1.20	0.00		0
1.30	0.00		0
1.40	0.00		0
1.50	0.00		0

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.02		0

0.20	0.04		0
0.30	0.05		0
0.40	0.07		0
0.50	0.09		0
0.60	0.11	Outlet (Subcritical)	1
0.70	0.13	Outlet (Subcritical)	1
0.80	0.14	Outlet (Subcritical)	1
0.90	0.16	Outlet (Subcritical)	1
1.00	0.18	Outlet (Subcritical)	1
1.10	0.20	Outlet (Subcritical)	1
1.20	0.22	Outlet (Subcritical)	1
1.30	0.23	Outlet (Subcritical)	1
1.40	0.25	Outlet (Subcritical)	1
1.50	0.27	Outlet (Subcritical)	1

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.07		0
0.20	0.14	Outlet (Subcritical)	1
0.30	0.21	Outlet (Subcritical)	1
0.40	0.28	Outlet (Subcritical)	1
0.50	0.36	Outlet (Subcritical)	2
0.60	0.43	Outlet (Subcritical)	2
0.70	0.50	Outlet (Subcritical)	2
0.80	0.57	Inlet (Supercritical)	3
0.90	0.64	Inlet (Supercritical)	3
1.00	0.71	Inlet (Supercritical)	4
1.10	0.78	Inlet (Supercritical)	4
1.20	0.85	Inlet (Supercritical)	4
1.30	0.92	Inlet	5
1.40	0.99	Inlet	5
1.50	1.03	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.12	Outlet (Subcritical)	1
0.20	0.25	Outlet (Subcritical)	1
0.30	0.37	Outlet (Subcritical)	2
0.40	0.49	Outlet (Subcritical)	2

0.50	0.62	Inlet (Supercritical)	3
0.60	0.74	Inlet (Supercritical)	4
0.70	0.86	Inlet (Supercritical)	4
0.80	0.99	Inlet	5
0.90	1.09	Inlet	5
1.00	1.19	Inlet	5
1.10	1.29	Inlet	5
1.20	1.39	Inlet	5
1.30	1.49	Inlet	5
1.40	1.59	Inlet	5
1.50	1.69	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.14	-	0
0.20	0.27	Outlet (Subcritical)	1
0.30	0.41	Outlet (Subcritical)	1
0.40	0.54	Outlet (Subcritical)	2
0.50	0.68	Outlet (Subcritical)	2
0.60	0.81	Outlet (Subcritical)	2
0.70	0.95	Inlet (Supercritical)	3
0.80	1.10	Inlet (Supercritical)	3
0.90	1.25	Inlet (Supercritical)	4
1.00	1.41	Inlet (Supercritical)	4
1.10	1.57	Inlet (Supercritical)	4
1.20	1.73	Inlet (Supercritical)	4
1.30	1.89	Inlet	5
1.40	2.03	Inlet	5
1.50	2.13	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.10	0.16		0
0.20	0.33	Outlet (Subcritical)	1
0.30	0.49	Outlet (Subcritical)	1
0.40	0.65	Outlet (Subcritical)	2
0.50	0.82	Outlet (Subcritical)	2
0.60	0.98	Inlet (Supercritical)	3
0.70	1.25	Inlet (Supercritical)	3

0.80	1.53	Inlet (Supercritical)	3
0.90	1.81	Inlet (Supercritical)	3
1.00	2.09	Inlet (Supercritical)	3
1.10	2.38	Inlet (Supercritical)	4
1.20	2.68	Inlet (Supercritical)	4
1.30	2.97	Inlet	5
1.40	3.20	Inlet	5
1.50	3.42	Inlet	5

DS-134+80L

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.00	3.0:1	3.0:1	15.0	1.00		

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.15 cfs	
Depth:	0.12 ft	1.12 ft
Top Width:	2.71 ft	8.71 ft
Velocity*:		
X-Section Area:	0.28 sq ft	
Hydraulic Radius:	0.101	
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.

DS-481+25L

Material: Riprap

Trapezoidal Channel

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	6.0	1.00		

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	8.62 cfs	
Depth:	0.14 ft	1.14 ft
Top Width:	8.87 ft	14.87 ft
Velocity*:		
X-Section Area:	1.22 sq ft	
Hydraulic Radius:	0.136	
Froude Number*:		
Manning's n*:		
Dmin:	1.00 in	
D50:	3.00 in	
Dmax:	3.75 in	

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

DS-551L and 552L

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.50	3.0:1	3.0:1	17.0	1.00		

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	6.47 cfs	
Depth:	0.12 ft	1.12 ft
Top Width:	5.19 ft	11.19 ft
Velocity*:		
X-Section Area:	0.56 sq ft	
Hydraulic Radius:	0.107	
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.