APPENDICES

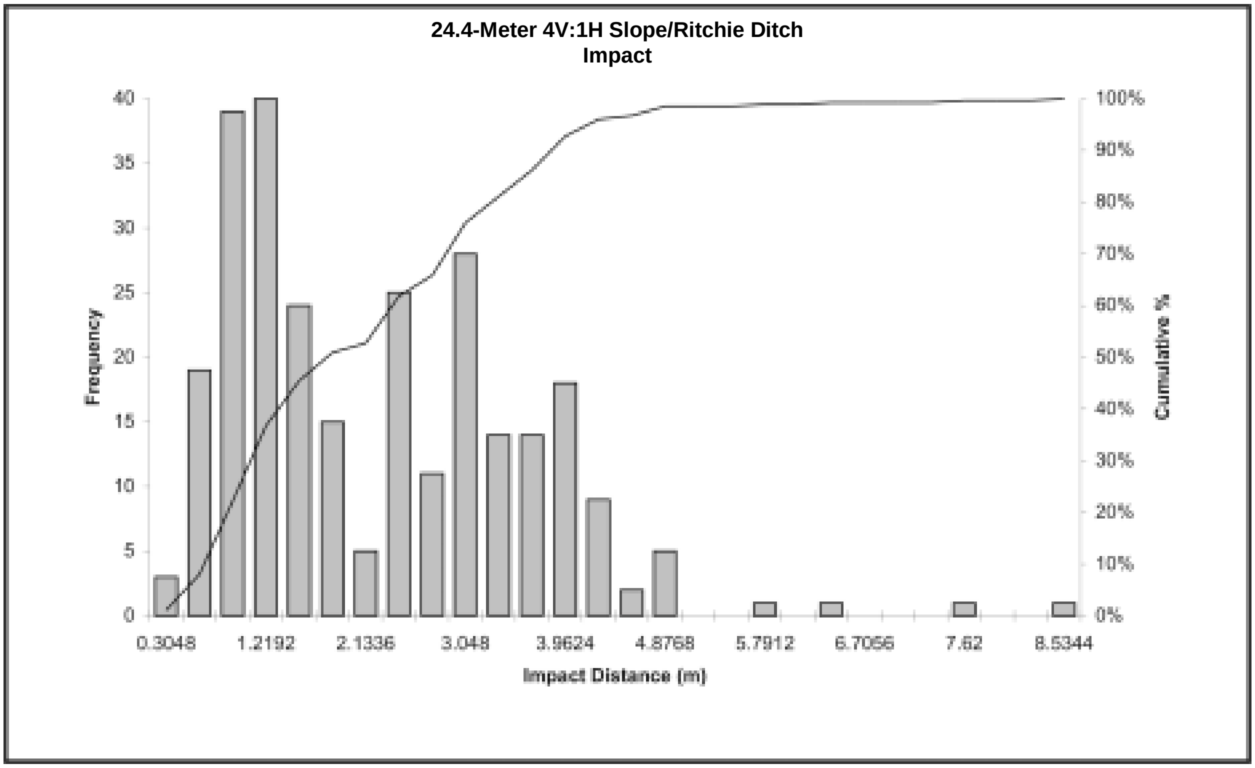
APPENDIX A: RITCHIE TEST CATCHMENT AREA COMPARISON

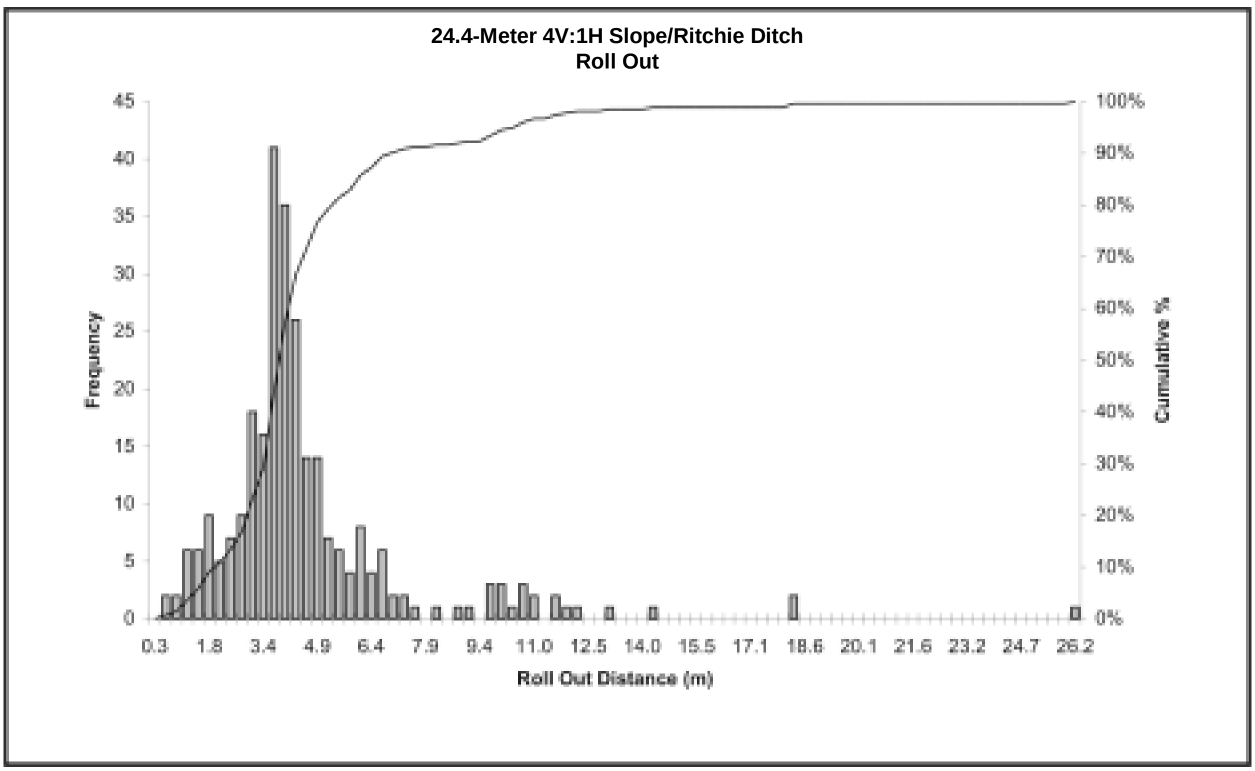
RITCHIE TEST CATCHMENT AREA COMPARISON

During the initial pilot research effort, a full suite of 250 rocks were rolled into a Ritchie catchment area from the 24.4-meter high, 4V:1H cutslope. For comparison purposes, the tested "Ritchie" catchment area was sloped and sized for an 24.4-meter (80-foot) high slope according to the Ritchie design chart contained in the FHWA Rock Slopes Manual (*FHWA 1989*), (see Figure 2.2). The Ritchie chart contained in the FHWA manual is slightly more conservative for higher slopes than is the original Ritchie criteria. The width of the tested Ritchie catchment area was 7.3 meters, with 1.8-meter depth and 1V:1H foreslope.

The most effective features of the tested Ritchie catchment area are its 1.8-meter depth and steep 1V:1H foreslope. Eight percent of the rocks (22 out of 275) escaped the limits of the tested catchment area; i.e., 92 percent of the rocks were retained. A catchment area designed to an exact Ritchie width would have been 20 feet wide, which would have allowed 41 rocks or about 15 percent of the total to roll through the catchment area; i.e., it would have retained 85 percent of the rocks. Of the 41 rocks, three would have landed (impacted) beyond the catchment area and the remaining 38 would have rolled through.

Refer to Section 2.3.2 of this report for further details and discussion of the tested Ritchie catchment area comparison.


24.4-Meter 4V:1H Slope/Ritchie Ditch
Impact
Frequency
Cumulative %
Impact Distance (m)
0.3048
1.2192
2.1336
3.048
3.9624
4.8768
5.7912
6.7056
7.62
8.5344


24.4-Meter 4V:1H Slope/Ritchie Ditch
Roll Out
Frequency
Cumulative %
Roll Out Distance (m)
0.3
1.8
3.4
4.9
6.4
7.9
9.4
11.0
12.5
14.0
15.5
17.1
18.6
20.1
21.6
23.2
24.7
26.2

APPENDIX B: ROCK ROLLING FIELD DATA

ROCK ROLLING FIELD DATA

This appendix contains the field data from the 11,250 rocks that were rolled off the five slope angles tested. The slopes were vertical, 4V:1H, 2V:1H, 1.33V:1H, and 1V:1H rock cutslopes. Each slope was tested from three heights at 12.2, 18.3 and 24.4 meters. Three catchment area slopes were compared for each slope height tested. The catchment area slopes included a flat catchment area and two inclined catchment areas that sloped downward toward the toe of the cutslope at a 1V:6H and 1V:4H. A standard suite of 250 rocks were rolled into each catchment area. This number included 100 rocks averaging 0.3 meters in diameter, 75 rocks averaging 0.6 meters in diameter and 75 rocks averaging 0.9 meters in diameter. The diameter dimension was measured along the longest axis. The actual diameter dimensions for each size category ranged within plus or minus 0.15 meters. For example, the 0.6-meter rocks varied from 0.45 to 0.75 meters in diameter along the longest axis.

The impact and roll out distances in the following tables are the field measured slope distances. Field data was measured to the nearest foot.

NOTE: Also included at the end of Appendix B is a limited set of data gathered from a 12.2-meter high, 1V:1.25H slope. The rocks rolled from this slope fell into a 1V:4H catchment area. The results were recorded but not compiled into catchment area percent retention graphs or design charts, because there were not sufficient funds to test the full suite of slope heights and catchment area inclinations for the 1V:1.25H test slope.

Field Data for Vertical Slopes

12.2 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.1	1.1	3.2	3.2	2.3	2.3
1.8	3.0	3.5	3.7	2.3	2.3
1.5	1.5	4.4	4.4	3.4	3.4
1.5	1.5	2.7	2.7	3.2	3.2
4.3	5.0	2.0	2.0	4.0	4.0
2.7	2.7	3.0	3.0	3.2	3.2
2.7	3.4	3.0	3.0	3.7	3.7
2.7	2.7	3.0	3.2	2.1	2.1
3.2	3.2	3.2	4.1	3.2	3.2
1.5	1.5	1.5	2.6	4.1	4.1
2.6	2.6	2.6	2.6	3.5	3.5
3.5	4.0	2.6	2.6	2.7	2.7
2.1	2.1	2.3	2.3	3.2	3.2
2.3	2.3	2.6	2.6	3.2	3.2
2.4	3.0	4.6	4.6	3.8	3.8
2.6	2.6	3.2	3.2	4.0	4.0
3.2	3.4	2.1	2.1	3.4	3.4
2.7	2.7	3.4	3.4	4.3	4.6
2.0	2.0	2.1	2.1	4.0	4.3
2.3	2.3	3.7	3.7	3.8	3.8
2.9	2.9	2.4	2.4	3.5	3.5
2.6	2.6	2.4	2.4	3.0	3.0
2.3	2.3	3.4	3.4	5.0	5.0
2.9	2.9	3.8	3.8	4.4	4.4
1.7	1.7	3.0	3.0	3.4	3.4
2.6	2.6	2.3	2.3	4.9	4.9
2.6	2.6	2.9	2.9	3.4	4.0
2.3	2.3	2.0	2.0	2.6	2.6
1.5	1.5	3.0	3.0	4.0	4.6
3.4	3.4	3.2	3.2	3.7	3.7
1.4	1.4	2.1	2.1	2.1	2.1
2.3	2.3	3.7	3.7	3.2	3.2
2.9	2.9	3.4	3.4	3.0	3.0
3.0	3.0	3.5	3.5	2.0	2.0
2.0	2.4	3.5	3.5	3.5	3.5
0.6	0.9	3.0	3.0	4.3	4.3
2.4	2.4	2.9	2.9	3.5	3.5
1.5	2.1	2.3	2.4	3.5	4.0
2.0	2.4	2.4	2.4	2.6	3.0
1.5	1.5	2.3	2.3	3.8	3.8
1.8	2.0	3.4	3.8	3.4	3.4
2.7	2.7	2.1	2.1	2.7	2.7
2.4	2.4	2.7	3.2	4.3	4.3
1.5	1.7	3.5	3.5	3.0	3.0
2.1	2.1	3.0	3.0	3.2	3.2
3.2	3.2	2.9	2.9	3.8	3.8
1.4	1.4	3.5	3.5	4.0	4.0
1.5	1.5	3.0	3.0	3.4	3.4
5.0	5.0	3.2	3.2	3.0	3.0
1.2	1.2	3.5	3.5	3.5	3.5

12.2 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
2.4	2.4	2.3	2.3		
1.7	2.1	3.0	3.0		
2.4	2.6	2.6	2.6		
2.4	2.6	3.0	3.8		
1.5	1.5	3.5	3.5		
2.0	2.0	3.0	3.0		
0.9	0.9	4.0	4.0		
2.0	2.0	4.6	4.6		
1.8	2.4	3.0	3.0		
3.4	4.1	4.3	4.3		
2.6	2.6	2.3	2.3		
1.5	2.0	3.4	3.4		
1.1	1.1	3.2	3.2		
2.3	2.3	3.8	3.8		
1.7	1.7	2.4	2.4		
3.4	3.4	3.5	3.5		
2.1	2.1	3.2	3.2		
1.8	1.8	2.9	2.9		
3.0	3.0	3.4	3.4		
3.4	3.4	2.7	2.7		
3.2	3.2	2.9	2.9		
3.2	3.2	3.0	3.0		
3.0	3.0	3.7	3.7		
1.7	1.7	3.2	3.2		
1.7	2.0	2.1	2.1		
1.8	2.3				
2.4	2.4				
3.4	3.7				
1.5	1.5				
3.2	3.2				
2.4	3.0				
3.8	3.8				
1.8	2.3				
3.5	3.5				
2.4	2.4				
2.0	2.0				
3.7	3.7				
2.7	2.7				
2.1	2.4				
2.0	2.0				
3.8	3.8				
2.4	2.4				
2.4	2.4				
2.1	2.4				
2.1	2.1				
2.3	2.3				
1.5	2.0				
2.1	2.1				
4.3	4.3				
3.0	3.0				

Field Data for Vertical Slopes

12.2 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
2.6	2.6	3.4	3.4	2.4	2.4
2.6	3.0	3.8	3.8	2.9	2.9
2.4	2.4	4.0	4.7	0.9	2.4
3.2	3.2	2.1	2.1	0.9	0.9
2.9	2.9	3.8	3.8	4.4	4.4
2.4	2.4	2.9	2.9	2.9	4.0
1.8	2.4	1.4	1.4	4.0	4.0
2.1	2.3	1.2	1.2	3.7	3.7
1.8	1.8	2.3	2.3	1.5	2.3
3.4	3.7	3.2	3.2	2.9	3.4
1.8	1.8	3.4	3.4	2.7	2.9
3.0	3.0	2.6	2.6	2.7	3.2
2.7	2.7	3.0	3.0	3.7	3.7
1.8	1.8	0.9	0.9	2.4	2.4
2.4	2.4	3.2	3.2	3.7	3.7
3.4	3.4	2.9	2.9	2.1	2.7
2.7	3.7	2.3	2.3	3.4	3.4
2.4	2.4	3.2	3.2	2.1	2.1
0.9	0.9	1.2	1.2	2.0	2.0
2.1	2.1	3.2	4.1	0.9	1.8
0.6	0.9	2.9	2.9	1.5	1.5
2.1	2.1	3.4	4.7	2.4	3.8
2.1	2.1	3.0	3.7	3.4	3.4
3.2	3.2	3.0	3.0	2.4	2.4
2.4	2.4	1.7	1.7	2.7	2.7
4.3	5.2	2.4	3.5	3.8	3.8
2.7	4.3	1.7	1.7	2.4	3.2
2.0	2.0	1.5	2.4	2.4	2.4
2.1	2.1	3.0	3.0	2.3	3.8
1.2	1.2	2.7	2.7	3.2	3.4
3.0	3.5	2.1	3.4	3.0	4.0
1.8	1.8	3.4	3.4	1.5	1.5
2.4	2.4	2.1	2.1	2.1	2.1
2.9	3.2	4.0	5.3	2.1	2.1
2.9	3.4	2.4	3.0	1.5	2.0
1.5	1.5	3.2	3.2	2.1	2.6
2.1	2.1	2.1	2.1	2.9	2.9
1.5	1.5	3.2	4.0	3.7	3.7
2.4	3.0	2.9	2.9	2.7	2.7
2.4	2.4	3.2	3.2	4.0	4.0
2.9	2.9	2.0	2.0	2.1	2.1
2.9	4.3	3.2	3.2	3.0	3.0
2.9	4.0	2.3	2.3	2.6	3.0
1.8	1.8	1.4	1.4	2.4	3.0
2.4	2.7	2.6	2.6	2.1	2.4
1.5	1.5	3.4	3.4	1.8	2.4
1.7	2.4	3.7	3.7	2.6	2.6
1.2	2.1	3.7	3.7	2.1	2.7
2.4	2.4	4.4	4.4	2.3	2.3
1.2	1.2	2.0	2.0	4.3	4.3

12.2 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
2.7	2.7	3.0	3.4	3.0	3.0
0.9	0.9	4.6	4.6	2.0	2.0
2.9	2.9	3.0	3.0	4.0	4.6
1.5	1.7	2.0	2.4	3.0	3.0
1.4	1.4	2.4	2.4	2.1	2.1
2.6	2.6	2.4	2.4	2.1	2.1
1.8	1.8	1.5	1.5	1.2	1.5
2.4	2.4	0.9	0.9	2.1	2.1
2.7	2.7	1.5	1.5	3.4	3.4
2.0	2.0	1.8	1.8	2.7	3.8
2.1	2.7	3.2	3.2	3.2	3.2
2.4	2.9	2.7	2.7	3.4	3.4
3.7	3.7	2.0	2.0	2.4	2.4
3.7	4.1	2.7	2.7	4.1	4.1
2.4	2.9	3.7	3.7	2.7	2.7
1.7	1.8	2.9	2.9	2.7	2.7
1.4	1.4	2.9	3.2	2.0	2.9
1.1	1.1	4.0	5.5	1.5	1.5
4.3	4.3	2.1	2.1	2.0	2.0
4.3	5.0	3.2	3.2	2.1	2.1
2.1	2.4	2.6	2.6	2.9	2.9
3.7	3.7	3.0	3.0	3.4	4.7
2.4	2.4	2.9	2.9	2.4	2.4
2.0	2.0	2.3	2.3	3.4	3.4
2.1	2.1	1.5	1.5	3.8	3.8
2.6	2.6			2.7	2.7
2.1	2.1			2.9	2.9
1.2	2.4			2.4	2.4
2.4	2.4			2.4	2.4
1.8	1.8			3.5	3.5
2.7	2.7				
3.2	3.2				
1.8	1.8				
2.4	2.4				
2.4	2.4				
2.7	2.7				
1.8	1.8				
1.2	1.2				
2.1	2.1				
2.7	3.7				
2.4	3.4				
2.1	2.3				
3.0	3.0				
2.7	2.7				
3.5	3.5				
3.5	3.5				
3.0	3.0				
3.0	3.0				
2.1	2.1				
1.8	1.8				

Field Data for Vertical Slopes

12.2 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.8	2.4	3.0	5.9	4.1	4.1
2.4	2.9	3.7	5.9	4.0	4.0
2.3	2.3	2.9	3.8	2.1	8.8
3.2	5.3	3.0	5.3	2.9	8.4
1.5	1.5	2.0	2.0	2.7	7.5
3.0	6.1	3.2	5.2	2.6	7.6
2.6	2.9	2.9	6.1	2.4	6.1
2.1	2.1	2.4	2.4	4.0	5.0
2.7	3.7	2.6	4.3	2.9	5.8
1.8	1.8	2.9	9.0	1.8	3.7
2.1	2.1	2.7	4.0	2.1	2.1
2.7	2.7	2.3	3.5	2.7	6.7
2.6	5.2	3.0	3.0	3.8	7.0
1.5	1.5	2.4	5.5	3.4	5.2
2.3	5.5	2.7	5.3	2.9	3.4
2.9	5.2	1.8	2.7	3.4	4.9
1.5	1.5	2.7	2.7	2.9	4.9
2.7	5.0	2.4	4.0	2.4	2.4
0.9	0.9	2.3	4.6	2.6	2.6
1.4	1.4	2.7	2.7	1.5	2.9
1.5	1.5	2.4	3.2	2.4	5.2
2.4	2.4	2.1	4.6	2.7	3.4
4.3	4.3	2.7	2.7	2.3	4.3
2.4	2.4	2.1	3.0	2.7	4.3
2.4	3.0	2.4	2.4	2.9	8.8
2.4	2.4	2.9	2.9	3.0	5.8
1.8	1.8	2.1	2.1	1.5	3.4
2.4	3.2	2.7	3.7	2.4	2.4
0.9	2.0	3.7	4.6	3.4	3.4
2.4	3.4	3.7	3.7	3.7	5.2
2.1	2.1	2.7	3.7	2.9	2.9
3.7	3.7	3.0	3.0	2.1	4.3
1.5	1.8	2.4	2.4	2.7	4.9
2.4	3.4	2.3	2.6	1.8	3.0
2.9	3.8	3.0	4.4	1.5	1.5
4.0	4.0	2.4	5.3	4.0	4.0
2.4	2.4	3.0	5.3	3.2	8.8
1.5	1.5	2.4	5.2	4.3	4.3
2.7	5.2	2.1	5.5	3.0	3.0
1.4	1.4	2.1	2.1	4.0	4.9
2.0	3.4	2.1	3.0	1.8	4.9
2.0	2.7	2.0	2.0	2.7	4.3
2.3	3.0	3.4	3.4	2.4	3.2
1.5	1.5	3.7	3.7	2.1	4.1
2.7	2.7	2.1	2.9	3.8	6.6
1.8	1.8	3.7	5.2	4.0	4.0
2.0	2.0	2.4	2.4	2.4	5.0
1.4	1.4	1.4	2.7	2.9	2.9
1.5	1.5	1.2	3.2	3.0	6.1
3.4	3.7	1.8	1.8	3.4	3.4

12.2 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
2.4	6.4	2.9	7.6	2.4	5.3
2.3	6.6	2.4	3.7	3.0	4.9
3.0	5.2	2.9	2.9	3.2	3.2
1.5	1.5	2.7	2.7	2.1	4.6
1.5	2.4	2.1	2.1	4.0	4.0
1.5	1.8	4.3	4.9	2.4	4.0
1.5	1.5	2.7	9.4	4.0	4.0
3.0	5.6	2.1	2.7	3.2	3.2
2.6	3.0	3.4	4.3	2.9	5.5
1.8	1.8	2.7	2.7	2.1	2.1
3.0	3.0	3.7	3.7	2.4	7.5
2.3	2.7	1.8	2.4	3.0	3.0
2.3	2.3	1.8	2.9	2.4	2.4
2.4	8.4	2.1	3.2	2.7	2.7
2.4	4.3	2.0	2.0	2.4	2.4
3.2	3.2	2.7	3.4	3.8	9.4
1.8	1.8	3.0	4.9	2.4	7.0
1.5	1.5	3.4	4.3	3.2	3.2
2.1	2.1	2.4	2.4	2.7	2.7
0.9	0.9	2.1	7.6	2.4	2.9
1.5	1.5	2.9	5.9	1.5	1.5
2.1	2.1	1.8	3.0	2.1	4.0
3.5	7.5	1.8	4.0	1.5	3.0
2.4	2.4	2.7	3.8	2.4	4.0
3.7	6.9	2.1	2.1	2.4	6.7
2.3	2.3				
2.4	2.9				
3.7	3.7				
2.7	5.2				
3.0	3.0				
2.3	2.3				
4.3	4.3				
1.5	2.4				
1.5	1.5				
2.6	2.6				
0.9	4.0				
2.1	2.1				
3.2	5.0				
3.0	3.8				
2.7	2.7				
2.1	2.9				
2.4	2.4				
2.1	2.7				
2.7	4.9				
3.5	3.5				
2.4	3.7				
3.4	4.3				
2.1	2.1				
2.4	3.4				
2.4	3.2				

Field Data for Vertical Slopes

18.3 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.8	1.8	3.2	3.2	2.7	2.7
3.5	3.5	2.9	2.9	2.4	2.4
2.1	2.1	3.8	3.8	3.4	3.4
3.2	3.2	2.9	2.9	2.7	2.7
2.1	2.1	4.0	4.0	1.8	1.8
3.4	3.4	4.3	4.3	2.4	2.4
1.2	1.2	3.0	3.0	4.3	4.3
3.4	3.4	1.5	1.5	3.0	3.0
3.0	3.0	3.8	3.8	3.4	3.4
4.6	4.6	2.4	2.4	3.4	3.4
2.9	2.9	4.0	4.0	4.9	4.9
4.4	4.4	3.0	3.0	4.3	4.3
3.4	3.4	3.7	3.7	2.9	2.9
2.4	2.4	3.7	3.7	3.4	3.4
4.0	4.3	2.7	2.7	3.7	3.7
2.4	2.4	2.7	2.7	2.4	3.2
3.7	3.7	2.1	2.1	5.8	5.8
3.2	3.2	4.0	4.0	3.0	3.0
2.7	2.7	4.3	4.3	4.1	4.1
2.4	2.4	2.7	2.7	2.4	2.4
2.1	2.1	2.4	2.7	2.1	2.1
2.9	2.9	4.0	4.0	2.4	2.4
2.9	2.9	3.0	3.0	4.4	4.4
1.8	1.8	2.4	2.4	3.2	3.2
2.4	2.4	2.3	2.3	3.5	3.5
3.7	3.7	2.6	2.6	4.4	4.4
3.7	3.7	2.7	2.7	3.8	3.8
3.7	3.7	3.5	3.5	3.2	3.2
3.0	3.0	5.3	5.3	3.2	3.2
2.7	2.7	3.4	3.4	3.8	3.8
3.2	3.2	2.7	2.7	2.9	2.9
3.7	3.7	2.6	2.6	4.0	4.0
4.3	4.3	4.1	4.1	1.8	4.3
3.8	3.8	3.7	3.7	4.0	4.0
3.0	3.0	3.7	3.7	3.4	3.4
3.4	3.4	3.4	3.4	4.3	4.3
3.4	3.4	2.7	2.7	5.3	5.3
4.7	4.7	3.7	3.7	3.0	3.0
3.0	3.4	2.1	2.1	3.8	3.8
3.0	3.0	2.7	2.7	4.0	4.0
2.4	2.4	1.8	2.6	2.1	3.4
3.0	3.0	1.8	3.0	3.0	3.0
1.8	1.8	3.4	3.4	3.8	3.8
1.5	1.5	4.6	4.6	2.4	2.4
1.5	1.5	4.0	4.0	2.7	2.7
1.2	1.2	3.7	3.7	3.2	3.2
3.0	3.0	4.3	4.3	1.8	3.4
4.9	4.9	2.4	2.4	4.3	4.3
3.4	3.4	3.8	3.8	4.3	4.3
1.2	1.2	3.0	3.0	3.5	3.5

18.3 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
3.4	3.4	1.5	5.6	3.4	3.4
2.4	2.4	2.6	2.6	1.8	3.2
1.8	1.8	2.7	2.7	2.6	2.6
4.6	4.6	2.3	2.3	2.7	2.7
1.8	1.8	3.7	3.7	2.7	2.7
4.0	4.0	3.2	3.2	4.0	4.0
2.7	2.7	2.7	3.4	3.8	3.8
3.4	3.4	2.4	2.4	4.0	4.0
3.0	3.0	2.7	2.7	4.3	4.3
2.7	2.7	2.7	2.7	4.0	4.0
2.4	2.4	1.5	1.5	2.9	2.9
2.7	2.7	3.4	3.4	3.2	3.2
2.3	2.3	2.7	2.7	2.1	2.1
4.0	4.0	4.3	4.3	2.1	2.1
2.4	2.4	3.2	3.2	4.0	4.0
1.8	1.8	1.8	1.8	2.4	4.7
2.4	2.4	2.9	2.9	2.1	2.7
3.4	3.4	3.4	3.4	2.4	2.4
3.2	3.2	2.1	2.1	3.2	3.2
3.5	3.5	2.7	2.7	2.9	2.9
5.8	5.8	3.0	3.0	3.8	3.8
3.0	3.0	2.1	2.1	2.6	2.6
3.0	3.0	2.9	2.9	4.3	4.3
2.3	2.3	4.3	4.3	2.4	5.3
2.7	2.7	3.4	3.4	1.8	1.8
2.4	2.4				
2.9	2.9				
2.0	2.0				
2.1	2.1				
3.2	3.2				
3.0	3.0				
1.5	3.4				
2.4	3.4				
1.5	1.5				
2.4	2.4				
3.0	3.0				
2.7	3.4				
4.0	4.0				
2.4	2.4				
4.9	4.9				
3.0	3.0				
2.3	2.3				
3.4	3.4				
2.1	2.1				
3.0	3.0				
3.7	3.7				
3.7	3.7				
2.1	2.1				
2.9	2.9				
3.4	3.4				

Field Data for Vertical Slopes

18.3 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
2.1	2.1	3.0	3.0	3.7	3.7
1.2	1.2	2.4	2.4	4.3	4.3
1.2	1.2	3.5	3.5	4.0	4.0
0.9	0.9	3.4	4.3	2.3	2.3
1.8	1.8	2.3	2.3	3.0	3.0
1.2	1.2	2.1	2.1	2.7	2.7
2.7	2.7	1.7	1.7	2.1	2.1
1.2	1.2	2.7	2.7	2.1	2.1
2.4	2.4	2.7	2.7	2.7	2.7
1.2	1.2	3.4	3.4	2.7	2.7
2.1	2.1	3.0	3.0	2.9	2.9
1.5	1.5	3.8	3.8	4.0	4.0
1.5	1.5	2.7	2.7	2.7	2.7
2.4	3.0	2.7	2.7	3.2	3.2
1.8	1.8	4.4	4.4	2.9	2.9
0.9	0.9	4.4	4.4	2.3	2.3
1.2	1.2	2.4	2.4	2.4	2.4
2.1	2.1	3.7	3.7	1.5	1.5
0.6	0.6	2.7	2.7	3.2	3.2
1.2	1.2	1.5	1.5	3.4	3.4
0.9	0.9	4.7	4.7	4.9	4.9
0.6	0.6	2.1	2.1	4.6	4.6
1.5	1.5	1.8	1.8	3.0	3.0
3.7	4.6	3.4	3.4	4.6	4.6
2.1	2.1	2.4	2.4	3.5	3.5
0.6	0.6	3.7	4.3	1.5	1.5
1.8	1.8	2.9	2.9	4.6	4.6
1.5	1.5	2.4	2.4	1.8	1.8
0.3	0.3	2.9	2.9	3.4	3.4
1.5	1.5	2.0	2.0	2.7	2.7
2.7	2.7	2.3	2.3	2.4	2.4
1.2	1.2	2.4	2.4	2.7	2.7
0.9	0.9	1.5	2.1	3.4	3.4
1.5	1.5	2.4	2.4	4.9	4.9
2.1	2.1	3.4	3.4	2.9	2.9
0.6	0.6	2.3	2.3	1.5	3.4
0.6	0.6	1.5	1.5	3.4	3.4
1.8	1.8	3.2	3.2	2.1	2.1
1.8	1.8	1.8	1.8	2.9	2.9
1.8	1.8	3.2	3.2	2.9	2.9
1.5	1.5	3.8	3.8	4.0	4.0
1.8	2.7	2.3	2.3	2.1	2.1
1.5	1.5	2.6	2.6	2.1	2.1
4.3	4.3	2.7	2.7	3.4	3.4
0.6	0.6	1.5	1.5	4.9	4.9
0.6	0.6	2.7	2.7	4.0	4.0
0.9	0.9	1.5	1.5	2.4	2.4
1.5	1.5	2.4	2.4	3.0	3.0
1.5	1.5	3.0	3.0	3.8	3.8
1.8	1.8	2.6	2.6	1.8	1.8

18.3 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.8	1.8	3.4	3.4	3.4	3.4
0.6	0.6	2.3	2.3	3.4	3.4
1.2	1.2	3.4	3.4	3.5	3.5
1.5	1.5	3.4	3.4	4.9	4.9
3.2	4.0	3.5	3.5	2.1	2.1
1.5	1.5	3.2	3.2	4.9	4.9
3.4	3.4	3.0	3.0	2.4	2.4
2.4	2.4	1.5	1.5	3.7	3.7
4.9	4.9	1.5	1.5	1.5	1.5
1.8	1.8	2.1	2.1	3.0	3.0
2.7	2.7	1.5	1.5	2.1	2.1
1.5	1.5	2.6	2.6	2.1	2.1
1.5	1.5	4.3	5.2	2.4	2.4
1.5	1.5	3.2	3.2	2.4	2.4
2.1	2.1	1.8	1.8	2.1	2.1
2.7	2.7	2.7	2.7	1.5	1.5
2.1	2.1	4.0	4.0	2.7	2.7
2.4	2.4	3.0	3.0	2.9	2.9
4.9	4.9	1.5	1.5	1.2	1.2
1.5	1.5	2.3	2.3	2.7	2.7
2.1	2.1	3.4	3.4	2.4	3.4
2.7	2.7	1.8	2.4	3.2	3.2
2.4	2.4	4.0	4.0	2.4	2.4
1.8	1.8	1.8	1.8	2.7	2.7
1.8	1.8	2.1	2.1	2.7	2.7
1.5	1.5				
2.6	2.6				
1.5	1.5				
2.7	2.7				
3.8	3.8				
4.3	4.9				
1.5	1.5				
2.1	2.1				
2.7	3.2				
1.8	1.8				
1.8	1.8				
2.6	2.6				
1.2	1.2				
3.5	3.5				
1.4	1.4				
1.5	1.5				
1.7	1.7				
2.0	2.0				
2.1	2.4				
0.9	0.9				
2.9	2.9				
2.7	2.7				
0.9	0.9				
0.9	0.9				
2.4	2.4				

Field Data for Vertical Slopes

18.3 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
2.7	3.0	3.0	3.0	3.0	3.0
3.0	3.0	3.0	3.0	2.4	2.4
2.7	3.0	4.3	4.6	1.5	1.5
2.1	2.4	1.5	1.5	3.7	3.7
2.4	2.7	2.7	2.7	3.0	4.3
3.0	3.0	1.8	1.8	2.9	2.9
2.1	2.1	3.4	4.0	1.8	3.0
3.0	3.0	4.3	7.3	2.4	3.4
5.2	5.5	3.0	3.0	4.0	4.0
1.8	1.8	1.8	2.1	3.0	3.0
1.5	1.5	1.5	1.8	3.0	3.0
3.7	3.7	3.0	3.8	2.7	3.4
2.7	2.7	2.4	3.7	1.5	1.5
1.2	1.2	2.7	2.7	1.7	1.7
1.5	1.5	2.9	2.9	3.4	3.7
1.2	1.5	2.6	2.6	3.5	4.0
1.8	1.8	3.8	3.8	2.9	2.9
2.4	2.4	3.0	3.0	3.2	3.8
2.1	3.0	2.7	3.4	2.4	3.0
3.0	3.0	3.0	3.0	1.5	1.5
4.9	5.5	3.2	3.2	3.2	3.2
3.4	3.4	4.3	4.6	4.0	4.0
1.2	1.2	2.9	2.9	4.9	4.9
1.2	1.2	2.7	2.7	2.4	3.5
1.8	1.8	3.0	3.0	3.2	3.2
3.0	3.4	0.3	0.3	3.0	3.0
1.5	1.5	3.0	3.0	1.5	4.3
2.1	2.1	2.7	2.7	2.7	2.7
3.0	3.0	2.4	2.4	3.7	4.3
5.5	5.5	2.1	2.1	3.8	3.8
2.1	2.1	1.8	1.8	4.0	4.0
3.8	3.8	2.6	4.0	3.8	3.8
2.0	2.0	3.4	3.4	2.7	4.4
2.6	2.6	4.0	4.0	3.7	3.7
1.2	1.2	3.4	3.4	2.6	2.6
1.8	1.8	4.9	6.1	2.7	2.7
3.0	3.0	3.0	3.0	3.8	3.8
2.4	2.4	4.4	4.4	4.0	4.0
0.9	0.9	4.9	6.1	4.4	4.7
3.0	3.0	1.8	2.4	2.9	2.9
3.0	3.0	2.0	2.0	2.7	2.7
3.4	3.4	2.1	2.1	1.5	1.5
2.3	2.3	3.0	3.0	3.8	3.8
4.6	4.6	1.1	1.1	4.6	4.6
1.8	1.8	2.3	2.3	3.7	3.7
1.2	1.2	4.0	4.3	2.4	2.4
3.8	3.8	2.4	2.4	3.0	3.0
1.2	1.8	4.1	4.1	3.0	3.0
4.0	4.0	2.6	2.6	2.7	2.7
0.8	0.8	3.0	3.0	2.4	2.9

18.3 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
2.0	2.0	2.1	2.1	3.4	3.4
1.2	1.5	4.9	6.2	3.4	3.4
4.6	4.6	3.5	3.5	3.8	3.8
2.7	2.7	4.0	5.0	2.4	2.4
0.9	1.5	3.8	4.0	2.7	2.7
2.3	2.3	4.4	4.4	1.8	2.6
2.7	2.7	3.0	4.3	4.3	4.7
1.8	1.8	2.3	2.3	3.7	3.7
2.4	2.4	2.4	2.4	4.7	6.4
0.9	0.9	3.4	3.4	2.4	4.3
1.5	1.5	2.6	2.6	2.7	3.7
2.1	2.1	2.7	2.7	2.4	2.4
5.3	6.1	4.1	4.1	5.3	5.5
1.8	1.8	3.0	3.0	2.7	2.7
2.7	2.7	2.1	2.4	2.4	2.4
2.4	2.4	3.7	4.3	1.8	1.8
1.5	1.5	3.4	3.4	4.0	4.0
1.5	1.5	4.1	6.7	4.6	4.6
2.3	2.3	2.4	2.7	4.0	4.3
4.3	4.3	2.1	3.0	2.7	2.7
1.5	1.5	2.6	2.7	4.6	4.6
1.7	2.1	2.1	2.6	3.4	3.4
4.3	5.5	2.4	2.4	4.6	5.8
3.0	3.0	3.4	4.6	3.4	3.4
3.0	3.0	3.4	4.0	3.7	3.7
1.8	1.8				
2.1	2.1				
1.5	1.5				
1.5	1.5				
2.7	2.7				
2.7	3.0				
3.0	3.4				
2.7	2.7				
1.8	2.0				
2.4	2.4				
2.3	2.3				
1.5	1.5				
0.9	0.9				
1.5	1.5				
2.3	2.3				
1.5	2.4				
2.0	2.0				
3.0	3.0				
1.2	1.5				
2.3	2.3				
1.5	1.5				
0.9	0.9				
3.7	3.7				
2.7	2.7				
2.0	2.0				

Field Data for Vertical Slopes

24.4 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.9	0.9	3.0	3.0	3.0	3.0
3.5	3.5	3.0	3.0	2.4	2.4
3.2	3.2	4.3	4.6	1.5	1.5
3.4	3.4	1.5	1.5	3.7	3.7
3.0	3.0	2.7	2.7	3.0	4.3
3.8	3.8	1.8	1.8	2.9	2.9
3.2	3.2	3.4	4.0	1.8	3.0
6.1	6.1	4.3	7.3	2.4	3.4
3.4	3.4	3.0	3.0	4.0	4.0
4.6	4.6	1.8	2.1	3.0	3.0
3.4	3.4	1.5	1.8	3.0	3.0
2.9	2.9	3.0	3.8	2.7	3.4
4.6	4.6	2.4	3.7	1.5	1.5
3.4	3.4	2.7	2.7	1.7	1.7
5.2	5.2	2.9	2.9	3.4	3.7
3.0	3.0	2.6	2.6	3.5	4.0
3.4	3.4	3.8	3.8	2.9	2.9
5.8	5.8	3.0	3.0	3.2	3.8
3.8	3.8	2.7	3.4	2.4	3.0
2.4	2.4	3.0	3.0	1.5	1.5
0.9	0.9	3.2	3.2	3.2	3.2
4.3	4.3	4.3	4.6	4.0	4.0
0.6	0.6	2.9	2.9	4.9	4.9
2.9	2.9	2.7	2.7	2.4	3.5
3.0	3.0	3.0	3.0	3.2	3.2
3.7	3.7	0.3	0.3	3.0	3.0
1.5	1.5	3.0	3.0	1.5	4.3
1.5	1.5	2.7	2.7	2.7	2.7
2.7	2.7	2.4	2.4	3.7	4.3
2.4	2.4	2.1	2.1	3.8	3.8
3.0	3.0	1.8	1.8	4.0	4.0
1.8	1.8	2.6	4.0	3.8	3.8
5.2	5.2	3.4	3.4	2.7	4.4
3.2	3.2	4.0	4.0	3.7	3.7
4.3	4.3	3.4	3.4	2.6	2.6
3.0	3.0	4.9	6.1	2.7	2.7
1.5	1.5	3.0	3.0	3.8	3.8
3.4	3.4	4.4	4.4	4.0	4.0
3.4	3.4	4.9	6.1	4.4	4.7
4.9	4.9	1.8	2.4	2.9	2.9
2.7	2.7	2.0	2.0	2.7	2.7
3.4	3.4	2.1	2.1	1.5	1.5
3.0	3.0	3.0	3.0	3.8	3.8
3.0	3.0	1.1	1.1	4.6	4.6
5.9	5.9	2.3	2.3	3.7	3.7
1.4	1.4	4.0	4.3	2.4	2.4
2.3	2.3	2.4	2.4	3.0	3.0
2.9	3.2	4.1	4.1	3.0	3.0
5.5	5.5	2.6	2.6	2.7	2.7
4.7	4.7	3.0	3.0	2.4	2.9

24.4 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
2.3	2.3	2.1	2.1	3.4	3.4
3.5	3.5	4.9	6.2	3.4	3.4
2.3	2.3	3.5	3.5	3.8	3.8
2.7	2.7	4.0	5.0	2.4	2.4
0.9	0.9	3.8	4.0	2.7	2.7
2.1	2.1	4.4	4.4	1.8	2.6
4.0	4.0	3.0	4.3	4.3	4.7
3.7	3.7	2.3	2.3	3.7	3.7
1.5	1.5	2.4	2.4	4.7	6.4
2.1	2.1	3.4	3.4	2.4	4.3
2.4	2.4	2.6	2.6	2.7	3.7
1.8	1.8	2.7	2.7	2.4	2.4
4.3	4.3	4.1	4.1	5.3	5.5
4.6	4.6	3.0	3.0	2.7	2.7
3.4	3.4	2.1	2.4	2.4	2.4
3.4	3.4	3.7	4.3	1.8	1.8
3.4	3.4	3.4	3.4	4.0	4.0
4.6	4.6	4.1	6.7	4.6	4.6
5.2	5.2	2.4	2.7	4.0	4.3
2.7	2.7	2.1	3.0	2.7	2.7
4.3	4.3	2.6	2.7	4.6	4.6
3.0	3.0	2.1	2.6	3.4	3.4
4.6	4.6	2.4	2.4	4.6	5.8
4.6	4.6	3.4	4.6	3.4	3.4
3.0	3.0	3.4	4.0	3.7	3.7
2.1	2.1				
3.4	3.4				
3.0	3.0				
4.3	4.3				
4.3	4.3				
3.8	3.8				
2.1	2.1				
1.8	1.8				
0.9	0.9				
1.5	1.5				
4.4	4.4				
3.8	3.8				
2.4	2.4				
0.9	0.9				
4.9	4.9				
2.7	2.7				
3.4	3.4				
3.0	3.0				
2.9	2.9				
1.2	1.2				
3.5	3.5				
3.2	3.2				
4.9	4.9				
5.0	5.0				
1.8	1.8				

Field Data for Vertical Slopes

24.4 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
6.2	6.2	2.4	2.4	4.3	4.3
3.8	4.6	1.8	1.8	3.4	3.4
4.6	4.6	1.8	1.8	3.4	3.4
3.2	3.2	2.3	2.3	3.0	3.0
4.3	4.3	4.3	4.3	3.7	3.7
3.0	3.4	2.7	2.7	2.9	2.9
2.3	2.3	4.6	4.6	2.7	2.7
4.3	4.3	2.4	2.4	3.7	3.7
3.8	3.8	3.0	3.0	3.8	3.8
2.3	2.3	3.7	3.7	3.0	3.0
2.7	2.7	3.7	3.7	1.8	1.8
4.3	4.3	1.5	1.5	2.3	2.3
1.8	1.8	2.4	2.4	3.0	3.0
3.7	3.7	3.2	3.2	2.7	2.7
1.5	1.5	2.1	2.1	5.5	5.5
4.6	4.6	3.4	3.4	3.0	3.0
2.4	2.4	3.8	3.8	4.6	4.6
3.4	3.4	3.2	3.2	2.3	2.3
4.9	4.9	6.6	6.6	3.0	3.0
2.3	2.3	2.3	2.3	1.8	1.8
1.8	1.8	4.4	4.4	4.3	4.3
1.8	1.8	5.3	5.3	2.3	2.3
2.7	2.7	3.8	3.8	3.7	3.7
2.7	2.7	2.3	2.3	3.0	3.0
4.6	4.6	2.7	2.7	4.0	4.0
5.3	5.3	0.9	1.8	4.6	4.6
5.3	5.3	2.3	2.3	4.6	4.6
4.3	4.3	2.7	3.7	3.4	3.4
2.4	2.4	4.0	4.0	4.0	4.0
3.4	3.4	3.2	3.2	2.4	2.4
2.7	2.7	4.6	5.5	3.2	3.2
3.2	3.2	1.5	1.5	2.1	2.1
3.8	3.8	2.3	2.3	2.1	2.1
2.3	2.3	1.8	1.8	2.1	2.1
3.0	3.0	4.7	4.7	3.7	3.7
3.0	3.0	3.7	3.7	2.4	2.4
4.9	4.9	4.3	4.3	1.5	2.4
3.2	3.2	2.1	2.1	4.3	4.3
4.3	4.3	1.8	1.8	5.8	6.4
2.9	2.9	4.6	4.6	4.3	4.3
3.4	3.4	3.0	3.0	3.0	3.0
4.0	4.0	1.5	1.5	3.4	3.4
4.3	4.3	1.2	2.1	2.1	2.1
3.4	3.4	2.3	2.3	2.9	2.9
5.5	5.5	2.4	2.4	1.7	1.7
3.0	3.0	2.7	2.7	3.0	3.0
1.8	1.8	3.4	3.4	3.0	3.0
3.4	3.4	3.7	3.7	3.4	3.4
1.5	1.8	2.7	2.7	2.7	2.7
2.4	2.4	1.5	1.5	3.8	3.8

24.4 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
3.7	3.7	3.4	3.4	3.4	4.6
1.8	1.8	3.4	4.3	4.0	4.0
2.4	2.4	2.3	2.3	3.0	3.0
4.3	4.3	4.3	4.3	4.3	4.3
3.0	3.0	1.8	1.8	3.4	3.4
3.0	3.0	1.8	1.8	2.1	2.1
1.8	1.8	1.2	1.8	2.1	2.1
5.3	5.3	3.4	3.4	4.0	4.0
5.8	6.4	1.8	1.8	3.0	3.0
3.4	3.4	3.4	3.4	4.0	4.0
4.6	4.9	0.9	0.9	4.0	4.0
2.1	2.1	0.3	10.4	4.9	4.9
3.7	3.7	3.2	3.2	5.2	5.2
3.0	3.0	4.9	4.9	0.6	2.1
2.9	2.9	3.7	3.7	2.1	2.1
3.4	3.4	1.8	1.8	2.1	2.1
4.6	4.6	2.4	2.4	3.7	3.7
3.5	3.5	3.7	3.7	4.6	4.6
6.4	6.4	2.7	2.7	3.0	4.0
4.3	4.3	4.3	4.3	4.6	4.6
2.7	3.4	2.1	2.1	5.2	5.2
5.3	5.3	3.7	3.7	4.9	4.9
2.7	2.7	1.8	1.8	2.7	2.7
4.3	4.3	3.0	3.0	2.1	2.1
2.3	2.3	3.0	3.0	3.0	3.0
5.8	5.8				
2.4	2.4				
4.9	4.9				
5.3	5.3				
3.4	3.4				
2.4	2.4				
3.4	4.3				
3.4	3.4				
4.6	4.6				
3.0	3.0				
4.3	4.3				
5.3	5.3				
3.7	3.7				
2.1	2.1				
5.3	5.3				
4.3	4.3				
1.5	1.5				
3.7	3.7				
3.8	3.8				
4.3	4.3				
2.4	3.0				
4.6	4.6				
4.0	4.0				
2.4	2.4				
4.9	4.9				

Field Data for Vertical Slopes

24.4 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
4.6	5.0	2.1	2.1	2.7	3.4
4.4	4.4	2.4	2.4	4.6	4.6
2.3	2.3	0.9	0.9	4.0	4.0
3.0	3.7	1.2	1.2	4.0	4.0
2.3	2.3	1.8	1.8	4.6	5.2
3.0	3.0	1.5	1.5	2.1	2.1
0.8	0.8	3.8	3.8	2.4	2.7
0.9	0.9	4.6	4.6	1.8	1.8
1.5	1.5	3.7	3.7	1.8	4.3
1.5	1.5	3.4	3.4	3.4	4.6
2.1	2.1	2.4	2.4	3.0	3.0
4.9	4.9	1.5	1.5	2.7	3.0
1.8	1.8	1.8	1.8	4.6	6.1
2.4	2.4	3.0	3.0	4.0	4.9
3.0	3.0	5.5	5.5	2.7	2.7
4.0	4.0	3.0	3.0	3.7	3.7
1.4	1.4	1.2	1.2	3.7	3.7
2.1	2.1	3.0	3.0	2.7	3.4
1.4	1.5	5.5	5.5	4.3	4.6
2.4	3.0	2.4	3.7	2.1	2.1
2.3	2.3	4.3	4.3	3.7	6.7
3.4	3.4	3.4	3.4	3.0	3.0
3.7	4.6	4.0	4.0	1.8	1.8
3.7	3.7	4.3	4.3	2.4	2.4
3.4	3.4	3.4	4.3	2.1	2.1
3.8	3.8	2.3	2.3	2.4	3.4
3.4	3.4	2.1	2.1	2.4	2.4
4.6	6.7	0.9	1.2	2.4	2.4
4.3	4.6	2.4	3.7	4.3	4.3
5.8	6.7	1.5	1.5	2.7	2.7
3.0	3.2	1.5	1.5	6.1	6.1
3.4	3.7	1.8	1.8	3.7	4.0
3.0	3.0	3.0	3.0	2.4	5.8
3.0	3.5	3.7	3.7	3.0	3.7
4.3	5.5	4.6	4.6	3.7	3.7
3.7	3.7	4.6	4.6	4.6	5.2
2.3	2.3	6.1	7.6	4.3	6.4
3.0	4.6	2.1	2.1	5.2	5.5
3.8	4.3	5.2	5.2	3.0	3.0
3.4	5.2	3.0	3.0	2.4	4.3
6.1	7.3	2.4	2.4	2.4	3.7
3.7	4.3	2.1	2.1	2.4	4.6
5.2	5.8	4.9	5.2	3.7	4.6
4.6	5.8	2.7	4.3	3.4	3.4
4.9	5.5	0.6	0.6	5.5	5.5
3.0	4.0	2.4	3.4	4.6	4.9
3.0	4.6	3.4	3.4	2.4	2.4
3.0	3.0	3.0	3.4	2.1	2.1
3.8	4.9	3.0	3.0	3.0	3.0
4.3	4.3	4.3	4.6	2.1	2.4

24.4 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
5.8	6.1	4.6	4.6	3.4	3.7
4.0	4.3	4.6	5.5	4.6	4.6
5.5	5.5	2.1	2.7	4.0	4.3
3.7	4.0	2.4	2.4	6.1	6.1
6.1	6.4	4.6	4.6	4.6	4.9
4.0	6.4	1.8	1.8	2.1	2.1
3.0	3.7	3.0	4.3	3.0	3.0
1.2	1.2	3.4	3.4	2.4	3.0
1.8	1.8	3.0	3.0	4.3	4.3
0.9	0.9	3.0	3.0	2.3	2.3
5.2	5.2	2.1	3.0	4.3	4.3
5.2	6.4	3.4	4.0	2.4	2.4
7.0	7.6	4.3	4.3	4.3	5.8
1.5	2.4	4.0	4.6	4.9	6.7
2.1	4.3	3.4	3.4	2.4	3.0
3.0	3.7	3.4	3.4	2.1	2.7
3.0	3.0	3.4	4.6	3.0	3.0
1.5	1.5	1.8	1.8	3.0	3.0
2.7	2.7	3.0	3.0	3.0	3.0
3.0	4.3	1.5	1.5	3.7	3.7
4.0	4.9	3.0	3.0	5.2	5.2
3.0	4.9	3.7	3.7	3.0	3.0
5.5	5.8	4.9	5.2	1.5	1.5
1.1	1.1	3.7	3.7	2.7	2.7
5.3	5.5	1.8	1.8	1.5	5.8
4.6	9.1				
4.3	4.6				
2.3	2.3				
4.3	4.3				
4.6	4.6				
4.6	4.9				
3.0	3.0				
4.6	4.6				
4.9	5.3				
4.9	5.3				
4.3	5.2				
4.3	4.3				
4.0	4.0				
3.0	3.4				
2.7	3.0				
2.3	2.3				
3.7	4.3				
3.7	6.1				
4.3	4.3				
3.5	3.5				
5.5	5.8				
1.5	2.4				
4.0	5.2				
1.2	1.2				
2.3	2.3				

Field Data for 4V:1H Slopes

12.2 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.3	1.2	1.5	1.8	0.6	0.6
0.9	1.2	0.9	0.3	2.1	2.4
2.7	3.4	2.1	2.7	0.6	0.6
0.6	1.2	0.6	0.9	1.2	0.9
2.1	3.7	0.9	0.3	1.5	2.1
0.6	0.6	1.5	2.1	0.9	1.5
0.3	0.9	0.3	0.9	2.1	0.9
2.1	6.1	0.3	5.8	0.9	1.2
0.3	1.2	0.3	0.9	0.3	3.0
1.5	1.8	1.2	1.5	0.3	3.0
0.6	1.5	0.6	0.9	1.8	1.5
1.2	2.1	0.9	0.6	0.6	1.5
0.6	0.6	1.2	1.2	0.9	1.2
0.6	0.6	0.6	1.5	0.6	1.8
0.3	0.9	0.6	0.9	0.6	3.7
0.3	1.5	0.3	0.6	0.9	0.9
1.5	1.5	1.5	0.9	0.6	0.9
0.9	1.2	0.3	2.4	0.9	0.6
0.3	0.6	0.3	4.3	1.8	1.8
0.9	0.3	0.3	4.3	0.6	3.0
0.6	0.6	2.1	1.5	0.3	5.2
0.9	0.9	0.3	2.7	0.3	4.0
0.9	0.6	2.1	1.8	2.1	2.1
0.9	2.4	0.3	4.0	0.9	0.9
1.2	1.5	0.3	4.3	0.9	0.6
0.6	0.9	0.6	0.6	0.6	0.9
0.9	2.1	1.5	2.1	2.1	0.9
0.3	3.4	0.3	3.7	1.5	2.7
0.6	0.3	1.2	0.9	0.3	6.1
0.6	3.0	1.2	0.6	2.1	1.8
0.3	7.0	0.6	0.6	0.3	5.5
1.8	1.8	1.8	0.9	2.1	1.2
0.3	0.9	0.6	0.6	0.6	0.6
2.4	1.2	0.6	1.5	2.1	2.4
2.1	2.4	0.9	0.9	0.6	0.6
1.8	2.1	0.9	0.3	1.2	0.9
0.6	0.9	1.5	1.5	0.6	1.2
1.5	0.6	0.6	0.6	1.2	1.8
1.2	3.7	2.1	2.7	1.5	1.5
1.2	0.9	1.5	3.7	0.9	1.5
0.9	0.9	0.3	2.4	0.6	4.9
0.6	0.3	0.6	3.4	1.2	1.2
0.3	0.6	0.6	0.6	0.3	1.5
0.3	0.9	0.6	1.2	0.9	2.1
0.9	4.0	0.3	2.7	0.3	5.2
0.6	1.8	1.5	0.9	0.3	0.3
1.2	1.2	0.9	0.6	0.6	0.3
0.9	0.9	1.5	0.9	0.6	0.6
0.9	0.9	0.6	1.2	0.6	4.3
0.6	0.6	1.2	1.2	0.3	4.0

12.2 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.6	2.1	1.5	1.8	0.6	0.3
0.6	0.9	0.6	0.6	0.6	0.6
0.6	1.2	1.2	1.2	0.3	6.4
0.9	0.9	1.2	0.9	0.9	0.3
1.5	1.5	0.6	0.6	1.2	1.2
0.6	0.6	2.7	4.3	0.3	0.3
0.3	0.6	0.9	0.9	2.7	2.7
0.6	0.6	0.3	3.4	0.6	2.7
1.2	0.3	0.3	3.7	0.6	0.6
1.5	3.0	2.1	1.8	0.6	0.6
0.9	0.9	0.3	2.1	1.2	0.9
1.5	1.5	0.9	0.6	0.9	1.5
1.2	1.2	0.9	1.5	0.9	0.9
0.6	0.9	0.6	0.9	0.6	2.1
0.3	1.2	0.6	2.4	0.9	0.9
0.9	1.5	0.3	4.0	0.9	0.6
1.2	0.3	1.2	0.6	0.6	0.3
0.9	2.7	0.9	1.2	0.9	0.9
0.6	2.4	0.9	1.8	0.6	0.3
0.9	0.9	0.6	0.6	1.2	1.5
0.6	0.3	0.9	0.6	0.9	0.9
0.3	4.9	1.5	0.6	0.6	0.3
0.3	4.6	0.9	0.6	0.6	0.9
0.3	0.3	1.2	2.4	0.6	0.9
0.6	0.3	0.3	3.7	0.6	2.1
0.6	0.6	0.3	4.0		
1.5	2.1	2.1	2.7		
0.3	0.6	0.6	2.1		
0.3	1.8	0.6	4.0		
0.6	0.9	1.8	1.5		
0.9	1.2	0.6	1.5		
0.3	4.3	1.2	1.8		
2.1	3.0	0.9	0.9		
0.3	1.5	0.6	1.2		
2.1	2.7	0.9	1.5		
2.1	2.7	0.3	6.7		
0.3	0.3	1.5	3.0		
0.3	2.4	0.6	1.2		
0.3	0.9	1.2	1.2		
0.9	1.2	0.9	1.2		
1.5	1.5	0.6	3.0		
1.8	3.0	0.3	2.7		
0.9	1.2	0.6	1.5		
1.2	0.3	1.5	0.9		
1.8	1.8	0.6	2.1		
0.6	1.2	1.2	1.8		
1.2	2.7	1.2	0.6		
0.6	2.7	1.2	1.2		
1.2	1.2	0.6	0.6		
0.6	0.6	1.5	2.1		

Field Data for 4V:1H Slopes

12.2 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.5	1.8	0.9	0.9	2.1	2.1
1.5	1.8	2.1	1.2	0.6	2.4
0.3	1.8	0.3	0.3	1.2	0.6
1.5	1.5	0.6	4.3	2.1	1.2
1.2	1.2	0.9	2.1	2.1	2.1
0.3	3.7	0.9	1.5	2.1	2.1
0.9	1.8	0.3	1.5	0.6	4.9
1.5	1.8	0.3	1.8	2.1	2.1
1.2	2.7	0.9	0.9	1.5	1.8
1.2	1.2	0.3	1.5	0.6	2.4
0.3	1.2	1.2	0.3	0.9	0.9
2.7	3.0	1.5	1.5	0.3	3.0
1.2	1.2	1.5	1.5	1.5	1.5
1.5	0.9	1.2	1.2	1.8	1.2
0.3	0.3	0.9	0.3	0.6	2.1
1.2	0.6	0.6	2.4	0.6	0.3
0.3	1.5	0.6	4.3	0.6	1.5
0.6	0.6	1.2	1.2	1.5	0.9
0.6	0.3	0.9	0.9	0.9	1.5
0.3	1.2	1.5	2.4	0.6	0.6
0.3	1.8	1.2	0.6	1.5	0.9
0.3	0.6	0.9	0.6	0.9	1.8
0.3	0.3	0.6	3.4	0.9	1.5
0.6	0.6	0.3	0.3	0.6	0.9
1.2	1.2	0.9	1.5	0.3	4.9
0.9	0.9	1.2	1.8	0.6	0.9
0.3	1.8	1.2	2.7	0.9	1.2
0.3	0.9	1.2	1.2	0.9	2.1
0.3	0.3	1.5	1.8	0.9	0.9
0.3	1.2	1.5	1.5	1.2	1.2
1.5	0.6	1.2	0.9	0.9	0.9
0.6	0.6	1.5	1.5	1.8	2.1
0.3	1.2	2.4	2.7	1.2	0.6
0.3	0.6	0.9	1.2	1.5	3.7
1.8	0.6	0.6	1.2	0.9	4.3
1.2	2.1	0.3	0.6	0.9	2.7
0.3	0.3	0.3	1.8	0.9	0.9
1.2	2.7	0.9	0.9	1.8	1.8
4.6	4.9	1.5	0.3	1.2	2.7
0.9	1.2	1.2	1.5	1.8	2.4
0.3	0.9	0.9	2.1	0.6	0.3
0.6	0.9	0.6	1.2	1.2	1.2
0.9	1.2	2.1	2.1	1.2	1.8
0.3	0.9	1.2	0.9	0.9	0.6
0.9	1.2	0.9	1.5	0.9	2.1
0.9	0.3	2.1	2.1	2.4	3.4
0.9	1.8	1.8	2.1	1.5	1.8
2.4	1.5	0.9	2.1	1.8	1.5
1.5	2.1	1.5	2.4	1.2	1.2
0.3	0.3	0.9	1.2	1.5	1.5

12.2 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
2.7	4.0	0.6	1.5	1.2	0.9
0.6	3.4	0.3	0.3	0.3	3.0
0.6	0.9	0.9	2.1	2.1	1.8
1.8	1.5	1.2	2.1	1.5	1.8
2.4	2.1	2.4	4.0	1.8	0.6
1.8	1.2	0.6	2.1	0.3	0.9
2.4	5.2	0.3	2.1	1.2	1.2
0.6	0.6	1.5	0.6	1.2	1.2
3.0	4.0	1.5	1.5	1.2	3.0
1.5	1.5	1.5	1.5	0.6	0.6
0.3	0.6	3.0	4.6	1.5	0.9
0.9	1.2	1.2	1.2	2.1	0.6
0.3	1.2	1.5	1.5	2.4	4.6
0.3	1.2	0.9	2.4	0.9	0.9
0.3	2.4	1.5	2.4	1.2	0.9
2.1	2.4	1.5	5.2	1.2	1.2
0.3	0.3	0.9	1.2	0.9	0.9
0.6	0.3	1.5	1.5	0.9	0.9
3.4	3.7	0.6	0.6	0.6	1.8
1.5	0.9	0.9	2.4	1.2	3.4
1.8	1.8	1.5	1.5	0.9	2.4
0.9	0.9	1.2	0.6	1.2	0.9
3.0	5.2	0.6	1.2	0.6	0.6
0.3	2.4	0.3	3.7	0.9	1.5
2.1	2.4	1.2	1.5	2.4	0.6
0.9	2.7				
0.3	0.6				
0.6	1.2				
0.3	1.8				
1.2	1.5				
0.9	1.5				
0.6	1.8				
0.3	1.5				
0.9	1.8				
0.3	2.1				
0.9	1.2				
0.6	2.1				
0.3	0.3				
0.6	0.3				
0.6	0.9				
0.9	1.2				
1.2	1.2				
0.6	3.4				
1.2	2.4				
1.8	1.5				
0.6	1.2				
1.2	0.9				
0.3	0.9				
0.6	1.2				
0.3	1.5				

Field Data for 4V:1H Slopes

12.2 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.5	3.4	0.6	3.0	2.1	3.7
0.9	1.5	1.2	2.4	0.3	6.1
0.3	0.9	0.6	5.5	1.2	3.4
2.4	5.5	0.3	0.9	1.5	2.7
0.6	1.5	0.3	2.1	1.5	2.1
0.9	2.1	0.3	9.1	0.9	1.8
0.9	0.9	0.9	1.8	1.8	6.7
0.3	0.3	0.6	7.9	3.7	7.6
0.9	3.0	0.9	4.0	1.5	1.8
1.5	2.4	1.8	4.0	1.5	1.5
0.9	2.4	0.3	2.4	0.9	3.4
1.5	2.4	0.3	5.8	2.1	2.1
0.9	2.1	0.6	2.1	1.5	1.5
0.9	0.9	0.9	1.8	0.9	1.8
0.6	0.6	1.5	2.7	2.4	3.7
1.2	2.7	0.9	0.9	2.1	4.6
0.9	0.9	1.8	3.0	0.3	4.6
0.3	1.2	0.9	2.1	0.6	2.4
1.8	4.0	0.3	1.5	0.3	0.9
1.5	3.7	1.8	2.7	0.3	5.8
1.2	4.0	0.6	4.0	0.9	4.0
1.5	1.8	1.2	3.0	1.2	2.7
0.3	1.2	0.9	6.1	2.4	4.3
0.6	0.9	0.9	3.7	0.9	0.9
1.2	1.8	2.4	3.4	2.7	6.7
2.4	4.0	0.6	2.4	1.5	1.5
1.8	2.1	2.1	3.4	0.9	1.5
0.6	0.9	2.1	2.1	0.9	1.8
0.9	1.2	2.1	2.7	0.9	5.5
4.0	5.2	2.1	4.3	1.2	2.7
0.9	2.4	0.6	0.6	1.5	4.3
0.6	1.8	1.2	1.2	0.6	0.6
1.5	3.4	1.8	3.4	1.2	1.8
0.6	1.5	0.6	2.4	0.9	6.4
1.2	2.1	1.8	1.8	1.8	1.8
0.6	1.8	0.9	0.9	0.9	2.4
0.9	0.9	0.3	0.6	0.6	1.8
1.5	2.1	0.9	1.8	2.7	3.4
0.6	0.6	0.9	0.9	1.2	1.2
0.3	0.3	1.5	6.4	2.1	2.1
1.2	1.2	0.9	1.2	0.3	4.0
1.2	4.9	2.4	3.4	0.6	3.7
1.5	1.5	1.2	1.2	0.9	2.4
2.1	2.1	0.6	4.6	2.4	8.5
3.0	3.0	1.2	2.1	1.2	1.2
3.0	4.9	1.5	2.4	1.5	5.5
1.5	1.8	0.9	2.7	0.3	3.4
0.9	0.9	0.3	0.6	0.9	2.1
0.6	0.9	0.9	3.0	0.9	0.9
0.9	0.9	1.5	4.0	2.4	10.1

12.2 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.6	1.2	1.2	4.9	0.9	0.9
0.9	0.9	2.1	2.4	1.2	3.0
2.1	5.2	2.1	4.0	1.2	5.2
0.6	1.8	0.3	4.0	0.6	1.5
0.9	3.7	2.1	2.4	0.6	3.4
1.2	1.2	1.5	1.8	0.6	4.0
1.8	2.7	0.9	0.9	0.6	1.8
1.2	1.2	1.5	3.0	0.9	2.7
2.4	2.4	0.6	1.8	0.6	0.6
1.8	3.0	1.8	2.7	1.2	1.2
1.5	1.5	0.6	1.5	1.5	2.1
1.2	1.2	1.2	8.8	2.4	3.4
1.5	3.0	0.9	2.4	1.2	1.8
1.8	2.4	0.6	2.1	0.9	0.9
1.5	1.5	0.9	0.9	0.6	0.6
0.3	0.9	1.5	1.2	1.8	2.1
1.8	1.8	0.9	0.9	2.1	2.4
2.4	3.7	1.2	1.5	1.8	2.1
1.2	1.5	0.9	2.4	1.2	7.3
2.1	2.1	0.6	0.6	0.9	0.9
1.2	3.0	2.1	6.4	0.9	0.9
1.2	1.2	1.5	4.3	2.1	2.1
1.5	2.4	1.5	1.5	0.3	6.4
0.3	1.8	1.5	6.1	0.9	4.0
0.3	1.2	1.8	5.8	0.9	6.1
0.9	2.4	0.9	0.9		
1.2	3.0	0.9	4.3		
0.9	4.0	1.2	4.3		
0.9	4.0	0.9	5.2		
1.8	2.1	2.4	1.8		
0.3	0.9	0.9	3.0		
1.5	2.4	1.5	3.7		
0.6	0.6	0.9	2.4		
0.6	0.9	1.2	2.1		
1.5	3.4	1.2	3.4		
2.7	3.0	0.6	4.3		
0.9	2.1	1.2	4.0		
2.1	2.4	0.6	1.2		
1.5	2.1	0.6	2.4		
0.3	0.9	0.6	3.7		
0.3	5.5	0.6	4.0		
0.9	1.5	1.5	2.1		
0.3	0.3	0.9	2.4		
1.2	3.4	0.3	1.5		
0.3	0.3	0.3	10.1		
2.1	3.0	1.2	4.3		
3.0	3.4	0.6	1.5		
2.1	5.2	0.6	0.6		
0.3	0.3	0.6	10.4		
0.6	0.6	1.5	5.5		

Field Data for 4V:1H Slopes

18.3 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.5	1.2	1.8	0.9	0.9	2.1
0.9	1.2	3.7	4.6	2.7	1.8
0.6	0.6	0.3	2.7	0.9	0.9
1.2	2.4	5.5	5.8	2.4	0.3
1.5	0.9	1.8	3.0	1.2	0.9
4.6	5.2	3.4	3.7	4.0	6.4
4.6	6.1	0.9	1.5	0.6	3.4
4.6	3.7	0.3	0.3	1.2	0.9
0.3	0.3	0.6	8.5	2.1	3.0
1.5	2.1	3.4	3.4	3.7	5.8
0.3	0.3	0.6	1.5	0.6	3.0
4.6	8.2	2.4	2.4	1.5	1.5
0.6	0.6	3.7	4.0	1.8	4.6
1.5	2.1	0.9	1.5	1.8	2.1
2.4	1.5	2.1	0.3	2.1	3.7
2.1	3.7	0.3	2.1	2.4	1.5
0.6	2.1	0.6	0.6	1.5	1.2
0.6	0.9	1.5	0.6	3.4	3.4
2.1	3.4	1.5	1.5	0.9	0.6
1.8	1.8	3.0	2.1	2.7	2.4
0.3	1.8	1.2	4.6	3.7	2.7
3.0	4.6	0.9	0.6	0.9	0.6
0.3	0.6	0.6	2.4	1.2	1.5
0.3	0.3	1.5	0.6	0.9	0.9
1.5	0.3	0.6	2.4	3.0	3.0
0.6	0.3	0.6	4.3	2.4	1.5
1.5	3.0	3.0	5.2	1.8	1.2
0.9	0.6	0.3	2.4	1.2	5.2
2.1	1.5	1.8	3.4	0.6	1.2
2.7	2.7	0.6	2.4	4.0	5.2
4.3	4.9	1.2	0.9	1.5	3.0
4.3	6.7	3.4	3.4	1.5	0.9
1.5	1.2	1.2	1.8	1.5	0.6
3.0	3.0	0.6	0.6	3.4	4.0
3.0	4.6	0.6	2.1	1.5	2.7
5.2	5.2	0.6	1.2	1.8	1.2
1.8	1.2	1.8	1.2	1.8	1.2
3.0	3.0	4.0	9.1	0.9	5.5
0.9	0.6	0.3	3.0	1.5	0.6
1.5	2.1	2.7	2.1	1.8	1.2
0.6	0.6	1.5	0.6	0.9	5.5
0.3	1.8	2.1	0.6	1.5	0.6
0.6	2.4	4.3	6.4	0.9	1.2
1.5	1.8	0.9	1.2	0.9	2.7
1.8	1.8	0.6	1.8	2.7	4.0
1.2	1.2	3.7	3.7	3.7	4.9
0.9	1.2	2.1	2.1	1.2	1.8
0.6	0.6	3.4	5.8	1.2	1.5
1.5	2.1	0.9	1.2	1.2	2.1
0.6	0.6	3.4	5.2	0.9	4.3

18.3 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.2	0.9	2.1	4.6	0.6	1.8
3.7	4.0	1.5	1.5	1.5	3.0
3.0	3.0	2.7	5.2	0.6	0.6
3.0	4.6	1.2	2.7	0.9	3.4
4.3	4.3	2.1	2.1	2.1	2.4
0.9	1.8	0.6	0.6	2.4	1.5
3.7	5.8	1.5	1.2	2.7	4.3
1.2	2.1	0.3	1.8	0.9	1.5
5.2	9.1	0.6	1.2	1.5	4.6
0.3	2.1	4.0	8.5	1.5	1.5
2.1	2.1	0.6	4.0	2.4	3.0
1.5	3.4	2.7	2.4	1.8	4.3
1.5	1.5	0.6	0.9	2.4	3.0
0.6	0.9	0.6	0.3	1.2	0.6
1.8	1.5	3.0	4.3	0.9	4.0
1.8	1.2	2.4	3.0	2.1	1.5
2.4	3.4	0.9	2.7	0.6	4.6
1.2	2.1	1.2	2.1	0.6	0.6
1.2	1.5	0.3	4.0	2.7	2.7
4.3	4.3	1.5	1.5	1.5	3.0
3.7	4.9	1.5	0.9	0.9	6.1
1.2	0.9	0.9	2.4	0.9	7.0
4.3	6.4	0.9	0.6	4.0	4.6
0.6	0.3	3.0	3.7	1.5	1.8
1.8	2.4	4.9	8.5	2.1	2.1
1.8	4.9	2.7	2.4		
2.4	4.6	0.9	2.4		
1.5	3.0	1.2	5.2		
0.6	0.6	0.9	0.9		
1.2	1.2	0.3	2.7		
1.5	1.5	1.5	0.3		
2.7	4.9	1.8	2.1		
0.9	1.5	1.5	0.9		
4.6	5.2	0.6	1.2		
2.7	4.3	1.2	3.0		
3.7	3.4	1.5	3.7		
4.6	4.6	0.6	0.6		
0.9	2.1	4.3	6.1		
0.6	0.3	1.5	3.7		
3.0	3.7	0.3	0.6		
0.3	1.8	0.3	1.8		
0.6	0.6	3.0	3.0		
1.2	2.1	0.9	0.3		
1.8	2.1	0.6	0.9		
0.3	0.3	0.6	0.9		
4.9	4.9	1.5	1.5		
2.1	2.7	0.6	4.6		
1.2	1.2	4.0	4.3		
0.3	1.8	0.6	2.4		
0.6	3.0	0.6	0.6		

Field Data for 4V:1H Slopes

18.3 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.8	2.1	0.6	0.6	1.5	1.2
1.8	2.7	0.9	1.2	0.6	1.2
0.3	1.8	4.3	7.3	0.6	0.9
2.4	3.0	0.6	3.0	2.4	3.7
3.0	4.6	1.5	6.4	0.6	4.6
1.5	2.4	2.1	4.6	1.8	4.6
0.3	1.2	2.1	2.1	0.6	5.8
0.9	1.2	2.1	6.4	1.5	5.8
3.7	3.7	2.1	3.0	0.6	2.1
0.6	1.5	0.6	0.6	1.2	7.9
1.5	1.5	0.6	4.6	1.8	1.5
1.2	3.7	1.8	2.1	2.1	2.1
0.6	0.3	1.8	3.7	1.2	1.2
2.4	2.4	1.8	3.7	2.4	3.4
1.5	3.0	0.6	5.2	3.4	5.2
1.2	1.5	0.6	2.4	1.5	5.5
0.6	6.7	0.6	3.4	0.9	13.1
0.3	1.5	0.6	0.6	7.6	9.1
0.3	0.9	4.3	6.7	0.6	2.1
4.6	4.9	0.6	0.9	0.6	4.9
1.5	2.4	3.0	5.2	0.6	2.1
0.3	0.3	3.0	6.7	0.3	8.5
4.0	4.9	3.0	2.4	0.6	4.9
2.7	2.7	0.9	2.7	1.2	3.0
1.5	3.7	0.9	0.3	0.6	1.5
1.5	1.5	0.3	0.6	1.8	3.7
1.5	1.8	2.4	2.4	1.2	2.7
1.5	1.8	0.9	0.9	0.9	1.5
0.9	1.5	0.6	0.6	0.6	0.9
0.3	0.3	0.6	0.9	0.3	10.7
3.7	8.5	1.8	5.2	0.3	9.1
3.7	4.6	0.6	0.6	1.5	3.7
4.9	5.5	0.9	1.8	0.6	0.9
3.0	4.9	0.9	0.9	3.4	6.7
2.7	3.4	1.2	1.8	1.8	1.2
3.4	5.2	0.6	0.6	0.6	5.2
2.1	3.0	2.4	2.1	0.6	1.8
0.6	0.6	1.5	2.4	0.6	5.8
4.0	7.9	2.1	4.3	0.6	3.0
1.2	1.5	2.7	4.6	0.6	4.9
1.2	1.5	2.1	5.5	0.6	5.2
4.0	4.3	2.4	3.0	0.3	5.8
1.5	3.0	3.7	6.4	0.3	4.3
1.5	4.3	0.3	4.3	1.2	1.2
0.6	0.3	0.3	7.3	0.3	5.8
1.8	2.1	1.8	2.1	2.7	6.4
2.1	6.1	0.3	7.9	0.6	6.1
0.3	0.3	0.6	3.7	1.2	7.3
2.1	0.3	1.2	1.2	2.7	5.2
1.8	3.0	0.3	0.3	1.2	1.5

18.3 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
3.7	4.6	1.8	1.8	2.4	2.4
0.3	2.7	1.2	0.6	0.3	14.9
2.1	2.1	0.6	2.4	2.4	2.4
1.8	2.4	1.5	1.5	0.3	9.8
3.7	9.1	3.0	4.0	0.9	4.6
3.7	5.8	1.5	0.3	0.6	6.1
1.5	1.2	0.3	8.5	2.1	2.7
3.7	5.2	1.2	7.0	1.8	6.1
0.6	0.3	1.2	5.2	0.9	0.6
3.7	5.2	3.7	10.1	0.9	3.0
2.1	3.7	2.1	7.6	0.9	4.6
2.1	2.1	0.9	1.8	0.9	0.9
3.7	6.1	1.8	3.0	3.7	10.1
0.6	2.1	1.2	4.6	1.2	1.5
0.3	0.3	2.1	2.7	1.2	6.1
0.9	0.9	0.9	6.4	1.8	2.1
3.0	2.1	4.0	7.0	0.6	10.4
0.9	1.8	6.1	10.4	2.1	1.5
1.2	4.6	2.4	6.7	0.9	8.5
0.6	0.9	2.7	6.4	2.1	2.1
0.6	0.6	3.7	8.5	3.7	5.8
3.7	7.9	0.9	2.7	0.9	7.0
0.9	0.3	0.6	1.8	2.7	2.1
0.9	3.0	0.3	2.1	2.7	2.4
1.2	3.7	1.8	7.6	2.1	3.4
0.3	7.3	0.9	5.2	0.6	4.6
1.8	1.8	2.7	8.2		
0.6	0.9	0.3	6.4		
4.9	5.8	2.4	2.4		
0.6	1.2	3.4	9.4		
0.9	0.9	2.1	4.3		
1.8	1.5	0.9	0.9		
2.4	2.4	0.3	4.6		
0.9	0.6	0.3	4.0		
1.8	2.4	0.9	3.7		
1.2	0.3	1.5	7.3		
1.2	2.7	0.3	4.9		
0.9	3.0	2.7	5.2		
0.9	0.6	0.9	0.9		
3.7	5.2	1.8	7.0		
2.1	4.6	1.5	1.5		
3.4	4.9	4.3	8.5		
3.0	5.8	2.4	7.0		
0.6	0.3	2.1	4.6		
2.1	7.0	0.9	1.2		
0.3	1.2	1.8	1.8		
0.3	1.5	2.1	2.1		
4.3	5.2	1.2	2.1		
0.9	2.7	0.3	0.9		
2.1	5.5	0.3	1.2		

Field Data for 4V:1H Slopes

18.3 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.6	12.2	0.9	4.9	1.2	4.6
1.8	2.1	4.9	11.0	0.9	7.3
0.9	6.1	1.2	15.2	0.9	10.7
0.9	2.7	3.4	4.6	1.2	0.6
0.6	9.1	1.2	4.6	3.0	10.7
0.3	6.7	1.2	7.0	0.9	11.3
3.0	10.4	1.2	4.3	2.1	2.1
0.9	2.4	2.4	3.4	2.1	2.4
0.6	1.8	1.2	4.6	4.6	21.6
2.7	1.2	1.8	4.3	0.9	2.4
2.7	4.3	1.8	13.4	3.0	9.8
0.9	1.2	0.6	0.9	1.2	1.2
2.4	2.4	2.1	7.3	1.2	11.0
0.6	1.5	3.7	14.9	1.5	6.7
2.1	4.3	4.3	8.2	1.8	19.8
0.6	4.0	1.8	9.4	0.9	0.3
1.2	6.4	3.7	13.7	3.0	9.4
4.6	8.8	0.6	2.4	1.2	7.3
2.1	7.9	0.9	5.5	1.8	11.3
2.1	7.3	1.5	12.2	1.2	21.3
0.6	4.3	0.9	7.6	1.5	6.4
0.6	2.1	4.0	11.3	1.8	14.3
1.5	1.8	0.6	6.1	1.8	16.8
0.9	2.1	4.6	13.7	1.5	5.8
2.7	4.3	0.9	3.7	0.9	11.0
2.1	2.7	1.5	1.5	3.7	6.1
2.1	2.4	0.6	10.4	0.6	5.5
2.1	2.1	3.0	4.6	4.3	14.0
0.6	0.6	0.6	0.9	1.5	23.2
0.6	0.9	3.4	9.1	1.5	1.2
0.6	3.0	1.2	2.4	2.1	19.8
0.9	0.9	3.4	16.2	1.8	1.8
0.6	4.9	1.2	8.2	0.9	8.8
0.6	0.9	1.5	1.5	3.0	3.0
1.2	4.9	2.1	11.3	0.9	11.3
2.7	11.0	3.4	6.1	1.8	2.4
3.4	4.6	1.2	1.5	2.1	14.6
3.7	11.9	2.1	4.3	2.4	3.7
4.0	6.4	0.6	6.1	0.9	2.4
0.9	1.2	1.5	10.7	1.5	1.2
1.5	1.5	1.5	5.2	2.7	4.3
0.9	0.9	1.2	7.6	1.2	12.8
0.9	2.1	0.9	1.5	0.9	2.4
2.1	4.3	0.9	1.5	1.8	11.0
0.9	7.6	1.5	2.4	1.2	1.2
0.9	6.1	1.5	2.1	0.9	4.0
0.6	1.5	2.1	7.3	1.5	6.7
1.2	4.0	1.2	3.4	1.2	9.8
0.6	2.7	4.6	11.3	0.9	7.9
3.0	9.4	0.6	2.7	1.8	0.3

18.3 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.6	4.3	2.7	13.7	0.9	5.2
0.6	6.4	0.9	4.9	0.9	13.4
1.5	2.4	1.2	1.2	4.9	10.7
1.2	7.0	1.2	2.7	1.8	3.0
0.6	0.6	2.1	16.8	2.1	5.2
4.3	9.8	1.8	7.0	1.2	9.8
1.8	6.7	0.9	6.1	0.9	7.6
2.1	4.9	2.1	11.6	0.9	14.9
0.9	5.2	3.0	5.2	1.2	4.9
1.8	1.8	2.1	8.2	1.5	2.1
0.9	4.0	4.6	8.5	2.7	10.7
0.3	6.7	2.1	2.4	2.1	2.4
4.6	11.3	1.2	2.7	1.8	15.2
1.8	8.5	1.2	1.5	1.8	4.3
0.6	7.0	2.4	6.7	0.9	4.6
3.4	4.0	1.5	14.9	0.6	15.5
3.0	8.2	3.0	8.2	0.6	16.5
1.8	1.2	1.8	3.0	0.6	4.6
2.1	3.7	1.2	8.5	1.8	0.6
5.8	6.4	1.5	5.8	4.3	17.7
0.6	4.3	1.5	10.4	0.6	2.1
0.6	3.4	2.1	8.5	1.5	2.7
1.8	8.5	0.9	5.2	1.2	9.4
3.0	8.2	2.1	19.8	0.9	7.0
1.5	9.4	1.5	7.3	2.7	8.2
1.5	4.3	2.7	4.9		
1.5	2.7	2.1	20.4		
1.2	3.7	1.2	5.2		
3.0	10.7	1.2	1.8		
1.8	1.8	2.7	5.5		
0.6	1.8	0.9	5.2		
1.8	3.4	2.1	12.5		
0.9	2.4	0.9	8.2		
1.8	5.5	2.1	12.5		
0.6	4.3	0.9	8.2		
0.6	5.8	1.5	6.4		
1.2	1.2	1.5	10.7		
1.2	4.9	3.0	4.9		
2.4	2.4	1.8	16.5		
1.2	2.7	0.6	9.8		
1.8	4.0	3.0	13.1		
5.2	11.6	3.0	4.3		
0.9	1.5	0.9	7.3		
3.0	3.0	2.7	12.2		
1.5	3.7	0.9	6.4		
1.5	1.8	1.5	4.9		
2.7	8.2	0.9	1.8		
0.9	0.6	2.1	4.0		
3.0	12.5	0.9	2.1		
0.9	1.5	1.5	12.2		

Field Data for 4V:1H Slopes

24.4 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.3	4.3	0.9	1.8	1.5	6.7
3.7	4.3	0.9	1.8	0.9	4.9
2.4	2.4	5.8	5.2	1.2	6.7
0.3	4.9	0.9	8.5	1.8	12.5
3.7	4.6	0.6	7.3	2.7	8.2
2.1	7.3	4.3	4.0	2.7	2.7
1.5	2.4	1.2	3.7	1.8	4.3
3.4	3.7	3.0	2.1	1.5	4.0
2.1	2.1	1.2	5.5	1.2	1.5
3.7	4.3	0.9	0.9	0.9	3.7
2.4	5.2	0.6	2.1	3.0	4.3
2.1	2.1	0.3	6.4	5.5	5.5
4.3	5.8	0.3	8.5	3.7	6.1
2.1	0.9	3.7	4.9	5.8	5.8
4.9	5.2	0.3	1.8	0.9	3.7
1.5	0.9	4.6	6.4	1.2	14.6
0.9	0.9	1.5	2.1	2.1	2.1
1.8	3.4	2.1	5.2	2.7	2.7
0.3	4.9	1.8	5.8	0.9	9.4
2.1	2.1	0.9	2.1	1.5	5.2
2.4	3.0	0.9	3.7	0.9	11.0
2.1	2.1	0.9	4.0	0.9	14.3
0.6	8.2	1.2	5.2	3.0	3.4
1.2	2.1	5.5	3.7	2.4	2.4
0.6	8.8	0.6	2.4	3.0	5.2
1.2	1.2	4.6	5.2	2.7	6.4
4.6	3.7	0.6	0.6	1.5	7.3
1.2	1.8	4.0	3.4	1.8	6.7
1.2	1.5	1.8	0.6	0.9	4.3
1.2	1.5	1.2	4.6	1.2	6.4
0.6	0.6	0.6	2.1	1.8	1.8
0.6	7.6	0.3	6.7	3.4	3.4
0.9	2.1	5.2	6.4	1.5	1.5
2.1	1.5	0.6	0.9	0.9	3.4
1.5	1.2	0.6	5.8	2.7	4.0
2.4	3.7	1.5	5.2	4.3	4.3
2.1	0.9	0.6	7.3	0.9	3.4
4.3	4.9	1.2	4.9	2.7	3.4
6.7	10.4	0.6	3.4	2.7	2.7
0.9	2.1	1.8	3.7	0.9	7.0
2.7	3.0	0.9	1.2	0.6	1.8
1.5	0.9	1.5	4.6	1.2	1.2
3.0	3.4	1.2	0.9	0.6	9.1
0.6	0.6	4.3	6.7	1.8	4.6
4.3	3.7	0.9	3.4	1.5	1.8
3.0	3.7	0.9	2.1	3.7	6.7
4.3	4.3	1.5	4.3	1.5	1.5
2.7	2.4	0.3	0.9	4.3	4.3
3.0	2.4	0.6	7.6	0.6	3.7
6.1	2.7	0.6	9.8	0.6	7.0

24.4 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
3.7	4.0	1.8	2.7	0.6	6.1
0.6	4.6	3.0	2.4	2.7	2.7
2.1	2.1	2.7	4.0	0.6	7.0
1.8	5.2	0.9	1.2	3.0	4.3
2.1	1.8	0.9	5.2	1.8	1.8
4.9	5.5	1.2	1.5	0.9	2.4
2.1	1.8	4.3	3.0	2.4	2.4
0.3	6.4	1.2	9.4	1.5	5.2
1.2	5.8	4.3	3.0	0.6	6.1
2.1	3.0	0.9	0.9	3.4	7.6
0.6	3.4	0.6	1.2	0.9	1.2
1.2	0.9	0.6	7.0	0.3	15.2
3.4	3.4	0.6	2.1	1.2	1.2
2.7	2.4	2.4	3.7	5.2	6.4
3.7	4.3	0.3	7.3	2.7	4.3
3.4	4.0	2.1	3.4	1.2	1.2
1.2	4.0	3.7	5.2	0.6	6.1
5.2	3.4	5.2	7.0	0.6	3.4
5.8	7.3	0.6	11.6	1.5	1.5
2.1	6.4	1.8	3.7	0.6	6.4
2.1	1.8	4.9	7.3	0.6	11.6
6.4	7.9	1.2	5.2	0.9	4.0
3.0	4.0	2.1	3.7	3.4	4.3
3.0	3.0	0.6	5.8	1.8	7.6
3.0	2.4	1.8	6.1	0.9	1.8
1.8	7.0	5.2	7.9		
0.6	3.4	0.6	1.2		
2.4	2.4	0.9	4.9		
4.0	4.0	0.9	4.9		
4.0	4.3	0.9	5.2		
3.0	3.4	0.6	11.0		
0.3	0.6	3.0	3.0		
4.0	4.0	6.7	9.1		
4.0	4.3	0.6	8.8		
3.0	3.4	0.3	9.1		
0.3	4.3	3.0	7.9		
0.6	0.6	3.0	3.7		
5.2	4.0	0.3	1.5		
2.4	4.9	5.2	4.6		
4.3	6.4	4.3	4.6		
6.1	6.4	0.9	8.2		
1.8	3.0	0.9	6.1		
0.6	1.2	3.7	5.2		
2.7	2.1	2.1	1.8		
0.3	4.9	0.6	5.2		
2.7	2.4	4.3	1.5		
4.6	6.7	3.0	1.5		
1.2	0.6	3.4	4.6		
0.6	1.8	1.5	0.9		
1.8	4.0	4.6	4.6		

Field Data for 4V:1H Slopes

24.4 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.2	1.2	5.8	6.1	0.9	7.9
4.9	7.0	2.1	2.1	3.4	6.1
4.9	8.8	2.1	2.7	1.8	5.8
0.3	8.5	3.4	4.0	0.9	7.0
0.9	2.7	1.2	4.6	2.7	3.4
4.3	5.8	2.4	4.9	1.5	3.0
2.1	4.3	2.7	2.7	2.7	7.0
0.9	0.9	1.2	10.4	2.1	5.5
1.5	1.5	0.6	17.1	0.9	2.1
1.8	1.8	2.1	3.4	1.5	3.0
0.3	5.2	1.5	3.0	0.3	13.1
1.2	5.5	1.5	3.4	3.0	4.6
0.3	6.4	1.2	1.2	6.1	6.1
2.7	2.7	3.7	9.8	1.5	8.2
1.5	2.1	1.2	2.7	1.5	2.1
0.3	3.4	5.5	8.2	0.3	2.4
7.6	11.6	0.6	7.3	0.6	13.1
0.9	1.2	2.4	3.0	3.0	7.0
1.8	6.1	0.6	7.0	1.2	2.1
3.0	3.4	3.0	3.0	3.0	6.1
5.2	5.5	3.7	5.5	1.2	12.8
6.1	6.7	4.3	5.5	2.7	7.3
0.9	0.9	1.2	2.1	3.4	3.4
0.3	4.6	3.4	9.1	1.5	1.8
7.0	14.3	3.0	8.2	5.5	11.3
4.0	4.9	0.6	6.4	2.1	4.3
3.0	3.7	0.3	1.5	0.6	9.1
4.9	6.4	0.3	1.5	0.6	8.2
5.2	5.5	4.3	4.3	3.7	3.7
2.1	4.0	2.7	4.6	1.5	1.5
3.0	3.0	2.1	2.1	0.6	8.2
7.6	7.9	1.5	1.8	1.8	9.1
0.3	5.2	0.9	2.1	0.9	4.3
3.7	3.7	7.0	7.0	1.2	7.6
0.3	5.2	0.6	4.0	3.0	3.7
1.5	1.5	0.9	4.3	1.5	1.5
2.7	5.2	7.0	8.5	1.2	11.0
0.3	9.1	2.1	3.4	3.7	7.9
0.9	4.9	1.2	1.5	3.0	3.7
0.6	2.4	3.0	8.2	2.1	2.1
1.2	3.0	2.4	2.7	2.4	8.5
4.3	5.5	1.5	2.1	0.6	13.7
3.0	3.7	2.7	8.2	2.7	4.9
5.2	5.8	0.6	9.4	1.5	2.1
2.4	2.4	0.6	6.7	0.9	16.8
3.0	3.7	0.9	5.5	1.8	3.0
0.3	5.2	0.6	10.1	0.9	12.2
2.4	2.4	1.2	4.3	2.1	7.6
1.8	5.5	0.9	4.9	0.9	9.1
1.2	4.3	0.9	3.4	1.2	11.6

24.4 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.6	5.5	3.0	7.0	4.3	5.2
0.9	4.3	0.9	0.9	4.0	5.8
0.6	4.9	0.6	18.3	0.6	4.0
0.3	11.0	5.2	5.5	3.0	4.3
1.2	6.1	1.5	3.0	3.0	4.6
3.4	3.4	0.6	3.7	1.5	2.7
5.2	6.4	0.9	6.4	0.6	9.4
5.5	6.1	1.5	6.7	5.2	9.1
4.9	4.9	1.5	9.1	1.2	4.3
0.9	8.2	0.3	4.6	0.9	0.9
1.5	4.3	1.2	3.0	0.9	12.5
3.0	7.0	3.4	5.2	3.7	6.7
4.9	5.8	4.6	11.9	4.6	6.1
1.2	3.0	0.6	9.4	0.9	1.5
6.1	6.1	7.3	7.3	4.3	4.3
0.9	10.1	0.6	6.1	3.0	3.7
0.9	4.0	0.6	7.3	0.6	11.6
2.1	2.7	1.5	3.0	1.5	6.1
0.9	2.1	0.6	2.1	4.3	7.3
5.8	8.8	0.6	8.8	4.6	6.4
3.0	4.6	7.0	13.1	1.2	3.7
0.9	4.3	0.6	7.6	1.2	4.9
0.9	3.4	3.4	5.8	0.9	6.1
0.3	3.0	0.6	8.5	1.2	14.6
1.2	4.0	3.0	4.0	1.2	1.2
0.6	6.7	0.9	0.9		
0.9	6.1	0.6	1.8		
4.9	6.1	0.9	3.7		
3.0	4.3	0.9	2.4		
3.0	7.0	3.0	6.1		
0.3	4.3	2.7	11.0		
4.0	4.0	4.3	5.2		
0.9	2.7	1.5	1.8		
2.1	2.1	0.9	11.3		
0.6	3.0	1.2	1.5		
3.4	3.7	1.2	5.5		
0.9	4.0	3.4	7.6		
3.0	3.4	0.6	7.0		
2.1	2.7	4.6	6.1		
2.1	3.4	1.2	10.1		
2.1	3.4	3.0	3.7		
6.7	9.4	0.9	9.8		
1.2	4.9	3.0	7.6		
2.1	3.0	2.7	5.8		
7.3	9.4	4.6	9.4		
3.7	4.6	1.2	1.2		
2.4	2.7	1.8	4.6		
1.2	4.3	0.6	9.8		
4.3	4.3	3.0	7.6		
2.7	2.7	4.6	5.2		

Field Data for 4V:1H Slopes

24.4 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.6	0.6	2.1	18.6	3.0	11.3
1.2	10.4	4.3	21.0	0.9	30.2
0.3	12.5	0.3	14.6	1.5	10.4
1.2	1.2	4.9	6.1	0.6	16.2
0.3	12.5	0.6	9.4	3.4	9.8
1.2	1.2	0.3	3.0	1.2	7.6
2.1	4.3	2.4	3.4	1.2	9.8
1.5	4.3	0.6	6.1	1.5	10.7
0.3	11.3	2.7	8.5	0.9	6.1
0.3	8.8	0.6	5.5	0.9	7.6
6.1	8.2	0.6	5.2	0.9	3.7
1.5	7.3	0.6	13.1	2.1	4.6
1.8	4.3	2.1	8.8	2.1	4.6
4.6	20.4	0.6	13.4	3.7	19.8
0.9	1.8	1.8	10.1	0.9	23.5
4.6	5.2	0.6	21.3	0.9	9.8
4.3	7.3	0.6	2.1	0.9	16.2
1.5	5.2	6.4	10.1	2.4	7.3
2.7	3.0	3.4	10.1	1.2	1.2
0.6	2.7	0.6	0.6	1.2	3.0
0.6	8.8	1.8	4.0	1.8	11.3
1.2	1.2	2.1	7.9	5.2	18.6
1.5	5.2	0.6	1.8	4.3	21.6
0.6	2.1	0.3	4.0	0.9	0.9
0.9	3.7	0.6	3.0	1.5	5.2
1.8	6.1	1.8	9.1	1.5	1.5
1.2	3.0	0.9	13.4	0.6	10.1
0.6	4.3	1.2	0.9	2.1	2.1
1.5	1.5	0.3	7.9	1.5	6.1
0.3	5.5	0.3	21.9	4.6	12.8
0.6	0.6	4.9	13.1	0.6	11.0
0.3	14.9	1.5	6.7	2.7	5.5
0.3	2.4	2.4	3.7	0.9	25.6
1.8	8.5	0.6	5.5	2.7	17.4
3.0	11.3	1.8	4.6	1.8	4.6
2.1	4.6	2.1	3.4	1.8	10.4
2.4	7.6	0.3	24.4	0.9	6.4
0.3	10.4	1.5	5.8	0.6	11.6
4.3	11.9	1.2	8.5	1.5	10.4
1.2	1.2	1.8	4.6	2.1	2.1
0.6	2.4	0.9	1.2	1.5	9.1
3.7	6.1	0.6	4.6	2.1	3.0
0.9	1.8	0.9	0.9	0.9	17.1
5.2	6.4	3.4	4.6	0.9	7.6
1.2	4.6	1.5	1.5	4.6	8.5
2.1	4.9	1.2	6.1	1.2	6.1
0.9	2.1	2.1	3.4	0.9	7.0
4.9	11.3	2.1	10.4	0.9	1.5
0.6	0.9	4.6	5.8	3.4	12.2
0.6	0.6	4.6	6.7	4.6	16.2

24.4 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.6	1.2	4.3	21.9	2.1	3.0
3.0	13.7	3.0	5.2	0.9	8.5
0.9	2.7	0.6	7.0	0.9	16.2
1.2	2.4	0.9	6.4	2.1	9.1
2.7	11.3	2.1	7.0	0.9	12.2
1.8	11.6	2.1	11.6	2.1	2.1
1.2	1.5	0.9	0.6	1.8	21.3
0.9	3.0	1.2	5.8	3.4	14.9
1.5	10.4	3.4	8.8	2.7	3.0
4.6	13.4	1.2	10.7	3.0	5.2
5.5	8.5	3.4	6.4	1.5	1.5
4.9	9.1	1.5	7.3	2.7	8.8
1.5	1.5	4.3	11.3	1.8	4.0
0.9	2.7	0.3	14.6	0.6	16.8
1.2	4.0	1.5	5.2	1.2	22.9
0.9	1.5	0.9	3.7	3.0	3.7
0.3	10.4	0.9	1.2	1.8	14.9
3.0	3.4	0.6	11.9	0.9	16.8
0.6	7.9	2.7	10.7	0.9	21.3
0.3	1.5	0.9	2.1	1.2	1.5
1.5	11.9	3.0	8.5	0.9	5.2
2.7	8.8	1.5	3.7	0.9	10.4
4.6	5.5	0.9	2.7	1.5	12.2
4.3	15.8	3.0	12.5	1.5	3.0
0.6	4.6	1.5	4.3	0.9	2.1
0.6	5.2	2.7	2.1		
1.8	2.4	0.6	2.1		
0.3	5.2	0.6	13.4		
4.6	17.4	0.9	4.0		
4.3	6.4	1.5	4.9		
0.6	8.5	0.6	1.8		
2.1	3.0	3.0	3.0		
2.1	3.7	4.6	19.2		
2.4	6.7	4.6	11.3		
0.3	14.0	1.2	6.7		
2.4	4.0	1.5	12.2		
1.5	13.4	0.9	14.0		
1.5	3.0	1.5	6.1		
0.6	0.6	1.5	9.4		
3.7	4.6	3.4	4.6		
4.6	10.4	1.5	7.6		
6.1	13.7	1.5	2.4		
0.3	1.8	0.6	0.6		
3.4	5.2	3.0	3.7		
2.1	3.7	0.6	18.9		
1.2	1.2	0.6	18.6		
2.1	7.3	3.4	9.1		
4.6	4.6	3.7	12.5		
1.8	3.4	0.6	6.1		
5.5	16.8	1.8	10.7		

Field Data for 2V:1H Slopes

12.2 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	1.5	0.0	5.2	2.1	2.1
0.0	1.5	0.9	3.0	1.5	1.5
0.0	1.2	0.6	1.2	0.6	3.7
0.0	1.5	0.0	3.4	0.9	3.4
0.0	2.1	0.0	5.2	1.2	2.1
0.0	3.0	0.0	4.0	0.6	5.2
0.9	0.9	0.9	0.9	0.9	1.2
0.0	0.9	0.0	1.8	0.3	1.2
0.6	1.2	0.9	0.9	0.9	2.4
0.0	0.9	0.0	2.7	0.6	4.3
1.5	2.1	1.2	3.7	0.9	1.5
0.9	1.5	0.0	1.8	1.2	1.2
0.0	1.5	0.0	4.6	1.2	2.1
0.0	1.5	0.0	1.8	0.3	2.7
0.0	1.5	1.5	2.4	0.6	2.7
0.0	2.1	1.8	1.8	0.6	4.0
0.0	1.2	1.2	2.7	0.9	2.7
0.0	1.8	1.5	2.4	0.9	0.9
0.0	2.7	0.0	4.9	0.6	3.4
0.0	1.5	0.0	2.7	1.5	1.5
0.9	0.9	0.3	1.5	0.6	3.0
0.0	0.0	0.6	2.7	0.9	1.8
0.0	0.9	0.0	1.5	0.9	0.9
0.0	2.4	0.0	3.0	0.6	4.9
0.0	1.2	1.5	1.5	0.6	2.7
0.0	2.7	0.0	2.1	1.2	3.7
0.0	1.5	0.0	3.7	0.3	1.2
0.0	2.4	0.0	2.1	0.9	0.9
0.3	0.9	0.9	3.0	1.5	1.5
0.0	2.4	0.0	2.4	0.6	1.8
0.0	2.1	0.0	1.5	0.9	2.4
1.2	1.2	0.0	1.8	1.8	3.4
0.0	1.5	0.6	1.8	0.9	0.9
0.0	1.2	0.3	2.4	0.9	2.4
0.0	1.5	1.2	2.1	0.6	2.7
0.9	0.9	0.3	0.3	0.3	3.0
1.8	1.8	1.2	1.8	1.5	2.7
0.9	0.9	1.2	3.0	0.9	4.6
1.2	1.2	0.0	3.4	1.2	1.8
0.0	0.3	0.0	4.0	1.2	4.6
0.0	0.0	1.5	1.5	0.9	2.4
1.2	2.1	1.5	1.5	1.8	1.8
0.0	1.2	0.6	1.8	1.5	1.5
1.5	2.4	0.0	2.1	0.9	4.3
0.0	2.1	0.0	4.3	1.2	3.7
0.0	1.5	0.0	2.7	0.6	2.7
0.0	0.9	0.0	4.6	0.6	2.7
0.0	1.2	0.0	4.9	1.2	3.0
0.0	2.7	0.0	3.7	1.5	1.5
0.0	2.1	1.5	3.0	0.6	4.6

12.2 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	0.9	0.0	2.7	0.6	3.0
0.0	1.2	0.0	4.6	0.9	2.1
0.6	0.6	0.9	2.1	0.6	0.6
0.0	2.7	1.5	2.7	1.5	1.5
0.0	0.9	0.9	0.9	0.9	2.1
0.0	2.7	0.9	3.4	0.9	3.0
2.4	2.4	0.0	2.1	0.3	3.0
0.9	0.9	1.5	1.5	0.3	1.8
0.0	0.6	0.0	4.3	1.2	2.4
0.0	1.5	1.8	1.8	1.2	2.4
0.6	0.6	0.0	3.4	1.2	1.2
2.1	2.1	0.0	3.0	0.6	4.9
0.0	1.2	0.3	1.2	0.6	0.9
0.0	0.9	0.0	3.7	1.2	2.1
0.0	3.4	0.6	2.1	1.2	3.4
1.2	2.7	0.0	2.4	1.8	3.4
0.0	1.5	0.0	4.3	1.8	3.4
0.0	2.1	0.0	2.7	2.1	2.1
0.0	1.5	0.0	4.9	1.2	1.2
0.0	1.5	0.0	2.4	0.9	0.9
0.0	3.0	0.0	2.4	0.9	2.1
0.0	3.4	0.0	3.7	1.5	4.0
1.2	1.2	0.0	2.4	0.6	3.0
0.0	0.9	0.0	3.0	0.9	2.1
0.0	1.5	0.0	6.1	1.5	1.8
0.0	3.7				
1.5	1.5				
0.9	0.9				
0.0	0.9				
0.0	1.5				
0.0	1.8				
1.5	2.4				
0.0	1.2				
0.0	1.5				
0.0	2.7				
0.0	2.1				
0.0	1.2				
1.5	1.5				
0.0	2.4				
1.2	3.0				
0.0	0.0				
1.5	1.5				
0.9	0.9				
0.0	0.6				
0.0	1.5				
0.0	1.8				
1.2	1.2				
0.6	0.6				
1.2	2.4				
0.0	3.0				

Field Data for 2V:1H Slopes

12.2 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	0.9	1.2	1.8	0.0	4.9
0.9	1.5	0.9	3.4	0.0	5.5
0.0	3.4	0.6	2.4	0.0	3.7
0.0	2.7	0.0	3.0	0.0	3.0
0.0	2.4	0.0	7.9	0.0	4.6
0.0	2.4	0.0	6.1	0.0	3.7
0.3	1.8	0.3	3.7	0.0	5.2
0.3	1.8	0.0	4.9	0.3	0.9
0.0	4.9	0.3	1.2	0.0	7.6
0.0	2.1	0.9	1.8	0.0	4.0
0.0	0.9	1.2	4.0	0.0	5.2
0.0	3.7	0.0	2.4	0.0	0.9
0.0	3.0	0.6	3.0	0.0	3.4
0.0	2.4	0.0	3.0	0.0	3.0
0.0	4.9	0.0	3.7	0.0	4.6
1.2	2.1	0.0	3.0	0.0	2.4
0.0	2.4	0.0	3.0	0.0	4.0
0.0	4.9	0.0	2.4	0.9	1.5
0.0	1.5	0.0	6.1	0.0	4.9
0.0	3.7	0.3	0.3	0.0	3.0
1.2	2.1	0.0	3.7	0.0	1.5
0.6	0.6	0.0	2.1	0.0	3.7
0.9	2.7	0.0	4.3	0.0	3.7
0.3	0.3	0.0	3.4	0.0	7.6
0.0	1.5	0.6	2.4	0.3	0.6
0.3	0.9	0.0	4.6	0.0	3.0
0.9	0.9	0.0	4.9	0.3	1.8
0.3	0.9	0.0	6.1	0.0	4.9
0.3	0.9	0.6	1.8	0.0	6.1
0.0	3.7	0.0	3.0	0.0	3.7
0.0	2.7	0.0	4.9	0.0	4.9
0.6	0.6	0.0	6.7	0.0	5.2
0.0	0.9	0.0	4.0	0.0	1.5
1.2	4.9	0.9	2.1	0.3	3.4
0.0	2.7	0.0	5.2	0.3	1.8
1.2	1.8	0.0	3.0	0.3	1.5
2.1	4.6	0.0	5.2	0.0	2.4
1.2	2.1	0.0	2.4	0.9	1.8
0.0	3.4	0.0	4.0	0.0	1.5
0.0	3.7	0.0	1.5	1.2	3.0
0.0	2.7	0.3	1.2	0.0	3.7
0.0	4.9	0.0	5.8	0.0	1.5
0.6	0.6	0.0	4.6	0.0	3.0
0.0	1.2	0.0	3.0	0.0	5.2
0.0	2.1	0.9	0.9	0.0	6.1
0.0	6.4	0.0	2.1	1.2	2.4
0.0	1.2	0.0	7.0	0.0	5.5
0.0	2.4	0.0	5.2	0.0	2.1
0.3	2.1	0.0	5.2	0.0	4.0
0.0	2.1	1.2	2.4	0.0	4.0

12.2 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	0.9	0.0	7.0	0.0	4.0
1.2	2.1	0.0	2.1	0.0	3.4
0.0	1.5	0.0	2.1	0.0	3.0
0.0	2.4	0.0	2.7	0.0	3.0
0.0	3.0	0.0	5.8	0.0	3.7
0.0	4.0	0.0	2.1	0.0	5.2
0.0	2.1	0.0	2.4	0.0	6.1
0.0	4.0	0.0	5.2	0.0	2.1
0.0	2.1	0.0	4.0	0.6	2.1
0.0	4.6	0.0	4.0	0.0	6.7
0.9	1.5	0.0	2.1	0.0	4.6
0.0	4.0	1.5	2.7	0.9	2.4
0.0	2.1	0.0	4.6	0.0	4.6
0.0	2.7	0.0	3.4	0.0	5.5
0.9	2.1	0.0	1.8	0.0	3.0
0.0	1.5	0.0	4.6	0.0	4.6
0.0	4.3	0.0	5.2	0.0	3.4
0.6	0.9	0.3	0.3	0.9	0.9
0.0	0.0	0.0	3.0	0.0	2.1
0.0	4.0	0.0	3.4	1.5	7.3
0.0	3.0	0.0	5.2	0.0	5.2
0.0	1.5	0.0	3.0	0.0	5.2
0.0	3.4	0.0	4.6	0.0	3.7
0.0	4.9	0.0	3.4	0.0	2.1
0.0	2.4	0.0	1.8	0.0	3.7
0.0	2.4				
0.6	3.4				
0.0	3.0				
0.3	0.3				
0.6	0.6				
0.6	1.2				
0.6	1.8				
0.0	3.0				
0.0	1.8				
0.0	4.3				
0.0	4.0				
0.0	2.4				
0.6	0.6				
0.9	4.0				
0.6	0.6				
0.0	3.7				
1.5	3.4				
0.0	1.8				
0.3	1.2				
0.0	2.4				
0.9	4.3				
0.0	1.8				
0.3	0.3				
0.3	0.3				
0.3	1.2				

Field Data for 2V:1H Slopes

12.2 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	3.7	0.9	7.0	0.0	7.6
0.0	0.6	0.0	4.9	0.0	10.7
0.0	3.0	0.0	1.8	0.9	10.7
0.0	5.2	1.2	2.7	0.0	12.2
0.3	7.9	0.9	9.1	0.0	0.9
1.5	4.6	0.9	6.1	0.0	5.2
1.5	3.0	0.9	11.6	0.0	4.9
1.5	2.1	1.2	10.7	0.0	7.6
0.0	2.4	0.9	7.6	0.0	3.7
0.9	9.1	0.0	8.5	1.5	6.4
0.6	3.7	0.0	6.1	0.0	9.1
0.6	5.5	1.5	6.4	1.5	10.7
1.2	2.4	1.5	8.2	1.2	12.2
0.0	5.5	0.9	13.4	0.9	8.5
0.0	2.1	0.0	10.1	0.0	13.7
0.0	2.4	0.9	8.5	1.5	6.7
0.9	5.5	0.9	7.9	1.2	7.0
0.6	5.5	0.9	2.1	0.9	6.1
1.2	6.7	1.5	7.9	0.0	7.0
0.3	3.0	0.0	7.0	0.6	3.7
1.2	4.6	0.0	5.2	0.6	4.6
0.9	5.5	0.0	7.0	0.9	0.9
1.5	6.4	0.9	4.3	0.6	10.7
1.2	3.0	0.6	4.6	0.0	10.7
1.5	5.8	0.0	6.1	0.0	12.2
0.6	4.0	0.9	6.7	0.0	14.3
0.0	5.2	1.5	6.1	0.9	10.4
0.9	2.1	0.9	5.2	0.0	8.5
1.2	2.7	0.6	1.5	1.5	3.7
3.0	6.7	1.5	4.6	0.9	8.5
0.6	2.4	0.0	5.5	2.1	5.5
0.9	2.1	0.9	3.0	0.0	2.4
0.9	0.9	0.9	5.8	0.6	4.0
0.9	2.4	1.5	1.8	0.0	10.7
1.5	2.4	1.2	5.2	0.6	6.1
0.0	2.4	0.9	14.6	0.3	6.1
0.9	3.4	1.5	4.3	0.9	9.1
0.6	4.9	1.2	7.0	0.0	10.4
0.0	2.4	1.5	10.4	0.0	8.2
0.9	1.5	0.0	7.0	0.6	8.2
0.9	0.9	0.9	4.0	1.5	10.4
0.9	1.8	0.0	6.1	1.2	11.3
0.6	7.6	0.9	5.5	0.6	9.1
0.0	7.0	0.0	4.6	0.0	4.6
0.3	10.7	0.0	6.1	0.0	7.0
0.9	6.1	0.0	4.9	0.9	4.9
0.6	6.1	1.5	11.6	0.0	17.4
0.9	2.4	0.6	2.1	0.0	10.7
0.0	9.1	0.0	5.2	0.6	12.8
0.0	8.8	0.0	7.6	0.0	4.6

12.2 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	4.9	0.0	6.1	1.5	5.5
0.9	1.8	0.0	5.2	1.8	13.7
0.6	5.8	0.3	12.2	0.6	5.5
0.0	7.6	1.2	10.7	0.0	7.3
0.6	6.1	0.9	12.2	0.0	9.1
1.5	4.6	0.9	10.1	0.0	4.6
1.8	8.2	0.0	8.8	0.6	2.4
0.6	1.5	0.0	7.3	0.9	6.1
0.0	7.0	0.0	7.6	0.0	7.6
0.9	3.4	0.6	12.2	1.5	7.0
1.2	2.4	0.9	5.8	0.0	14.6
0.9	0.9	0.0	12.5	0.6	4.6
0.0	9.1	1.5	1.8	0.0	9.1
0.9	5.2	0.9	6.1	1.5	9.1
0.3	1.2	0.9	11.6	0.6	5.2
1.5	8.5	0.9	9.4	1.5	5.2
1.5	4.9	0.6	7.6	0.0	11.0
0.9	11.3	0.6	11.3	0.6	9.1
0.6	8.2	0.6	7.6	0.9	10.1
0.3	3.0	0.9	4.3	0.0	7.6
0.3	6.7	1.5	10.4	1.5	14.6
1.5	7.6	0.0	12.2	0.6	7.6
0.9	0.9			0.9	9.1
0.6	2.4				
0.6	8.5				
1.2	5.5				
0.3	1.2				
0.0	2.4				
0.0	1.8				
0.0	1.2				
1.5	7.0				
1.5	5.5				
0.9	1.5				
0.9	6.1				
0.6	4.3				
1.5	5.2				
0.0	3.0				
0.0	1.2				
0.0	3.4				
0.0	8.5				
1.2	2.4				
0.0	3.7				
1.5	8.2				
1.2	3.0				
0.6	3.0				
0.0	1.2				
1.5	7.3				
0.0	11.3				
0.0	4.0				
0.3	10.4				

Field Data for 2V:1H Slopes

18.3 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	1.5	3.0	3.7	1.8	2.7
2.7	3.0	0.0	1.5	3.4	5.2
3.4	4.9	3.7	5.2	1.8	1.8
3.7	4.0	2.1	3.4	2.4	2.4
3.0	3.0	0.0	4.6	1.8	4.3
2.1	2.1	0.0	2.4	3.4	4.6
1.5	2.1	1.5	1.8	3.4	4.9
2.4	5.2	1.2	2.1	2.4	2.4
0.3	0.3	1.8	2.4	3.4	5.5
2.4	4.9	0.0	3.4	2.4	4.6
2.4	3.0	0.3	1.5	2.4	3.7
0.9	0.9	4.3	4.3	0.0	4.6
2.4	2.4	1.5	2.7	3.0	5.2
2.7	3.4	2.4	2.4	1.5	2.7
4.0	6.4	2.4	4.6	2.4	2.4
3.0	4.0	2.4	2.4	2.1	4.9
2.7	4.0	1.5	5.5	2.4	5.2
0.3	0.3	3.0	4.9	3.0	4.0
2.1	3.0	1.5	4.6	2.4	2.4
3.0	4.9	2.1	5.2	2.1	3.4
0.9	2.7	2.1	3.4	2.4	2.4
2.1	2.7	3.7	3.7	3.7	4.9
2.1	2.4	2.1	2.1	2.4	3.7
0.0	4.0	1.5	1.5	1.2	1.2
0.0	2.1	4.0	7.6	2.4	3.4
0.0	1.8	2.7	4.3	2.1	4.0
0.0	1.8	2.4	2.4	4.6	7.6
2.1	2.1	2.7	3.7	0.9	3.0
2.1	2.1	3.0	3.7	3.4	3.4
0.0	0.3	1.8	2.4	3.0	3.0
3.0	4.3	2.1	4.0	0.0	3.7
0.9	1.2	3.0	4.0	2.4	5.2
0.6	0.9	3.0	5.2	0.0	4.0
0.6	1.5	2.1	2.1	3.7	5.5
0.3	0.3	3.7	6.7	0.0	3.0
1.5	2.1	0.0	3.0	2.4	2.7
1.8	2.1	3.0	3.7	2.1	4.9
2.1	2.1	3.0	3.7	1.8	3.4
1.8	2.4	2.4	4.3	0.0	4.9
0.3	0.6	0.0	3.7	0.0	3.7
0.6	0.6	1.5	2.7	3.7	5.2
1.2	1.5	2.7	3.0	0.0	5.2
1.5	4.9	1.8	3.7	1.5	5.5
0.9	1.8	2.7	4.9	2.4	3.4
1.5	1.8	2.4	3.4	1.5	1.5
0.0	1.8	0.0	2.1	5.5	7.0
0.0	0.3	1.5	3.7	0.0	3.4
0.9	1.5	2.1	4.0	0.0	3.7
4.3	6.1	1.5	2.1	3.0	4.9
2.4	3.0	1.8	3.4	1.5	5.2

18.3 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
3.0	3.7	1.5	3.4	2.4	5.5
3.7	4.6	1.5	3.4	0.9	2.1
0.0	2.1	3.0	5.2	0.3	3.4
1.5	1.5	0.0	4.6	0.3	0.3
2.4	3.0	0.0	6.7	4.0	4.9
1.2	1.2	2.1	2.4	3.0	5.2
4.3	6.1	3.4	3.4	2.1	3.7
0.0	0.6	2.1	3.7	2.1	2.1
2.7	4.0	1.8	4.0	1.2	2.1
0.0	0.9	3.0	3.7	0.0	2.4
2.4	2.4	3.4	3.7	1.8	3.4
1.2	1.8	1.5	2.7	2.4	3.4
1.8	2.1	2.1	4.6	0.0	4.3
1.8	3.4	2.1	2.4	1.5	6.7
0.6	0.6	2.1	6.7	2.4	3.0
1.8	1.8	3.4	3.4	0.0	2.4
1.5	1.8	2.4	3.0	3.0	4.9
0.0	1.5	1.5	4.6	3.0	3.7
0.9	0.9	1.5	2.4	1.8	3.0
1.5	2.1	1.8	4.0	3.0	3.7
2.4	3.4	0.0	2.4	3.4	4.6
2.1	3.4	1.5	4.6	2.4	4.3
3.0	3.0	2.1	2.1		
0.0	0.3	4.6	5.2		
0.6	0.6	3.0	3.7		
0.0	0.9				
1.5	1.8				
1.8	2.1				
3.0	3.4				
1.8	4.0				
4.0	5.5				
1.5	2.1				
2.1	2.1				
2.7	3.7				
0.9	1.5				
1.5	2.1				
0.0	1.5				
2.1	2.1				
1.8	1.8				
2.7	3.0				
0.0	0.0				
3.7	4.9				
2.1	3.0				
2.4	2.4				
0.0	0.3				
1.2	1.5				
4.6	5.2				
1.2	2.1				
1.5	1.5				
1.8	1.8				

Field Data for 2V:1H Slopes

18.3 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
3.4	4.3	1.5	2.7	2.1	5.2
3.0	4.6	2.1	2.7	1.5	2.4
0.9	3.0	1.8	3.7	2.1	3.0
1.2	3.0	0.0	6.4	3.0	5.5
2.7	6.7	0.0	3.7	3.7	6.1
1.2	2.4	3.7	5.2	0.0	5.5
0.6	2.7	3.0	5.2	3.0	6.1
3.0	3.0	0.0	2.4	1.5	3.7
3.0	3.7	3.4	4.9	3.0	4.0
0.6	2.4	2.4	3.7	3.0	8.5
0.6	1.2	3.0	4.0	2.1	2.1
2.4	4.6	0.0	3.7	3.7	7.0
3.0	3.0	0.0	2.4	1.2	1.2
1.2	2.4	1.5	3.0	3.7	5.2
3.4	4.0	3.4	4.3	0.0	3.0
4.6	5.2	3.0	4.3	3.7	8.5
4.3	5.5	4.0	7.0	2.1	4.3
0.9	4.0	0.0	3.7	2.4	4.0
0.9	2.4	1.2	3.0	1.5	5.2
1.8	1.8	1.2	2.1	4.0	7.0
4.0	5.5	0.0	1.2	3.0	6.4
3.7	3.7	2.4	4.6	1.5	2.4
4.3	4.3	3.7	5.2	3.4	3.4
2.7	2.7	1.8	4.9	2.1	4.0
1.5	1.5	2.4	4.3	3.0	5.2
0.0	2.1	2.1	4.9	3.0	3.7
2.4	3.7	3.4	4.0	3.0	3.0
2.4	4.0	4.6	11.3	2.7	3.7
4.3	4.9	3.7	3.7	3.7	10.7
2.4	2.4	3.7	6.4	2.1	3.0
2.4	4.0	0.0	3.4	3.0	6.1
2.4	4.0	1.8	3.0	0.0	1.8
1.5	1.8	1.8	3.0	1.8	3.0
2.7	3.4	2.1	5.2	1.8	4.6
2.1	2.4	3.4	4.3	1.5	4.0
1.8	5.8	1.5	3.7	2.1	3.4
2.1	4.0	1.8	5.2	2.4	2.4
4.6	4.6	2.1	4.0	2.1	3.7
1.2	2.4	1.5	2.1	2.4	2.4
4.9	6.7	2.4	5.8	1.5	3.7
3.4	4.0	1.8	3.7	2.1	4.3
2.7	4.0	1.8	4.9	1.8	3.0
3.4	7.0	1.2	2.4	2.1	3.4
1.5	6.7	2.4	4.9	0.0	7.0
0.6	1.8	2.4	7.9	3.7	5.2
0.9	1.2	2.4	4.9	0.0	3.7
3.7	5.2	3.7	7.6	0.0	10.1
2.4	2.4	3.4	3.4	0.0	4.0
0.0	4.9	2.1	4.0	2.1	3.0
3.4	4.6	1.8	2.4	4.6	9.8

18.3 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	4.0	2.7	4.9	2.1	7.3
0.0	4.6	3.7	5.8	2.1	7.9
1.8	2.4	2.1	2.1	3.4	8.2
0.9	1.8	2.1	4.0	2.1	4.9
0.9	1.5	2.1	3.7	2.1	4.9
0.0	0.3	1.8	4.0	3.0	3.0
3.4	3.7	2.4	8.2	3.0	6.7
0.0	2.4	3.7	5.5	3.0	3.0
0.0	5.5	0.0	7.9	2.4	2.4
0.0	4.0	1.2	3.0	2.1	4.9
0.0	3.0	2.4	9.1	2.4	2.4
0.0	5.2	4.0	5.8	2.4	5.2
0.9	2.4	2.4	6.7	1.5	6.1
0.0	3.0	2.4	4.3	2.7	3.4
0.9	4.9	1.8	3.7	2.4	5.2
3.4	4.9	0.0	1.5	0.0	2.1
3.7	3.7	0.0	2.4	2.4	3.0
2.4	3.7	3.0	5.2	3.0	6.4
1.8	2.7	4.0	6.1	1.8	1.8
0.9	0.9	2.7	3.7	1.5	2.1
0.6	0.9	0.0	7.0	0.0	2.4
0.0	1.2	1.5	3.7	3.7	7.3
3.0	3.0	3.0	7.3	3.0	4.9
1.5	1.5			1.8	3.4
1.8	5.5				
3.0	3.7				
0.0	4.6				
3.0	3.0				
3.0	4.9				
3.7	3.7				
2.1	4.6				
2.7	4.0				
0.0	5.2				
0.0	2.1				
3.7	3.7				
0.9	3.0				
2.4	4.6				
1.5	2.4				
1.5	1.8				
2.4	3.7				
1.2	1.8				
1.5	1.5				
2.7	4.9				
2.1	3.0				
2.4	3.4				
0.0	4.0				
2.7	3.0				
0.0	2.1				
1.5	1.5				
0.0	2.7				

Field Data for 2V:1H Slopes

18.3 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
2.7	3.4	0.9	12.8	2.7	7.9
2.1	2.1	2.7	9.1	0.0	6.4
0.9	4.3	1.8	4.9	2.4	8.2
3.7	8.2	2.7	9.1	2.1	9.8
3.0	6.7	0.6	10.4	1.8	14.0
2.7	4.9	4.3	11.9	0.0	4.9
1.5	2.4	2.4	3.7	2.1	2.1
1.5	2.4	0.6	15.2	0.0	11.6
0.6	3.7	3.0	7.6	3.7	4.6
3.4	4.6	2.1	7.0	2.1	7.6
3.0	9.1	4.6	6.7	0.0	15.2
4.0	9.8	3.0	7.3	1.5	7.9
1.5	3.0	4.3	15.8	1.5	7.9
3.7	4.6	3.7	9.1	0.0	9.8
1.2	4.9	4.9	9.4	2.1	3.7
4.9	12.5	1.8	9.4	1.2	4.6
2.4	4.6	1.8	4.3	1.8	6.4
2.4	4.6	2.1	10.7	3.0	4.9
3.4	4.6	2.1	2.1	2.1	13.1
2.1	8.2	1.8	5.2	3.4	11.9
5.2	7.0	1.5	4.6	3.7	9.1
3.7	6.7	3.0	4.3	2.4	9.4
1.5	3.0	4.3	10.4	2.4	8.5
3.0	4.6	2.7	9.4	1.2	11.3
3.7	6.7	4.6	9.1	2.1	7.0
3.0	4.3	2.7	8.5	4.6	7.9
3.0	12.2	2.1	11.3	4.6	9.8
1.8	8.5	0.9	7.0	0.0	15.8
1.5	5.5	2.1	9.4	1.2	3.0
0.0	3.4	1.5	4.3	2.7	7.0
2.7	6.4	3.0	4.3	3.0	6.7
0.9	1.5	3.0	7.9	0.9	13.7
1.5	4.6	1.2	5.8	0.0	4.9
1.5	4.6	2.4	6.1	0.9	7.6
1.2	3.0	2.1	2.1	3.0	6.4
2.4	11.6	0.9	4.9	2.4	6.7
1.5	5.2	4.3	10.4	6.7	9.8
1.5	1.8	0.0	8.8	1.5	9.8
1.8	3.4	3.0	5.2	1.2	4.6
2.1	11.6	1.5	4.6	2.4	16.5
2.7	4.6	0.6	3.0	0.0	3.0
1.5	2.1	1.5	7.9	0.0	2.4
2.4	4.6	0.9	1.5	3.0	4.9
1.5	3.0	1.2	7.6	3.7	10.4
1.2	3.0	1.5	7.6	1.5	10.4
3.4	4.6	2.7	7.9	0.0	1.5
2.1	6.7	3.0	4.9	3.0	12.8
1.5	2.7	3.4	12.8	2.1	8.2
0.0	7.6	2.1	8.5	0.0	9.8
1.2	6.4	2.4	3.0	5.2	13.1

18.3 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
2.1	6.4	3.4	7.0	0.0	17.1
3.7	4.9	3.4	10.4	4.6	18.3
2.7	6.1	2.1	7.3	0.0	7.0
1.2	2.1	2.1	14.6	0.6	2.1
2.1	4.6	3.4	7.3	0.0	22.6
3.0	6.1	1.5	11.3	3.0	9.1
1.5	2.7	3.7	8.5	3.4	11.3
1.8	4.0	3.0	9.8	0.0	10.4
0.3	1.5	1.8	4.3	0.0	8.8
3.4	3.4	2.7	5.5	0.0	12.2
0.6	3.4	2.7	8.8	0.6	8.2
1.8	3.7	4.9	11.9	0.6	15.2
3.0	7.6	3.4	4.3	0.9	8.2
3.4	5.5	3.0	5.8	1.2	2.7
1.5	1.5	1.8	5.2	0.9	18.0
2.7	7.3	4.0	7.9	2.7	7.0
2.1	3.7	1.2	1.2	0.0	16.2
0.6	5.2	4.6	9.1	1.8	20.1
1.5	2.7	2.7	17.4	0.6	7.6
2.4	6.4	0.9	12.5	2.4	19.8
0.6	4.9	2.1	7.9	1.5	8.5
2.7	4.9	1.5	6.4	1.2	7.9
3.0	14.3	0.9	6.1	2.1	5.8
1.2	4.9	3.0	16.8	0.0	4.6
1.8	2.1	2.4	10.7	2.7	21.0
3.0	4.9				
2.4	6.4				
2.4	3.4				
4.9	11.3				
1.2	3.0				
4.6	7.0				
1.5	7.3				
1.8	4.3				
3.0	9.1				
1.8	2.1				
2.1	4.6				
3.4	6.1				
2.1	7.3				
2.1	3.0				
2.4	14.3				
0.9	12.2				
2.4	4.6				
0.0	3.0				
2.7	7.3				
2.1	7.0				
4.6	9.4				
0.0	4.9				
1.2	4.9				
1.8	6.1				
2.1	4.0				

Field Data for 2V:1H Slopes

24.4 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.8	2.1	2.1	2.1	0.6	4.9
1.8	1.8	2.1	3.4	0.6	5.8
4.9	4.9	4.0	4.0	3.7	3.7
1.2	1.8	1.8	3.7	4.0	4.0
4.6	6.4	3.4	6.1	1.5	3.4
2.1	2.4	1.2	1.2	3.4	3.4
0.0	8.5	1.8	6.7	2.1	2.1
3.7	4.0	4.0	4.0	1.8	1.8
3.4	3.4	1.5	5.2	2.7	2.7
0.0	2.1	5.5	7.3	0.6	6.7
1.2	1.2	3.0	3.0	5.5	5.5
0.9	1.2	4.0	4.0	4.6	4.6
1.8	2.7	1.5	2.7	4.9	4.9
1.5	3.4	1.5	2.1	2.7	3.0
1.5	1.8	1.5	3.0	1.5	1.8
0.9	3.0	4.0	4.0	1.5	3.0
1.8	1.8	4.0	4.0	1.5	2.4
0.3	0.6	0.0	6.1	3.7	7.9
2.7	3.0	1.8	2.4	3.0	3.0
2.1	2.1	1.5	4.6	3.4	5.2
2.7	2.7	2.1	4.9	6.1	7.3
3.4	5.5	1.5	1.8	5.8	8.2
4.6	4.6	1.2	4.0	4.3	6.1
0.9	0.9	1.8	2.1	1.2	2.7
2.7	4.0	1.8	2.7	2.4	2.4
4.3	5.2	0.9	3.7	3.0	4.9
5.5	6.4	1.2	6.1	0.6	8.8
2.1	2.1	0.6	1.2	0.9	4.3
0.0	1.8	0.3	0.9	0.0	11.0
0.3	2.1	0.9	6.1	4.3	4.9
0.9	0.9	6.4	6.7	4.3	4.3
0.0	4.9	0.9	1.5	3.0	5.5
1.5	1.5	1.2	1.2	1.5	4.6
0.9	1.8	1.8	1.8	1.5	2.4
0.9	1.2	3.0	4.0	2.4	2.4
1.8	2.4	1.5	5.5	3.0	3.0
1.5	2.1	2.7	5.2	2.7	3.7
1.2	4.6	0.0	4.9	1.8	5.5
0.0	1.8	5.8	5.8	2.1	6.7
1.2	1.2	2.4	2.4	3.0	3.7
4.0	4.0	1.2	1.8	3.0	4.6
4.0	4.0	0.9	0.9	2.7	4.3
3.7	4.0	0.0	0.0	0.6	4.9
2.7	4.3	2.1	2.1	0.3	0.9
3.4	3.4	3.0	4.6	4.6	6.7
0.6	1.2	3.4	5.2	3.0	3.4
1.2	1.5	2.1	2.7	3.0	6.1
0.9	1.5	3.0	4.9	0.9	8.2
0.9	0.9	2.4	3.0	2.1	2.1
0.0	2.4	2.7	4.3	4.6	7.6

24.4 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
3.7	4.6	2.1	4.9	3.4	3.4
0.9	0.9	0.9	1.2	0.9	6.7
0.9	0.9	1.2	3.0	4.0	5.2
0.9	1.8	0.0	1.8	2.7	5.2
3.4	4.3	4.0	4.0	4.0	4.0
1.8	1.8	0.9	2.1	1.5	1.5
1.8	1.8	0.0	3.7	0.9	3.4
4.3	4.3	4.6	8.2	3.0	4.9
4.0	4.0	5.2	5.2	2.7	5.2
4.0	4.0	0.6	0.9	4.0	5.2
2.1	2.1	3.4	4.9	0.9	4.9
1.5	3.0	1.5	1.8	0.0	7.0
0.9	1.2	0.3	2.7	0.6	5.5
0.9	1.5	0.9	1.5	0.0	1.8
1.5	1.5	3.4	4.9	1.8	1.8
2.7	2.7	4.3	7.0	3.0	4.6
3.4	3.4	0.0	1.2	4.3	4.3
4.0	4.0	3.4	3.7	0.9	4.0
1.5	4.3	6.1	7.0	0.0	4.6
0.9	1.5	3.0	3.0	1.2	1.2
2.1	2.1	1.2	1.2	2.1	2.1
0.9	0.9	3.4	3.4	1.5	3.4
0.9	1.5			0.9	4.0
0.9	0.9			2.7	4.0
0.9	1.5			5.5	5.5
0.9	1.5				
3.4	3.4				
1.5	2.1				
0.3	0.9				
0.9	1.2				
1.5	2.4				
1.2	1.5				
3.4	3.4				
1.5	1.8				
1.2	1.5				
0.0	4.9				
3.0	4.3				
1.2	2.1				
0.6	0.9				
0.0	4.3				
0.9	0.9				
3.4	3.4				
3.0	4.3				
4.6	4.6				
0.9	1.5				
0.9	2.7				
1.2	3.0				
0.9	1.5				
1.2	1.2				

Field Data for 2V:1H Slopes

24.4 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.2	3.4	4.6	9.1	5.2	7.0
1.5	1.5	3.0	4.6	0.0	0.6
1.2	1.2	2.7	6.1	2.1	2.7
1.5	3.0	4.0	4.0	3.4	8.8
2.1	2.1	2.4	3.0	2.1	2.1
0.0	1.5	3.0	5.2	3.4	3.7
0.0	9.1	3.0	7.0	0.0	10.4
0.6	1.2	0.9	2.4	3.4	4.0
4.3	7.3	2.7	2.7	3.0	6.4
0.0	5.5	1.5	2.1	6.1	8.2
2.4	3.4	0.0	4.3	1.8	2.4
0.9	0.9	1.2	7.0	4.3	5.5
0.0	5.5	3.0	4.6	3.4	6.1
0.0	0.6	4.0	5.2	0.9	1.5
0.9	0.9	4.9	6.1	4.0	4.3
0.0	3.0	2.1	2.1	2.7	2.7
0.0	7.9	2.7	2.7	2.4	2.4
0.6	0.9	0.0	9.1	2.7	4.0
4.0	5.2	2.4	5.8	1.5	2.4
3.0	8.2	3.7	4.9	2.1	2.1
2.1	2.1	0.0	4.9	2.1	5.2
0.0	4.3	0.0	5.8	3.0	4.0
1.2	1.2	0.0	4.6	1.8	3.4
1.2	1.2	0.0	0.0	2.7	4.3
0.9	0.9	3.7	7.6	2.1	2.1
2.1	2.1	0.6	0.6	4.6	8.2
1.5	2.7	0.9	0.9	0.6	3.4
2.1	2.4	0.0	0.0	0.0	2.4
2.4	4.0	0.6	7.0	1.2	1.8
3.0	5.5	0.6	1.5	3.4	8.2
0.9	0.9	4.3	5.2	2.7	6.4
1.8	1.8	2.7	3.7	3.0	4.0
1.2	1.8	5.2	6.7	0.0	15.2
1.2	1.2	0.0	7.6	3.0	5.8
1.2	2.7	0.0	9.8	1.2	3.0
3.4	4.0	2.7	3.4	2.4	9.1
1.8	1.8	2.4	2.4	2.4	4.6
1.5	1.5	2.1	3.0	0.0	3.0
2.7	3.4	2.4	2.4	3.0	3.0
0.0	5.2	2.7	2.7	1.5	2.4
0.0	4.0	0.0	5.8	3.0	5.8
1.2	1.2	1.2	3.0	3.4	4.9
1.8	2.4	2.7	2.7	1.5	3.0
0.0	0.9	1.8	3.7	2.1	2.1
2.4	2.4	2.4	3.4	3.0	4.0
3.0	4.3	2.1	2.7	1.5	1.5
1.8	4.0	3.0	5.2	0.0	8.5
0.0	3.7	2.4	2.4	3.7	3.7
3.7	4.0	1.8	2.7	3.4	7.9
2.4	2.4	1.2	2.4	2.4	4.3

24.4 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.6	2.7	2.1	3.4	1.5	2.4
4.6	4.6	1.8	3.7	1.2	3.0
2.7	3.7	3.7	5.5	3.7	3.7
3.4	3.7	4.3	5.2	3.4	5.8
3.0	3.0	2.4	2.4	2.1	3.0
0.3	4.9	0.0	4.9	1.2	3.7
2.7	3.0	1.8	2.1	4.6	4.6
1.5	3.7	1.5	1.5	2.1	2.1
0.9	1.8	4.6	6.1	1.5	1.8
2.1	3.4	0.0	7.3	2.4	2.7
0.0	3.4	0.0	4.0	0.0	8.8
2.4	2.4	0.6	3.7	1.5	7.3
4.6	5.5	0.9	1.8	1.5	3.0
0.6	0.6	0.0	4.3	2.1	5.2
0.0	5.8	5.5	6.4	1.5	3.0
0.3	0.3	1.8	3.0	1.5	3.4
2.1	2.1	3.7	7.3	1.2	2.1
0.0	4.0	2.7	2.7	6.4	6.4
1.5	1.5	0.0	4.0	4.6	7.0
1.8	1.8	2.1	2.1	0.0	5.2
4.6	7.9	1.8	2.7	2.1	2.7
3.0	4.9	2.4	3.4	2.4	3.0
1.8	1.8	0.9	3.0	0.0	8.2
3.0	4.3	1.5	2.7	1.5	2.7
3.0	5.5	1.8	2.7	4.6	6.7
1.2	1.5				
0.9	0.9				
4.6	7.3				
0.0	4.0				
3.4	4.3				
0.6	4.9				
0.3	1.5				
2.4	3.0				
0.0	6.7				
1.5	2.1				
0.6	0.6				
3.4	3.4				
0.6	1.2				
4.3	5.5				
2.4	2.7				
4.0	4.9				
1.8	4.3				
2.4	3.7				
0.3	0.3				
1.2	1.8				
2.1	3.4				
0.6	2.1				
2.7	4.3				
2.1	2.1				
0.0	2.7				

Field Data for 2V:1H Slopes

24.4 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
3.4	5.2	0.0	9.1	3.4	5.8
3.0	4.3	0.0	4.3	3.7	5.2
0.6	0.6	3.7	3.7	2.4	6.1
0.3	0.3	6.1	15.8	1.5	4.3
0.9	5.5	3.0	9.8	3.0	5.5
0.3	4.3	3.0	4.6	0.0	13.1
0.0	3.4	1.5	6.1	3.0	10.1
4.0	4.0	4.3	6.7	4.0	5.2
2.7	4.9	3.4	7.3	5.5	8.5
2.7	5.2	4.3	4.6	1.2	3.7
2.4	4.9	1.5	4.3	3.0	6.4
1.5	5.8	0.0	1.5	0.0	1.8
0.9	0.9	1.2	1.2	0.0	6.4
1.2	3.4	0.0	8.5	2.4	3.0
4.6	5.8	0.9	4.0	3.4	17.7
2.7	3.7	2.4	4.3	1.2	4.3
0.0	3.4	0.0	0.6	1.2	1.2
0.0	11.3	1.5	4.6	1.5	3.0
0.9	1.8	0.0	4.9	1.5	11.9
0.9	1.8	0.0	11.9	1.8	3.4
0.9	5.5	0.9	6.1	5.5	13.1
0.6	2.4	1.5	3.0	1.5	4.3
0.9	1.2	1.8	4.0	3.0	5.2
3.4	4.3	0.9	3.7	3.4	3.4
2.4	2.7	0.0	3.0	2.1	7.0
1.2	5.2	1.5	4.0	0.9	1.2
4.3	4.9	1.2	2.7	1.8	6.4
2.7	2.7	2.7	10.4	3.0	6.1
4.6	5.2	4.6	10.7	2.4	4.3
1.8	2.1	0.6	3.0	2.4	2.7
3.0	3.7	0.0	1.5	2.1	2.4
1.5	2.4	2.1	8.8	2.4	2.4
3.4	4.9	1.5	9.8	0.0	8.5
1.2	2.1	3.0	7.3	4.3	5.8
1.2	5.5	1.2	4.0	3.7	6.4
2.7	9.8	2.4	4.3	4.6	5.2
1.5	3.0	0.0	2.7	2.4	2.4
2.7	2.7	1.2	2.4	3.7	3.7
2.1	2.4	2.7	9.4	0.9	16.8
2.7	8.5	6.1	11.0	5.5	11.6
3.0	5.5	1.2	3.0	2.1	6.7
4.3	7.9	1.5	1.5	5.5	12.5
0.0	4.9	3.0	4.9	1.2	1.2
0.9	1.5	1.5	3.4	1.5	7.0
1.5	2.1	2.4	4.9	3.7	5.2
3.0	3.4	0.9	1.8	1.8	6.7
1.5	2.7	3.0	9.1	1.5	5.5
0.0	6.4	3.0	6.1	2.1	3.0
0.3	0.3	2.1	2.1	1.5	2.7
0.6	4.0	0.9	2.1	0.0	18.3

24.4 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.5	4.6	3.0	3.7	2.1	6.7
0.0	2.7	2.4	7.0	4.6	5.2
0.6	3.7	3.0	13.7	2.4	6.1
0.9	3.4	1.5	1.5	0.9	0.9
1.5	9.1	3.0	3.0	1.5	8.5
5.2	11.0	3.0	12.5	2.1	6.4
0.9	2.4	0.0	4.6	3.0	3.7
3.7	3.7	4.6	8.2	1.5	7.6
0.0	1.8	0.9	0.9	0.0	9.1
0.0	1.5	0.9	7.9	2.1	4.9
3.0	4.0	0.9	2.1	0.9	4.3
0.9	3.7	4.9	13.1	1.5	7.0
4.3	5.8	4.3	4.3	1.2	6.1
3.7	5.5	2.4	2.4	2.7	8.2
1.8	2.4	3.0	4.3	2.1	4.0
4.9	6.7	3.0	4.9	4.3	8.2
1.5	2.4	1.2	2.7	4.6	9.8
0.9	4.0	5.5	9.1	1.5	4.6
0.6	0.9	2.7	2.7	0.9	9.8
0.0	3.4	0.0	5.5	3.0	11.6
1.2	4.9	0.0	5.8	4.6	7.3
0.0	1.2	3.4	3.4	1.5	4.0
3.4	4.6	1.8	6.7	2.1	10.7
4.0	7.6	0.9	4.9	3.0	4.6
1.5	2.1	3.0	6.4	4.0	14.6
5.2	7.9				
1.8	3.0				
2.7	5.2				
1.5	2.7				
0.3	3.0				
0.6	2.7				
1.8	2.7				
2.7	3.0				
1.2	1.2				
3.0	4.9				
1.5	1.8				
2.4	5.2				
3.0	3.4				
0.0	1.5				
0.0	4.0				
1.2	2.7				
4.9	11.0				
0.0	2.1				
3.0	5.8				
0.9	0.9				
0.0	2.4				
2.1	2.1				
4.3	4.3				
0.6	0.9				
2.7	3.7				

Field Data for 1.33V:1H Slopes

12.2 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	0.3	0.0	4.0	0.0	3.0
0.0	0.6	0.0	1.2	0.0	1.5
0.0	1.2	0.6	3.4	0.6	0.6
0.3	0.3	0.6	0.6	0.9	4.0
0.0	0.6	0.3	1.2	0.0	3.0
0.0	1.2	0.0	0.9	0.0	3.7
0.0	0.9	0.0	1.8	0.0	0.9
0.0	1.5	0.0	3.0	0.0	3.4
0.0	1.2	0.6	0.6	0.0	3.7
0.0	0.6	0.6	0.6	0.0	3.7
0.3	1.8	0.0	1.2	0.0	2.7
0.0	1.5	0.0	2.4	0.0	1.8
0.3	0.3	0.0	1.5	0.6	1.2
0.0	0.0	0.0	2.1	0.6	1.2
0.0	0.6	0.0	2.1	0.0	1.5
0.0	0.9	0.0	1.2	0.0	1.8
0.3	0.3	0.0	1.5	0.9	0.9
0.0	0.9	0.9	2.1	0.0	3.4
0.0	0.0	0.0	1.5	0.0	5.8
0.0	1.2	0.9	0.9	0.0	0.9
0.0	0.9	1.2	1.2	0.6	1.2
0.0	0.3	0.6	1.8	0.0	4.0
0.0	0.0	0.0	3.4	0.6	1.5
0.0	0.0	0.9	0.9	0.6	1.2
0.0	0.3	0.6	1.2	0.0	5.2
0.0	0.6	0.3	0.9	0.6	3.4
0.0	0.9	0.0	4.0	0.6	1.8
0.0	1.2	0.0	1.2	0.0	4.3
0.0	1.8	0.0	2.1	0.0	2.7
0.0	2.1	0.0	2.1	0.0	5.2
0.0	0.3	0.3	1.2	0.0	2.1
1.2	1.5	0.0	1.5	0.0	2.4
0.3	1.2	0.0	1.5	0.9	2.1
0.0	0.6	0.0	1.8	0.6	2.7
0.0	0.6	0.0	2.4	0.9	0.9
0.3	0.6	0.0	4.6	0.9	0.9
0.0	0.6	1.2	3.7	0.0	2.7
0.0	0.6	0.9	2.1	0.0	2.1
0.0	0.9	0.0	7.0	0.3	1.5
0.0	0.6	0.3	1.8	0.9	0.9
0.0	3.0	0.9	0.9	0.0	4.3
0.0	0.9	0.0	2.4	0.0	2.7
0.6	0.6	0.6	0.6	1.2	2.4
0.0	0.9	0.0	1.2	0.9	2.1
0.0	1.5	0.0	1.5	0.0	2.1
0.0	0.6	0.3	1.8	0.3	1.2
0.0	0.6	0.0	1.8	0.0	5.2
0.0	0.3	0.3	0.3	0.0	1.2
0.0	0.3	0.6	1.8	0.0	3.4
0.0	0.9	0.3	0.9	0.6	1.8

12.2 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	0.6	0.0	2.1	0.0	3.0
0.0	1.2	0.0	1.8	0.0	3.0
0.0	1.5	0.0	1.8	0.6	1.2
0.0	0.9	0.0	1.2	0.9	0.9
0.0	0.6	0.0	1.8	0.0	3.4
0.0	1.2	0.0	2.1	0.9	0.9
0.0	1.5	0.0	4.3	0.0	4.0
0.0	2.4	0.0	2.1	0.3	0.3
0.0	0.9	0.0	2.7	0.0	2.7
0.0	1.2	0.0	1.5	0.6	0.6
0.0	0.3	0.3	1.2	0.6	1.5
0.0	1.5	0.6	0.6	0.0	3.7
0.0	0.6	0.0	2.1	1.2	1.2
0.0	0.0	0.0	1.8	0.0	2.1
0.0	1.2	0.0	1.8	0.6	1.5
0.3	0.3	0.0	3.0	0.0	2.1
0.0	0.6	0.0	3.0	0.0	2.1
0.0	0.9	0.0	3.7	0.0	1.5
0.3	0.3	0.0	2.7	0.3	1.2
0.0	2.4	0.0	1.8	1.2	1.2
0.0	0.9	0.9	0.9	0.9	0.9
0.0	0.9	0.6	1.2	0.6	1.5
0.3	0.9	0.0	2.4	0.0	4.0
0.0	1.5	0.0	3.0	1.2	1.2
0.0	1.8	0.0	2.7	0.3	0.9
0.0	1.8				
0.0	1.2				
0.0	0.0				
0.0	0.6				
0.0	0.6				
0.0	0.6				
0.6	0.6				
0.0	0.6				
0.0	0.3				
0.0	0.6				
0.0	0.9				
0.0	1.5				
0.0	1.8				
0.9	1.5				
0.0	0.9				
0.3	0.3				
0.0	3.0				
0.0	3.4				
0.0	0.6				
0.0	0.9				
0.0	0.6				
0.0	0.9				
0.0	0.3				
0.0	0.9				
0.0	0.9				

Field Data for 1.33V:1H Slopes

12.2 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	0.6	0.6	2.4	0.9	4.9
0.0	1.2	0.0	5.8	0.0	3.0
0.9	1.2	0.0	0.9	0.0	1.5
0.6	0.9	0.3	1.8	0.0	3.7
0.0	1.2	0.0	2.1	0.0	5.5
0.9	4.9	0.3	1.2	0.6	1.2
0.0	0.9	0.0	2.7	0.0	1.8
0.0	0.9	0.0	1.2	0.0	2.1
0.0	0.6	0.0	1.2	1.2	1.2
0.0	1.5	0.0	3.0	0.0	4.0
0.0	0.9	0.0	3.0	0.0	2.4
0.0	0.6	0.0	2.1	0.0	1.8
0.0	1.8	0.0	4.0	0.0	2.4
0.0	2.7	0.0	5.5	0.0	4.9
0.3	0.9	0.0	2.4	1.2	1.2
0.0	1.8	0.0	4.3	0.0	4.9
0.0	0.9	0.0	2.1	0.0	1.5
0.0	1.2	0.3	0.9	0.0	1.5
0.0	1.2	0.0	1.2	0.3	3.4
0.0	0.9	0.0	0.9	0.9	2.1
0.9	1.5	0.0	1.2	0.0	3.4
0.0	2.7	0.0	1.5	0.0	2.7
0.6	2.1	0.0	4.6	0.0	1.5
0.0	2.1	0.0	2.4	0.0	1.5
0.0	0.9	0.0	3.7	0.0	4.9
0.0	1.8	0.0	5.5	0.0	1.5
0.0	1.2	0.0	4.3	0.0	2.4
0.0	0.6	0.0	3.0	0.9	5.2
0.0	1.5	0.0	2.7	1.2	1.2
0.0	0.9	0.0	1.2	0.0	1.5
0.0	2.7	0.0	1.8	0.0	3.0
0.0	0.9	0.9	0.9	0.0	1.5
0.0	0.6	0.0	1.2	0.0	3.7
0.0	0.9	0.0	4.3	0.3	1.2
0.0	1.8	0.0	4.0	0.0	4.3
0.0	0.9	0.3	3.4	0.0	1.5
0.6	0.9	0.0	1.8	0.3	1.5
0.6	0.9	0.0	2.1	0.3	1.5
0.3	0.3	0.0	0.0	0.3	1.5
0.0	1.5	0.3	1.8	0.0	5.2
0.0	1.5	0.0	1.5	0.0	1.8
0.0	1.5	0.0	1.8	0.9	0.9
0.0	0.9	0.9	0.9	0.0	4.0
0.0	1.5	0.9	3.0	0.0	3.7
0.0	0.9	0.0	4.9	0.0	5.2
0.0	1.8	0.0	3.7	0.0	3.0
0.0	0.9	0.0	2.7	0.0	2.7
0.0	2.7	0.9	1.5	2.1	2.1
0.0	1.5	0.0	2.1	0.0	2.1
0.0	0.9	0.0	3.4	0.0	1.8

12.2 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	0.9	0.0	0.9	0.0	2.1
0.0	0.6	0.9	1.5	1.2	3.7
0.6	0.9	0.0	2.1	0.0	3.0
0.0	0.9	0.0	2.1	0.0	4.6
0.0	2.7	0.0	3.7	0.0	5.5
0.9	0.9	0.9	4.0	0.6	1.5
0.0	0.3	0.9	2.1	0.0	3.7
0.0	1.8	0.9	4.0	0.0	2.7
0.9	1.5	0.3	0.9	0.9	0.9
0.6	1.8	0.9	1.5	1.2	1.2
0.6	0.9	0.0	3.0	1.2	3.0
0.3	1.2	0.0	5.5	1.5	1.5
0.0	1.8	0.3	3.0	0.0	4.3
0.0	1.2	0.0	2.7	0.9	1.5
0.0	1.5	0.6	1.2	0.0	3.0
0.0	3.0	0.0	1.8	1.2	4.9
0.0	0.9	0.0	2.1	0.0	2.1
0.6	0.6	0.0	3.0	0.0	4.6
0.0	0.9	0.3	1.2	0.0	2.1
0.3	0.3	0.0	1.5	0.0	2.1
0.0	0.9	0.6	1.8	0.0	1.5
0.0	2.4	0.0	1.5	0.0	2.1
0.0	0.9	0.0	1.8	1.2	1.2
0.0	1.5	0.0	6.1	0.0	3.0
0.0	0.6	1.2	2.4	0.0	2.4
0.3	0.3				
0.9	0.9				
0.0	0.9				
0.0	2.1				
0.0	0.6				
0.0	0.6				
0.9	0.9				
0.0	0.9				
0.0	1.5				
0.9	0.9				
0.0	0.9				
0.0	0.9				
0.0	2.1				
0.0	1.2				
0.0	0.9				
0.0	2.1				
0.0	1.2				
0.0	0.9				
0.0	0.9				
0.0	0.6				
0.0	0.3				
0.0	1.5				
0.0	1.8				
0.0	3.0				
0.0	1.8				

Field Data for 1.33V:1H Slopes

12.2 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.9	5.2	0.9	4.0	0.9	12.8
0.9	2.7	1.5	7.6	0.9	7.3
0.0	3.0	0.3	1.8	1.5	6.7
0.0	1.2	0.6	5.2	0.0	11.6
0.0	2.1	1.8	5.5	0.0	1.5
0.0	1.8	0.9	2.4	0.0	4.3
0.9	6.7	0.6	4.0	0.0	4.9
0.9	3.7	1.2	4.6	1.5	7.6
0.0	1.5	1.2	5.5	0.0	6.7
0.0	4.6	1.2	10.7	0.0	1.5
0.9	4.9	0.6	5.5	0.0	8.8
0.0	3.4	0.0	2.1	0.0	13.7
0.0	4.0	0.9	5.2	0.9	4.0
0.9	5.2	0.9	1.8	0.6	4.0
0.0	1.2	0.0	12.2	1.5	6.7
0.0	4.3	0.0	6.4	0.9	6.1
0.9	2.4	1.2	4.6	0.0	3.4
0.6	3.0	1.2	6.4	1.2	13.1
0.0	4.9	0.0	1.2	0.9	8.2
0.0	4.0	0.9	2.1	0.9	8.5
0.6	1.8	0.0	11.6	0.9	9.8
0.6	2.1	0.0	11.6	0.9	6.1
0.9	4.3	0.6	7.0	1.5	5.8
0.9	4.3	1.2	6.7	1.2	4.6
1.2	6.1	0.0	8.5	0.0	9.1
0.0	5.2	0.0	8.2	0.6	3.7
0.9	4.9	0.0	0.3	1.5	10.1
0.6	1.8	0.0	6.4	0.6	5.8
0.9	4.3	0.0	9.1	0.9	9.1
0.0	0.9	0.0	4.6	0.9	7.6
0.6	4.3	0.0	1.5	0.9	6.7
0.0	1.8	1.2	5.8	0.6	7.6
0.0	4.0	0.0	12.2	0.9	10.1
1.8	5.2	0.9	7.0	0.0	7.6
0.0	4.3	0.0	7.0	0.0	3.7
0.0	2.1	0.0	6.7	0.0	7.0
0.6	1.8	0.0	14.6	0.6	8.5
0.0	4.3	0.0	8.2	0.0	5.2
0.9	4.0	0.0	6.7	1.2	7.3
1.5	4.3	0.0	5.2	0.9	8.5
1.5	6.7	0.0	6.4	0.0	3.7
0.0	2.1	1.5	4.3	0.9	7.6
0.0	3.0	0.0	6.1	1.2	5.8
0.0	3.0	0.0	2.1	1.5	8.5
0.0	6.1	0.0	11.3	0.0	7.9
0.0	4.0	0.0	8.2	0.0	4.0
0.0	1.8	0.0	7.6	0.6	9.1
0.6	4.9	0.0	7.0	0.0	6.7
0.9	4.9	1.2	7.0	0.0	8.2
0.0	2.4	0.0	4.6	0.0	8.8

12.2 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.9	4.6	0.0	1.5	0.9	5.5
0.3	3.0	0.0	11.0	0.9	2.7
0.0	4.9	0.0	7.0	1.5	9.8
0.9	4.0	0.0	8.2	0.9	3.4
0.6	4.9	0.0	1.8	0.9	5.5
0.6	5.5	0.0	6.1	1.2	3.0
1.5	7.9	0.3	10.4	0.9	5.8
0.9	4.0	0.3	0.9	0.6	3.7
0.0	1.5	0.0	10.4	0.9	3.0
1.5	5.5	0.0	5.8	0.9	1.5
0.9	7.3	0.0	2.1	0.0	6.4
1.2	6.1	0.0	3.4	0.6	9.8
1.2	1.2	1.5	6.7	0.9	4.0
0.0	3.7	0.6	2.4	0.0	7.9
0.0	2.4	0.6	3.7	0.0	3.0
0.0	4.6	0.0	2.1	1.5	2.4
0.0	5.2	0.0	5.2	0.3	2.1
1.2	4.6	0.0	2.1	0.9	2.7
0.0	2.4	0.0	3.7	0.0	6.1
0.0	1.5	0.0	5.2	0.0	8.2
1.2	4.6	1.8	3.7	1.5	13.7
0.9	4.0	0.0	1.8	0.0	1.5
0.0	3.0	0.0	3.7	1.2	10.1
1.2	3.7	0.0	7.9		
0.0	4.6	0.6	3.0		
0.9	2.1	0.0	3.0		
0.0	4.6				
1.5	4.6				
0.0	1.2				
0.9	3.0				
1.2	2.1				
0.0	6.1				
0.0	1.8				
0.0	2.1				
0.9	2.4				
0.0	3.0				
0.9	4.0				
0.9	2.4				
0.6	3.7				
0.9	5.2				
0.0	3.0				
1.2	6.1				
0.9	1.8				
0.6	2.4				
0.9	7.0				
1.2	2.1				
1.5	9.1				
0.6	4.6				
0.6	8.2				
0.6	4.9				

Field Data for 1.33V:1H Slopes

18.3 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
2.7	3.0	0.0	8.8	3.7	10.1
2.1	4.0	3.0	5.2	1.8	3.0
2.1	2.7	0.0	6.4	0.0	6.4
1.8	2.1	0.0	3.7	1.8	4.3
1.8	3.0	0.0	3.4	0.0	4.6
2.4	2.4	1.5	2.4	0.0	4.6
2.1	3.0	0.0	4.9	0.0	5.8
2.1	2.1	1.5	1.8	0.0	5.5
2.7	4.6	0.0	5.2	0.0	5.2
0.0	3.0	0.0	3.4	0.0	7.3
0.0	3.7	0.6	3.0	0.9	5.2
0.0	5.5	0.0	3.7	1.5	3.7
0.0	2.1	1.5	2.1	0.0	7.3
1.8	2.1	1.8	5.5	0.0	3.7
3.4	4.0	0.0	5.2	1.2	2.1
3.0	4.9	3.0	3.4	2.4	7.3
1.8	4.0	0.0	4.0	0.0	3.0
0.0	2.4	0.0	6.7	1.5	4.6
2.1	2.1	0.0	3.7	1.5	6.1
0.0	2.4	1.5	2.4	0.0	3.0
2.4	4.9	0.0	4.9	0.0	8.2
3.4	3.7	1.5	2.7	0.0	7.3
0.9	3.7	0.0	3.7	0.0	6.4
0.0	5.8	0.0	3.7	0.0	6.7
1.8	3.4	0.0	3.4	0.6	5.2
0.0	1.8	0.9	3.7	1.5	2.4
1.2	1.5	1.5	4.0	0.0	10.7
1.5	2.1	0.0	4.6	0.0	9.4
1.2	3.7	1.2	2.7	2.4	6.1
0.0	3.7	0.0	5.2	0.0	8.2
2.1	3.4	0.0	4.3	1.5	2.1
1.2	1.2	2.4	3.0	0.0	6.1
0.3	1.8	0.0	5.8	0.0	2.1
2.1	2.1	0.0	1.5	1.2	3.7
1.8	2.4	1.5	3.4	0.0	5.2
2.1	3.7	0.0	3.7	0.0	13.1
2.7	3.4	2.1	3.7	1.5	2.4
0.0	2.1	2.1	3.7	1.5	4.9
1.5	3.7	2.1	2.4	0.0	4.6
0.0	7.9	1.5	2.1	0.0	9.8
2.1	3.4	3.0	5.2	0.0	6.1
0.0	2.7	1.5	4.0	1.8	5.8
4.6	4.6	1.5	4.6	2.7	3.4
1.8	3.4	2.1	4.0	1.5	4.9
2.1	2.7	1.5	2.1	0.0	4.3
2.1	4.3	1.5	3.0	0.0	9.1
0.0	2.4	0.0	10.1	0.0	8.8
1.8	5.2	3.7	4.3	1.5	7.9
1.5	2.7	3.0	5.5	0.0	6.1
0.0	2.1	1.2	5.8	1.5	1.5

18.3 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.9	0.9	1.5	3.0	0.0	4.9
0.0	1.8	1.2	4.9	0.0	7.9
0.0	1.2	2.7	3.7	0.0	4.6
0.0	2.7	2.1	7.6	0.0	7.6
0.0	2.4	0.0	4.6	0.0	4.6
1.2	2.1	0.0	3.4	2.4	4.3
1.5	2.1	0.0	5.2	1.2	4.9
0.9	1.2	0.0	7.3	0.0	4.0
3.0	3.7	0.0	8.5	0.0	4.6
0.0	4.0	0.0	3.7	2.4	3.7
0.0	1.8	0.0	8.2	0.0	7.6
2.4	3.4	0.0	6.1	0.0	6.1
1.8	3.0	3.0	5.5	0.0	6.1
1.5	1.5	4.6	4.9	0.0	6.1
1.8	5.5	2.1	3.4	0.0	3.0
0.0	2.1	0.0	4.6	0.0	5.2
1.8	1.8	0.0	3.7	0.0	4.9
0.9	1.5	1.2	8.8	1.5	3.7
2.4	2.7	3.4	4.0	0.0	6.1
0.0	3.0	1.2	6.1	0.0	2.1
0.0	2.1	0.0	6.4	1.5	4.3
0.0	5.5	0.0	6.7	1.5	3.0
2.1	3.0	1.2	4.6	0.0	4.6
0.0	0.6	1.5	4.0	0.0	6.1
0.9	2.1			0.0	4.6
2.4	2.4				
0.0	2.4				
0.0	1.5				
0.0	1.5				
0.0	2.4				
0.6	0.9				
1.5	1.8				
0.0	2.1				
0.0	4.0				
2.1	2.4				
0.0	2.7				
1.5	2.1				
0.9	1.2				
2.1	3.4				
0.0	0.3				
0.0	0.3				
0.0	2.4				
1.8	1.8				
0.3	0.6				
0.0	0.3				
0.0	1.8				
1.5	1.5				
0.6	0.6				
0.0	0.3				
2.1	3.0				

Field Data for 1.33V:1H Slopes

18.3 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
2.1	3.7	1.5	3.7	0.0	7.3
0.0	2.7	0.0	3.7	3.4	4.9
0.0	7.6	1.5	7.6	1.8	4.0
0.0	3.7	0.0	2.4	0.0	4.6
0.0	5.5	1.8	3.4	0.0	4.6
4.0	5.5	0.0	7.6	0.0	7.3
0.0	8.2	0.0	6.1	0.0	3.0
1.5	4.6	0.3	0.6	2.1	6.4
0.6	1.5	1.5	7.6	0.0	8.2
1.5	4.0	0.0	4.0	0.0	6.7
0.3	4.0	1.5	8.8	1.8	9.1
2.1	4.9	1.8	1.8	2.1	6.7
1.8	4.6	0.0	3.7	0.0	4.0
0.0	4.3	0.0	7.6	0.0	3.4
0.0	4.0	1.2	6.1	0.0	4.9
3.7	8.8	0.0	10.4	0.0	17.1
1.5	4.6	0.0	5.2	1.8	7.6
0.0	4.9	0.0	4.6	1.5	10.4
1.8	3.4	0.0	3.0	2.1	4.0
0.0	2.1	1.5	5.2	1.2	2.7
3.7	3.7	0.0	4.0	2.7	6.7
2.1	4.0	0.0	3.7	0.0	5.8
2.4	3.7	0.0	4.6	0.0	7.9
0.6	0.6	1.5	5.2	0.0	5.5
2.7	4.6	1.5	4.6	0.0	3.0
2.4	4.9	0.0	5.5	1.8	1.8
2.4	2.7	0.0	2.1	2.1	2.1
0.0	6.4	0.0	3.7	0.0	2.7
0.0	6.7	1.5	2.1	0.0	4.9
1.5	2.4	0.0	6.4	0.0	2.7
1.8	4.0	0.0	5.5	0.0	5.2
0.0	7.9	1.5	3.4	0.0	3.0
1.5	3.7	1.5	3.0	0.0	2.4
3.0	5.5	1.5	1.5	1.5	3.4
2.1	3.0	0.0	1.5	3.0	8.2
3.0	4.0	1.5	3.7	1.5	7.3
0.0	5.2	0.0	9.8	1.5	2.1
0.0	3.4	0.0	10.1	2.1	4.0
0.6	1.2	1.8	4.9	1.5	3.7
0.0	7.3	1.5	2.4	0.0	2.1
0.0	7.6	2.1	2.1	0.0	4.9
0.0	2.1	1.5	1.5	0.0	4.0
0.0	6.4	1.2	2.4	0.0	3.0
3.0	3.7	0.0	5.8	1.5	1.5
0.0	5.8	0.0	9.8	4.3	7.9
0.3	2.4	1.8	1.8	0.0	5.5
0.0	6.7	3.0	5.8	0.0	4.0
2.1	5.2	0.0	3.0	0.0	6.7
0.9	2.4	0.0	2.1	3.0	4.3
1.5	1.8	5.2	7.6	0.0	8.2

18.3 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.5	7.0	2.4	5.8	1.5	4.6
0.0	4.3	1.5	7.9	1.5	4.3
2.7	7.0	1.5	4.0	0.0	2.4
1.8	4.3	0.0	7.3	0.0	2.7
1.8	4.6	1.8	2.4	0.0	6.7
2.1	4.0	1.5	10.4	0.0	5.2
1.8	3.4	2.1	4.0	0.0	8.5
1.2	5.2	0.0	4.6	1.8	6.1
0.0	7.0	0.0	7.6	0.0	9.8
0.3	1.5	0.9	7.3	0.0	4.9
1.2	2.4	1.8	5.5	2.4	3.7
1.8	5.8	0.9	3.0	2.4	5.5
1.5	5.5	0.0	1.5	1.8	3.7
3.4	6.1	2.4	7.3	0.0	4.6
0.0	7.6	2.1	4.9	1.5	4.0
0.0	8.5	1.5	8.2	1.5	7.9
1.8	2.1	1.5	7.9	1.8	4.9
3.7	8.2	0.0	2.7	1.5	2.1
0.0	2.1	1.5	2.1	1.8	11.3
0.0	1.8	1.5	4.9	0.0	5.2
0.9	5.5	0.0	5.2	0.0	6.1
0.0	3.7	1.5	5.2	1.5	2.4
1.5	3.7	0.0	2.4	1.5	2.4
2.7	5.5	0.0	4.3		
0.0	8.2				
0.3	0.6				
0.0	3.4				
2.1	2.1				
0.0	2.1				
1.2	2.4				
0.0	5.5				
1.2	5.2				
2.4	5.5				
0.9	3.0				
1.8	2.7				
1.8	1.8				
0.0	4.9				
1.8	4.3				
2.7	7.0				
2.1	3.7				
0.0	1.5				
0.9	1.8				
0.0	8.5				
1.8	3.7				
2.1	5.2				
0.0	5.8				
0.0	6.4				
1.8	2.7				
1.5	5.2				
1.8	3.4				

Field Data for 1.33V:1H Slopes

18.3 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.2	7.6	2.1	17.4	0.0	14.3
1.8	4.6	0.6	5.5	0.0	15.8
0.6	1.2	3.0	9.8	2.1	4.6
1.2	5.8	0.6	10.1	0.9	9.4
3.0	6.1	0.9	3.7	1.5	10.1
2.1	9.1	0.0	14.6	0.0	11.3
1.8	6.4	1.8	11.3	0.0	6.1
0.9	8.5	1.2	4.6	0.0	11.0
0.0	0.3	1.2	15.8	1.5	7.0
1.8	7.0	3.4	13.4	0.0	7.9
2.1	8.2	0.9	4.6	0.0	4.6
1.5	2.4	1.5	12.5	1.2	12.5
1.5	3.0	1.8	5.5	2.7	14.0
1.2	6.1	0.3	5.2	0.0	11.0
2.4	8.5	0.0	7.9	0.0	8.5
0.0	11.0	0.9	5.5	0.0	4.9
2.4	3.0	1.8	11.3	0.0	14.6
1.8	4.3	3.4	13.1	0.0	14.0
1.8	6.4	1.5	12.8	0.0	15.5
0.3	4.3	1.8	4.3	0.6	21.3
2.4	7.0	2.1	13.1	0.0	9.8
2.7	3.7	1.5	22.3	2.4	10.1
1.2	2.1	0.3	14.0	0.0	17.1
0.0	4.9	1.5	12.8	0.0	4.6
4.9	12.8	1.8	12.2	0.0	9.1
0.9	4.6	1.2	13.4	1.5	7.9
1.2	1.8	3.0	10.1	0.0	8.2
0.0	2.1	1.5	7.6	0.0	14.0
0.0	3.0	0.0	6.4	0.0	8.5
2.1	7.3	0.0	3.0	0.0	6.7
1.2	4.0	2.1	12.2	2.4	18.6
0.3	6.7	0.6	8.5	0.0	11.3
1.2	4.9	1.5	16.8	0.3	5.2
0.0	4.9	1.5	7.6	0.3	6.1
0.6	7.9	2.7	4.6	0.0	15.8
0.9	10.1	0.3	7.6	0.0	18.9
2.4	4.0	1.2	14.3	0.3	4.9
0.3	3.4	0.9	3.0	0.0	9.8
1.8	8.2	2.4	4.6	0.0	11.0
2.7	5.2	2.1	8.5	0.0	4.6
0.0	4.9	1.5	14.9	2.4	4.9
0.0	0.3	1.2	6.4	0.0	16.5
3.0	4.9	1.2	4.9	0.0	11.3
0.3	0.3	1.2	12.5	0.0	7.0
0.9	3.0	1.8	8.5	0.0	7.6
1.2	3.7	1.5	14.0	0.6	7.6
0.9	3.7	0.6	4.9	0.0	4.6
3.4	9.1	0.9	6.4	0.0	15.8
0.0	2.4	1.8	8.2	0.0	12.2
1.8	4.0	0.6	7.9	0.0	14.9

18.3 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
2.1	3.4	2.1	19.8	2.4	9.4
0.6	6.7	1.5	12.8	4.9	8.8
2.1	4.9	0.6	9.1	1.8	7.0
2.4	4.3	0.6	16.8	2.1	4.6
2.1	3.7	0.6	3.7	1.2	2.1
1.5	6.7	1.2	4.6	3.7	4.3
2.1	7.0	0.9	15.2	0.3	1.5
1.8	2.7	2.1	17.1	4.0	15.2
0.3	1.5	2.1	7.6	2.4	6.4
1.2	7.3	2.1	6.7	2.4	5.2
1.2	3.4	1.5	9.4	4.3	12.8
1.8	2.7	2.1	14.3	3.4	13.7
2.1	2.1	1.5	14.6	4.3	10.7
1.2	4.6	0.3	8.8	1.2	4.0
6.4	18.0	0.0	16.2	4.6	5.8
1.2	2.1	0.9	12.2	2.7	8.2
4.3	13.1	0.9	5.8	0.6	19.5
2.1	8.2	0.9	4.9	1.5	5.2
0.6	1.2	1.2	11.6	0.9	1.5
1.8	4.6	0.6	3.7	3.4	11.9
1.2	7.6	3.0	16.5	1.2	9.4
2.7	6.7	2.1	9.4	3.4	10.4
1.5	5.2	1.5	14.6	5.2	14.0
0.6	4.0	1.2	12.2	3.4	14.0
1.5	4.3	1.8	6.7	4.3	7.0
1.8	8.8				
1.2	8.2				
1.5	7.6				
0.6	12.5				
2.7	3.7				
0.3	6.4				
0.6	16.2				
1.2	8.5				
0.9	14.6				
0.0	11.0				
1.8	6.1				
3.0	10.7				
1.2	8.2				
1.2	7.6				
3.4	6.1				
0.6	5.2				
2.7	7.6				
0.6	6.4				
0.9	5.8				
1.5	8.8				
1.2	3.7				
3.4	12.5				
0.3	12.5				
1.2	4.3				
0.0	3.7				

Field Data for 1.33V:1H Slopes

24.4 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	4.3	0.0	11.0	1.5	4.9
1.5	1.5	1.5	1.5	0.6	0.6
0.3	0.3	0.3	7.6	3.0	4.0
1.5	2.1	1.5	10.7	3.0	9.1
2.1	4.0	0.6	5.2	0.9	3.7
0.0	1.5	1.8	1.8	1.2	2.4
0.0	2.7	1.5	11.3	1.5	6.1
0.0	2.1	1.2	4.9	0.9	10.4
0.0	0.9	0.9	3.4	1.8	1.8
0.0	4.3	1.5	9.8	1.5	11.0
1.2	1.5	0.6	2.7	1.2	12.8
0.0	0.9	1.2	5.5	0.9	0.9
0.0	3.4	0.9	2.4	1.5	11.9
0.6	3.4	1.2	5.5	1.2	13.7
0.0	1.8	1.2	1.2	1.2	1.2
1.8	1.8	0.6	6.7	0.6	3.7
1.2	1.2	0.9	5.2	4.3	5.5
0.6	9.1	0.9	1.5	2.4	2.4
0.3	0.9	0.9	4.9	0.9	7.0
0.0	5.2	1.5	4.3	1.2	11.0
0.0	1.2	1.2	5.8	1.5	2.4
0.6	2.4	1.8	4.6	1.5	1.5
1.5	6.1	1.2	3.7	1.5	8.5
4.0	4.0	1.8	5.5	0.6	7.0
0.9	1.8	0.9	5.5	1.5	4.3
0.0	7.9	0.9	6.7	4.6	7.0
0.9	6.7	0.3	5.5	0.6	0.9
1.2	1.5	0.6	3.4	0.6	1.2
1.2	1.2	0.0	7.3	1.2	1.5
0.9	3.4	1.2	2.7	0.6	5.5
1.2	3.0	0.6	0.9	1.8	4.3
0.0	0.9	0.9	5.2	0.6	1.2
0.3	1.2	1.2	4.9	0.6	1.8
0.0	2.7	0.3	4.0	1.2	7.6
0.0	2.4	0.6	3.4	1.2	4.9
1.8	4.3	1.5	6.1	0.9	6.1
1.2	1.2	2.1	6.4	0.6	10.7
0.0	4.0	1.8	6.7	2.4	5.5
0.9	0.9	1.2	5.5	0.3	5.8
0.3	2.1	2.1	3.7	2.1	3.0
0.3	0.9	0.6	3.0	0.6	5.8
0.6	1.8	0.9	4.9	1.5	3.0
2.1	4.0	0.9	7.3	0.9	5.5
0.3	1.5	1.5	2.7	1.5	1.5
1.5	1.5	1.5	10.4	0.9	0.9
3.4	4.0	1.8	4.9	1.5	7.3
1.5	3.4	0.0	7.0	1.2	4.6
0.6	1.8	1.5	1.5	0.0	4.6
0.0	4.9	4.0	5.2	1.8	6.4
0.0	4.0	1.2	3.7	2.1	2.1

24.4 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	3.0	0.9	3.7	0.0	1.5
1.2	1.2	0.0	6.7	0.6	2.1
0.3	6.4	0.6	4.3	1.5	4.3
0.6	3.7	0.0	9.1	0.6	4.6
1.2	2.7	1.5	2.1	0.6	11.9
2.4	4.3	0.3	4.0	0.9	5.2
1.2	1.2	1.5	3.7	4.0	4.6
0.0	2.1	0.0	9.8	2.1	7.3
0.9	5.8	0.6	1.2	0.9	6.1
0.6	3.7	1.5	4.9	1.2	4.3
0.0	2.4	1.2	1.2	1.2	4.3
0.9	1.5	0.9	4.0	2.1	2.1
0.9	3.4	1.2	1.2	0.9	2.7
0.0	2.4	0.9	3.0	0.6	6.1
0.0	1.5	0.9	4.3	1.8	4.6
0.9	5.5	1.2	3.0	0.0	3.7
0.6	2.7	0.9	1.5	1.8	3.7
1.5	1.5	2.1	2.1	1.2	8.2
1.2	4.9	0.0	4.3	0.0	3.0
0.9	3.7	1.2	1.5	1.8	4.3
2.1	2.1	1.5	1.8	0.6	4.6
0.0	2.4	1.8	2.1	0.9	4.0
1.5	3.7	1.2	6.4	1.5	7.0
3.0	3.4	0.9	1.5	1.2	6.1
1.5	5.5	0.3	0.6	0.9	8.2
0.9	0.9				
1.8	1.8				
0.9	2.4				
0.0	0.6				
0.3	4.0				
1.2	2.4				
1.8	3.7				
2.4	2.4				
4.3	5.2				
1.2	2.7				
2.4	6.1				
1.2	1.2				
3.7	5.5				
0.0	5.8				
1.8	1.8				
1.5	4.9				
0.9	1.5				
0.0	5.2				
1.2	4.9				
0.0	2.4				
1.5	1.5				
2.1	2.1				
1.2	3.0				
0.9	4.3				
2.1	2.4				

Field Data for 1.33V:1H Slopes

24.4 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.6	9.8	0.0	1.2	1.5	6.1
1.2	3.7	3.4	4.3	1.5	7.0
0.9	5.2	0.0	11.6	0.6	8.8
2.7	3.0	1.2	3.4	0.0	12.8
0.6	2.1	0.6	6.7	0.9	2.4
0.9	3.4	1.8	2.4	1.5	3.4
1.2	4.0	0.0	4.6	0.0	4.0
1.5	5.2	0.9	0.9	0.0	2.1
0.9	3.4	0.0	7.3	0.9	6.7
0.9	3.0	0.0	2.1	0.3	11.9
1.5	4.9	0.0	4.3	0.9	2.7
0.6	3.0	1.5	4.0	1.5	3.0
1.2	2.7	1.5	12.8	0.9	3.4
0.3	1.5	0.0	10.1	0.0	3.7
0.3	2.1	0.0	2.4	0.9	14.9
1.5	3.0	1.2	3.7	0.0	11.0
0.3	3.0	1.8	5.5	0.0	6.4
2.7	7.9	0.3	7.9	1.2	3.4
0.6	3.4	0.0	1.2	0.0	3.7
0.6	1.5	0.6	0.9	0.0	3.4
0.9	4.6	0.0	1.2	1.8	6.1
1.5	8.2	0.0	4.3	0.0	0.9
2.1	2.7	3.0	7.0	0.0	11.3
0.3	1.8	0.0	2.7	0.0	1.8
2.1	3.0	0.0	11.3	1.2	2.4
1.2	2.7	0.0	3.7	0.9	5.2
0.6	1.2	2.1	18.9	1.5	5.2
2.7	6.7	0.9	1.5	0.0	11.6
1.2	4.0	0.0	14.9	0.0	5.2
1.2	2.4	0.0	4.6	1.5	2.7
1.2	2.4	2.7	4.3	1.8	7.0
0.9	2.7	1.5	4.0	0.9	4.9
1.2	6.1	0.0	1.5	0.0	7.6
1.8	3.7	1.8	3.4	1.5	10.1
0.0	3.4	1.5	5.2	0.0	7.9
0.0	3.7	1.5	7.3	0.0	4.9
0.0	5.2	0.6	0.6	1.5	6.1
0.0	1.5	2.4	2.4	0.0	11.0
0.0	0.6	0.0	2.1	0.9	5.8
0.0	6.7	0.0	18.3	0.9	7.6
0.9	0.9	1.5	8.8	3.0	6.7
1.5	5.8	0.0	7.3	0.0	4.3
2.1	8.8	0.0	8.5	0.0	7.0
0.6	3.7	0.9	2.7	2.4	4.9
0.9	5.2	0.6	0.6	0.0	6.4
0.3	0.9	0.9	6.7	0.0	5.8
0.0	2.1	0.0	3.0	0.0	6.7
0.9	2.7	0.0	11.9	0.0	11.3
3.0	5.8	0.0	7.0	0.6	4.3
0.0	1.2	0.0	3.0	0.0	4.6

24.4 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.9	2.1	1.5	2.7	0.6	6.7
0.3	0.3	0.0	4.3	0.9	13.1
1.2	1.5	0.9	5.5	0.0	6.7
2.4	2.4	0.6	4.3	0.0	5.2
0.6	1.2	0.0	2.7	0.0	8.2
2.1	4.0	1.8	7.9	0.0	8.2
0.6	2.7	0.0	9.1	0.0	9.1
0.0	2.1	0.0	5.5	0.0	6.4
0.0	3.4	0.6	3.7	0.6	3.7
0.6	4.0	1.2	3.0	1.5	2.1
1.2	4.6	0.3	0.3	2.1	3.0
0.9	5.5	3.0	4.0	0.0	15.5
0.0	7.3	0.0	8.8	0.0	8.5
0.0	3.0	0.6	4.6	0.0	7.0
1.5	1.5	0.0	2.7	0.9	13.4
0.9	3.0	0.0	5.5	0.0	7.3
0.0	0.0	0.0	3.4	1.5	5.2
0.0	5.2	0.6	1.8	1.2	1.2
0.0	9.4	0.9	2.1	0.0	7.3
0.6	1.2	0.0	1.2	1.2	1.2
0.0	0.9	1.8	5.2	0.6	5.2
3.7	4.9	1.5	2.4	0.0	9.8
0.0	1.5	0.0	4.9	0.0	7.0
1.5	7.0	0.9	4.0	0.0	6.1
1.2	4.0	1.2	1.2	3.0	4.3
0.0	6.4				
1.5	2.4				
0.0	2.1				
3.0	4.9				
0.9	4.3				
1.2	2.1				
0.0	1.8				
0.0	1.2				
0.9	8.2				
0.6	5.8				
0.0	4.6				
1.5	3.4				
0.6	7.3				
0.6	3.0				
1.5	4.6				
1.5	1.5				
1.2	1.8				
0.0	5.5				
0.0	1.8				
0.9	3.7				
0.9	1.8				
0.6	0.6				
0.9	3.0				
0.9	2.1				
0.0	4.0				

Field Data for 1.33V:1H Slopes

24.4 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.5	2.1	1.5	14.3	1.5	15.8
1.2	3.7	1.5	21.0	0.0	7.6
0.0	5.2	1.5	4.6	0.0	19.8
0.0	3.0	0.0	8.2	0.0	15.8
1.8	1.8	1.5	7.0	1.5	5.5
0.0	6.7	2.1	4.9	1.5	14.0
1.5	5.8	0.0	15.8	0.9	4.3
1.2	9.8	1.5	10.7	0.3	4.9
0.0	5.8	0.0	10.1	1.2	11.3
0.6	6.4	0.0	12.8	0.9	12.8
0.0	0.6	0.0	7.9	0.3	7.0
0.3	14.0	1.5	1.5	0.0	21.0
4.6	7.9	1.5	13.7	2.7	3.7
0.0	1.8	0.0	5.5	0.0	10.1
1.2	3.4	0.0	8.2	2.7	7.6
3.0	6.1	0.0	4.9	0.0	10.1
0.6	3.0	0.0	12.2	0.0	5.8
1.8	2.1	3.0	13.4	0.6	2.4
3.4	7.6	1.5	5.8	0.3	7.9
1.8	2.4	0.0	18.3	0.3	0.6
0.0	2.1	0.0	11.6	1.5	6.4
0.0	7.3	0.0	11.9	0.0	7.9
1.2	2.7	1.2	10.7	1.5	6.7
0.3	0.3	1.8	10.7	3.4	15.8
0.0	1.2	3.7	11.0	0.0	19.2
0.0	4.3	0.0	7.0	0.0	8.2
0.0	9.1	1.5	1.8	0.0	7.3
0.0	2.4	3.0	8.5	3.0	11.3
1.2	4.0	1.5	5.5	2.7	8.5
1.5	11.6	0.0	0.0	0.0	5.5
0.0	0.9	1.2	14.0	1.5	11.6
0.0	4.6	0.0	11.0	2.7	4.6
0.0	1.2	0.0	18.9	0.0	17.7
0.0	14.6	1.5	8.2	2.7	8.8
0.0	5.8	1.2	9.1	0.0	6.4
0.0	7.9	0.9	6.7	0.0	15.8
4.6	9.1	0.9	4.3	1.2	8.8
0.0	4.3	1.2	9.1	0.0	11.3
0.0	7.9	0.0	14.6	0.0	13.7
0.0	4.0	2.4	8.8	0.0	11.3
0.0	0.3	0.0	5.8	1.5	2.7
1.5	5.5	0.9	7.3	0.0	4.6
0.0	0.9	0.0	13.7	0.0	4.3
2.7	8.2	0.0	18.3	1.2	2.4
0.0	4.3	1.2	4.6	0.0	9.1
0.9	4.9	1.2	1.8	0.6	4.9
0.0	0.9	1.8	4.6	0.9	3.0
0.0	1.8	0.0	9.8	0.0	19.8
0.0	5.2	0.0	6.1	4.0	10.4
0.9	4.9	1.5	7.0	1.5	8.5

24.4 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	6.1	0.9	6.7	1.5	7.9
0.0	2.4	0.0	4.3	0.9	7.0
4.6	5.8	0.0	5.8	1.2	8.5
0.0	7.0	0.0	1.2	0.0	11.9
0.0	0.9	0.0	17.4	0.6	8.2
0.0	0.6	0.0	3.7	1.5	11.3
0.0	5.2	0.0	3.4	1.5	20.7
1.2	3.4	1.5	6.1	0.0	1.2
0.0	7.0	1.5	9.8	0.0	10.1
0.0	2.1	0.0	3.0	0.0	3.4
0.9	1.8	0.0	3.0	0.6	6.1
0.9	1.2	1.5	9.4	0.0	5.2
0.0	5.2	3.0	3.0	0.0	4.0
1.2	2.1	1.5	7.0	0.0	0.6
0.0	1.8	1.5	3.0	0.0	20.7
0.9	3.4	1.5	6.1	0.0	1.8
0.9	5.2	3.0	8.5	0.0	16.8
0.6	6.1	0.9	5.8	0.0	18.6
0.9	4.0	1.2	3.0	0.9	0.9
0.0	8.2	1.5	4.6	1.8	18.0
0.9	0.9	0.0	13.7	1.2	11.6
0.0	2.7	3.0	7.3	0.9	22.9
1.5	7.3	0.9	8.2	1.8	19.8
0.0	2.4	3.0	6.7	1.2	4.0
1.5	8.8	1.8	12.8	0.9	10.4
0.0	0.6				
0.0	12.8				
0.0	3.4				
1.2	6.7				
0.3	0.3				
0.3	0.3				
1.2	1.2				
0.3	2.4				
1.8	10.4				
1.2	7.0				
0.0	5.8				
0.0	11.0				
0.9	7.3				
0.0	4.0				
0.9	13.7				
2.1	9.1				
0.0	10.1				
0.0	5.5				
0.0	7.9				
0.0	4.0				
0.0	1.2				
0.0	3.7				
4.6	5.8				
2.7	17.7				
1.5	7.9				

Field Data for 1V:1H Slopes

12.2 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	0.9	0.0	3.7	0.0	4.0
0.0	1.2	0.0	3.0	0.0	3.4
0.0	2.1	0.0	4.0	0.0	4.9
0.0	1.8	0.0	2.1	0.0	2.4
0.0	1.5	0.0	4.6	0.0	3.7
0.0	1.8	0.0	2.4	0.0	2.7
0.0	1.5	0.0	1.5	0.0	0.9
0.0	0.0	0.0	0.9	0.0	4.6
0.0	2.4	0.0	2.1	0.0	4.0
0.0	1.2	0.0	2.4	0.0	3.4
0.0	0.9	0.0	2.1	0.0	2.7
0.0	3.0	0.0	1.2	0.0	1.5
0.0	1.5	0.0	1.5	0.0	1.8
0.0	2.4	0.0	2.7	0.0	2.4
0.0	3.0	0.0	2.1	0.6	3.0
0.0	1.8	0.0	4.9	0.0	1.5
0.0	2.1	0.0	6.4	0.0	3.0
0.0	2.4	0.0	4.3	0.0	3.7
0.0	1.5	0.0	2.4	0.0	4.0
0.0	2.4	0.0	4.0	0.0	1.8
0.0	1.8	0.0	3.0	0.0	3.4
0.0	2.1	0.0	3.4	0.0	2.1
0.0	2.4	0.0	3.4	0.0	1.8
0.0	1.5	0.0	5.2	0.0	2.4
0.0	1.8	0.0	4.6	0.0	2.4
0.0	0.9	0.0	2.1	0.0	2.1
0.0	0.9	0.0	4.0	0.0	1.5
0.0	1.5	0.0	1.8	0.0	3.4
0.0	2.1	0.0	3.0	0.0	1.2
0.0	0.6	0.0	3.7	0.0	2.4
0.0	0.9	0.0	4.9	0.0	3.0
0.9	0.9	0.0	3.0	0.0	3.7
0.0	1.8	0.0	0.0	0.0	0.9
0.0	1.5	0.0	5.2	0.0	3.4
0.0	0.9	0.0	2.4	0.0	2.7
0.0	2.1	0.0	4.6	0.0	2.7
0.0	1.2	0.0	2.1	0.0	4.9
0.0	1.2	0.0	2.4	0.0	4.6
0.0	1.5	0.0	2.7	0.0	3.7
0.9	0.9	0.0	2.1	0.0	2.7
0.0	2.1	0.0	1.5	0.0	2.4
0.0	1.8	0.0	3.4	0.0	3.7
0.0	0.9	0.0	2.4	0.0	1.5
0.0	0.3	0.0	3.7	0.0	2.4
0.0	1.2	0.0	4.0	0.0	2.7
0.0	0.3	0.0	3.7	0.0	7.0
0.0	0.0	0.0	2.7	0.0	2.1
0.0	0.0	0.0	3.4	0.0	3.0
0.0	1.5	0.0	1.2	0.0	3.4
0.0	1.2	0.0	2.4	0.0	0.9

12.2 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	0.3	0.0	2.4	0.0	3.7
0.0	1.2	0.0	2.1	0.0	1.8
0.0	0.6	0.0	1.8	0.0	4.0
0.0	1.2	0.0	2.4	0.0	3.0
0.0	0.0	0.0	2.1	0.0	2.4
0.0	1.5	0.0	3.4	0.0	4.6
0.0	0.9	0.0	2.1	0.0	3.0
0.0	0.9	0.0	2.4	0.0	2.7
0.0	0.3	0.0	2.1	0.0	2.4
0.0	0.6	0.0	3.0	0.0	3.0
0.0	0.6	0.0	1.8	0.0	2.7
0.0	0.0	0.0	4.3	0.0	2.4
0.0	1.2	0.0	3.7	0.0	1.5
0.0	0.6	0.0	0.9	0.0	2.4
0.0	0.3	0.0	2.1	0.0	4.0
0.0	0.6	0.0	2.7	0.0	3.0
0.0	1.8	0.0	2.4	0.0	1.5
0.0	1.5	0.0	3.4	0.0	4.0
0.0	2.4	0.0	2.7	0.0	3.7
0.0	0.9	0.0	4.0	0.0	3.4
0.0	1.8	0.0	2.1	0.0	0.0
0.0	0.9	0.0	2.7	0.0	1.5
0.0	0.6	0.0	3.7	0.0	2.1
0.0	1.2	0.0	2.1	0.0	3.4
0.0	0.9	0.0	1.5	0.0	4.6
0.0	0.3			0.0	3.0
0.0	1.5			0.0	1.2
0.0	0.3			0.0	2.7
0.0	1.5			0.0	2.4
0.0	0.9			0.0	4.3
0.0	1.2			0.0	2.1
0.0	0.9			0.0	4.3
0.0	1.5				
0.0	0.6				
0.0	2.7				
0.0	1.2				
0.0	0.9				
0.0	1.2				
0.0	0.9				
0.0	1.2				
0.0	0.0				
0.0	0.9				
0.0	1.2				
0.0	0.9				
0.0	1.5				
0.0	0.6				
0.0	0.9				
0.0	1.2				
0.0	0.9				
0.0	1.5				

Field Data for 1V:1H Slopes

12.2 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	3.0	0.0	7.9	0.0	7.6
0.0	4.3	0.0	4.0	0.0	11.6
0.0	1.2	0.0	9.8	0.0	3.7
0.0	2.4	0.0	6.7	0.0	5.8
0.0	4.0	0.0	8.2	0.0	2.7
0.0	5.5	0.0	5.5	0.0	2.4
0.0	5.8	0.0	1.8	0.0	1.8
0.0	5.2	0.0	5.8	0.0	9.1
0.0	4.3	0.0	6.1	0.0	5.5
0.0	4.0	0.0	7.3	0.0	4.9
0.0	3.7	0.0	5.2	0.0	6.7
0.0	4.3	0.0	3.7	0.0	6.4
0.0	2.7	0.0	4.0	0.0	7.0
0.0	0.9	0.0	2.7	0.0	4.3
0.0	1.5	0.0	7.0	0.0	5.8
0.0	7.3	0.0	4.3	0.0	2.4
0.0	3.4	0.0	5.8	0.0	5.5
0.0	4.0	0.0	5.2	0.0	4.9
0.0	3.7	0.0	3.4	0.0	4.3
0.0	4.0	0.6	4.9	0.0	3.0
0.0	7.0	0.0	7.0	0.0	3.4
0.0	1.5	0.0	0.9	0.0	4.9
0.0	3.4	0.0	6.7	0.0	6.7
0.0	3.7	0.0	5.8	0.0	2.7
0.0	4.0	0.0	2.7	0.0	2.4
0.0	4.0	0.0	4.9	0.0	8.8
0.0	4.3	0.0	6.7	0.0	7.3
0.0	2.1	0.0	4.6	0.0	5.5
0.0	8.2	0.0	5.2	0.0	3.4
0.0	4.6	0.0	3.4	0.0	4.9
0.0	4.3	0.0	4.3	0.0	5.8
0.0	4.0	0.0	2.1	0.0	4.0
0.0	4.3	0.0	3.7	0.0	5.5
0.0	4.9	0.0	1.5	0.0	4.9
0.0	4.9	0.0	2.1	0.0	6.7
0.0	1.5	0.0	4.0	0.0	7.0
0.0	4.0	0.0	6.1	0.0	4.0
0.0	1.2	0.0	8.8	0.0	4.9
0.0	1.8	0.0	4.6	0.0	7.3
0.0	1.5	0.0	4.6	0.0	5.5
0.0	1.5	0.0	2.1	0.0	2.1
0.0	2.1	0.0	3.7	0.0	10.1
0.0	1.5	0.0	7.0	0.0	4.3
0.0	2.4	0.0	4.6	0.0	4.3
0.0	3.4	0.0	5.5	0.0	4.6
0.0	5.8	0.0	3.7	0.0	3.0
0.0	4.9	0.0	2.4	0.0	3.7
0.0	2.7	0.0	4.9	0.0	4.9
0.0	3.0	0.0	3.0	0.0	4.0
0.0	3.0	0.0	4.3	0.0	4.3

12.2 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	2.7	0.0	4.3	0.0	5.2
0.0	3.4	0.0	4.9	0.0	2.7
0.0	4.9	0.0	4.0	0.0	2.4
0.0	2.4	0.0	5.5	0.0	3.0
0.0	3.7	0.0	2.4	0.0	7.3
0.0	4.0	0.0	5.2	0.0	9.8
0.0	4.9	0.0	2.7	0.0	9.1
0.0	3.4	0.0	6.4	0.0	11.3
0.0	3.7	0.0	5.2	0.0	8.8
0.0	1.2	0.0	6.7	0.0	7.3
0.0	4.6	0.0	3.4	0.0	3.7
0.0	4.0	0.0	4.3	0.0	7.6
0.0	3.7	0.0	2.1	0.0	3.0
0.0	2.4	0.0	5.2	0.0	4.6
0.0	1.8	0.0	4.3	0.0	5.8
0.0	5.2	0.0	4.9	0.0	3.0
0.0	2.4	0.0	5.5	0.0	5.5
0.0	1.8	0.0	4.6	0.0	2.7
0.0	1.5	0.0	1.2	0.0	3.4
0.0	3.0	0.0	4.9	0.0	4.3
0.0	1.2	0.0	5.2	0.0	4.3
0.0	3.7	0.0	4.6	0.0	4.9
0.0	3.0	0.0	1.8	0.0	4.6
0.0	3.7	0.0	3.4	0.0	3.7
0.0	3.4	0.0	3.0	0.0	4.0
0.0	1.2				
0.0	0.9				
0.0	2.1				
0.0	3.0				
0.0	2.4				
0.0	4.3				
0.0	0.9				
0.0	2.1				
0.0	2.4				
0.0	3.4				
0.0	1.5				
0.0	2.1				
0.0	1.2				
0.0	0.9				
0.0	1.2				
0.0	1.8				
0.0	3.7				
0.0	4.3				
0.0	3.4				
0.0	4.6				
0.0	2.4				
0.0	0.9				
0.0	3.4				
0.0	2.1				
0.0	4.3				

Field Data for 1V:1H Slopes

12.2 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	8.2	0.0	17.1	0.0	21.3
0.0	10.1	0.0	18.6	0.0	15.8
0.0	4.9	0.0	15.8	0.0	10.7
0.0	4.9	0.0	13.1	0.0	18.3
0.0	10.1	0.0	12.8	0.0	13.7
0.0	6.1	0.0	17.7	0.0	10.4
0.0	1.5	0.0	7.9	0.0	11.6
0.0	7.0	0.0	5.5	0.0	7.3
0.0	10.1	0.0	16.5	0.0	4.0
0.0	0.9	0.0	9.8	0.0	4.6
0.0	8.8	0.0	10.4	0.0	8.2
0.0	6.7	0.0	18.3	0.0	12.2
0.0	2.4	0.0	16.2	0.0	5.8
0.0	10.1	0.0	4.9	0.0	15.5
0.0	11.6	0.0	10.7	0.0	6.7
0.0	7.9	0.0	6.1	0.0	5.5
0.0	11.6	0.0	11.9	0.0	0.9
0.0	6.7	0.0	13.4	0.0	0.9
0.0	14.6	0.0	10.1	0.0	9.8
0.0	8.2	0.0	10.7	0.0	6.7
0.0	7.3	0.0	13.7	0.0	12.2
0.0	6.1	0.0	7.3	0.0	13.4
0.0	7.9	0.0	6.4	0.0	6.7
0.0	13.4	0.0	8.2	0.0	8.5
0.0	5.8	0.0	6.7	0.0	2.4
0.0	4.0	0.0	6.1	0.0	6.1
0.0	0.6	0.0	12.8	0.0	8.2
0.0	2.1	0.0	7.0	0.0	2.7
0.0	3.0	0.0	13.7	0.0	5.2
0.0	7.0	0.0	7.6	0.0	15.8
0.0	9.8	0.0	9.4	0.0	5.5
0.0	7.3	0.0	15.2	0.0	5.2
0.0	2.1	0.0	7.9	0.0	9.8
0.0	3.7	0.0	3.4	0.0	4.3
0.0	8.8	0.0	3.7	0.0	8.5
0.0	4.0	0.0	5.2	0.0	8.8
0.0	2.7	0.0	11.3	0.0	5.8
0.0	9.1	0.0	5.8	0.0	7.6
0.0	5.2	0.0	10.1	0.0	7.0
0.0	4.9	0.0	12.8	0.0	0.0
0.0	11.6	0.0	13.1	0.0	18.3
0.0	2.4	0.0	15.5	0.0	7.0
0.0	9.4	0.0	11.3	0.0	9.1
0.0	7.0	0.0	14.6	0.0	10.7
0.0	7.3	0.0	6.1	0.0	11.3
0.0	12.5	0.0	7.0	0.0	9.1
0.0	8.8	0.0	7.0	0.0	5.5
0.0	10.4	0.0	3.4	0.0	9.1
0.0	3.4	0.0	4.0	0.0	6.1
0.0	6.4	0.0	8.8	0.0	17.7

12.2 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	5.5	0.0	7.6	0.0	10.4
0.0	15.2	0.0	14.0	0.0	15.5
0.0	6.7	0.0	9.1	0.0	11.0
0.0	6.4	0.0	5.2	0.0	9.8
0.0	4.6	0.0	11.6	0.0	8.8
0.0	7.6	0.0	4.9	0.0	6.7
0.0	1.8	0.0	9.8	0.0	4.6
0.0	4.0	0.0	11.3	0.0	11.0
0.0	6.4	0.0	6.1	0.0	6.7
0.0	10.1	0.0	10.1	0.0	11.6
0.0	7.0	0.0	8.8	0.0	7.0
0.0	8.8	0.0	11.0	0.0	6.1
0.0	7.3	0.0	6.4	0.0	8.8
0.0	7.0	0.0	5.8	0.0	4.3
0.0	6.7	0.0	10.1	0.0	6.4
0.0	7.9	0.0	10.7	0.0	6.7
0.0	7.6	0.0	8.2	0.0	13.4
0.0	4.3	0.0	11.6	0.0	5.5
0.0	11.9	0.0	10.1	0.0	8.5
0.0	7.0	0.0	3.7	0.0	9.8
0.0	1.5	0.0	7.3	0.0	9.1
0.0	6.1	0.0	2.4	0.0	8.5
0.0	8.5	0.0	9.4	0.0	8.2
0.0	5.8	0.0	3.7	0.0	10.1
0.0	8.2	0.0	13.4	0.0	5.5
0.0	5.8				
0.0	7.9				
0.0	1.5				
0.0	5.5				
0.0	4.0				
0.0	7.0				
0.0	7.6				
0.0	5.5				
0.0	7.3				
0.0	9.1				
0.0	7.3				
0.0	5.8				
0.0	2.4				
0.0	5.2				
0.0	4.9				
0.0	7.9				
0.0	2.4				
0.0	3.7				
0.0	11.0				
0.0	7.3				
0.0	3.7				
0.0	8.2				
0.0	4.9				
0.0	5.5				
0.0	7.3				

Field Data for 1V:1H Slopes

18.3 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	1.5	0.0	3.0	0.0	3.0
0.0	1.8	0.0	2.7	0.0	1.5
0.0	2.4	0.9	0.9	0.0	4.6
0.0	1.2	0.0	7.6	0.0	4.3
0.0	1.8	0.0	4.3	0.0	6.7
1.2	1.2	0.0	4.0	0.0	4.0
0.3	1.2	0.0	3.4	0.0	4.3
0.0	1.5	0.6	1.2	0.0	2.7
0.0	2.1	0.0	4.9	0.0	1.5
0.9	1.2	0.0	3.4	0.0	3.0
0.0	3.4	0.0	1.5	0.0	0.9
0.0	2.7	0.0	1.8	0.0	1.2
0.0	2.1	0.0	2.4	0.0	4.6
0.0	0.6	0.0	2.7	0.0	4.3
0.0	3.0	0.0	4.6	0.0	4.0
0.0	1.2	0.0	3.0	0.0	4.3
0.0	2.1	0.0	6.7	0.0	1.2
0.0	0.9	0.0	5.2	0.0	4.6
0.9	1.5	0.0	3.4	0.0	4.3
0.0	0.9	0.0	3.7	0.0	2.4
0.3	0.9	0.9	1.5	1.2	2.7
0.6	1.2	0.0	2.1	0.0	4.0
0.0	1.5	0.0	4.3	1.2	2.7
0.0	0.3	0.0	4.0	0.9	3.0
0.0	1.5	0.0	3.7	0.6	3.0
0.0	2.1	0.0	4.6	0.0	3.4
0.0	1.8	0.0	4.3	0.3	4.0
0.0	1.5	0.0	4.3	0.0	5.2
0.0	1.5	1.2	1.2	0.0	4.3
0.0	2.4	0.0	3.7	0.0	3.0
0.0	0.6	0.0	2.4	0.6	1.8
0.0	2.4	0.0	3.7	0.0	6.4
0.0	0.3	0.0	5.5	0.0	3.4
0.0	1.2	0.0	3.4	0.0	2.1
0.0	1.8	0.0	4.9	0.0	6.1
0.0	3.4	0.0	7.3	0.0	4.0
0.0	2.4	0.0	4.3	0.0	8.5
0.0	0.6	0.0	5.2	0.0	4.3
0.0	1.8	0.0	8.8	0.0	2.4
0.0	1.8	0.0	3.0	0.0	3.7
0.3	0.6	0.0	3.4	0.0	2.7
0.0	0.9	0.0	1.8	0.0	7.6
0.6	1.2	0.0	4.9	0.0	4.0
0.3	2.1	0.0	6.4	0.0	2.4
0.9	1.5	0.0	3.7	0.0	2.1
0.6	1.2	0.0	4.0	0.0	2.4
0.3	2.4	0.0	3.4	1.5	1.5
0.3	3.0	0.0	1.2	0.0	4.9
0.0	2.4	0.0	3.0	1.2	1.2
1.2	1.2	0.0	2.4	0.0	4.0

18.3 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	2.1	0.0	0.3	0.0	3.4
0.0	2.1	0.0	2.1	0.6	1.5
0.0	1.8	0.0	6.7	0.0	4.3
0.0	1.5	0.0	4.0	0.0	4.9
0.6	0.9	0.0	4.6	0.0	9.4
0.0	2.1	0.0	5.8	0.0	4.3
0.0	1.5	0.0	4.0	0.0	4.3
0.3	1.8	0.0	4.0	0.0	5.2
0.0	0.9	0.0	1.5	0.0	4.6
0.6	1.2	0.0	3.4	0.0	3.7
0.3	0.9	0.0	8.8	0.0	6.7
0.3	1.5	0.0	4.6	0.0	4.6
0.0	1.5	0.0	4.3	0.0	4.3
0.0	0.9	0.0	3.0	0.0	5.8
0.0	0.6	0.0	4.6	0.0	5.2
0.0	0.0	1.5	3.0	0.0	4.9
0.0	1.2	0.0	2.4	0.0	5.5
0.0	2.7	0.0	4.0	0.0	4.3
0.0	0.9	0.0	3.7	0.0	4.0
0.0	2.1	0.0	3.0	0.0	3.0
0.0	2.4	0.0	7.3	0.0	4.3
0.0	1.2	0.0	9.4	0.0	4.9
0.0	1.8	0.0	7.0	0.0	3.4
0.0	2.1	1.2	1.2	0.0	4.3
0.0	1.8	0.0	2.7	0.0	5.2
0.0	2.4	0.0	6.1		
0.3	1.5				
0.0	1.2				
0.0	2.1				
0.0	1.5				
0.0	1.2				
0.0	1.8				
0.0	2.4				
0.0	2.7				
0.0	1.8				
0.0	2.7				
0.0	1.2				
0.0	2.1				
0.0	2.7				
0.0	2.1				
0.0	4.9				
0.0	1.2				
0.0	0.9				
0.0	1.5				
0.0	1.8				
1.2	1.2				
0.0	3.4				
0.0	2.1				
0.0	2.1				
0.0	1.8				

Field Data for 1V:1H Slopes

18.3 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	8.2	1.2	3.4	1.2	4.9
0.0	3.4	1.5	3.7	0.9	6.7
0.0	5.8	0.0	3.7	0.9	2.4
0.0	2.7	0.0	2.7	2.1	4.0
0.9	0.9	0.0	3.7	1.5	1.5
0.9	1.5	0.9	2.7	1.5	4.9
0.0	2.7	0.0	2.4	0.9	4.6
0.0	1.8	2.1	4.9	0.0	5.2
0.6	0.9	0.0	0.9	0.3	6.7
0.0	5.5	0.0	7.3	0.9	3.4
0.0	2.1	0.0	8.2	0.0	3.4
0.0	4.6	0.0	6.4	0.0	4.6
0.9	0.9	0.0	4.9	1.2	2.4
0.0	1.8	0.0	4.3	0.6	0.9
0.0	2.7	0.0	4.3	0.9	3.7
2.7	3.4	0.0	3.0	0.3	7.0
1.2	2.4	0.0	6.7	1.2	1.2
1.2	2.1	1.2	1.8	0.0	5.5
0.9	1.5	1.2	7.0	0.6	1.2
0.0	2.4	0.6	3.4	1.2	2.1
0.0	2.1	1.2	8.5	0.0	5.8
1.5	1.5	1.5	5.2	0.0	6.4
1.5	2.4	0.0	4.9	0.0	10.7
0.0	3.4	0.0	5.8	1.2	4.0
0.9	1.2	0.0	5.2	0.9	3.0
0.9	3.4	0.0	6.7	0.0	3.7
1.2	1.8	0.0	5.2	0.0	6.4
0.9	1.5	0.0	4.9	1.5	4.0
1.2	3.4	0.9	5.8	0.0	3.7
1.2	3.0	1.2	4.0	0.6	4.6
0.0	2.7	0.9	5.2	0.9	5.5
0.6	0.9	0.0	7.3	1.5	2.7
1.2	1.8	0.0	8.2	0.0	2.7
0.0	3.4	0.0	12.2	0.0	5.2
0.9	2.1	1.5	6.7	0.9	4.3
1.2	2.1	0.0	6.4	1.5	2.7
0.6	2.7	0.0	2.7	2.4	2.4
0.9	1.8	0.0	2.4	1.2	3.4
0.0	3.0	0.0	8.8	1.5	3.7
1.2	3.7	0.0	6.4	0.0	1.8
0.0	2.4	0.0	5.2	0.0	2.7
0.0	1.5	0.0	6.1	0.0	5.5
2.1	4.9	1.5	3.0	1.8	1.8
0.0	3.0	1.5	3.7	0.0	4.3
0.3	2.4	0.0	6.7	0.0	5.8
1.2	1.8	0.0	3.4	0.0	4.9
0.0	3.0	0.0	4.6	0.0	1.5
0.0	3.7	0.0	4.3	0.0	3.7
0.0	2.1	0.0	5.2	1.2	1.2
1.2	2.7	0.0	2.1	0.0	2.4

18.3 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	4.6	1.2	2.7	0.6	6.7
0.0	5.5	0.9	3.7	0.0	1.8
0.9	1.5	0.0	9.4	0.0	4.3
0.9	1.2	0.0	3.7	0.0	6.1
0.0	4.0	0.0	11.6	0.0	5.2
0.0	3.4	1.5	2.7	0.0	3.7
0.0	4.6	0.0	5.2	0.0	3.4
0.0	3.4	0.9	3.4	0.0	6.7
3.0	4.3	1.2	4.9	1.2	1.8
1.2	2.7	0.0	7.3	0.0	4.6
2.4	2.4	0.0	4.3	1.2	1.2
0.0	7.3	0.3	4.0	0.0	6.7
0.0	1.5	0.0	4.3	2.1	3.7
0.0	3.4	0.0	4.6	0.0	4.0
0.0	5.2	0.0	4.6	0.9	3.4
0.0	1.5	0.6	5.8	0.0	7.6
0.0	0.3	0.0	5.2	1.2	3.4
0.0	3.4	1.5	4.3	0.9	6.1
0.0	2.4	0.0	4.0	0.9	7.3
0.0	4.6	0.0	5.2	0.0	4.9
1.5	2.1	0.0	5.5	0.0	6.4
0.0	1.8	0.0	4.0	1.5	4.0
1.2	3.7	1.2	2.4	0.0	2.1
0.0	4.0	1.5	3.0	0.0	2.7
0.0	4.3	0.0	7.3	0.0	11.3
0.0	4.0				
1.2	3.0				
0.0	4.0				
0.0	3.7				
0.0	1.5				
0.0	3.4				
0.0	4.0				
0.0	3.7				
2.1	3.0				
1.2	1.5				
1.5	1.5				
0.0	2.4				
1.2	3.7				
0.0	2.7				
0.0	3.0				
0.0	2.4				
0.0	2.1				
0.0	4.0				
0.0	3.4				
0.0	2.7				
0.0	1.2				
0.0	7.0				
0.0	7.6				
0.0	4.0				
0.0	2.1				

Field Data for 1V:1H Slopes

18.3 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.3	7.3	0.9	11.6	0.0	20.7
0.9	4.6	1.2	11.3	0.0	12.2
0.0	4.3	0.3	10.7	1.2	10.4
0.0	1.2	0.0	16.8	0.0	7.0
2.7	9.1	0.0	4.3	0.0	5.8
0.0	5.8	0.0	9.8	1.2	6.1
0.0	12.5	0.0	9.4	1.8	12.5
1.2	4.3	0.0	9.1	2.1	5.8
0.0	3.7	0.0	11.3	0.0	5.2
0.0	7.0	0.0	12.2	0.0	12.2
0.0	7.3	0.0	3.7	0.0	7.0
0.9	4.3	0.0	10.1	0.0	11.3
0.0	13.7	0.9	10.1	0.9	4.0
0.0	13.7	0.0	15.8	0.0	11.0
0.0	6.4	0.0	11.0	0.0	6.7
0.0	4.6	0.0	3.7	0.0	10.7
0.0	4.6	0.0	7.6	0.0	4.9
0.9	1.5	0.0	4.0	0.0	14.0
0.3	0.6	1.5	5.2	0.0	7.3
1.5	2.4	0.0	8.2	1.5	4.6
1.2	8.5	0.0	7.3	0.0	7.3
0.0	6.7	0.9	5.2	0.0	7.6
0.0	2.7	0.0	13.1	0.0	5.8
0.9	5.5	0.0	9.4	0.0	4.0
0.0	4.3	0.0	8.5	1.2	4.0
1.8	6.1	1.2	11.0	1.2	4.3
0.0	6.4	0.6	11.3	0.0	8.2
0.0	4.3	0.0	16.2	0.0	7.3
0.6	0.9	2.7	5.8	0.0	4.6
0.3	4.6	0.0	9.8	1.5	6.1
0.0	0.9	0.0	7.3	0.0	11.9
0.0	12.2	0.0	8.8	1.5	2.7
0.9	8.5	0.0	5.5	0.0	5.2
0.0	6.1	0.0	5.2	1.2	21.3
0.0	8.5	1.2	7.9	1.5	17.4
0.3	0.3	0.0	10.1	0.0	5.5
0.3	7.6	1.5	3.4	0.0	9.4
0.9	4.3	0.0	3.4	0.9	6.7
0.0	5.8	2.1	14.3	0.9	7.3
1.2	3.7	0.0	17.1	1.2	5.2
0.0	4.3	0.9	10.1	0.9	10.7
1.2	5.2	0.0	10.1	1.5	7.6
3.0	10.4	0.0	18.3	0.0	4.9
0.0	6.4	1.2	11.3	0.0	15.2
0.9	0.9	0.0	13.4	1.5	6.4
2.7	9.8	0.0	12.5	1.2	11.0
0.9	1.5	0.0	9.8	2.1	7.0
2.1	4.9	1.5	8.2	1.5	12.8
0.0	2.4	0.9	6.1	2.4	3.7
0.3	6.7	0.0	13.4	0.0	10.1

18.3 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.9	5.2	0.0	7.9	0.0	10.1
0.0	1.2	0.0	16.2	0.0	4.3
0.0	4.0	1.5	3.4	0.0	12.8
0.0	2.7	1.2	7.0	0.0	17.7
0.0	10.7	1.2	11.6	0.0	10.1
0.0	4.3	0.0	21.3	0.0	8.8
0.0	4.0	0.0	12.5	0.0	6.7
1.2	9.1	0.6	9.8	2.4	4.0
0.0	6.1	0.0	12.2	1.2	6.1
0.0	6.4	0.0	14.6	0.9	2.4
0.3	4.9	0.0	10.1	1.2	14.0
0.0	16.5	0.0	12.8	2.4	7.0
0.0	2.4	0.0	3.4	0.0	7.0
1.2	6.7	0.0	7.9	0.0	5.5
0.9	7.9	0.0	7.3	0.9	4.6
1.2	6.7	0.0	5.5	1.2	12.5
0.0	9.8	0.0	5.8	1.2	19.8
0.0	5.5	0.0	4.3	0.3	17.7
0.3	2.1	0.0	7.6	0.9	14.3
1.8	4.9	0.0	5.5	1.5	5.5
1.2	4.0	0.9	7.0	0.0	7.9
0.9	6.7	0.0	7.9	3.4	18.3
0.0	2.1	0.0	8.5	2.7	7.6
0.6	3.7	1.5	7.6	0.0	11.0
3.7	5.2	0.0	10.4	1.2	16.2
1.5	2.4				
1.2	3.4				
0.0	8.5				
1.2	9.4				
0.9	1.8				
0.0	7.0				
0.3	6.7				
1.5	1.8				
1.2	3.0				
1.2	3.7				
0.0	4.0				
0.0	6.7				
1.2	3.0				
1.2	3.7				
0.3	5.2				
0.9	6.7				
0.9	7.6				
0.0	8.2				
0.9	5.5				
0.0	6.7				
0.9	1.5				
0.0	7.6				
0.0	5.8				
0.9	5.5				
1.5	5.8				

Field Data for 1V:1H Slopes

24.4 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	2.4	0.0	1.5	0.0	2.1
0.0	1.5	0.0	6.7	1.2	6.1
0.0	0.6	1.2	6.1	0.0	3.0
0.0	0.3	0.0	7.9	1.8	1.8
0.0	1.2	1.2	6.7	0.9	2.4
0.0	2.1	0.0	2.4	0.3	0.6
0.0	2.1	0.0	6.4	0.0	1.5
0.0	1.5	1.2	3.0	1.2	5.2
0.0	3.7	0.9	4.3	0.0	5.5
0.0	0.3	0.0	3.7	0.0	7.0
0.0	3.0	1.5	4.6	0.0	5.2
0.0	1.8	0.0	8.8	0.0	11.3
0.0	0.9	0.0	8.5	0.0	11.6
0.0	1.5	0.9	3.0	0.0	4.3
1.5	4.0	1.2	2.4	0.0	4.0
0.0	1.2	0.9	8.8	0.0	6.1
0.0	0.6	1.5	10.4	1.5	2.4
1.8	3.0	0.0	5.5	0.9	1.8
0.3	3.0	1.2	1.8	0.0	4.3
0.0	1.2	0.0	5.2	0.0	5.2
0.3	6.4	0.0	4.0	0.0	6.4
0.0	4.6	0.0	5.8	0.0	4.0
0.0	3.4	0.0	4.3	0.0	4.6
0.0	2.4	0.0	6.4	0.0	4.9
0.0	0.6	0.0	0.0	0.0	1.5
0.3	0.9	0.0	3.7	0.0	7.3
0.0	0.0	0.0	1.2	0.0	7.3
0.0	1.8	0.0	6.7	0.0	1.8
0.3	0.3	0.0	6.4	0.0	10.1
0.0	2.1	1.2	7.0	0.6	8.5
0.0	0.0	0.9	5.8	0.0	7.3
0.0	0.0	0.0	4.0	1.5	4.9
0.0	1.2	0.9	4.9	0.0	4.3
0.0	0.9	0.0	5.5	0.0	6.4
0.0	0.9	1.5	4.6	0.0	4.6
0.0	2.1	1.2	5.2	0.0	1.5
0.0	1.5	0.0	4.6	0.0	6.7
0.0	2.7	0.9	8.2	0.0	6.1
0.0	4.0	1.2	2.4	0.0	9.1
0.0	1.8	0.0	7.3	0.0	1.5
0.0	1.8	0.0	4.9	0.0	6.1
0.0	0.9	0.0	5.5	1.5	4.0
0.0	2.4	1.2	11.6	0.0	4.0
0.0	4.6	0.6	1.5	0.6	3.4
1.5	2.4	0.0	5.2	0.6	7.6
0.6	1.8	1.5	4.3	0.0	9.1
0.0	2.1	1.2	6.1	0.0	4.6
0.0	1.2	0.0	7.0	0.0	6.4
0.0	3.0	0.0	5.8	0.6	8.5
0.0	0.3	0.0	2.1	1.5	4.6

24.4 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	2.1	0.0	6.4	0.0	8.5
0.0	2.7	0.0	4.0	0.0	11.6
0.0	5.8	1.5	4.9	0.6	1.8
0.0	2.1	0.0	5.2	0.0	7.6
0.0	2.4	0.0	3.7	0.0	4.9
0.0	1.8	0.0	2.7	0.0	6.7
0.0	1.8	0.0	3.0	0.0	3.7
0.0	1.8	0.0	4.6	1.5	4.6
0.0	0.6	0.0	3.4	0.0	4.3
0.0	2.4	0.0	4.0	0.0	5.5
0.3	0.3	0.0	5.8	0.0	4.0
0.0	1.2	0.0	10.4	0.0	7.6
1.5	1.5	0.0	6.4	0.0	7.0
0.3	6.7	0.0	4.6	0.0	4.9
0.0	2.7	0.0	4.0	1.5	6.1
0.9	0.9	0.0	5.2	1.2	9.8
0.0	2.7	0.0	5.5	0.0	10.4
0.3	3.4	0.9	3.7	0.0	10.1
0.0	4.9	1.2	2.7	0.0	8.8
0.0	0.6	0.9	5.5	0.0	2.7
0.0	3.7	1.2	2.1	0.0	8.2
0.0	1.5	1.2	4.3	0.0	7.3
0.0	4.3	1.8	4.9	0.0	5.2
0.3	0.6	0.0	3.4	0.0	6.1
0.6	0.9	0.0	3.7	0.0	5.5
0.0	0.3				
0.0	1.8				
0.0	2.1				
0.0	0.0				
0.6	2.1				
0.0	1.8				
0.0	2.1				
0.0	2.4				
0.0	2.7				
0.3	0.6				
0.0	0.9				
0.0	2.1				
0.0	4.9				
0.0	1.5				
0.3	0.9				
0.3	4.0				
0.0	0.9				
0.0	2.1				
0.3	0.3				
0.0	1.8				
1.2	1.5				
0.0	1.2				
0.0	0.6				
0.9	0.9				
0.6	2.7				

Field Data for 1V:1H Slopes

24.4 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	4.9	0.9	4.9	0.0	10.1
0.9	0.9	0.0	10.1	0.0	5.5
0.0	3.7	0.0	5.5	0.0	9.8
0.0	3.4	0.9	6.7	0.0	3.4
0.3	1.5	1.5	2.7	0.0	15.2
0.0	2.4	0.9	10.4	0.0	9.8
0.0	6.7	0.9	6.4	0.0	13.7
0.9	1.2	0.0	5.5	0.0	7.0
0.0	4.3	0.0	6.7	0.0	6.1
0.6	1.2	0.0	5.2	0.0	15.2
0.0	1.2	0.0	9.1	0.0	11.3
0.0	5.2	0.0	9.8	0.0	11.6
1.2	4.6	0.0	7.0	0.0	5.8
0.0	1.2	0.0	8.5	0.0	7.3
1.2	1.5	0.9	2.4	0.0	4.0
0.0	5.5	0.0	7.9	0.0	9.1
0.0	4.0	1.2	4.0	0.9	10.4
0.0	3.7	0.0	5.8	1.8	4.6
0.0	5.2	0.0	5.2	0.0	12.8
0.9	5.5	1.2	7.0	0.0	12.8
0.0	7.6	0.0	9.4	0.6	10.7
0.0	5.8	0.0	9.1	0.0	13.7
1.5	1.8	0.9	7.6	0.9	5.5
0.0	11.9	0.0	5.2	0.9	5.2
0.0	0.0	0.0	4.6	0.6	7.0
0.3	1.5	0.0	7.3	0.0	3.7
0.0	4.3	2.1	3.4	0.0	15.8
0.0	9.1	0.0	3.4	0.0	8.5
1.2	1.8	1.5	6.4	0.0	4.0
0.9	2.7	0.0	4.6	1.2	2.7
1.5	1.5	0.0	11.0	0.0	4.9
0.9	6.4	0.0	3.7	0.0	7.0
0.9	4.0	0.0	5.5	0.0	10.7
0.0	3.0	0.0	4.9	1.5	6.1
0.0	8.5	0.0	5.2	0.0	17.7
0.3	0.9	1.5	5.2	0.0	7.3
0.0	4.9	3.7	4.3	0.0	2.4
0.0	4.3	0.9	8.2	0.0	5.5
0.0	4.0	0.0	3.4	0.0	7.9
0.0	4.6	0.0	8.5	0.0	11.0
0.0	6.7	0.0	3.7	0.0	6.4
0.0	11.3	0.0	11.3	0.0	4.9
1.2	4.9	1.2	4.9	0.0	9.4
0.9	3.0	0.9	4.6	0.0	11.3
0.0	12.8	0.0	5.2	0.0	11.6
0.0	4.0	0.0	10.1	0.0	14.9
0.0	4.6	0.0	7.0	0.0	12.8
0.0	2.4	1.5	4.3	0.0	10.1
2.1	3.0	0.0	7.6	1.2	7.0
0.0	2.7	1.2	5.5	0.0	10.7

24.4 Meter Slope with a 1V:6H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	8.5	0.0	5.8	0.0	11.9
0.0	2.4	0.9	2.7	1.2	7.3
0.0	4.3	0.6	4.3	0.0	7.9
0.0	2.1	0.0	5.8	0.0	8.5
0.0	0.0	1.2	2.4	0.9	5.2
0.0	1.2	1.2	1.8	0.0	9.4
0.0	1.5	0.0	4.6	0.0	6.1
0.0	4.6	1.5	3.4	0.9	12.2
0.0	4.9	0.0	7.0	1.2	9.1
0.6	0.9	2.1	6.7	0.6	9.8
0.6	2.1	0.0	4.9	0.0	4.3
0.0	3.4	0.0	4.6	1.2	5.2
0.9	1.5	0.0	6.7	1.2	1.2
1.8	3.0	0.0	4.3	2.4	6.7
0.0	2.1	0.0	2.7	0.0	6.7
0.0	0.0	0.0	4.3	1.2	4.0
0.9	0.9	0.0	5.5	0.9	7.3
0.9	2.4	1.5	3.0	0.0	8.2
0.0	0.9	1.5	5.8	0.0	11.6
0.0	6.7	0.0	5.5	0.0	9.8
0.0	1.5	0.0	7.3	0.0	5.8
0.3	1.2	0.0	4.0	2.4	2.4
0.0	3.0	0.0	4.9	0.0	12.2
0.3	1.5	0.0	1.5	0.0	6.4
0.0	5.5	0.0	10.7	0.0	10.7
0.0	7.9				
0.0	5.8				
0.0	3.7				
0.0	4.6				
1.2	1.5				
1.5	4.6				
0.0	4.9				
0.6	0.9				
1.2	3.4				
0.0	5.8				
0.0	5.2				
0.0	4.3				
0.9	2.7				
0.0	2.4				
0.0	0.9				
0.9	1.2				
0.0	2.4				
0.0	2.7				
0.0	5.8				
0.0	1.8				
0.0	4.6				
0.0	1.2				
0.3	0.6				
0.0	4.0				
1.2	3.7				

Field Data for 1V:1H Slopes

24.4 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	1.2	0.0	6.7	0.0	13.1
0.0	10.1	0.0	7.9	1.2	21.0
0.0	15.8	0.0	7.6	0.0	24.4
0.0	4.0	0.0	14.0	0.0	20.7
0.0	12.2	0.0	12.8	0.0	12.5
0.0	4.3	0.0	11.6	1.5	21.3
0.0	8.8	0.0	8.5	1.5	18.9
0.0	3.7	0.0	7.6	0.0	23.2
1.2	9.8	0.0	11.3	0.0	14.9
0.0	3.7	0.0	9.1	1.2	10.1
1.5	5.2	0.0	11.9	0.0	7.3
0.9	3.7	0.0	15.5	0.0	11.6
0.0	1.8	0.0	17.4	0.0	10.1
1.2	10.7	0.0	13.4	0.0	8.5
0.9	7.9	0.0	9.4	0.0	15.2
1.5	8.5	0.0	10.1	0.0	17.4
1.5	8.5	0.0	9.8	0.0	24.4
0.6	10.4	0.0	9.4	0.0	16.2
0.6	4.6	0.0	14.6	0.0	17.4
0.9	12.8	0.0	14.0	0.0	13.1
0.0	2.4	0.0	6.1	0.0	13.4
0.0	4.9	0.9	10.7	1.8	7.0
0.0	2.4	0.0	9.8	1.8	9.4
0.0	10.7	0.0	14.9	0.0	9.1
0.3	1.2	0.0	7.0	0.0	14.3
0.0	4.9	0.0	10.1	0.0	24.4
0.6	4.0	0.0	11.3	0.0	11.6
0.0	4.3	0.0	13.4	0.0	12.8
0.0	10.1	0.0	8.5	0.0	9.8
1.5	9.8	0.0	8.8	2.4	15.8
0.0	10.1	0.0	11.9	0.0	9.4
0.0	5.5	0.0	9.8	0.0	24.4
1.5	10.1	0.0	11.3	0.0	23.8
0.0	10.1	0.6	8.8	0.0	24.4
0.9	9.1	0.0	11.0	0.0	21.3
1.2	16.5	0.0	15.5	0.0	11.6
0.0	8.2	1.5	14.9	0.0	13.4
0.0	9.8	1.5	7.9	0.0	20.1
0.9	8.5	2.4	7.3	0.0	24.4
0.0	2.4	0.0	3.7	0.0	8.8
1.2	9.4	0.0	9.8	0.0	11.0
0.0	10.4	1.5	1.5	0.0	15.8
1.2	3.0	0.0	10.7	0.0	17.1
0.0	3.0	0.0	8.8	0.0	22.9
0.0	11.6	0.0	4.0	1.8	9.4
0.0	4.3	0.0	7.6	1.5	9.1
0.0	12.2	0.0	9.1	1.5	12.2
2.1	8.5	0.0	15.2	0.0	6.7
1.2	9.4	0.0	2.4	0.0	13.4
0.9	6.1	0.0	15.5	0.0	11.0

24.4 Meter Slope with a Flat Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
1.8	10.4	0.0	7.0	0.0	12.2
0.0	10.1	0.0	5.8	0.0	10.7
1.5	13.7	0.0	3.4	0.0	7.6
0.0	9.8	0.0	17.7	0.0	4.9
0.0	4.3	0.0	6.7	0.0	8.5
0.0	13.1	0.0	14.3	0.0	6.4
0.0	11.3	0.0	10.4	0.0	11.9
0.0	10.1	0.0	11.9	0.0	18.3
0.0	15.2	0.0	13.4	1.5	11.6
0.0	14.0	0.0	11.3	1.5	11.3
0.0	11.3	0.0	8.2	0.0	19.2
0.3	9.8	0.0	11.6	0.0	17.7
0.0	8.2	0.0	19.5	0.0	21.9
3.4	6.7	0.0	9.1	0.0	24.4
0.0	6.4	0.0	9.4	0.0	24.4
1.8	7.3	0.0	4.6	0.0	17.7
0.0	12.8	0.0	6.4	0.0	23.8
0.0	1.5	0.0	2.4	0.0	24.4
0.0	4.9	0.0	0.6	0.0	23.8
0.9	4.6	0.0	10.4	0.0	5.5
0.0	5.8	0.0	16.8	0.0	14.6
1.2	11.9	0.0	10.4	0.0	16.8
1.2	5.2	0.0	10.7	0.0	21.9
0.9	2.4	0.0	4.3	0.0	24.4
0.0	5.2	0.0	15.2	0.0	18.3
0.0	3.0				
0.9	3.0				
0.0	12.5				
1.5	4.3				
0.0	8.2				
0.0	3.0				
0.0	9.4				
0.0	8.5				
1.2	3.4				
1.2	2.4				
0.6	4.3				
0.0	6.1				
0.0	2.4				
0.0	9.8				
0.0	4.3				
0.0	3.4				
0.0	4.6				
0.0	9.4				
0.0	11.9				
0.0	8.5				
0.0	6.4				
0.0	2.7				
0.0	5.5				
0.9	12.5				
0.0	6.7				

Field Data for 1V:1.25H Slopes

12.2 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	1.5	0.0	3.7	0.9	1.5
0.0	2.1	0.0	2.4	0.0	2.4
0.0	2.4	0.0	4.6	0.9	2.1
0.0	2.1	0.0	4.6	0.0	3.0
0.0	1.8	0.0	4.0	0.0	0.0
0.0	0.0	0.0	3.7	0.0	1.2
0.0	1.2	0.0	1.8	1.8	2.4
0.0	2.1	1.2	1.8	0.0	2.4
0.0	0.9	0.0	4.3	0.0	2.7
0.0	2.1	0.0	3.7	0.0	1.5
0.0	1.2	0.0	2.4	0.0	1.2
0.0	0.0	0.0	2.1	0.0	3.4
0.0	1.5	0.0	2.7	0.0	4.3
0.0	0.0	0.0	2.1	0.0	4.0
0.0	1.8	0.0	1.5	0.0	1.8
0.0	1.5	1.2	3.0	0.0	4.9
0.0	0.0	1.2	3.0	0.0	4.3
0.0	0.0	0.9	1.8	0.0	5.2
0.0	1.2	0.0	2.4	0.0	4.0
0.0	2.4	0.0	2.1	0.0	4.3
0.0	1.8	0.0	3.7	0.0	3.0
0.0	1.2	0.0	2.7	0.0	1.8
0.0	2.1	0.0	2.1	0.0	4.9
0.0	0.0	0.0	3.4	0.0	2.4
0.0	2.4	0.0	3.7	0.0	0.0
0.1	2.1	0.0	1.8	0.0	3.0
0.0	1.8	0.0	3.0	0.0	1.2
0.0	2.4	0.9	0.9	0.0	1.2
0.0	1.8	0.6	1.2	0.0	1.8
0.1	1.5	0.0	1.8	0.0	1.5
0.0	0.9	0.0	2.4	0.0	1.5
0.0	2.1	0.0	3.7	0.0	6.7
0.0	0.0	0.0	4.6	0.0	4.6
0.0	1.8	0.0	3.7	0.0	3.0
0.0	1.5	0.0	4.0	0.0	5.5
0.0	0.6	0.0	1.8	0.0	4.0
0.0	2.1	0.0	2.7	0.0	3.4
0.1	1.8	0.0	1.8	0.0	4.9
0.0	1.2	0.0	2.1	0.0	4.0
0.0	0.9	0.0	1.8	0.0	3.7
0.0	0.0	0.0	0.0	0.0	2.7
0.0	0.9	0.0	4.3	0.0	2.7
0.0	0.3	0.0	2.4	0.0	3.4
0.0	1.5	0.0	2.1	0.0	2.1
0.0	1.2	0.0	3.0	0.0	3.4
0.0	1.8	0.0	2.7	0.0	2.1
0.0	1.5	0.0	2.4	0.0	3.7
0.0	2.1	0.0	4.0	0.0	2.4
0.0	1.8	0.0	1.2	0.0	4.3
0.0	1.5	0.0	3.7	0.0	4.0
0.0	0.0	0.0	4.0	0.0	3.7

12.2 Meter Slope with a 1V:4H Catchment Area					
0.3 meter		0.6 meter		0.9 meter	
Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)	Impact (m)	Roll Out (m)
0.0	1.8	0.0	4.6	0.0	5.2
0.0	1.5	0.0	1.8	0.0	4.6
0.0	1.5	0.0	3.7	0.0	3.4
0.0	1.2	0.0	4.3	0.0	0.0
0.0	2.7	0.0	4.3	0.0	3.0
0.0	1.5	0.0	4.0	0.0	4.3
0.0	1.2	0.0	0.9	0.0	2.4
0.0	1.2	0.0	2.7	0.0	4.9
0.0	1.5	0.0	3.7	0.0	3.7
0.0	2.4	0.0	1.5	0.0	4.0
0.0	2.1	0.0	2.7	0.0	4.3
0.0	2.4	0.0	3.7	0.0	2.7
0.0	0.9	0.0	0.0	0.0	3.4
0.0	1.5	0.0	3.7	0.0	2.4
0.0	2.1	0.0	5.5	0.0	1.2
0.0	0.9	0.0	3.7	0.0	3.4
0.0	2.1	0.0	2.4	0.0	2.7
0.0	1.8	0.0	3.4	0.0	4.9
0.0	0.0	0.0	3.4	0.0	6.1
0.0	0.9	0.0	2.7	0.0	1.8
0.0	1.5	0.0	1.2	0.0	2.4
0.0	1.2	0.0	4.3	0.0	1.2
0.0	0.0			0.0	1.8
0.0	1.8			0.0	1.2
0.0	1.2				
0.0	2.4				
0.0	0.6				
0.0	2.1				
0.0	0.9				
0.0	2.7				
0.0	1.8				
0.0	2.1				
0.0	1.5				
0.0	1.8				
0.0	1.2				
0.0	1.2				
0.0	2.4				
0.1	0.6				
0.0	1.5				
0.0	2.7				
0.0	2.4				
0.0	1.8				
0.0	2.7				
0.0	2.1				
0.0	0.9				
0.0	1.8				
0.0	0.9				
0.0	0.0				
0.0	0.9				
0.0	1.5				

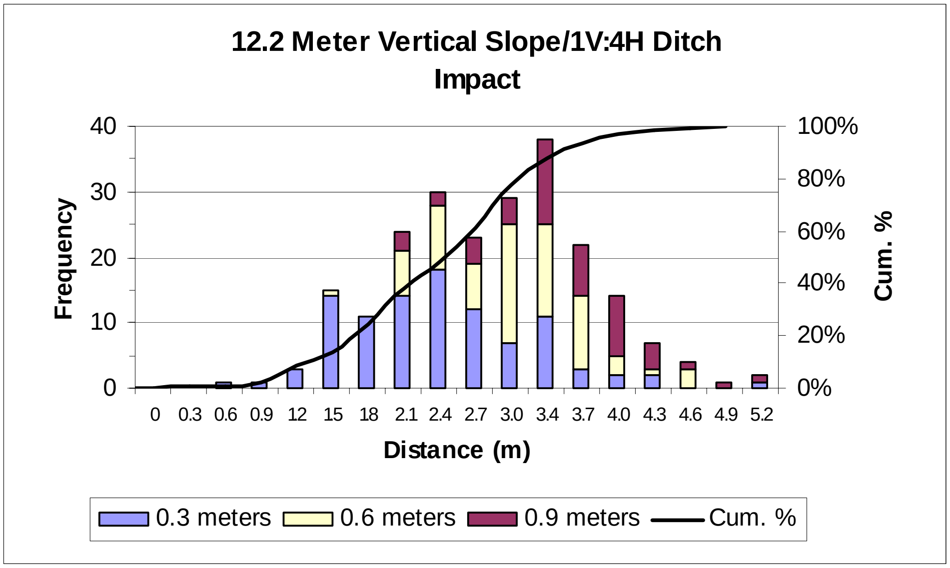
Note: This was the only 1V:1.25H slope tested. Insufficient funds were available to test additional slopes.

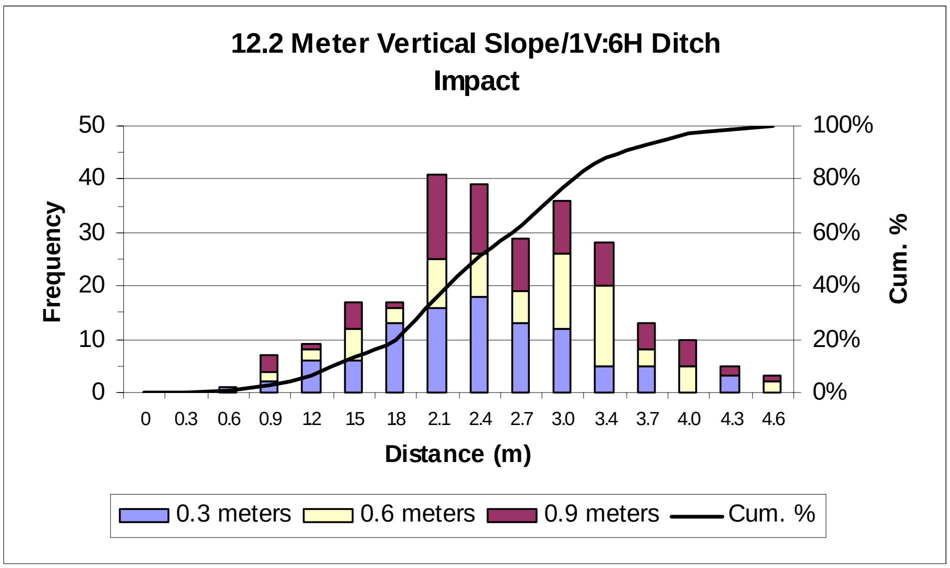
APPENDIX C: ROCKFALL IMPACT DISTANCE HISTOGRAMS

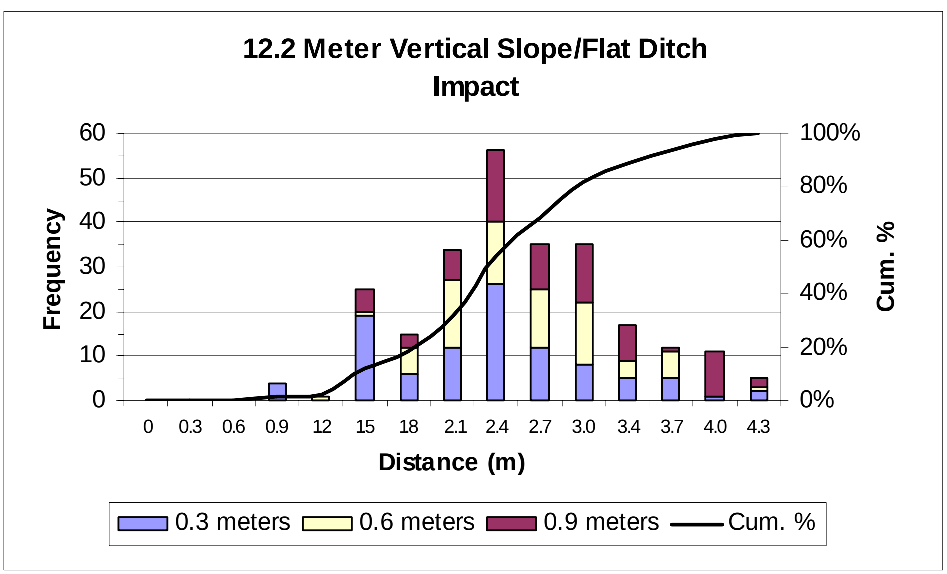
ROCKFALL IMPACT DISTANCE HISTOGRAMS

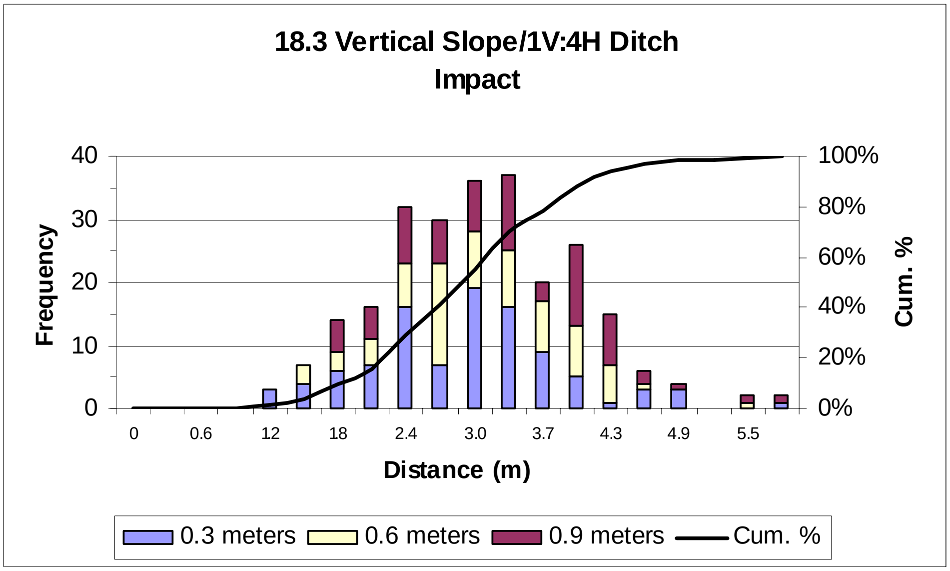
Impact histograms show the tabulated rockfall impact data from Appendix B in a graphical manner. The frequency bars show the relative number of 0.3-meter, 0.6-meter, and 0.9-meter rocks that comprise them. The histograms include a cumulative frequency line. This line provides a quick reference for determining the percentage of rocks rolled that landed within a specific width. On steep slopes the rocks rarely impacted (first contacted the catchment area) near the toe of the slope. Conversely, rockfalls on the flatter slopes commonly entered the catchment area in a rolling manner, resulting in many recorded <u>impact</u> distances of zero meters. The impact distances are the field measured slope distances. Field data was recorded to the nearest foot (0.3 meters).

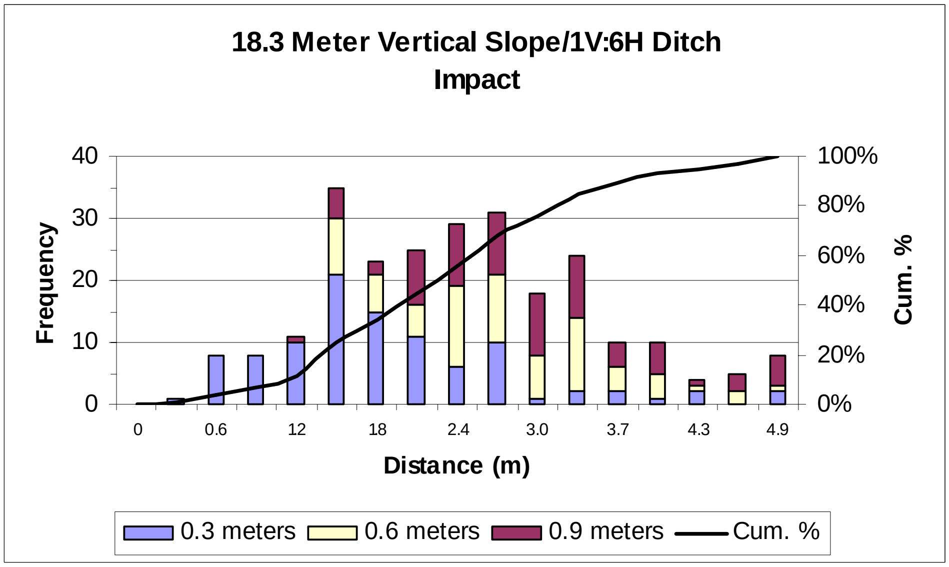
NOTE: Also included at the end of Appendix C is a limited set of data gathered from a 12.2-meter high, 1V:1.25H slope. The rocks rolled from this slope fell into a 1V:4H catchment area. The results were recorded but not compiled into catchment area percent retention graphs or design charts, because there were not sufficient funds to test the full suite of slope heights and catchment area inclinations for the 1V:1.25H test slope.

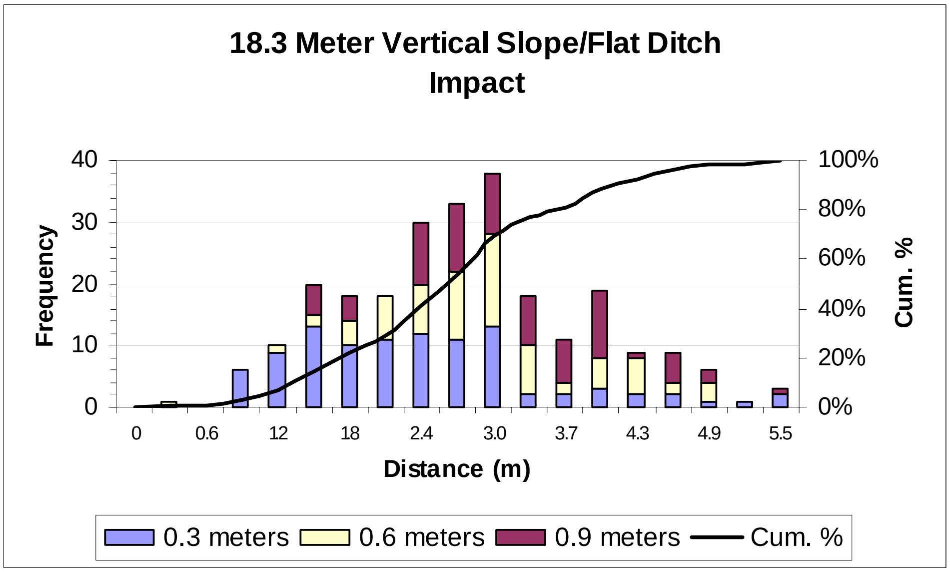

12.2 Meter Vertical Slope/1V:4H Ditch
Impact
Frequency
Cum. %
40
30
20
10
0
100%
80%
60%
40%
20%
0%
0 0.3 0.6 0.9 12 15 18 2.1 2.4 2.7 3.0 3.4 3.7 4.0 4.3 4.6 4.9 5.2
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

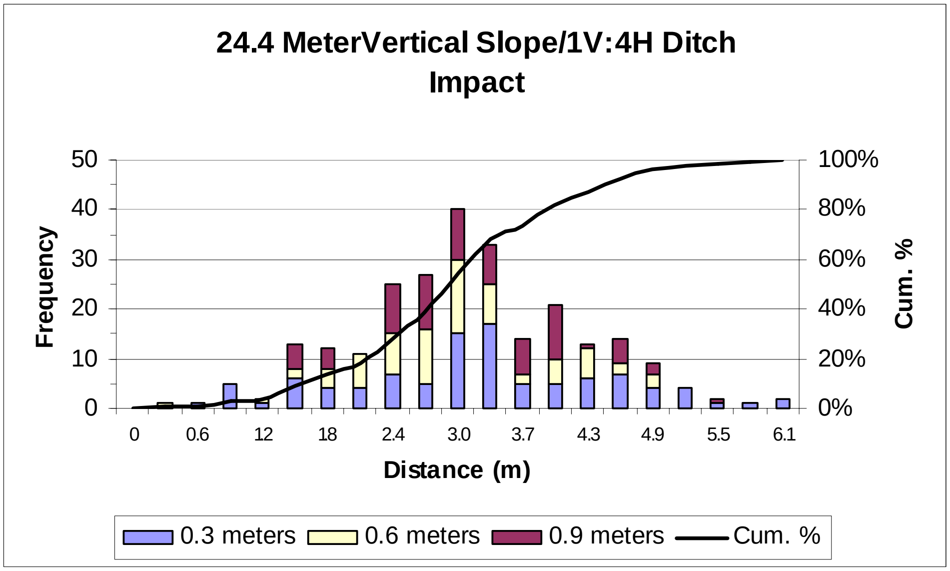

12.2 Meter Vertical Slope/1V:6H Ditch
Impact
Frequency
Cum. %
50
40
30
20
10
0
100%
80%
60%
40%
20%
0%
0 0.3 0.6 0.9 12 15 18 2.1 2.4 2.7 3.0 3.4 3.7 4.0 4.3 4.6
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

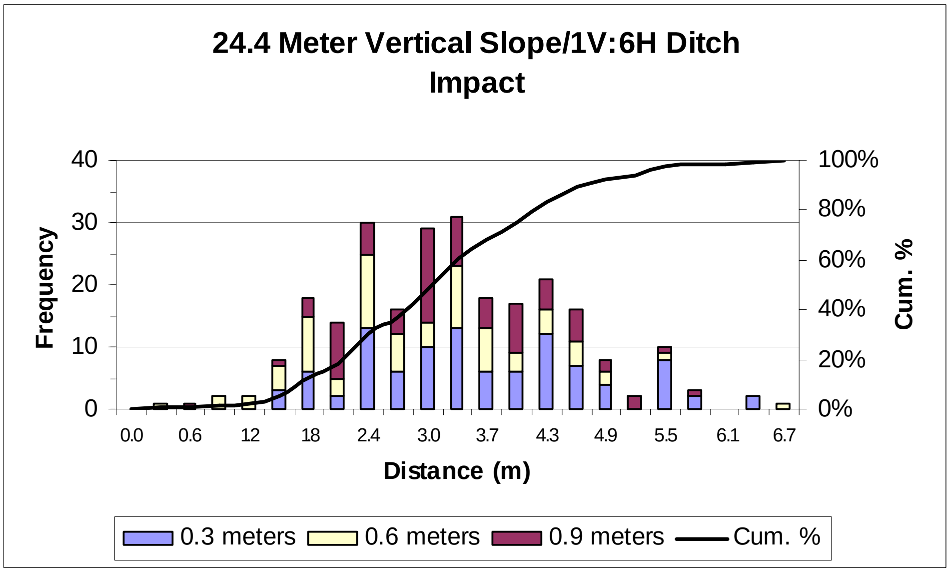

12.2 Meter Vertical Slope/Flat Ditch
Impact
Frequency
Cum. %
60
50
40
30
20
10
0
100%
80%
60%
40%
20%
0%
0 0.3 0.6 0.9 12 15 18 2.1 2.4 2.7 3.0 3.4 3.7 4.0 4.3
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

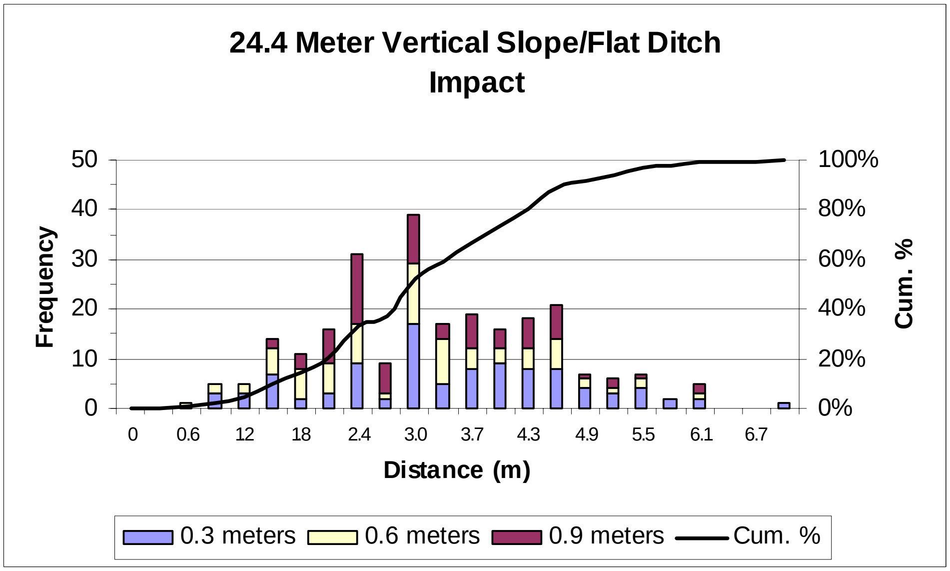

18.3 Vertical Slope/1V:4H Ditch
Impact
Frequency
Cum. %
Distance (m)
0
0.6
12
18
2.4
3.0
3.7
4.3
4.9
5.5
0
10
20
30
40
0%
20%
40%
60%
80%
100%
0.3 meters
0.6 meters
0.9 meters
Cum. %

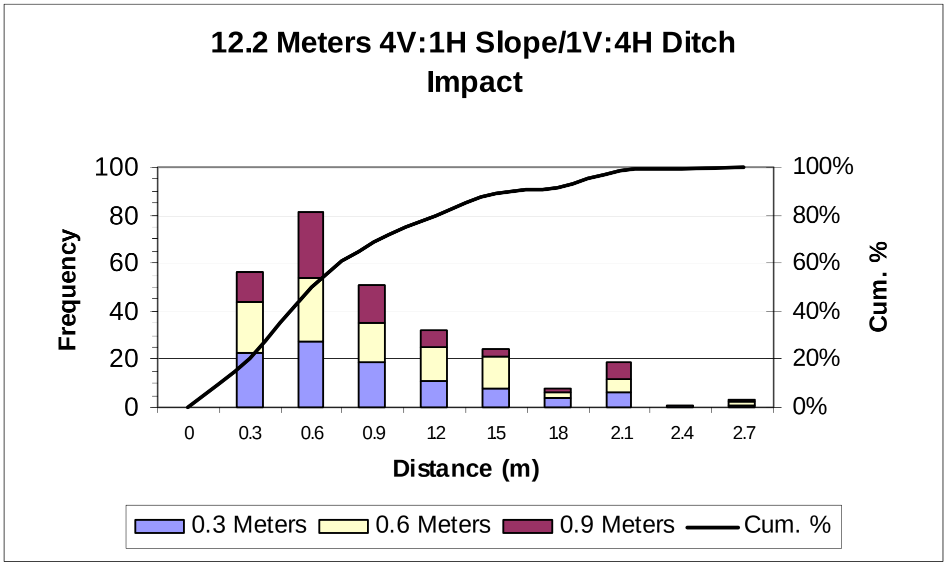

18.3 Meter Vertical Slope/1V:6H Ditch
Impact
Frequency
Cum. %
Distance (m)
0
0.6
12
18
2.4
3.0
3.7
4.3
4.9
0
10
20
30
40
0%
20%
40%
60%
80%
100%
0.3 meters
0.6 meters
0.9 meters
Cum. %

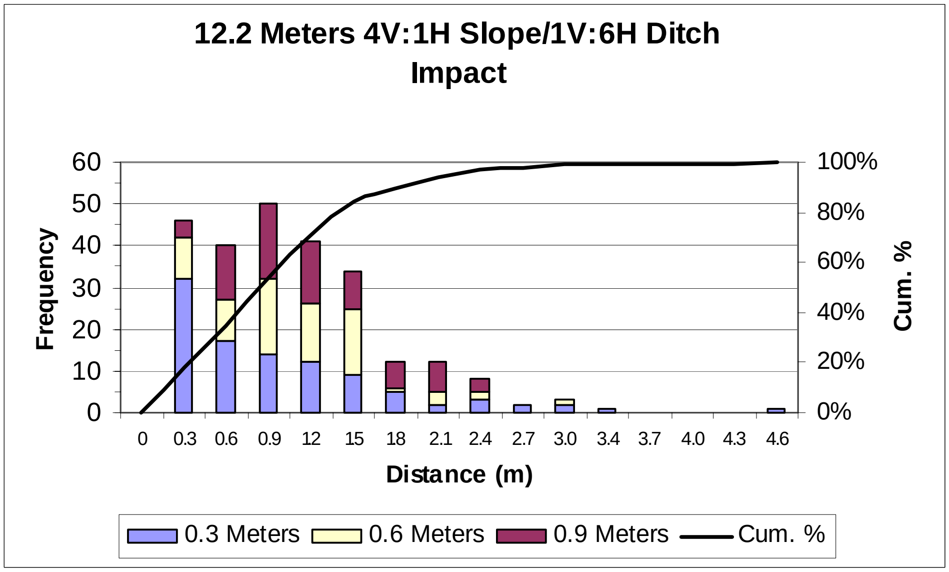

18.3 Meter Vertical Slope/Flat Ditch
Impact
Frequency
Cum. %
Distance (m)
0
0.6
12
18
2.4
3.0
3.7
4.3
4.9
5.5
0
10
20
30
40
0%
20%
40%
60%
80%
100%
0.3 meters
0.6 meters
0.9 meters
Cum. %

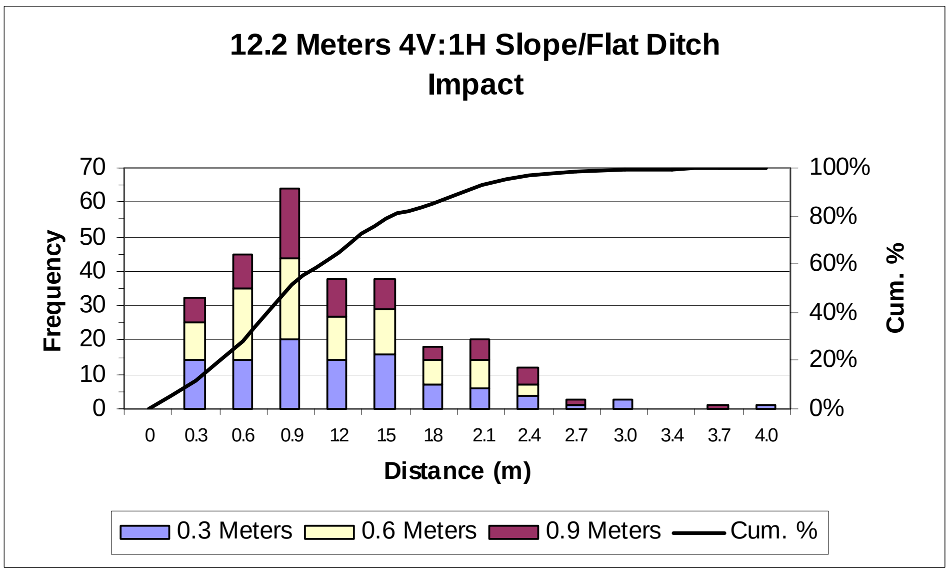

24.4 MeterVertical Slope/1V:4H Ditch
Impact
Frequency
Cum. %
50
40
30
20
10
0
100%
80%
60%
40%
20%
0%
0
0.6
12
18
2.4
3.0
3.7
4.3
4.9
5.5
6.1
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

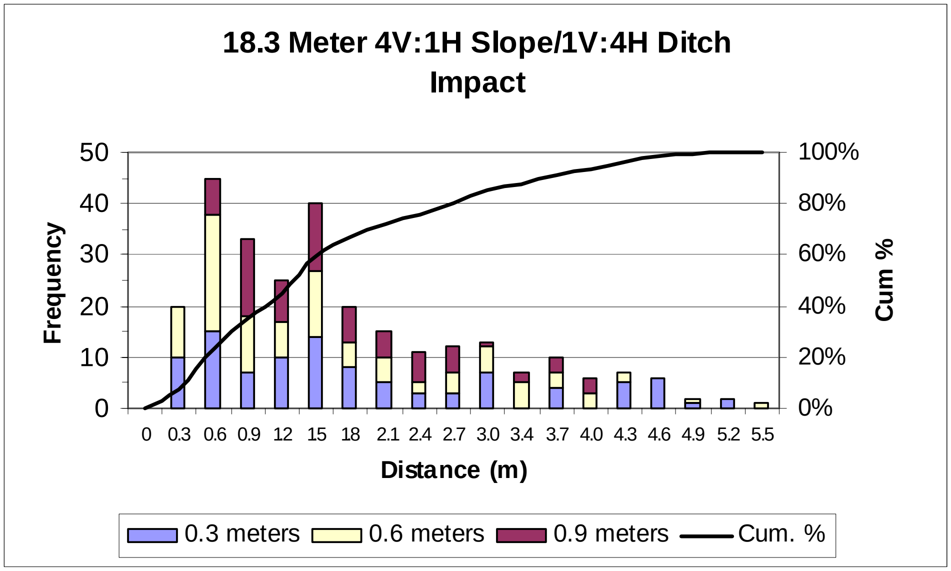

24.4 Meter Vertical Slope/1V:6H Ditch
Impact
Frequency
Cum. %
40
30
20
10
0
100%
80%
60%
40%
20%
0%
0.0
0.6
12
18
2.4
3.0
3.7
4.3
4.9
5.5
6.1
6.7
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

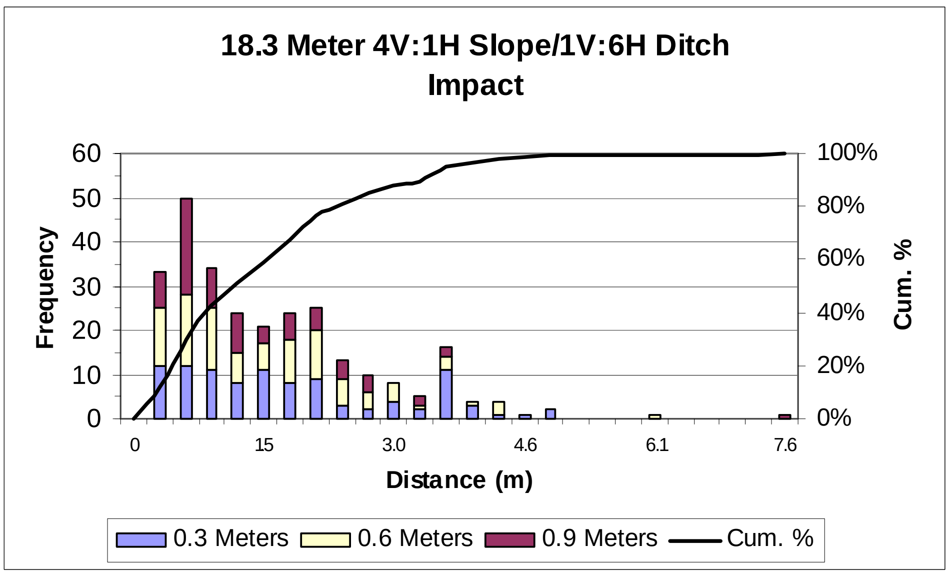

24.4 Meter Vertical Slope/Flat Ditch
Impact
Frequency
Cum. %
50
40
30
20
10
0
100%
80%
60%
40%
20%
0%
0
0.6
12
18
2.4
3.0
3.7
4.3
4.9
5.5
6.1
6.7
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

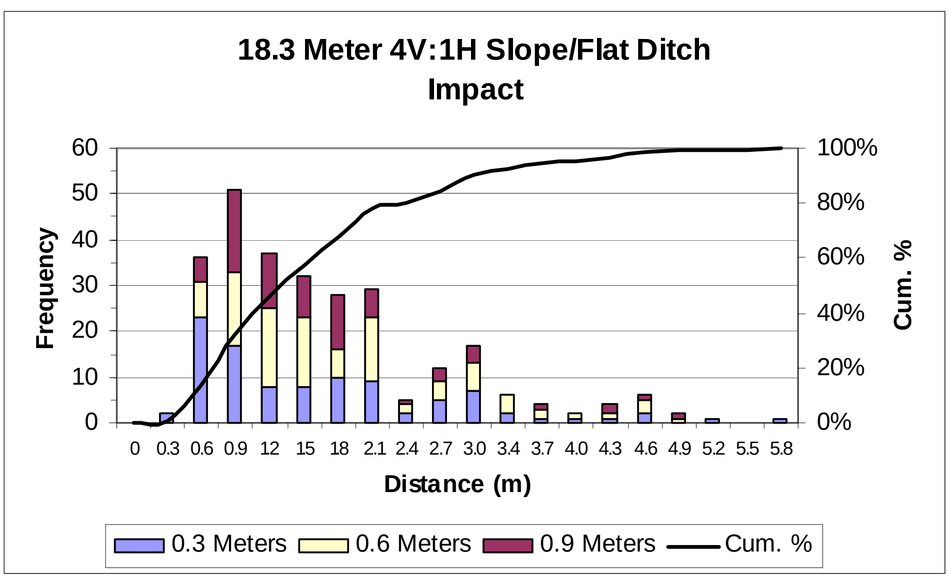

12.2 Meters 4V:1H Slope/1V:4H Ditch
Impact
Frequency
Cum. %
Distance (m)
0.3 Meters
0.6 Meters
0.9 Meters
Cum. %

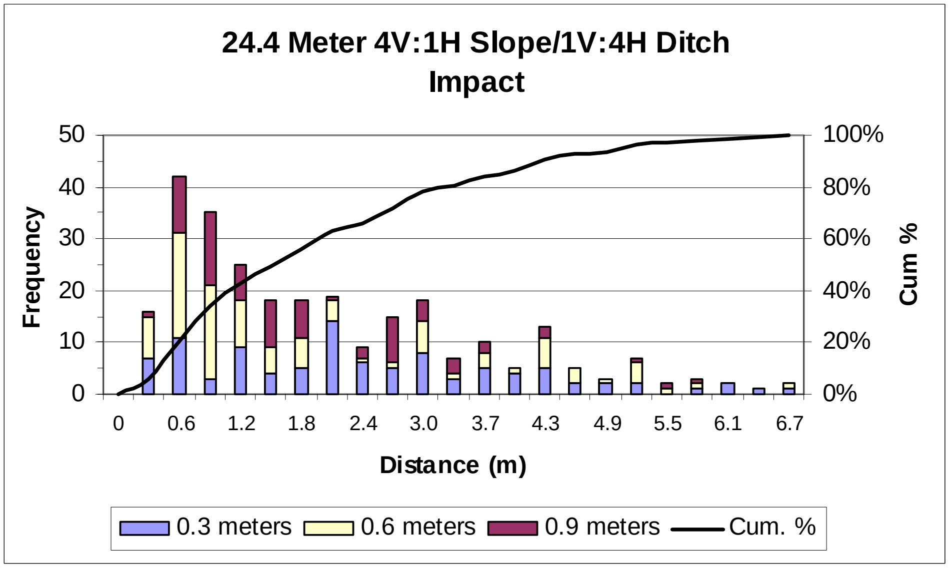

12.2 Meters 4V:1H Slope/1V:6H Ditch
Impact
Frequency
Cum. %
Distance (m)
0.3 Meters
0.6 Meters
0.9 Meters
Cum. %


12.2 Meters 4V:1H Slope/Flat Ditch
Impact
Frequency
Cum. %
Distance (m)
0.3 Meters
0.6 Meters
0.9 Meters
Cum. %

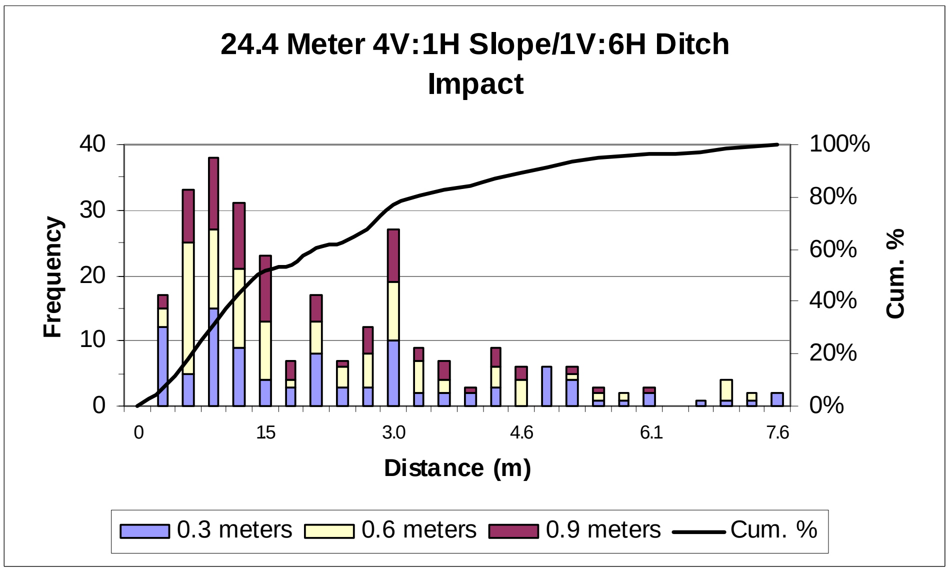

18.3 Meter 4V:1H Slope/1V:4H Ditch
Impact
Frequency
Cum %
Distance (m)
0 0.3 0.6 0.9 12 15 18 2.1 2.4 2.7 3.0 3.4 3.7 4.0 4.3 4.6 4.9 5.2 5.5
0.3 meters
0.6 meters
0.9 meters
Cum. %


18.3 Meter 4V:1H Slope/1V:6H Ditch
Impact
Frequency
Cum. %
Distance (m)
0 15 3.0 4.6 6.1 7.6
0.3 Meters
0.6 Meters
0.9 Meters
Cum. %

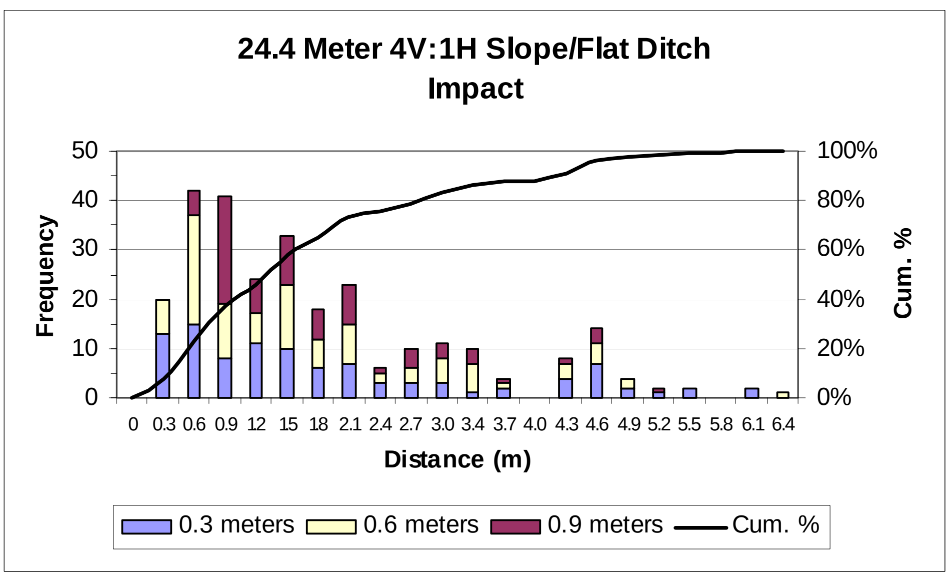

18.3 Meter 4V:1H Slope/Flat Ditch
Impact
Frequency
Cum. %
Distance (m)
0 0.3 0.6 0.9 12 15 18 2.1 2.4 2.7 3.0 3.4 3.7 4.0 4.3 4.6 4.9 5.2 5.5 5.8
0.3 Meters
0.6 Meters
0.9 Meters
Cum. %



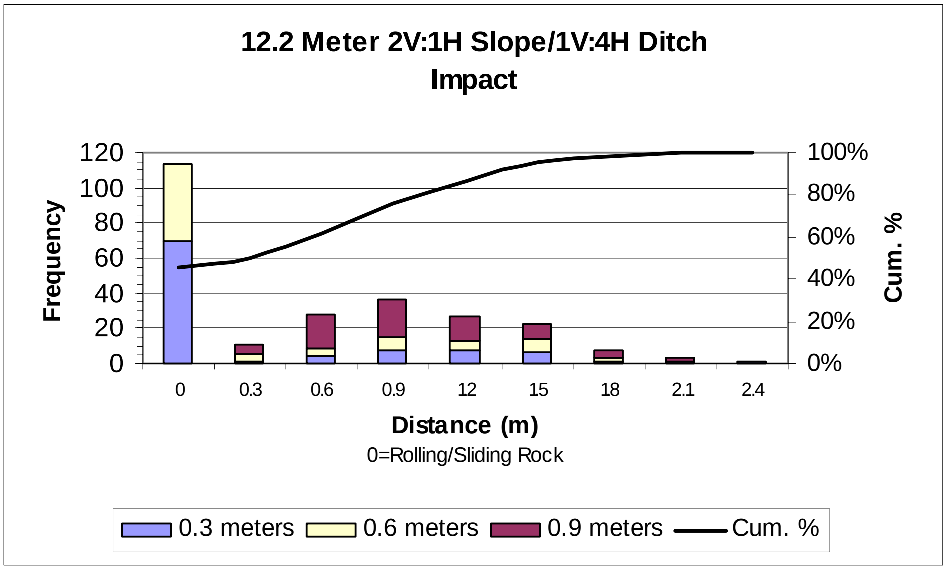
24.4 Meter 4V:1H Slope/1V:4H Ditch
Impact
Frequency
Cum %
0
10
20
30
40
50
0%
20%
40%
60%
80%
100%
0
0.6
1.2
1.8
2.4
3.0
3.7
4.3
4.9
5.5
6.1
6.7
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

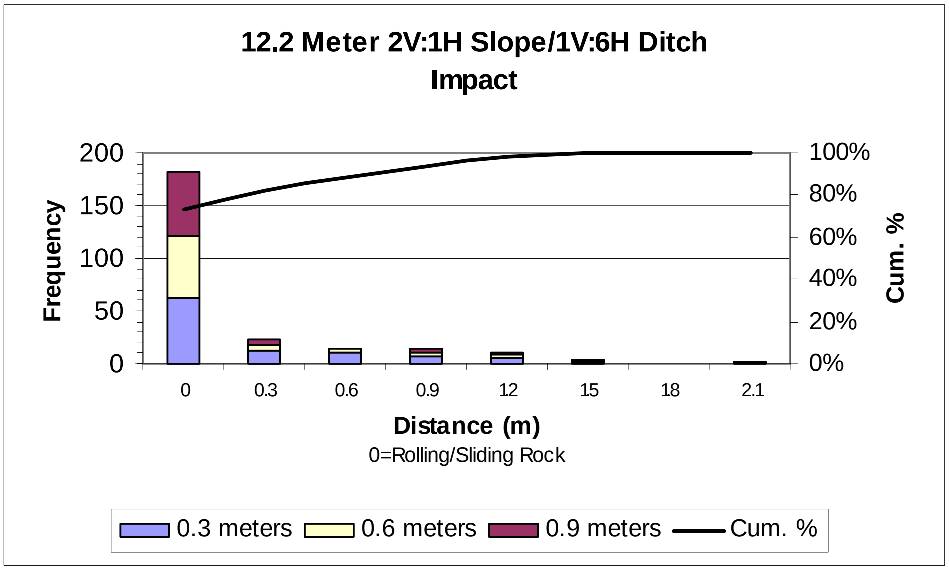


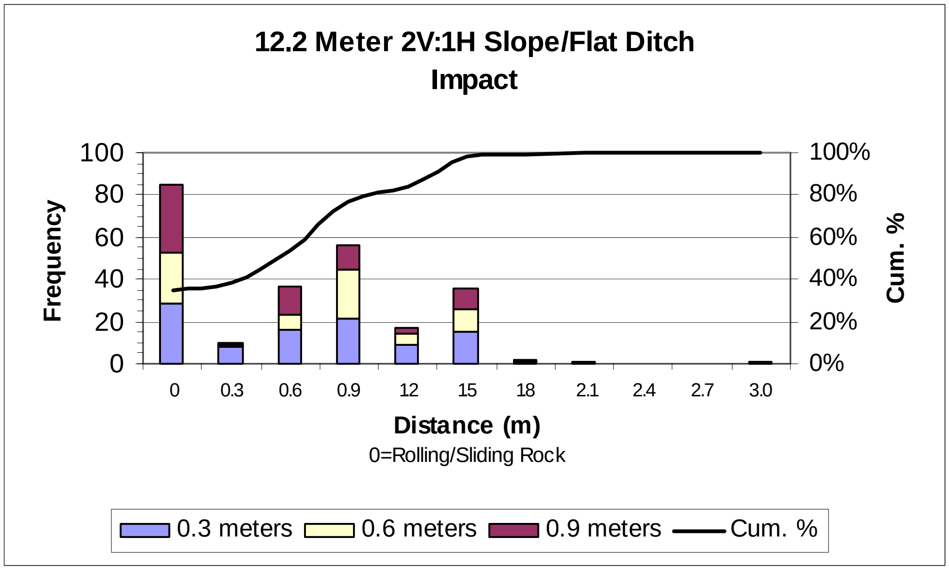
24.4 Meter 4V:1H Slope/1V:6H Ditch
Impact
Frequency
Cum. %
0
10
20
30
40
0%
20%
40%
60%
80%
100%
0
15
3.0
4.6
6.1
7.6
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

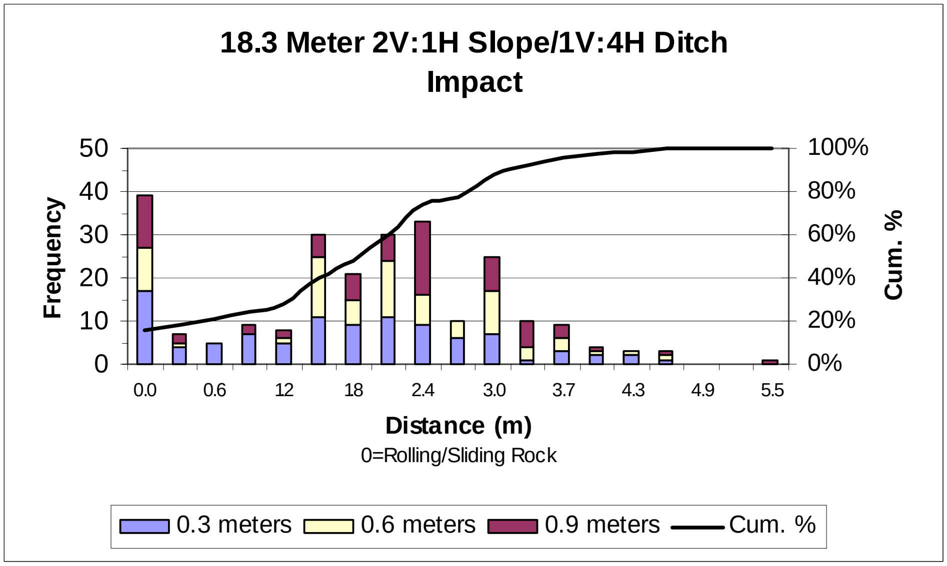


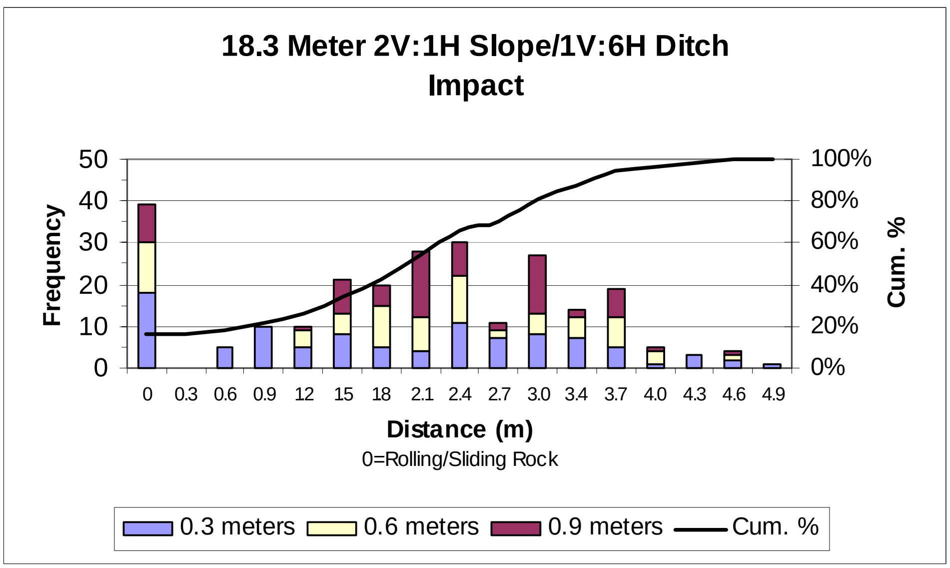
24.4 Meter 4V:1H Slope/Flat Ditch
Impact
Frequency
Cum. %
0
10
20
30
40
50
0%
20%
40%
60%
80%
100%
0
0.3
0.6
0.9
12
15
18
2.1
2.4
2.7
3.0
3.4
3.7
4.0
4.3
4.6
4.9
5.2
5.5
5.8
6.1
6.4
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

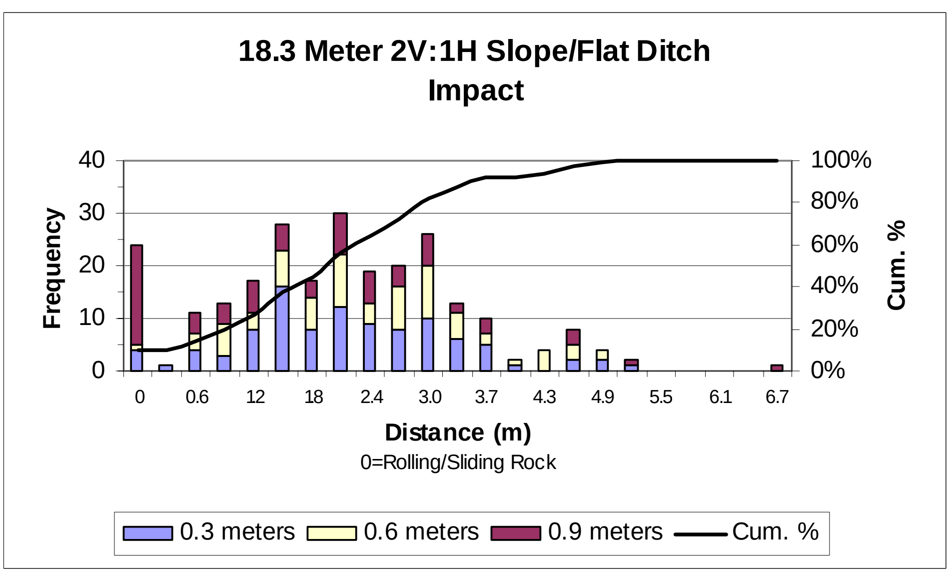

12.2 Meter 2V:1H Slope/1V:4H Ditch
Impact
Frequency
Cum. %
0
20
40
60
80
100
120
0%
20%
40%
60%
80%
100%
0
0.3
0.6
0.9
12
15
18
2.1
2.4
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

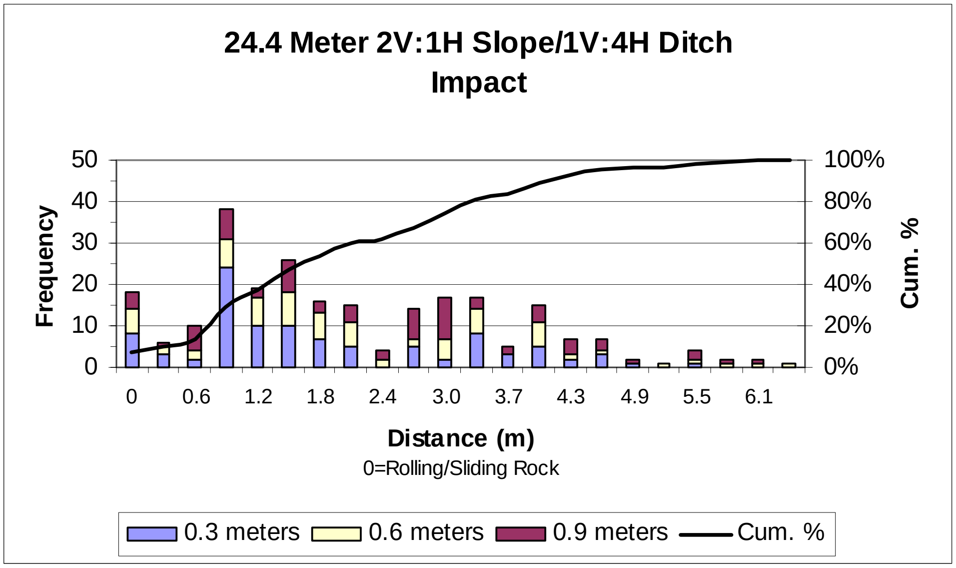

12.2 Meter 2V:1H Slope/1V:6H Ditch
Impact
Frequency
Cum. %
0
50
100
150
200
0%
20%
40%
60%
80%
100%
0
0.3
0.6
0.9
12
15
18
2.1
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

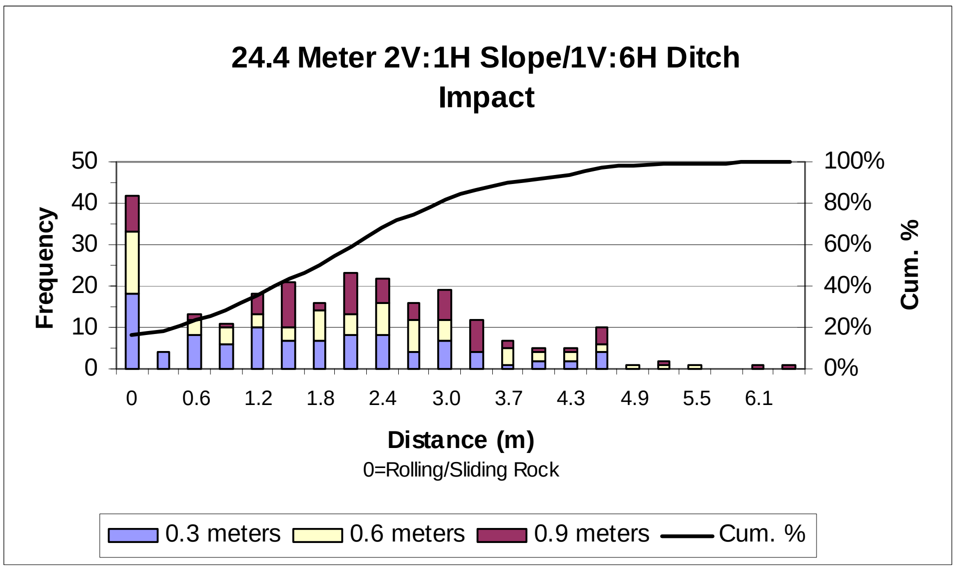

12.2 Meter 2V:1H Slope/Flat Ditch
Impact
Frequency
Cum. %
0
20
40
60
80
100
0%
20%
40%
60%
80%
100%
0
0.3
0.6
0.9
12
15
18
2.1
2.4
2.7
3.0
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

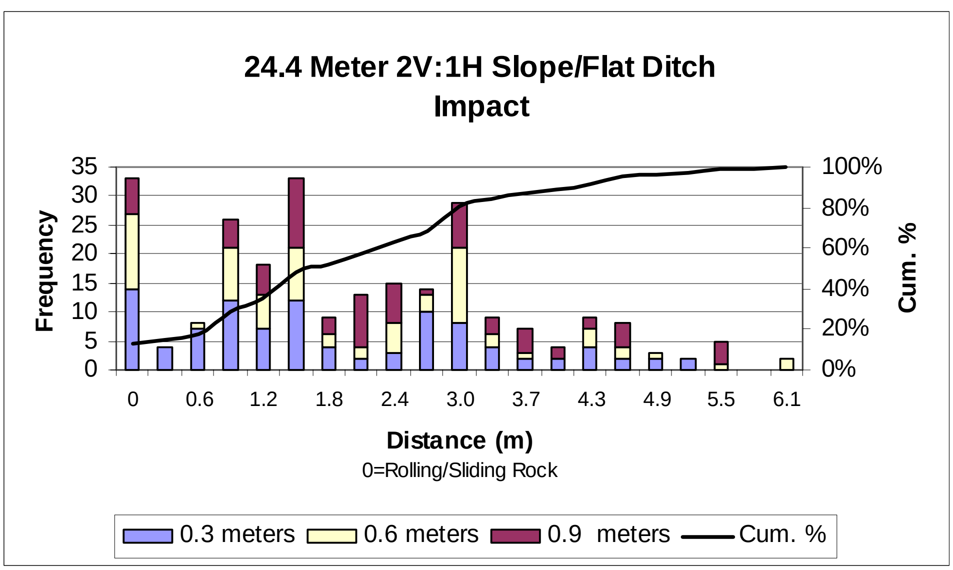

18.3 Meter 2V:1H Slope/1V:4H Ditch
Impact
Frequency
Cum. %
50
40
30
20
10
0
100%
80%
60%
40%
20%
0%
0.0 0.6 12 18 2.4 3.0 3.7 4.3 4.9 5.5
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

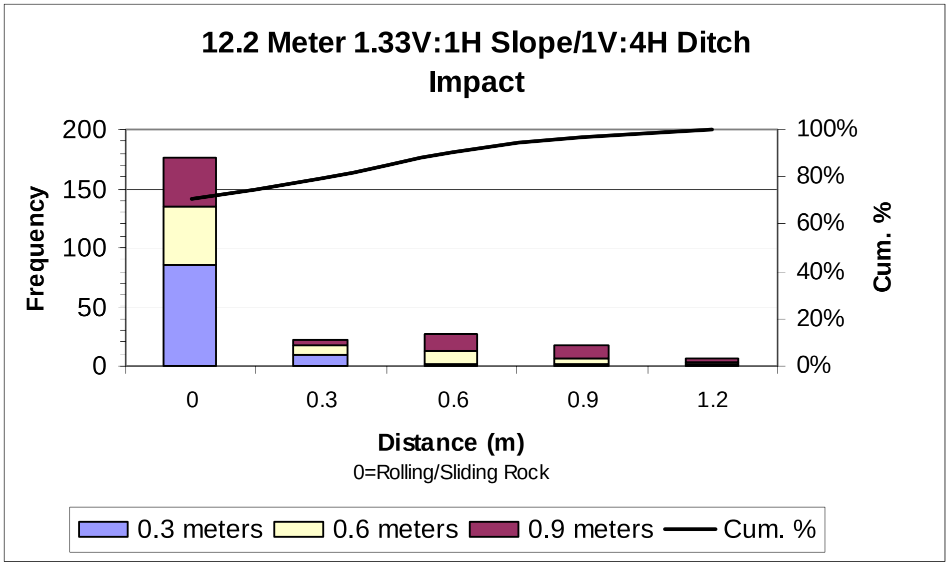

18.3 Meter 2V:1H Slope/1V:6H Ditch
Impact
Frequency
Cum. %
50
40
30
20
10
0
100%
80%
60%
40%
20%
0%
0 0.3 0.6 0.9 12 15 18 2.1 2.4 2.7 3.0 3.4 3.7 4.0 4.3 4.6 4.9
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %


18.3 Meter 2V:1H Slope/Flat Ditch
Impact
Frequency
Cum. %
40
30
20
10
0
100%
80%
60%
40%
20%
0%
0 0.6 12 18 2.4 3.0 3.7 4.3 4.9 5.5 6.1 6.7
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

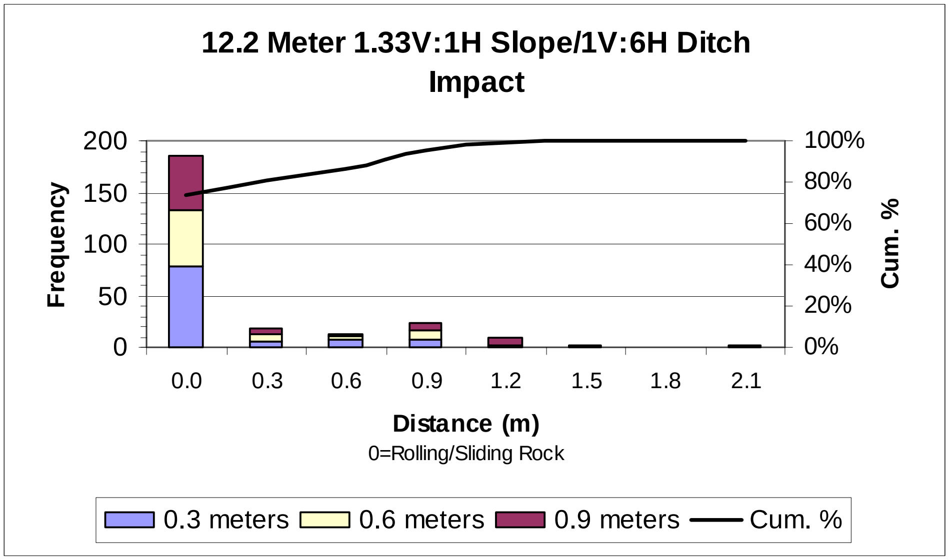

24.4 Meter 2V:1H Slope/1V:4H Ditch
Impact
Frequency
Cum. %
50
40
30
20
10
0
100%
80%
60%
40%
20%
0%
0
0.6
1.2
1.8
2.4
3.0
3.7
4.3
4.9
5.5
6.1
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %


24.4 Meter 2V:1H Slope/1V:6H Ditch
Impact
Frequency
Cum. %
50
40
30
20
10
0
100%
80%
60%
40%
20%
0%
0
0.6
1.2
1.8
2.4
3.0
3.7
4.3
4.9
5.5
6.1
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

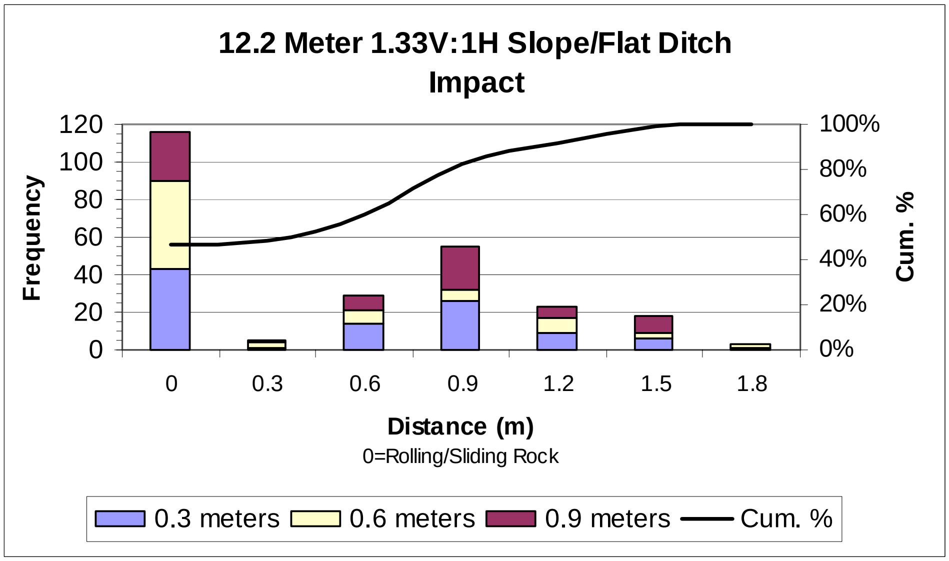

24.4 Meter 2V:1H Slope/Flat Ditch
Impact
Frequency
Cum. %
35
30
25
20
15
10
5
0
100%
80%
60%
40%
20%
0%
0
0.6
1.2
1.8
2.4
3.0
3.7
4.3
4.9
5.5
6.1
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %



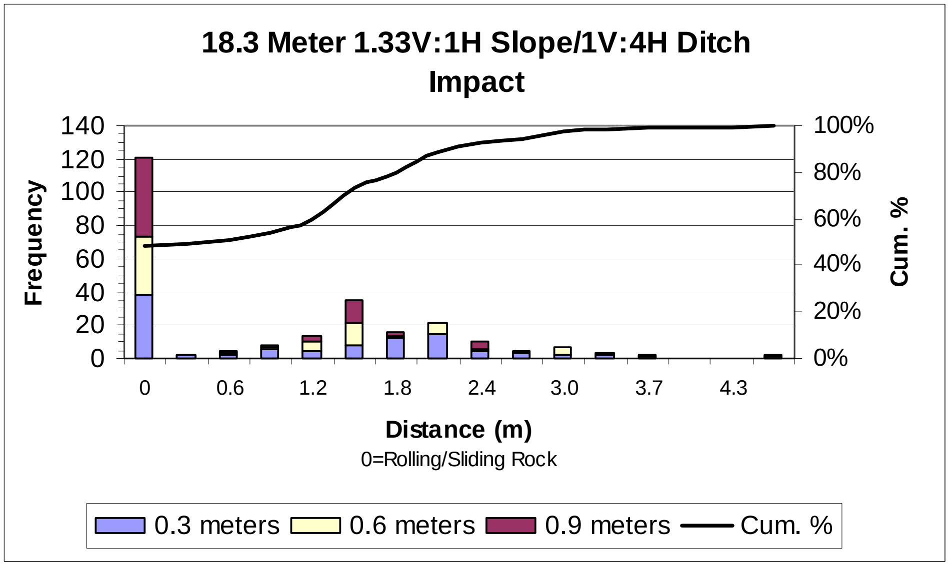
12.2 Meter 1.33V:1H Slope/1V:4H Ditch
Impact
Frequency
Cum. %
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

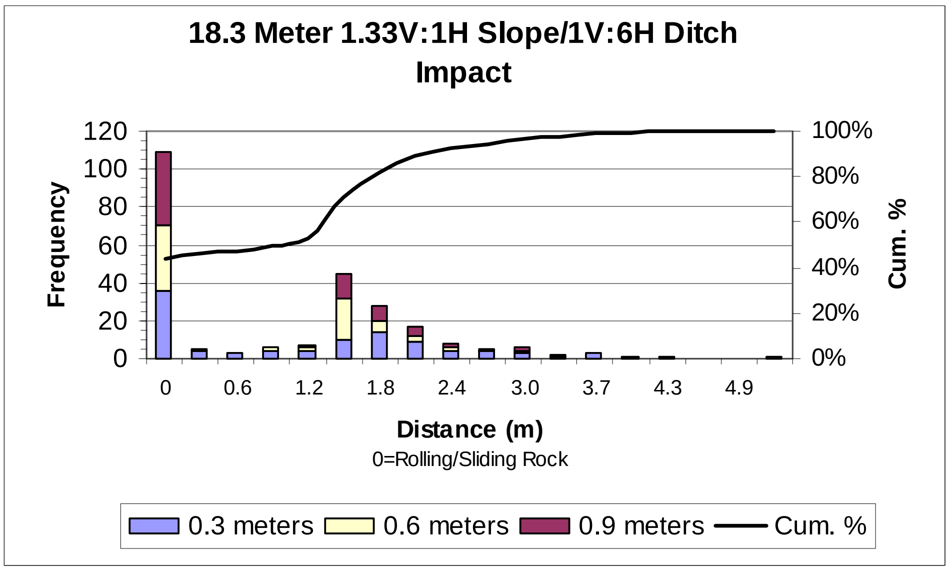


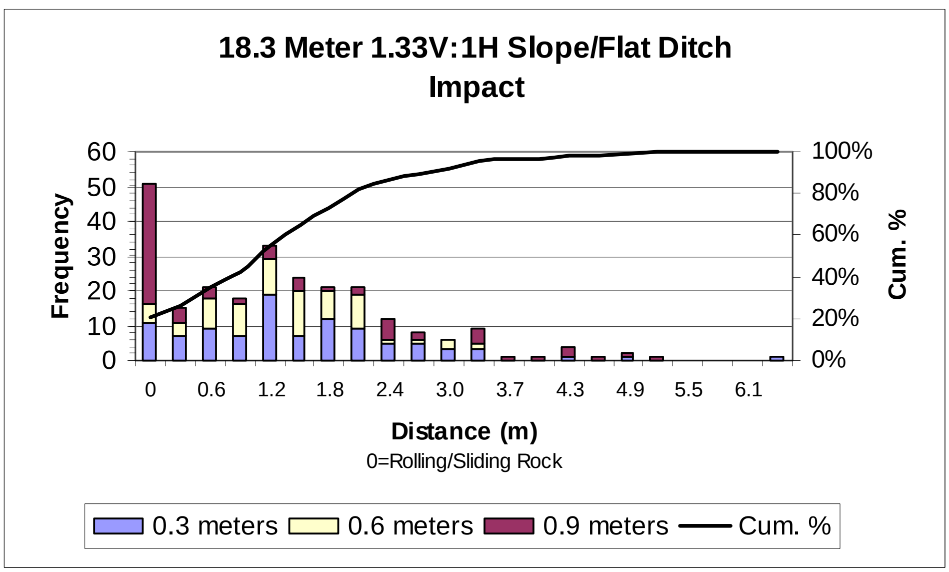
12.2 Meter 1.33V:1H Slope/1V:6H Ditch
Impact
Frequency
Cum. %
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

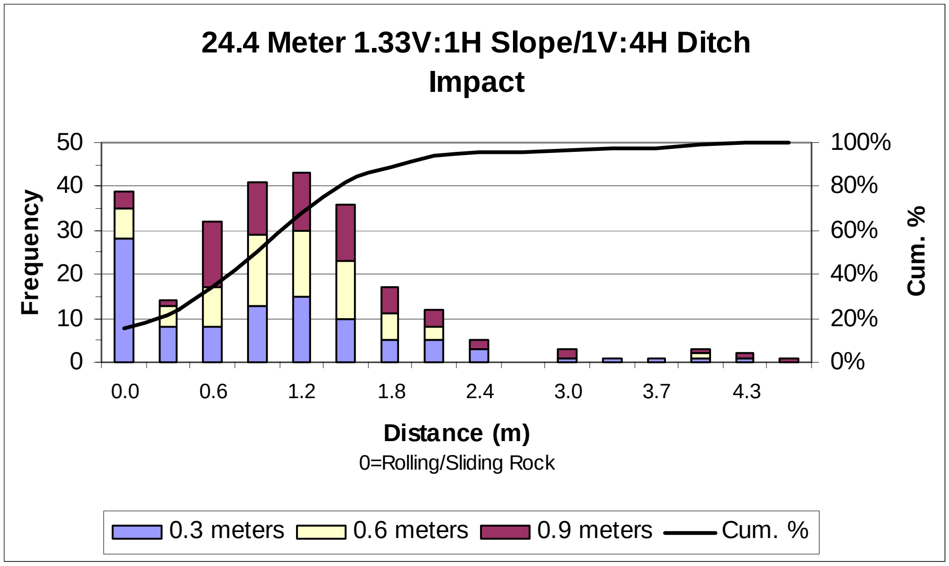


12.2 Meter 1.33V:1H Slope/Flat Ditch
Impact
Frequency
Cum. %
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

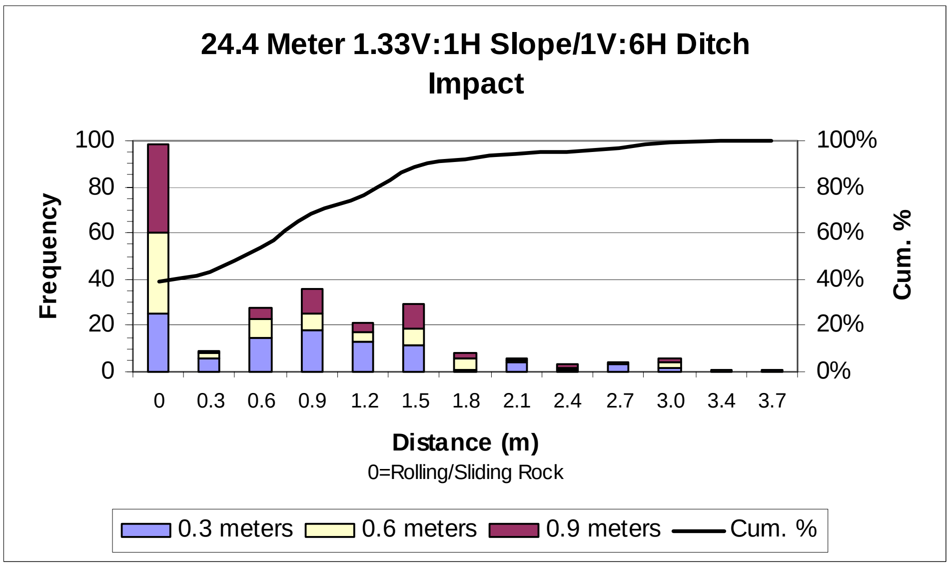

18.3 Meter 1.33V:1H Slope/1V:4H Ditch
Impact
Frequency
Cum. %
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
0.6
1.2
1.8
2.4
3.0
3.7
4.3
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %


18.3 Meter 1.33V:1H Slope/1V:6H Ditch
Impact
Frequency
Cum. %
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
0.6
1.2
1.8
2.4
3.0
3.7
4.3
4.9
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

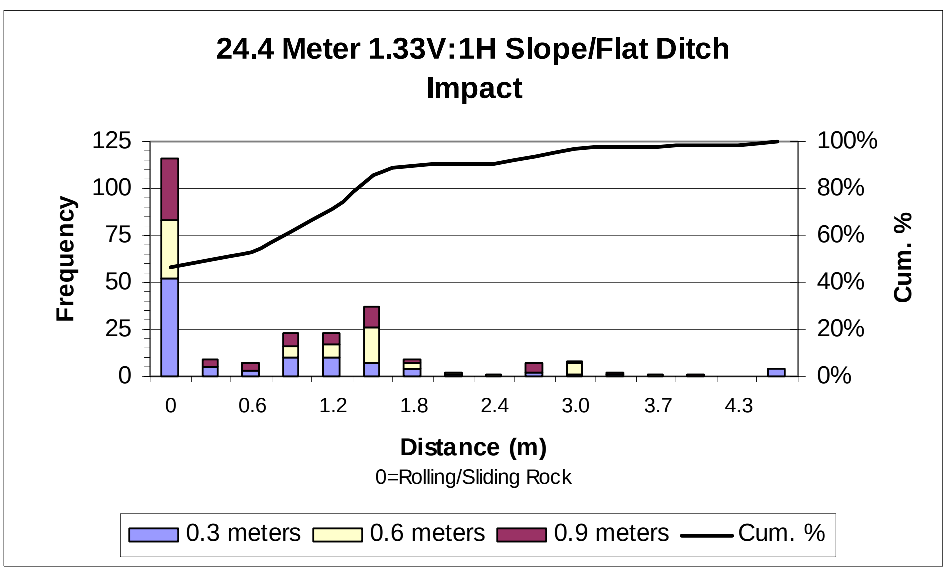

18.3 Meter 1.33V:1H Slope/Flat Ditch
Impact
Frequency
Cum. %
60
50
40
30
20
10
0
100%
80%
60%
40%
20%
0%
0
0.6
1.2
1.8
2.4
3.0
3.7
4.3
4.9
5.5
6.1
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %



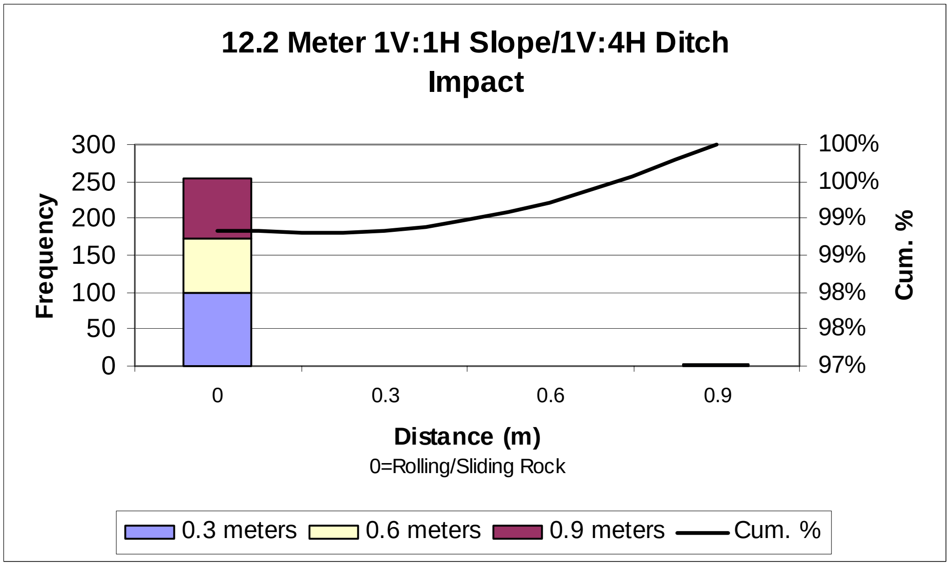
24.4 Meter 1.33V:1H Slope/1V:4H Ditch
Impact
Frequency
Cum. %
50
40
30
20
10
0
100%
80%
60%
40%
20%
0%
0.0
0.6
1.2
1.8
2.4
3.0
3.7
4.3
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

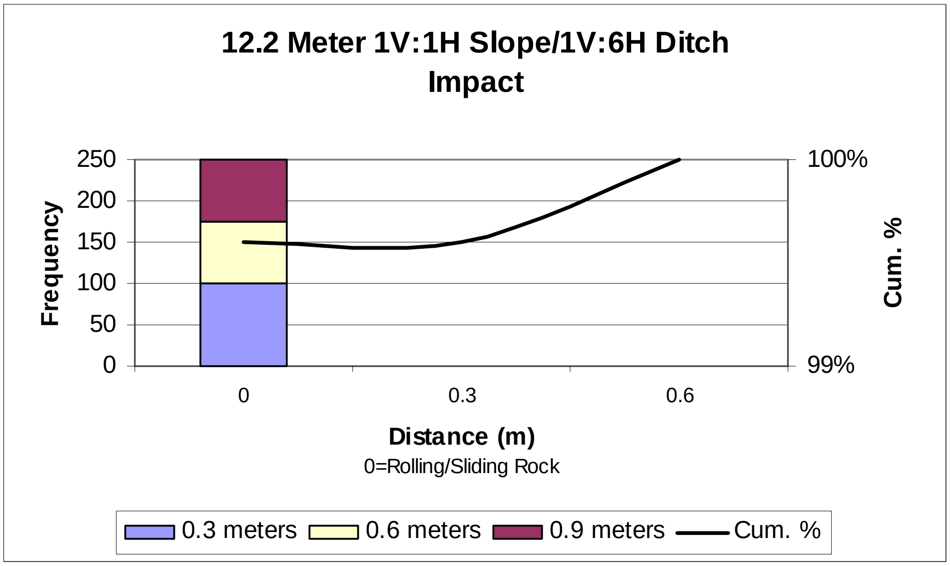


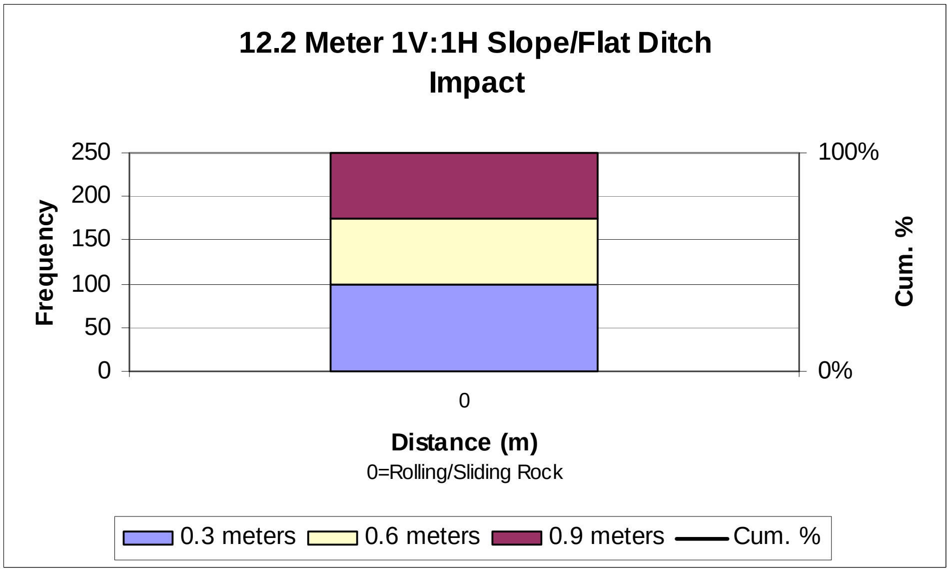
24.4 Meter 1.33V:1H Slope/1V:6H Ditch
Impact
Frequency
Cum. %
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
0.3
0.6
0.9
1.2
1.5
1.8
2.1
2.4
2.7
3.0
3.4
3.7
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

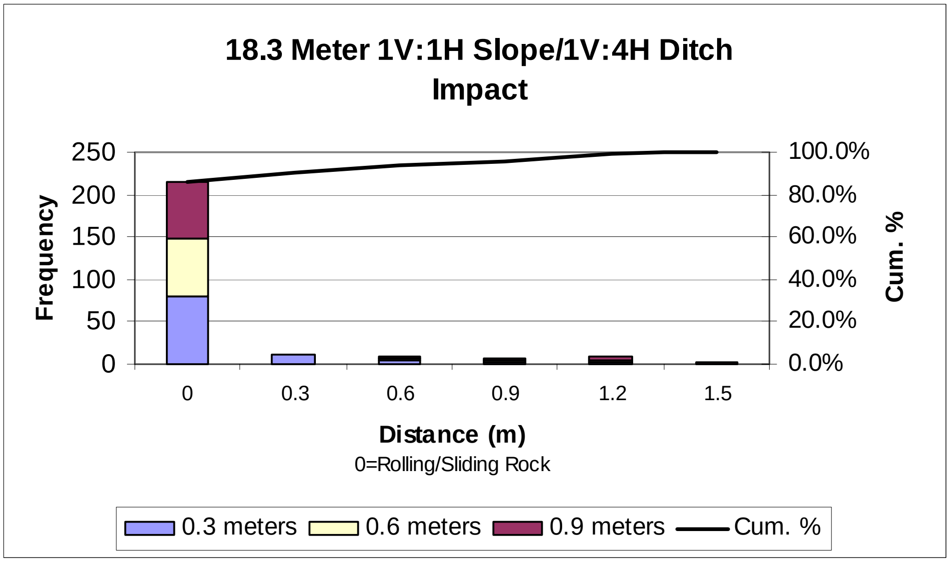


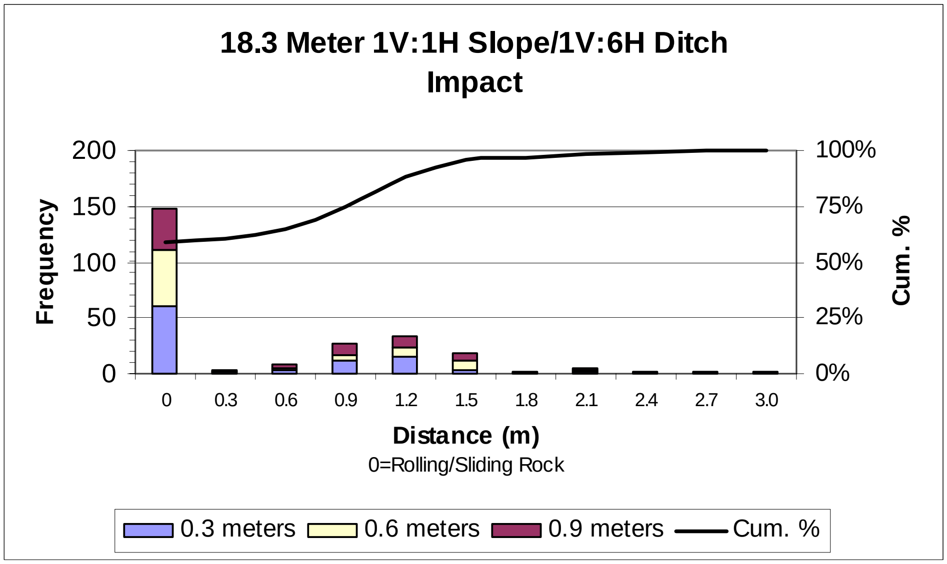
24.4 Meter 1.33V:1H Slope/Flat Ditch
Impact
Frequency
Cum. %
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.6
1.2
1.8
2.4
3.0
3.7
4.3
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

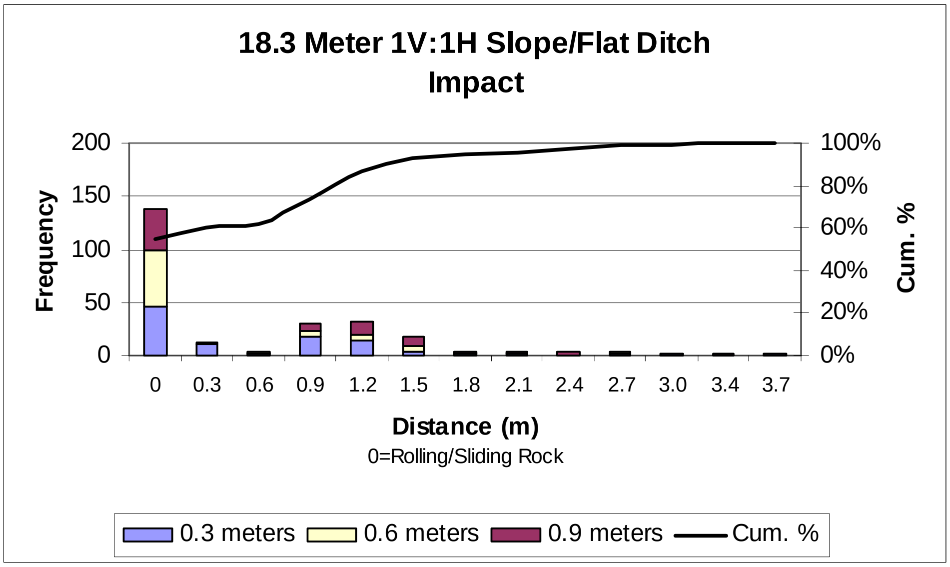

12.2 Meter 1V:1H Slope/1V:4H Ditch
Impact
300
250
200
150
100
50
0
Frequency
100%
100%
99%
99%
98%
98%
97%
Cum. %
0
0.3
0.6
0.9
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

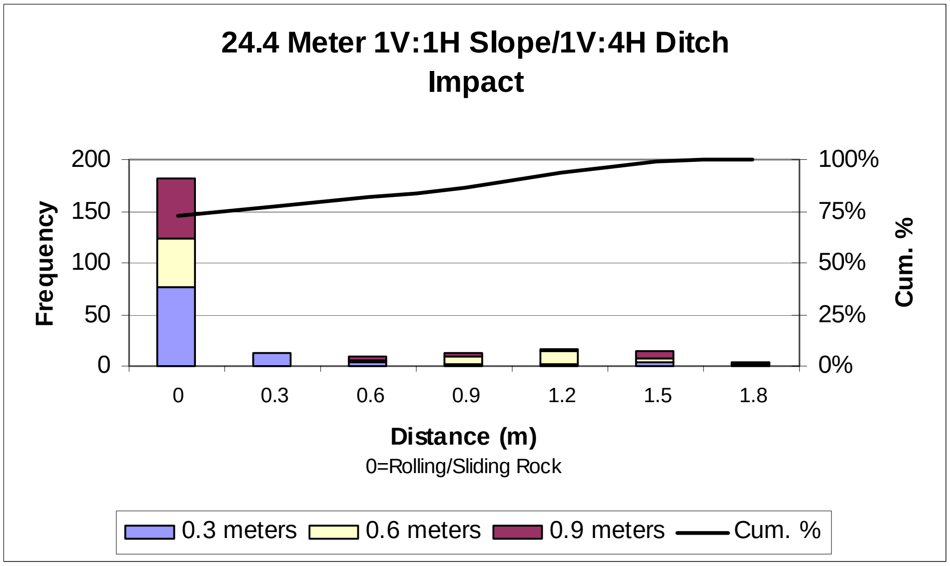

12.2 Meter 1V:1H Slope/1V:6H Ditch
Impact
250
200
150
100
50
0
Frequency
100%
99%
Cum. %
0
0.3
0.6
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %


12.2 Meter 1V:1H Slope/Flat Ditch
Impact
250
200
150
100
50
0
Frequency
100%
0%
Cum. %
0
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

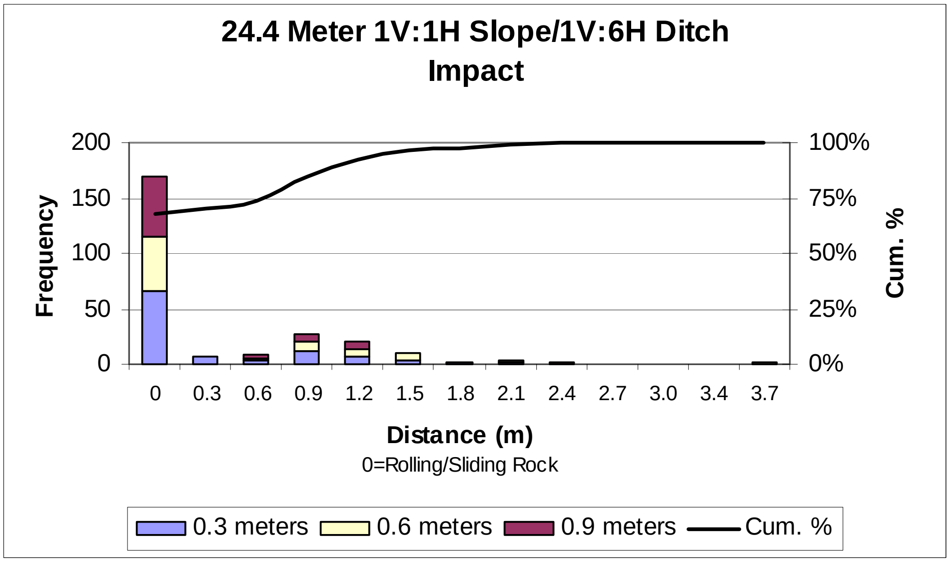

18.3 Meter 1V:1H Slope/1V:4H Ditch Impact
Frequency
Cum. %
250
200
150
100
50
0
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
0
0.3
0.6
0.9
1.2
1.5
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %


18.3 Meter 1V:1H Slope/1V:6H Ditch Impact
Frequency
Cum. %
200
150
100
50
0
100%
75%
50%
25%
0%
0
0.3
0.6
0.9
1.2
1.5
1.8
2.1
2.4
2.7
3.0
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %

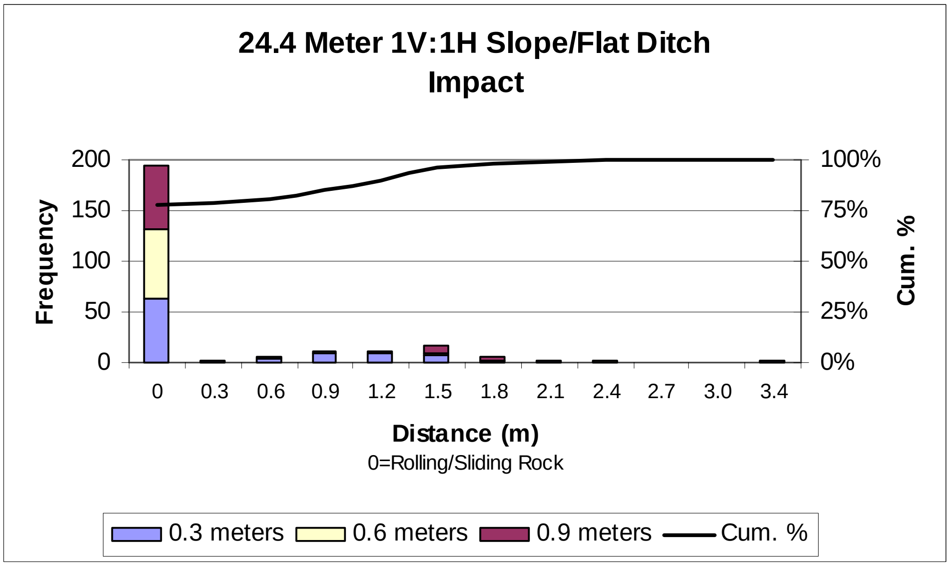

18.3 Meter 1V:1H Slope/Flat Ditch Impact
Frequency
Cum. %
200
150
100
50
0
100%
80%
60%
40%
20%
0%
0
0.3
0.6
0.9
1.2
1.5
1.8
2.1
2.4
2.7
3.0
3.4
3.7
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %



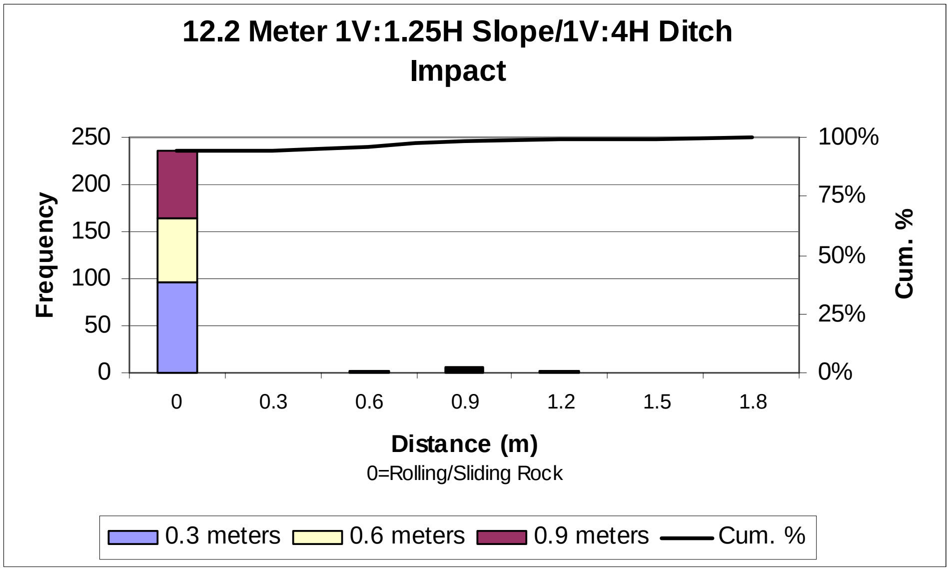
24.4 Meter 1V:1H Slope/1V:4H Ditch
Impact
200
150
100
50
0
Frequency
100%
75%
50%
25%
0%
Cum. %
0
0.3
0.6
0.9
1.2
1.5
1.8
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %



24.4 Meter 1V:1H Slope/1V:6H Ditch
Impact
200
150
100
50
0
Frequency
100%
75%
50%
25%
0%
Cum. %
0
0.3
0.6
0.9
1.2
1.5
1.8
2.1
2.4
2.7
3.0
3.4
3.7
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %



24.4 Meter 1V:1H Slope/Flat Ditch
Impact
200
150
100
50
0
Frequency
100%
75%
50%
25%
0%
Cum. %
0
0.3
0.6
0.9
1.2
1.5
1.8
2.1
2.4
2.7
3.0
3.4
Distance (m)
0=Rolling/Sliding Rock
0.3 meters
0.6 meters
0.9 meters
Cum. %



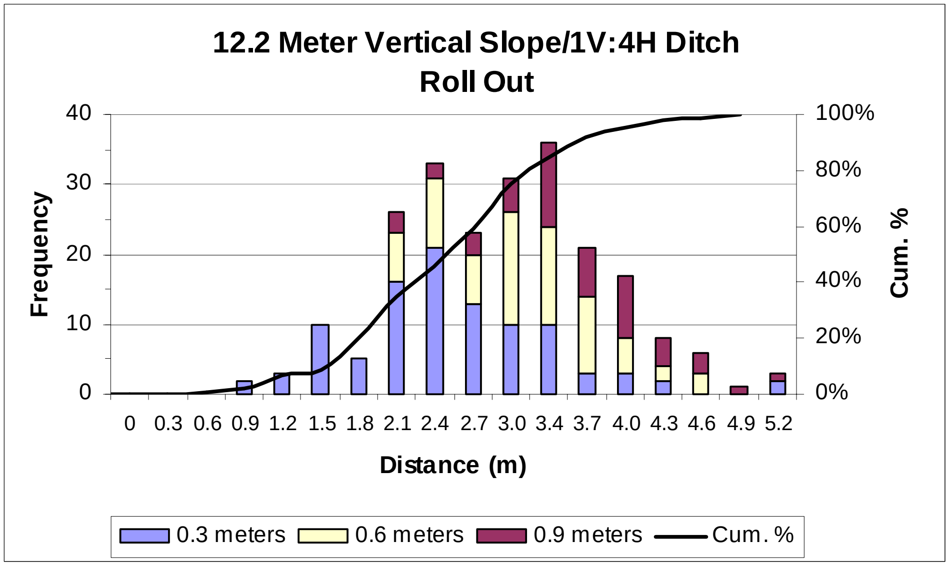
Note: This was the only 1V: 1.25H slope tested. Insufficient funds were available to test additional slopes.

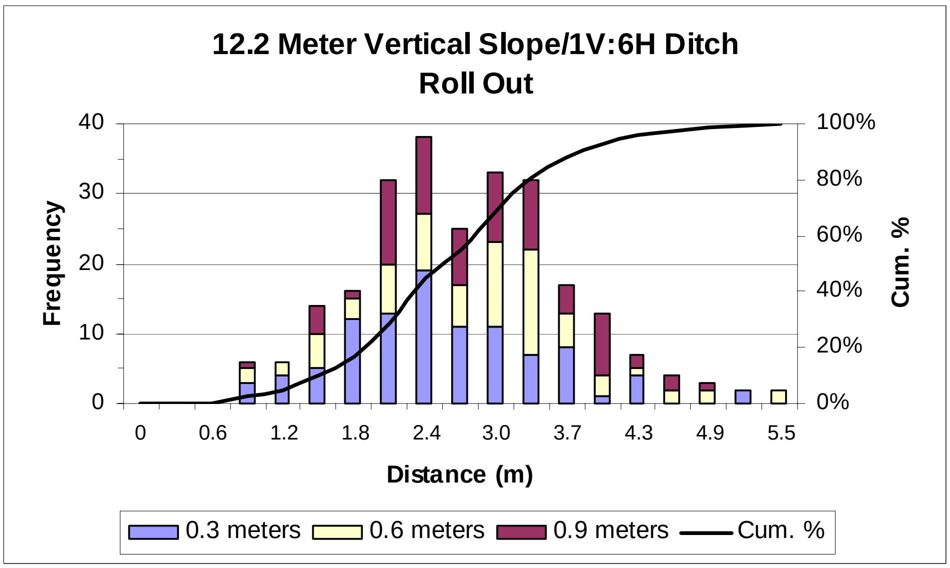
APPENDIX D: ROCKFALL ROLL OUT DISTANCE HISTOGRAMS

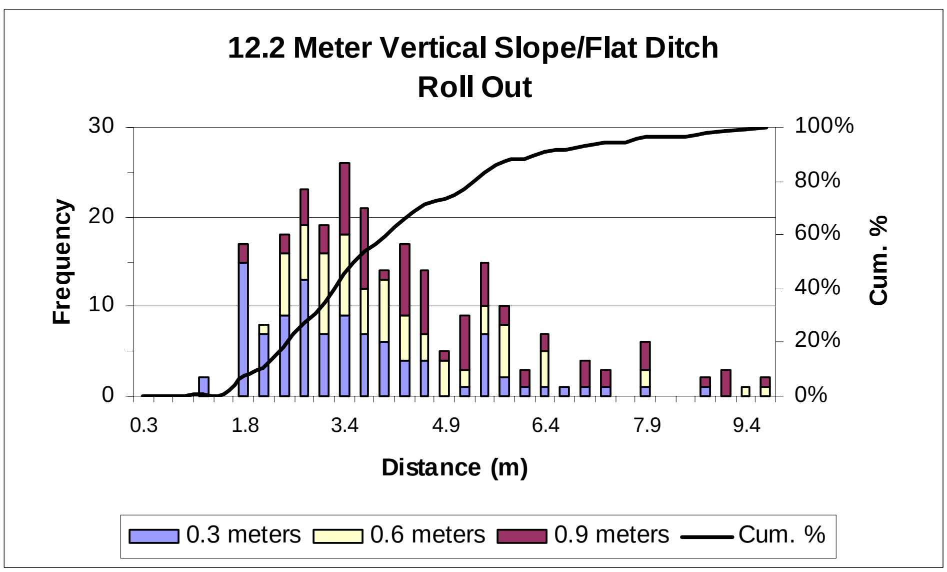
ROCKFALL ROLL OUT DISTANCE HISTOGRAMS

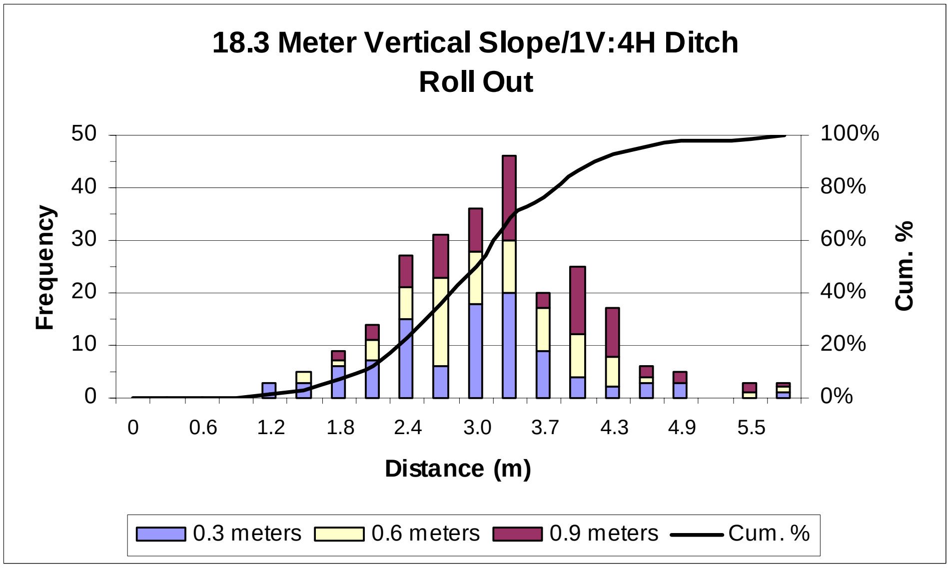
The roll out histograms have a similar appearance to the impact histograms but instead graphically represent the maximum distance each test-rock obtained from the toe of the slope as the rock rolled through the catchment area after impact. In some cases the rockfalls created a crater and did not move beyond the impact distance. This was more common with the steeper slopes. For flatter slopes, a zero distance roll out value was very rare. These general observations of rockfall roll out behavior should not be construed to mean that rockfalls from steep slopes would not result in large roll out values. The largest roll out measured was from a 4V:1H, 24.4-meter high slope. That distance was 30.2 meters. The roll out distances are the field measured slope distances. Field data was recorded to the nearest foot (0.3 meters).

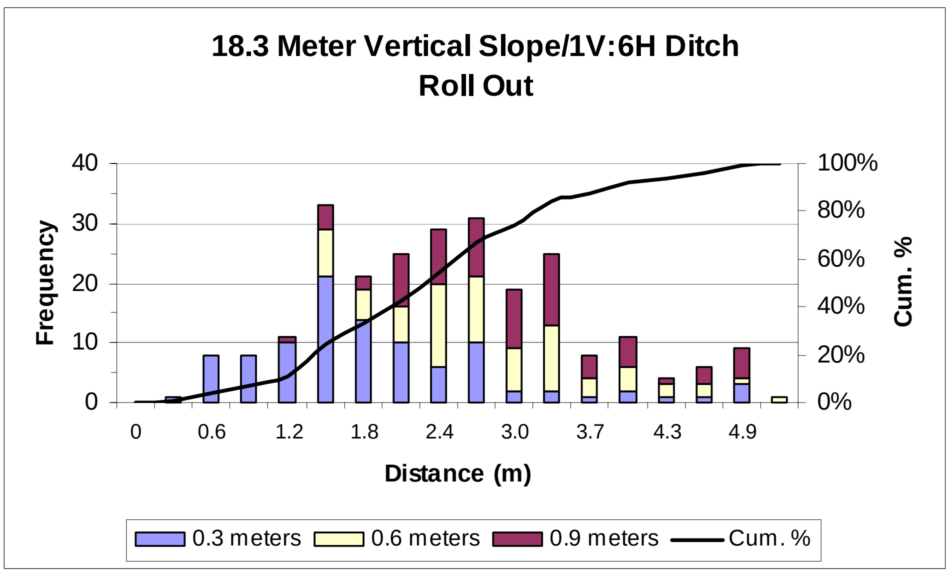
NOTE: Also included at the end of Appendix D is a limited set of data gathered from a 12.2-meter high, 1V:1.25H slope. The rocks rolled from this slope fell into a 1V:4H catchment area. The results were recorded but not compiled into catchment area percent retention graphs or design charts, because there were not sufficient funds to test the full suite of slope heights and catchment area inclinations for the 1V:1.25H test slope.

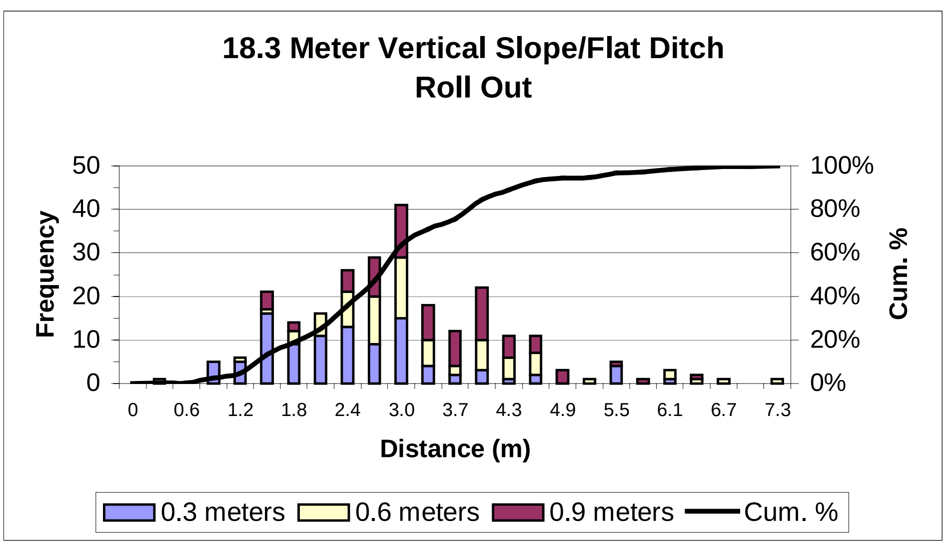

12.2 Meter Vertical Slope/1V:4H Ditch
Roll Out
40
30
20
10
0
100%
80%
60%
40%
20%
0%
Frequency
Cum. %
0 0.3 0.6 0.9 1.2 1.5 1.8 2.1 2.4 2.7 3.0 3.4 3.7 4.0 4.3 4.6 4.9 5.2
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

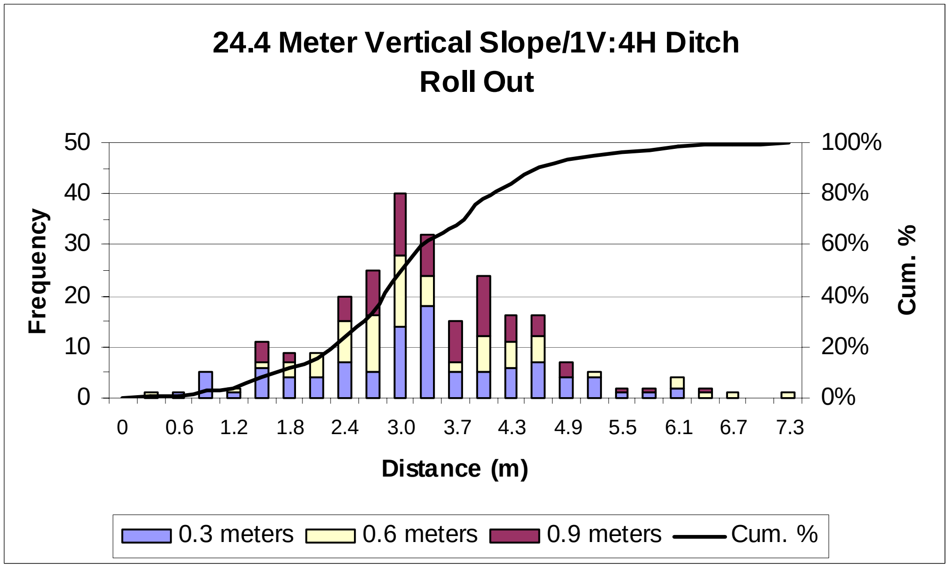

12.2 Meter Vertical Slope/1V:6H Ditch
Roll Out
40
30
20
10
0
100%
80%
60%
40%
20%
0%
Frequency
Cum. %
0 0.6 1.2 1.8 2.4 3.0 3.7 4.3 4.9 5.5
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

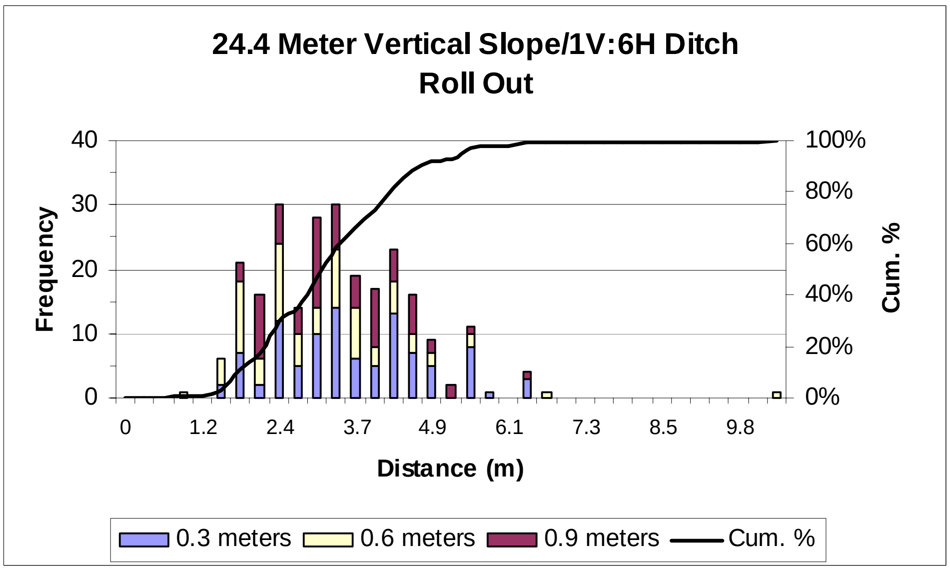

12.2 Meter Vertical Slope/Flat Ditch
Roll Out
30
20
10
0
100%
80%
60%
40%
20%
0%
Frequency
Cum. %
0.3 1.8 3.4 4.9 6.4 7.9 9.4
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

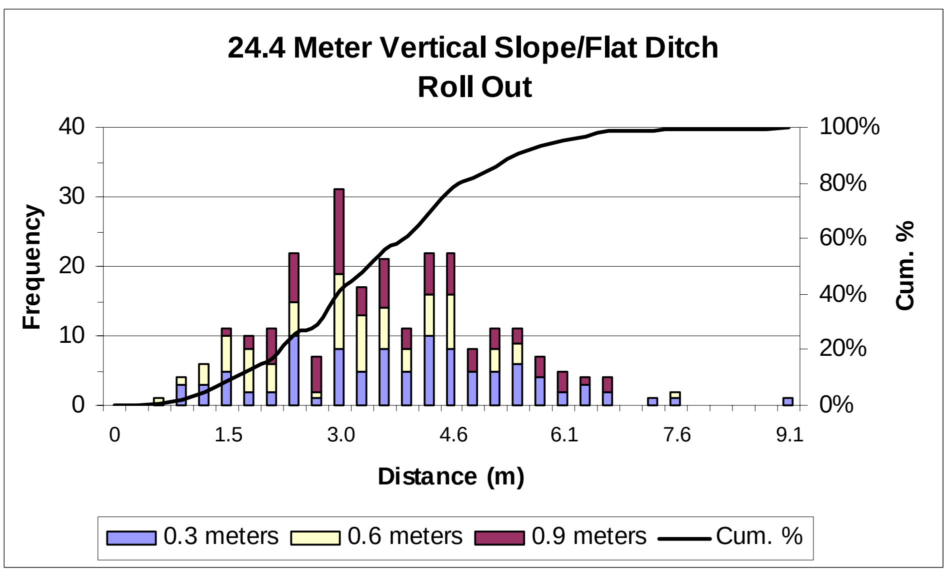

18.3 Meter Vertical Slope/1V:4H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

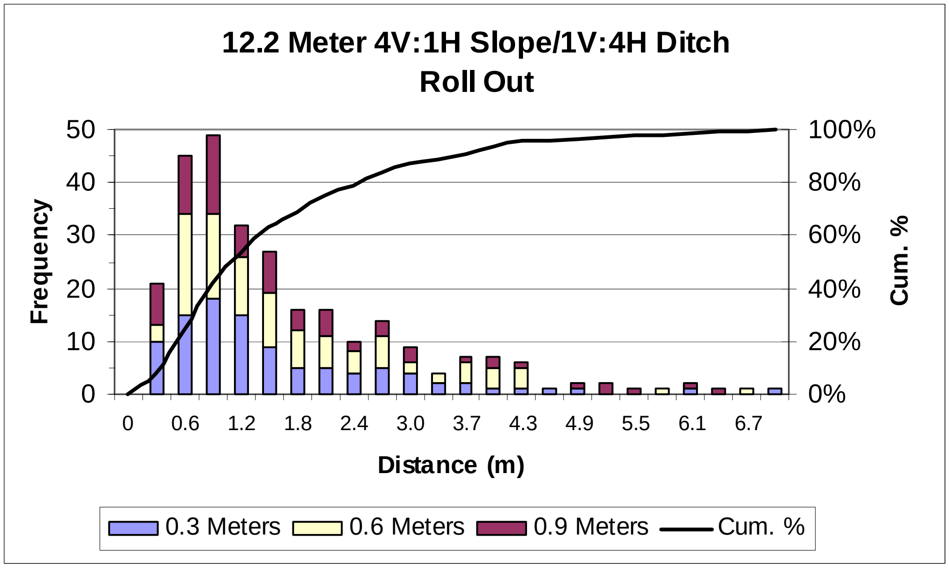

18.3 Meter Vertical Slope/1V:6H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

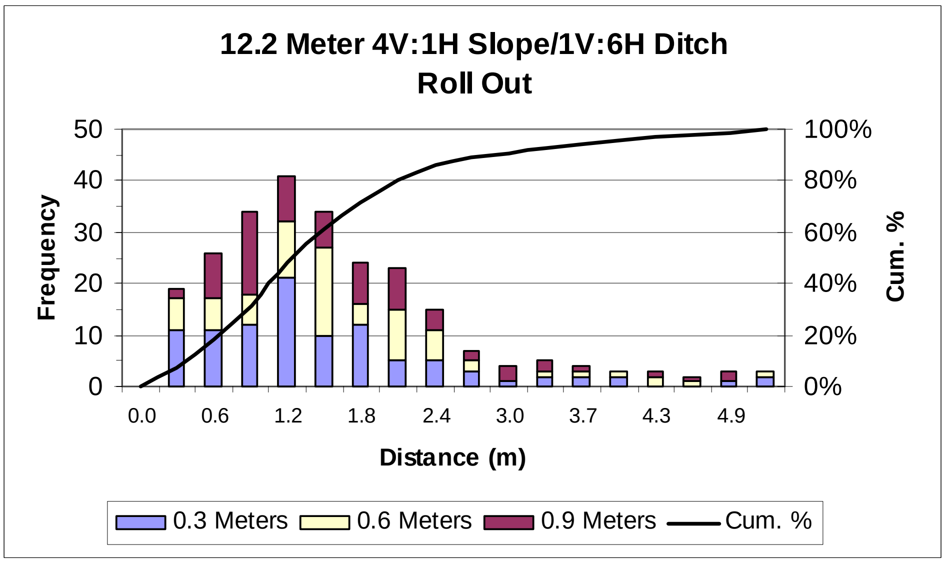

18.3 Meter Vertical Slope/Flat Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

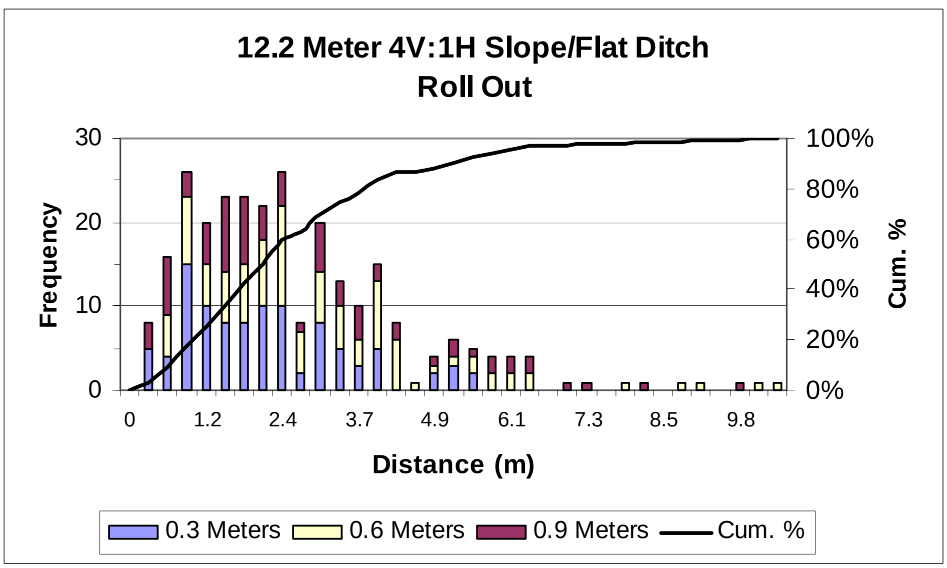

24.4 Meter Vertical Slope/1V:4H Ditch
Roll Out
Frequency
Cum. %
0
10
20
30
40
50
0%
20%
40%
60%
80%
100%
0
0.6
1.2
1.8
2.4
3.0
3.7
4.3
4.9
5.5
6.1
6.7
7.3
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

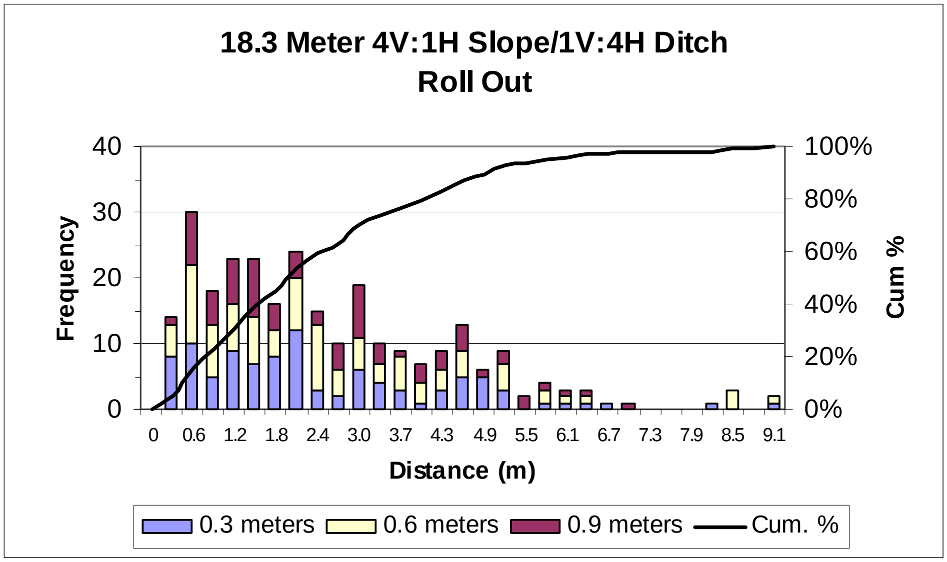

24.4 Meter Vertical Slope/1V:6H Ditch
Roll Out
Frequency
Cum. %
0
10
20
30
40
0%
20%
40%
60%
80%
100%
0
1.2
2.4
3.7
4.9
6.1
7.3
8.5
9.8
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

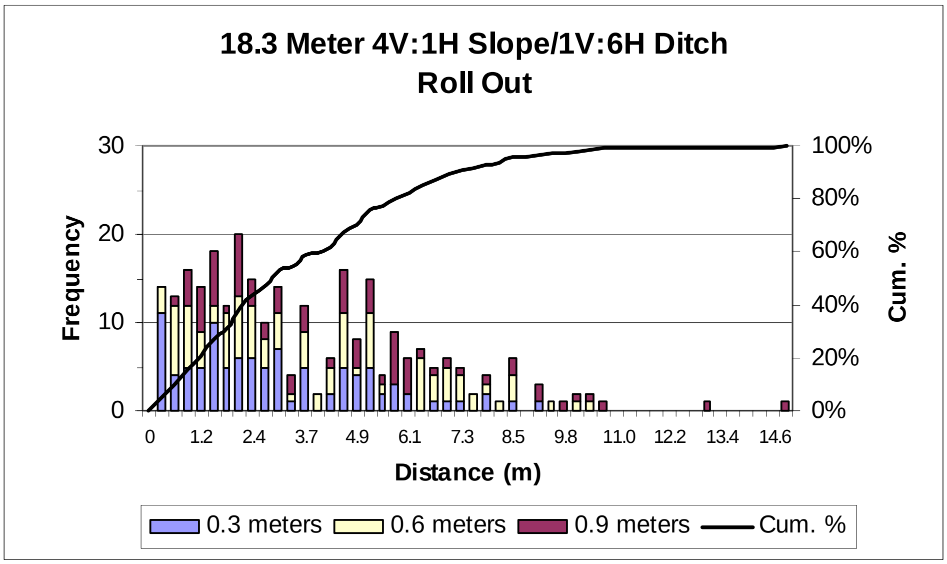

24.4 Meter Vertical Slope/Flat Ditch
Roll Out
Frequency
Cum. %
0
10
20
30
40
0%
20%
40%
60%
80%
100%
0
1.5
3.0
4.6
6.1
7.6
9.1
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

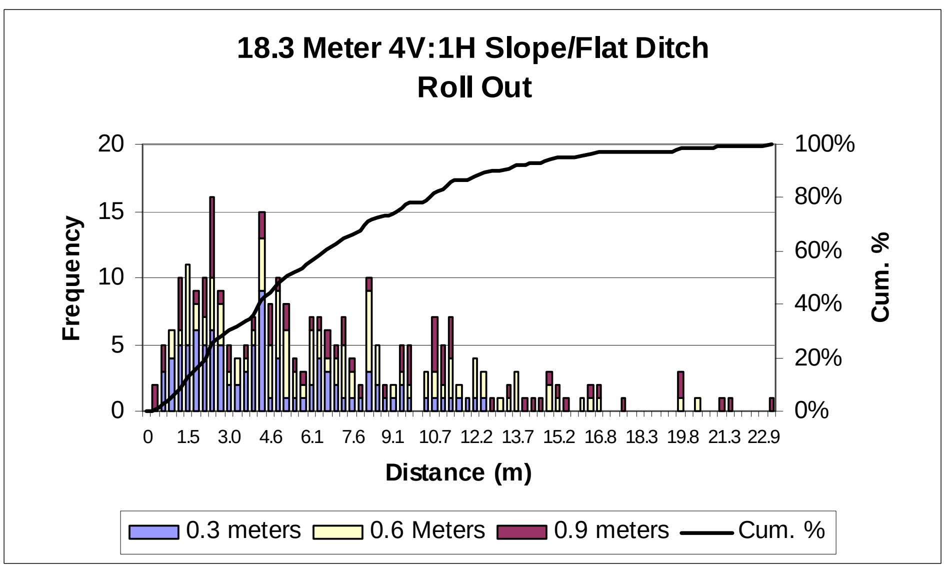

12.2 Meter 4V:1H Slope/1V:4H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0 10 20 30 40 50
0% 20% 40% 60% 80% 100%
0 0.6 1.2 1.8 2.4 3.0 3.7 4.3 4.9 5.5 6.1 6.7
0.3 Meters
0.6 Meters
0.9 Meters
Cum. %

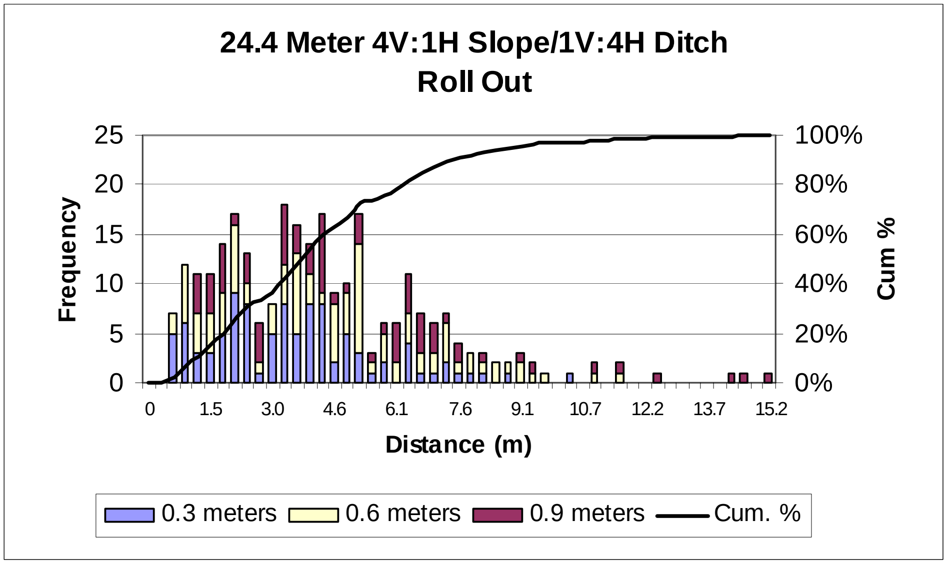

12.2 Meter 4V:1H Slope/1V:6H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0 10 20 30 40 50
0% 20% 40% 60% 80% 100%
0.0 0.6 1.2 1.8 2.4 3.0 3.7 4.3 4.9
0.3 Meters
0.6 Meters
0.9 Meters
Cum. %

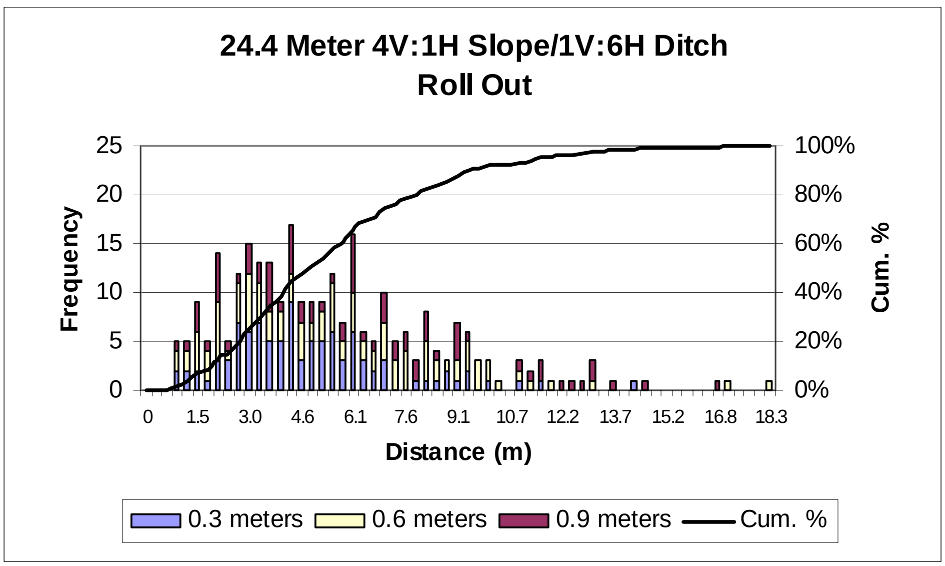

12.2 Meter 4V:1H Slope/Flat Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0 10 20 30
0% 20% 40% 60% 80% 100%
0 1.2 2.4 3.7 4.9 6.1 7.3 8.5 9.8
0.3 Meters
0.6 Meters
0.9 Meters
Cum. %

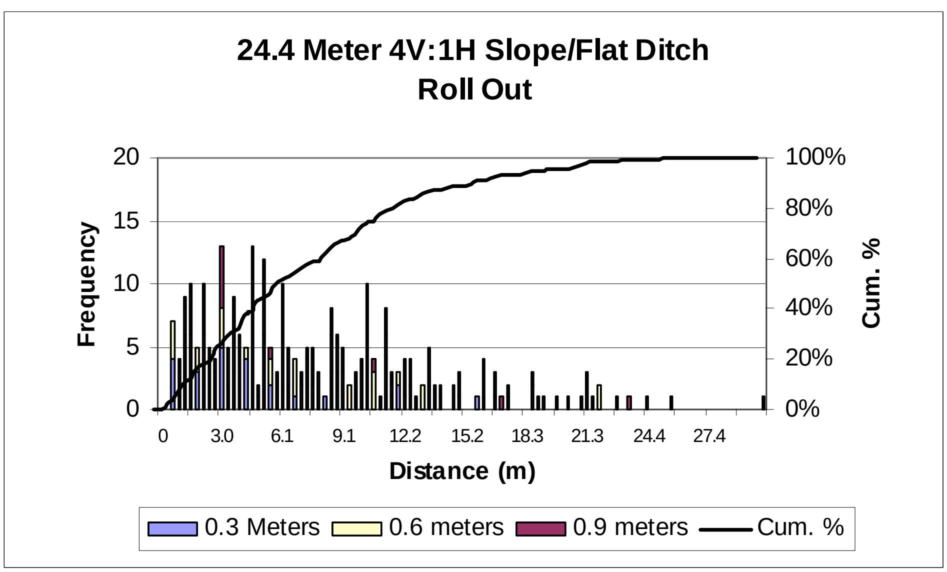

18.3 Meter 4V:1H Slope/1V:4H Ditch
Roll Out
Frequency
Cum %
Distance (m)
0 0.6 1.2 1.8 2.4 3.0 3.7 4.3 4.9 5.5 6.1 6.7 7.3 7.9 8.5 9.1
0.3 meters
0.6 meters
0.9 meters
Cum. %

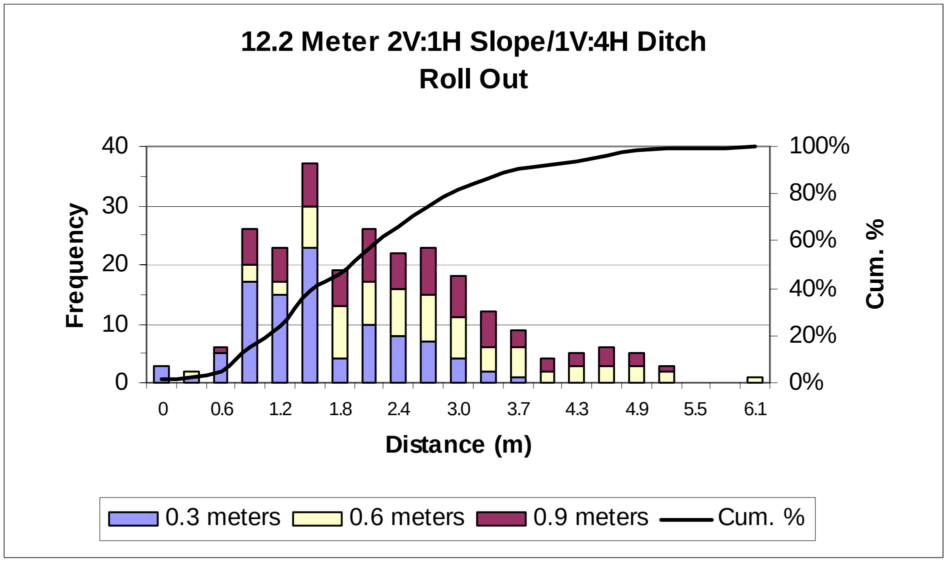

18.3 Meter 4V:1H Slope/1V:6H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0 1.2 2.4 3.7 4.9 6.1 7.3 8.5 9.8 11.0 12.2 13.4 14.6
0.3 meters
0.6 meters
0.9 meters
Cum. %

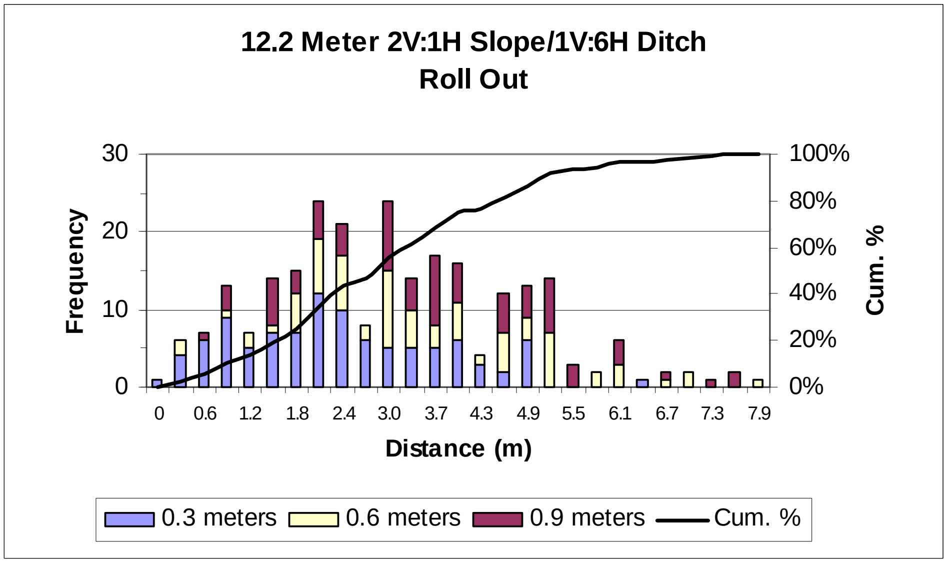

18.3 Meter 4V:1H Slope/Flat Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0 1.5 3.0 4.6 6.1 7.6 9.1 10.7 12.2 13.7 15.2 16.8 18.3 19.8 21.3 22.9
0.3 meters
0.6 Meters
0.9 meters
Cum. %

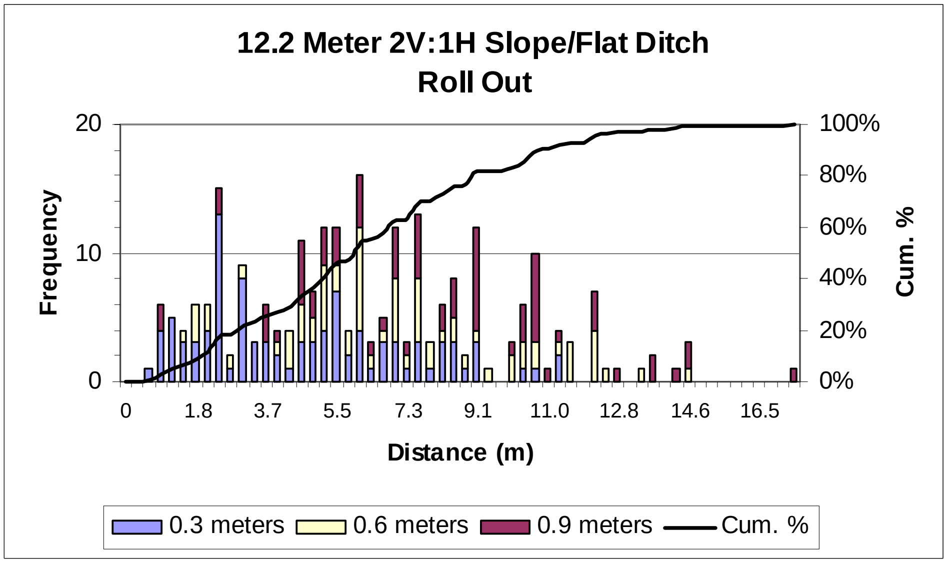

24.4 Meter 4V:1H Slope/1V:4H Ditch
Roll Out
Frequency
Cum %
Distance (m)
0
1.5
3.0
4.6
6.1
7.6
9.1
10.7
12.2
13.7
15.2
0
5
10
15
20
25
0%
20%
40%
60%
80%
100%
0.3 meters
0.6 meters
0.9 meters
Cum. %

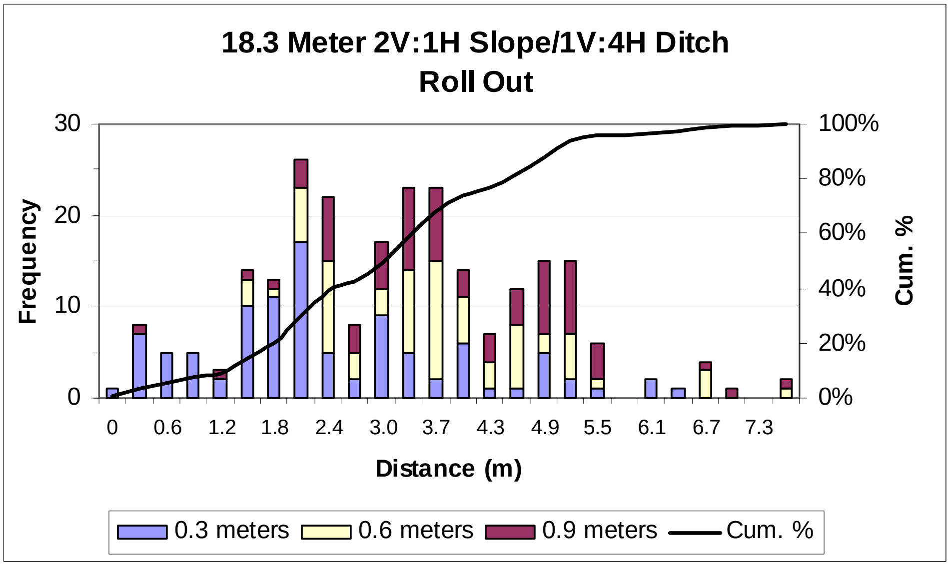

24.4 Meter 4V:1H Slope/1V:6H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0
1.5
3.0
4.6
6.1
7.6
9.1
10.7
12.2
13.7
15.2
16.8
18.3
0
5
10
15
20
25
0%
20%
40%
60%
80%
100%
0.3 meters
0.6 meters
0.9 meters
Cum. %

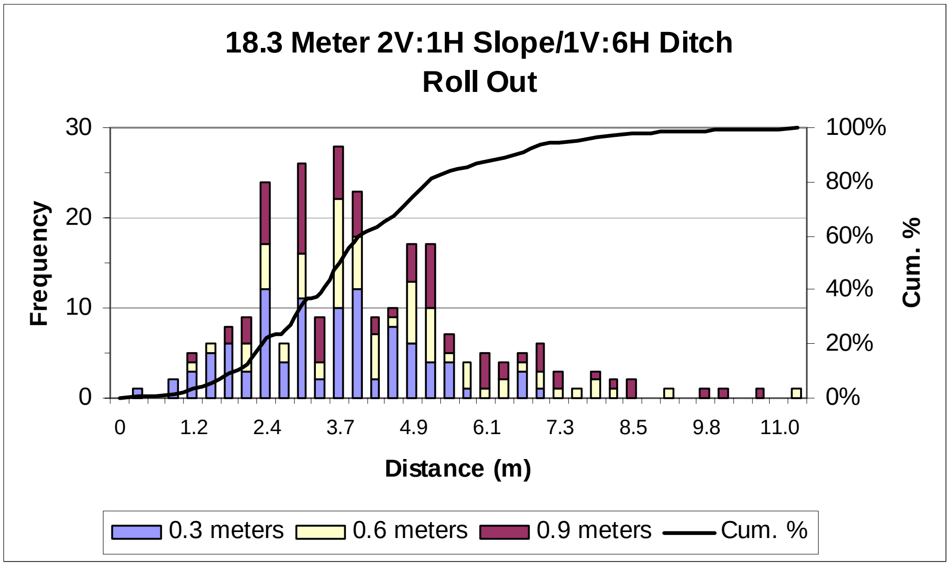

24.4 Meter 4V:1H Slope/Flat Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0
3.0
6.1
9.1
12.2
15.2
18.3
21.3
24.4
27.4
0
5
10
15
20
0%
20%
40%
60%
80%
100%
0.3 Meters
0.6 meters
0.9 meters
Cum. %

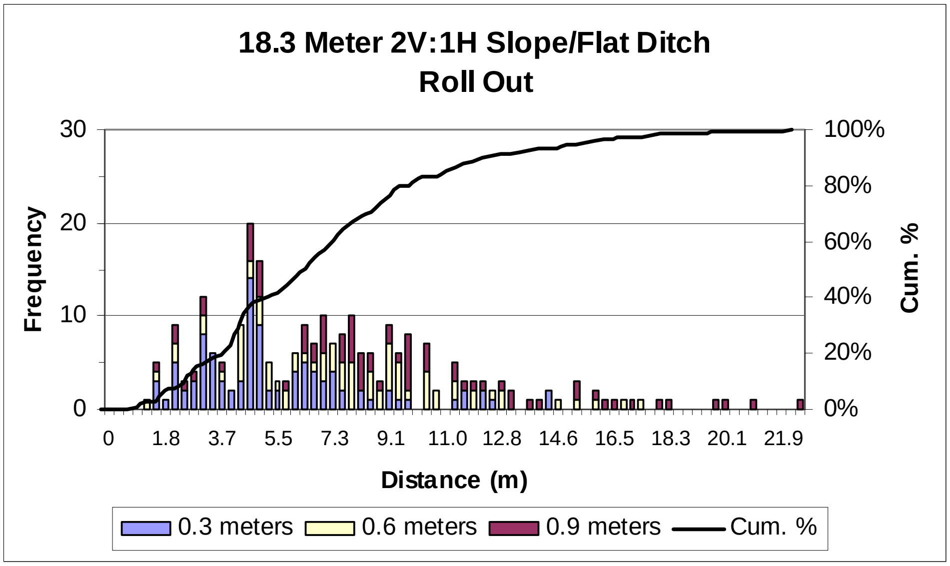

12.2 Meter 2V:1H Slope/1V:4H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0
10
20
30
40
0%
20%
40%
60%
80%
100%
0
0.6
1.2
1.8
2.4
3.0
3.7
4.3
4.9
5.5
6.1
0.3 meters
0.6 meters
0.9 meters
Cum. %

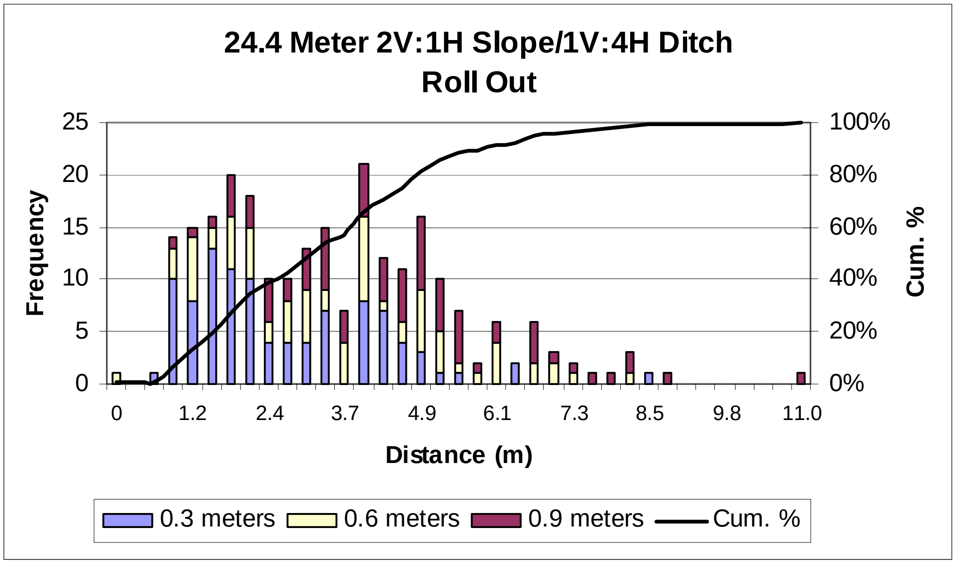

12.2 Meter 2V:1H Slope/1V:6H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0
10
20
30
0%
20%
40%
60%
80%
100%
0
0.6
1.2
1.8
2.4
3.0
3.7
4.3
4.9
5.5
6.1
6.7
7.3
7.9
0.3 meters
0.6 meters
0.9 meters
Cum. %

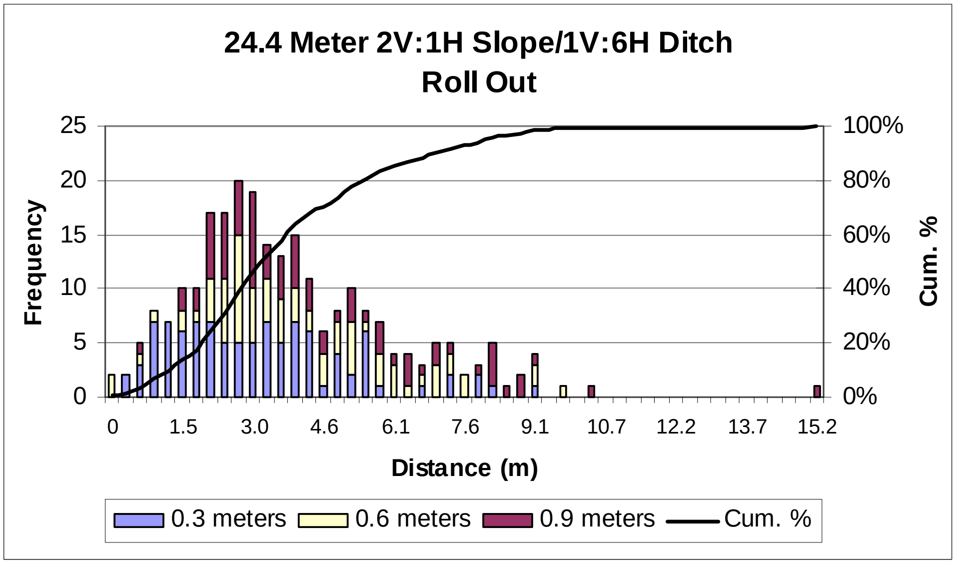

12.2 Meter 2V:1H Slope/Flat Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0
10
20
0%
20%
40%
60%
80%
100%
0
1.8
3.7
5.5
7.3
9.1
11.0
12.8
14.6
16.5
0.3 meters
0.6 meters
0.9 meters
Cum. %

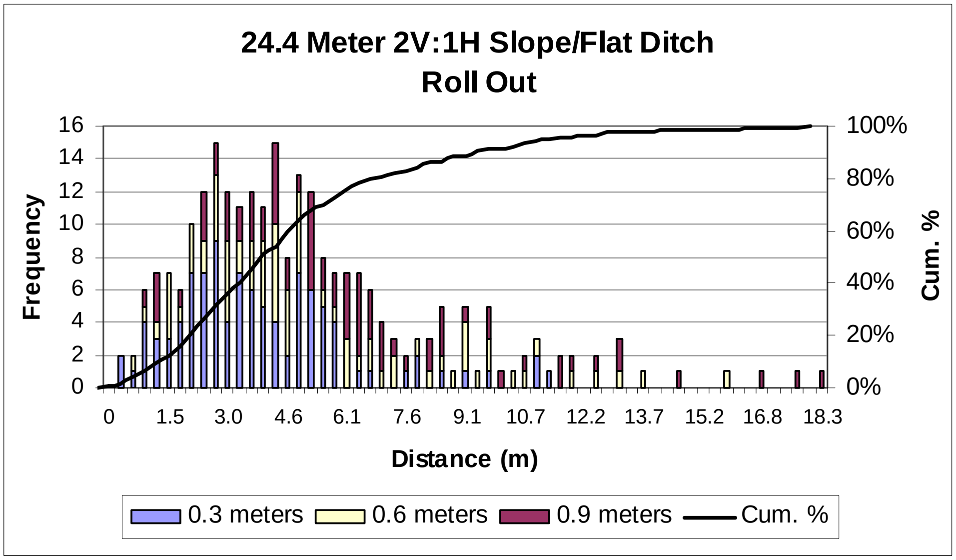

18.3 Meter 2V:1H Slope/1V:4H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0
0.6
1.2
1.8
2.4
3.0
3.7
4.3
4.9
5.5
6.1
6.7
7.3
0
10
20
30
0%
20%
40%
60%
80%
100%
0.3 meters
0.6 meters
0.9 meters
Cum. %

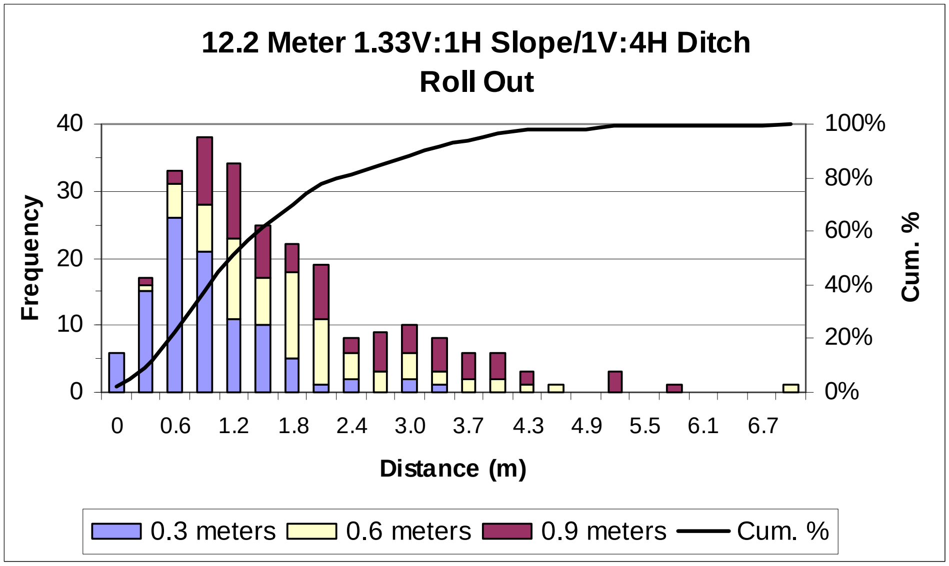

18.3 Meter 2V:1H Slope/1V:6H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0
1.2
2.4
3.7
4.9
6.1
7.3
8.5
9.8
11.0
0
10
20
30
0%
20%
40%
60%
80%
100%
0.3 meters
0.6 meters
0.9 meters
Cum. %

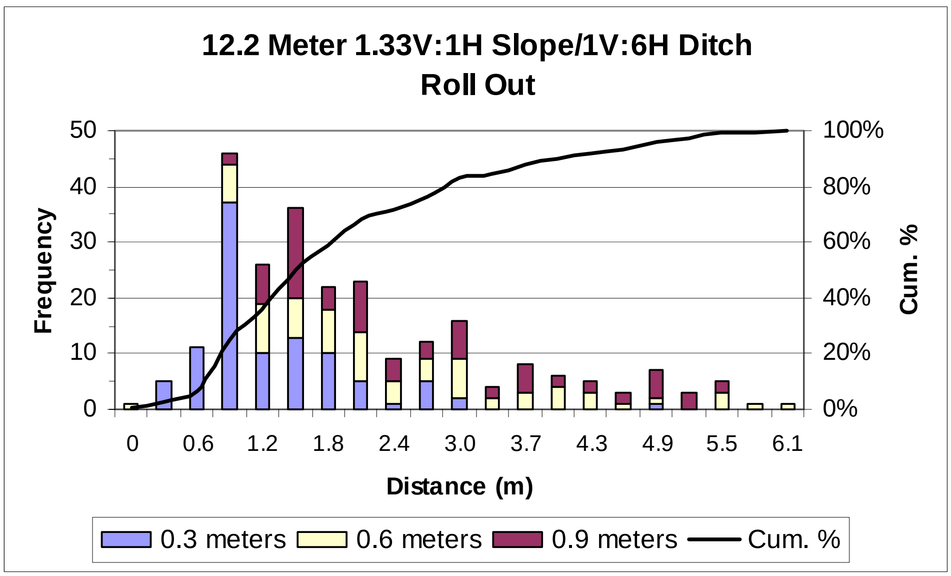

18.3 Meter 2V:1H Slope/Flat Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0
1.8
3.7
5.5
7.3
9.1
11.0
12.8
14.6
16.5
18.3
20.1
21.9
0
10
20
30
0%
20%
40%
60%
80%
100%
0.3 meters
0.6 meters
0.9 meters
Cum. %

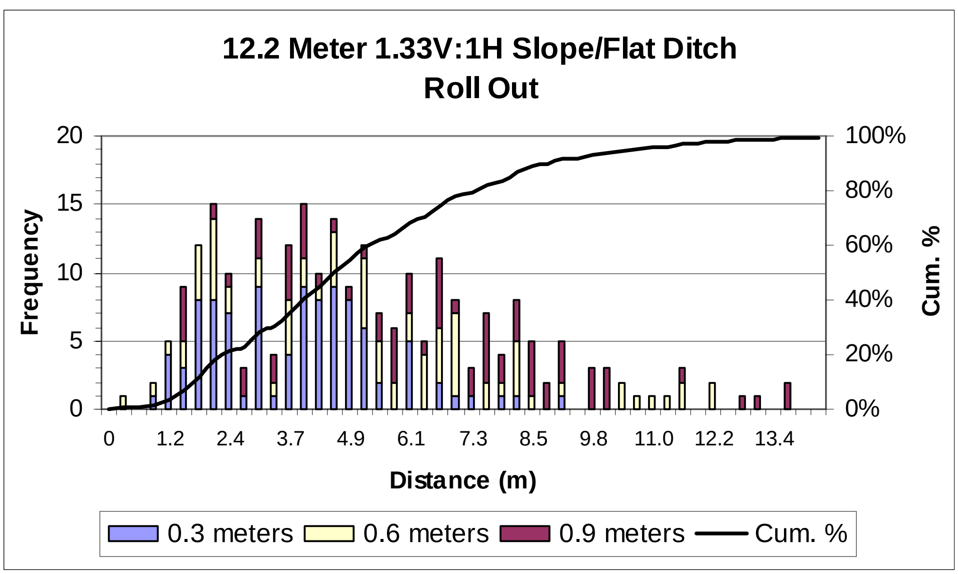

24.4 Meter 2V:1H Slope/1V:4H Ditch
Roll Out
Frequency
Cum. %
0
5
10
15
20
25
0%
20%
40%
60%
80%
100%
0
1.2
2.4
3.7
4.9
6.1
7.3
8.5
9.8
11.0
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

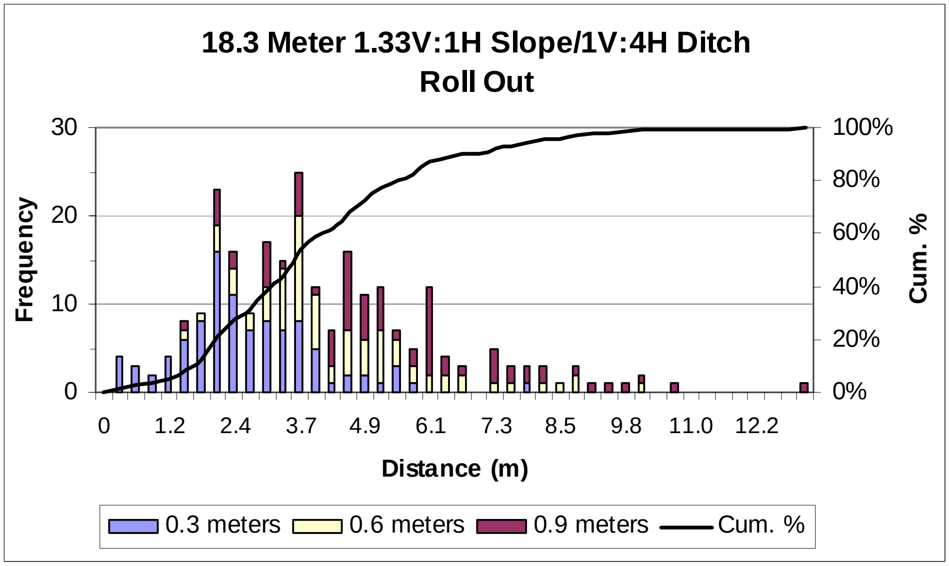

24.4 Meter 2V:1H Slope/1V:6H Ditch
Roll Out
Frequency
Cum. %
0
5
10
15
20
25
0%
20%
40%
60%
80%
100%
0
1.5
3.0
4.6
6.1
7.6
9.1
10.7
12.2
13.7
15.2
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

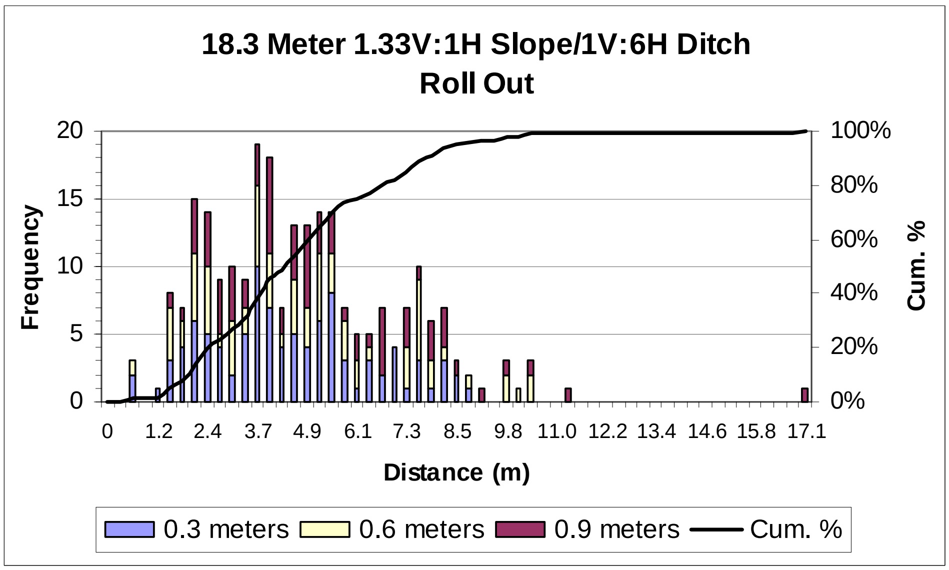

24.4 Meter 2V:1H Slope/Flat Ditch
Roll Out
Frequency
Cum. %
0
2
4
6
8
10
12
14
16
0%
20%
40%
60%
80%
100%
0
1.5
3.0
4.6
6.1
7.6
9.1
10.7
12.2
13.7
15.2
16.8
18.3
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

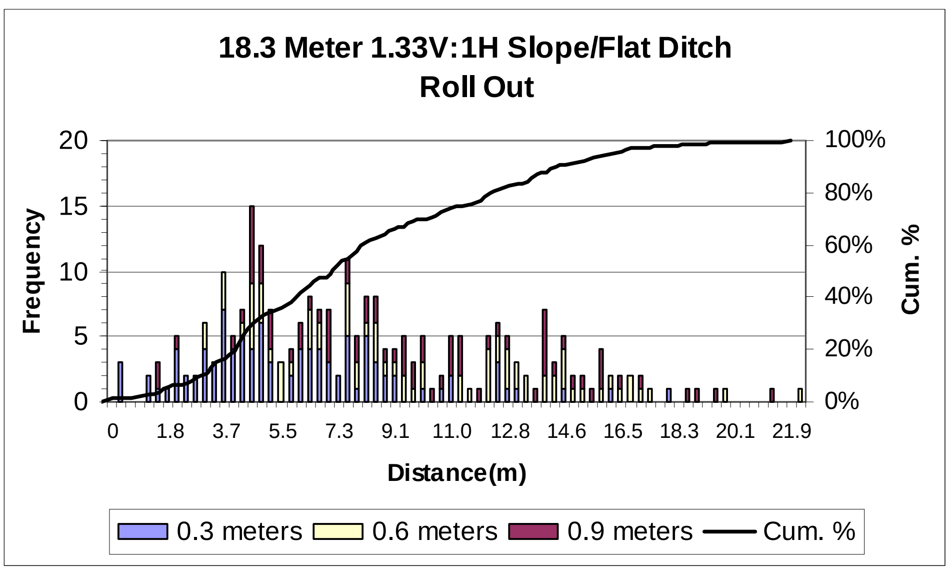

12.2 Meter 1.33V:1H Slope/1V:4H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0 0.6 1.2 1.8 2.4 3.0 3.7 4.3 4.9 5.5 6.1 6.7
0 10 20 30 40
0% 20% 40% 60% 80% 100%
0.3 meters
0.6 meters
0.9 meters
Cum. %

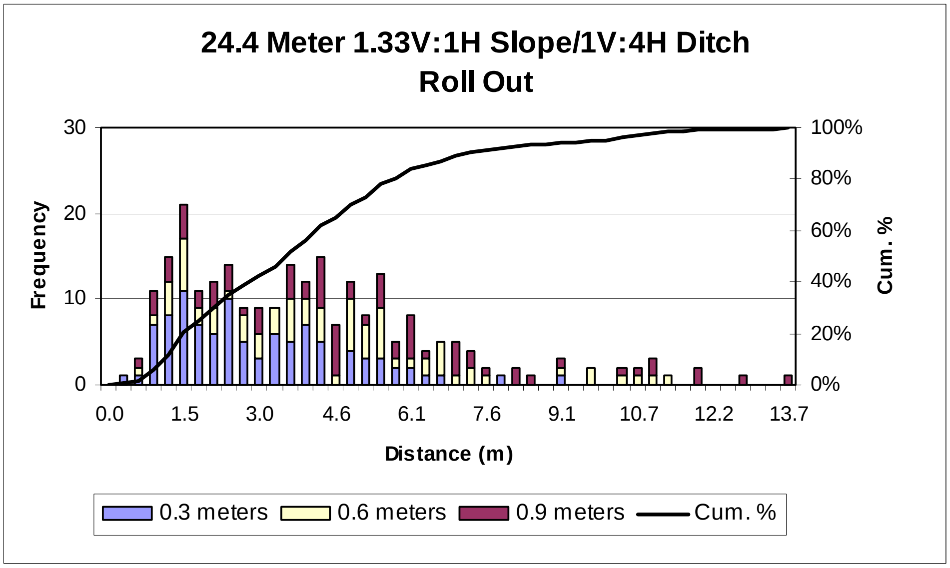

12.2 Meter 1.33V:1H Slope/1V:6H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0 0.6 1.2 1.8 2.4 3.0 3.7 4.3 4.9 5.5 6.1
0 10 20 30 40 50
0% 20% 40% 60% 80% 100%
0.3 meters
0.6 meters
0.9 meters
Cum. %

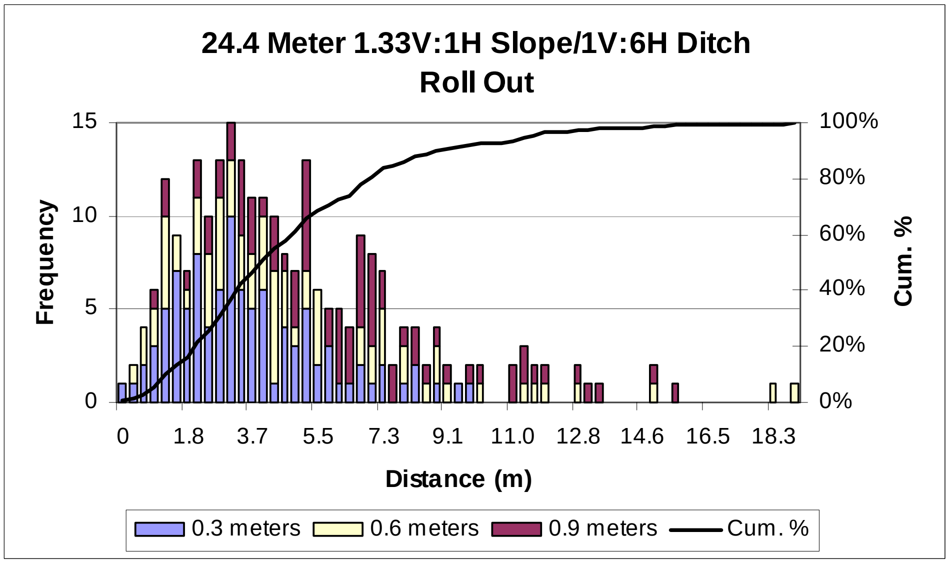

12.2 Meter 1.33V:1H Slope/Flat Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0 1.2 2.4 3.7 4.9 6.1 7.3 8.5 9.8 11.0 12.2 13.4
0 5 10 15 20
0% 20% 40% 60% 80% 100%
0.3 meters
0.6 meters
0.9 meters
Cum. %

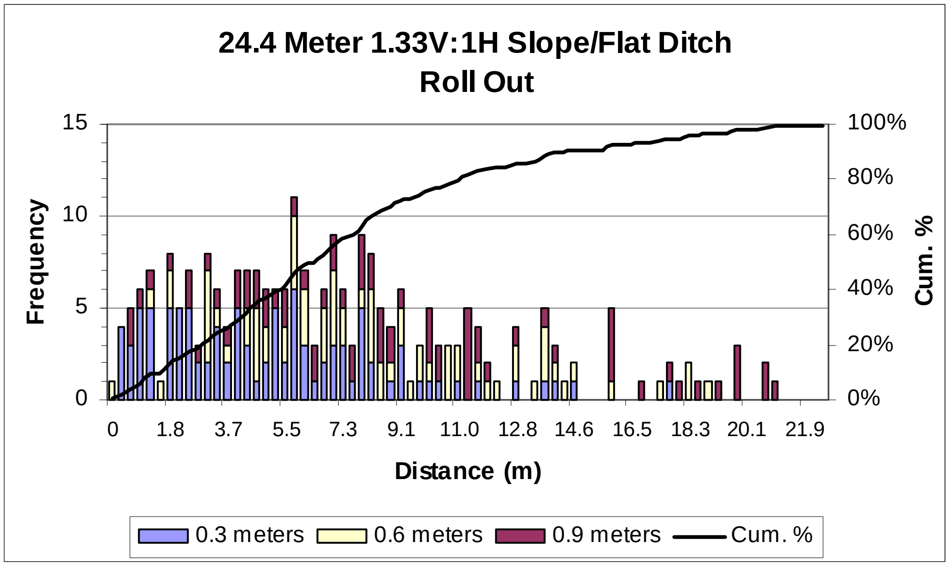

18.3 Meter 1.33V:1H Slope/1V:4H Ditch
Roll Out
Frequency
Cum. %
0
10
20
30
0%
20%
40%
60%
80%
100%
0
1.2
2.4
3.7
4.9
6.1
7.3
8.5
9.8
11.0
12.2
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

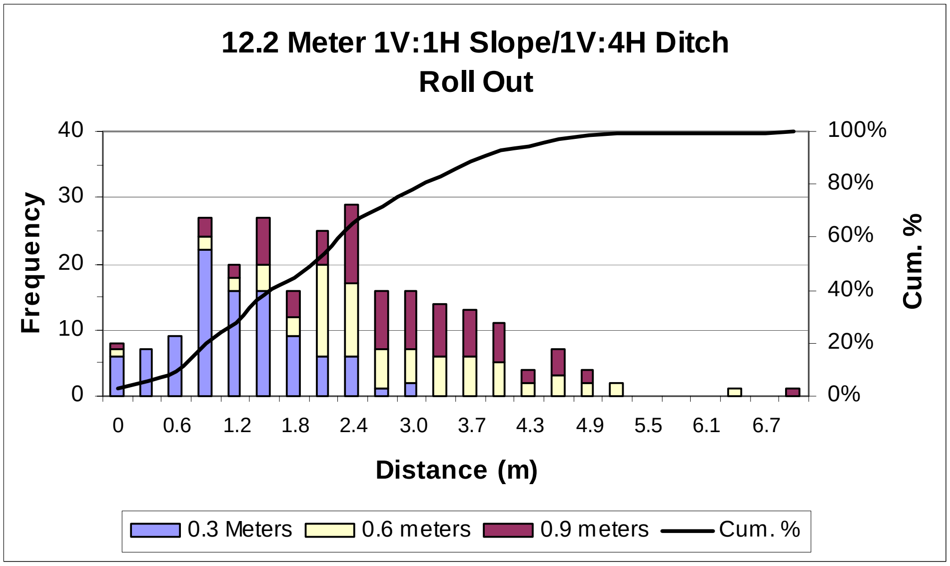

18.3 Meter 1.33V:1H Slope/1V:6H Ditch
Roll Out
Frequency
Cum. %
0
5
10
15
20
0%
20%
40%
60%
80%
100%
0
1.2
2.4
3.7
4.9
6.1
7.3
8.5
9.8
11.0
12.2
13.4
14.6
15.8
17.1
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %


18.3 Meter 1.33V:1H Slope/Flat Ditch
Roll Out
Frequency
Cum. %
0
5
10
15
20
0%
20%
40%
60%
80%
100%
0
1.8
3.7
5.5
7.3
9.1
11.0
12.8
14.6
16.5
18.3
20.1
21.9
Distance(m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

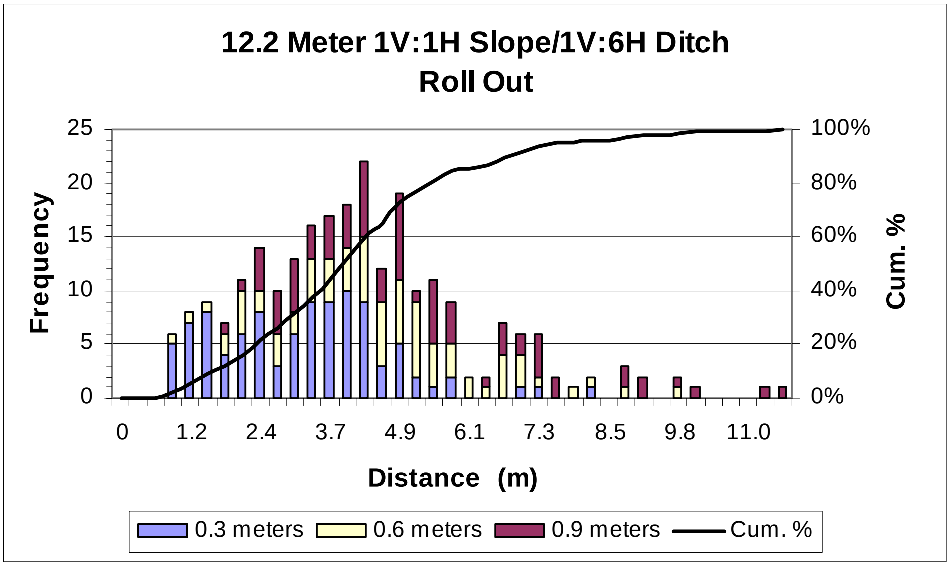

24.4 Meter 1.33V:1H Slope/1V:4H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %


24.4 Meter 1.33V:1H Slope/1V:6H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

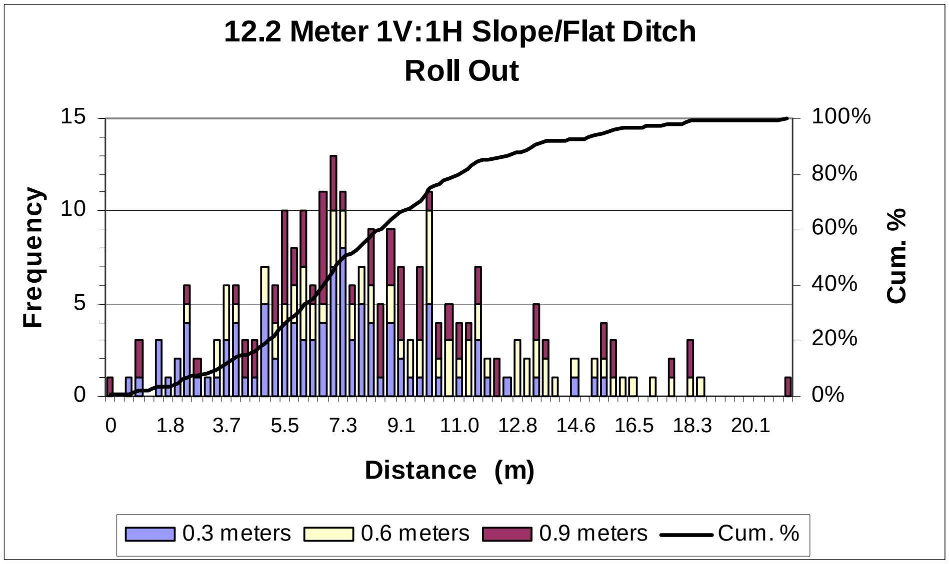

24.4 Meter 1.33V:1H Slope/Flat Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %



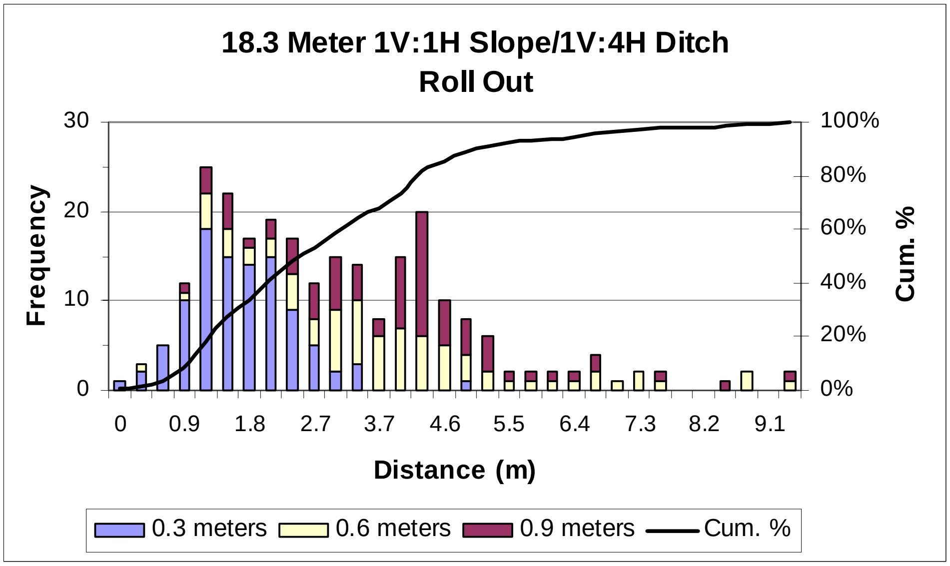
12.2 Meter 1V:1H Slope/1V:4H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0.3 Meters
0.6 meters
0.9 meters
Cum. %

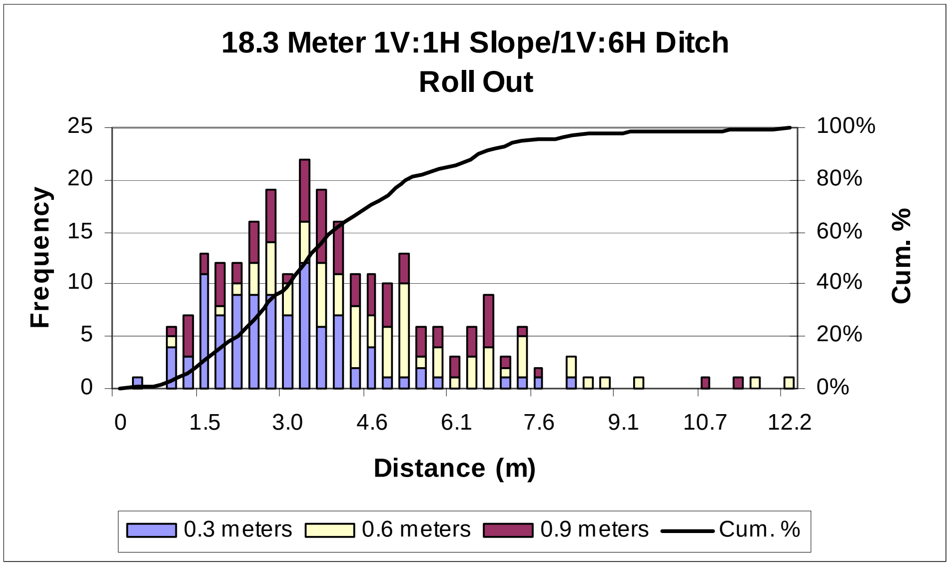


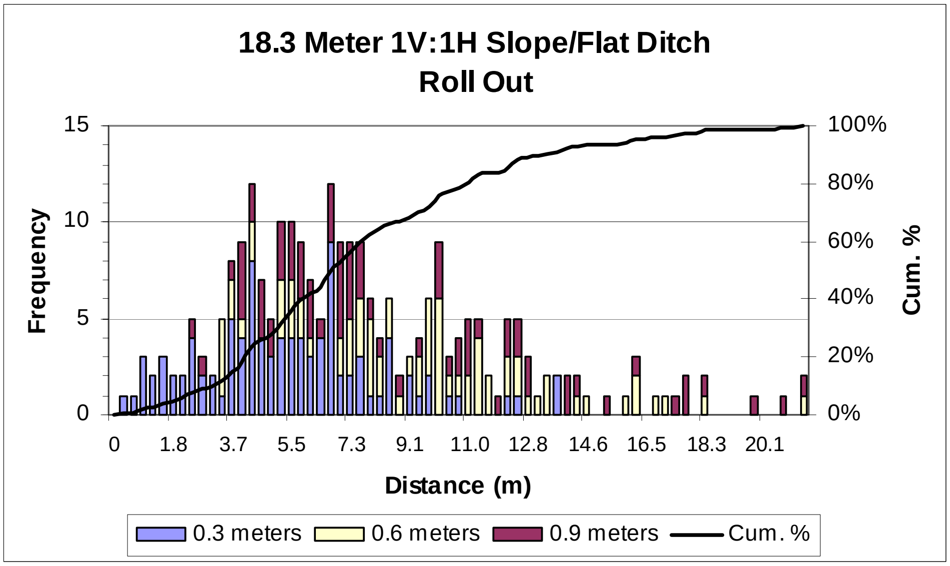
12.2 Meter 1V:1H Slope/1V:6H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

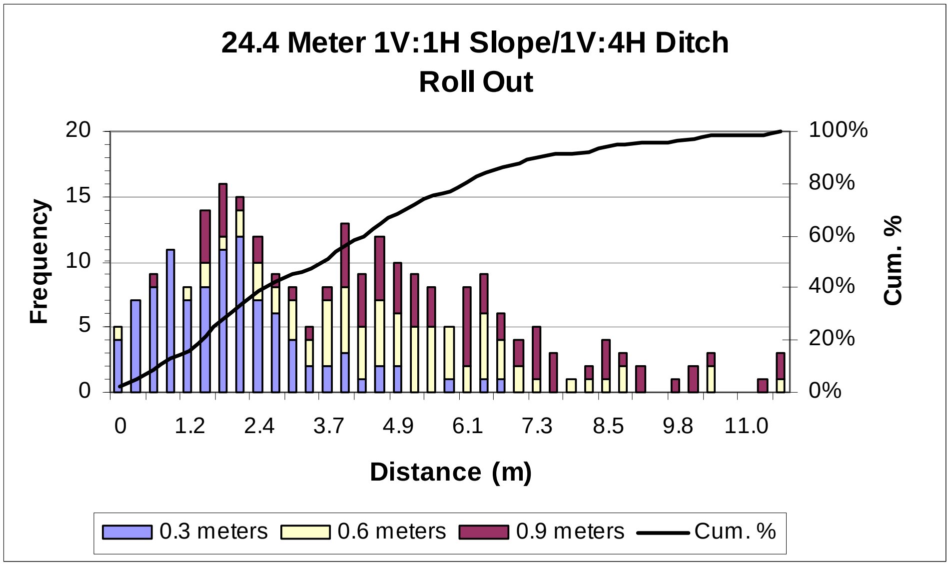


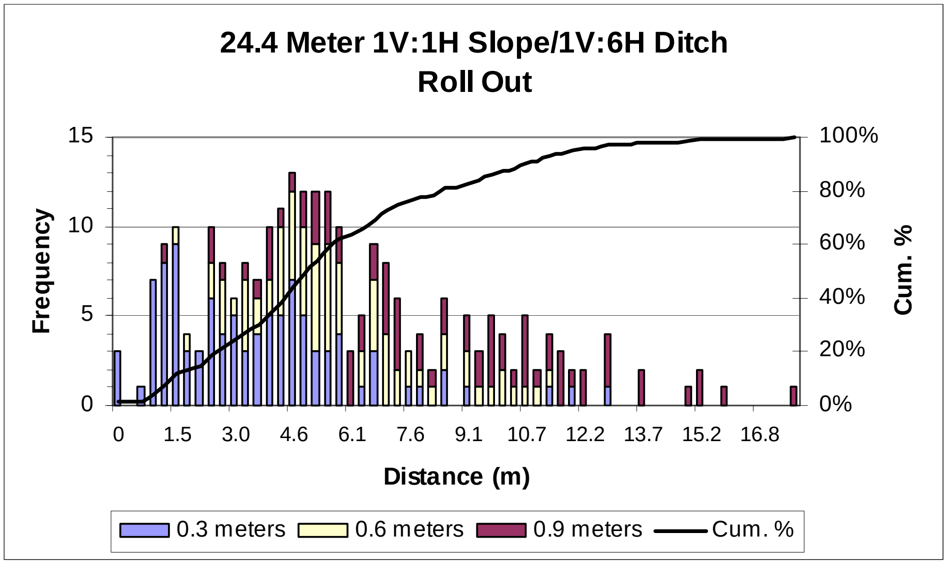
12.2 Meter 1V:1H Slope/Flat Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

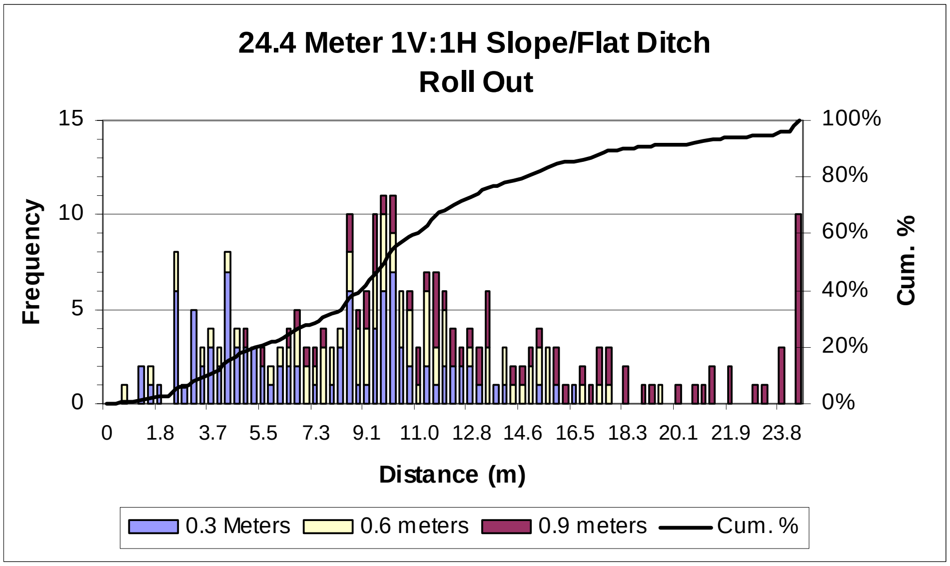

18.3 Meter 1V:1H Slope/1V:4H Ditch
Roll Out
30
20
10
0
100%
80%
60%
40%
20%
0%
Frequency
Cum. %
0
0.9
1.8
2.7
3.7
4.6
5.5
6.4
7.3
8.2
9.1
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %

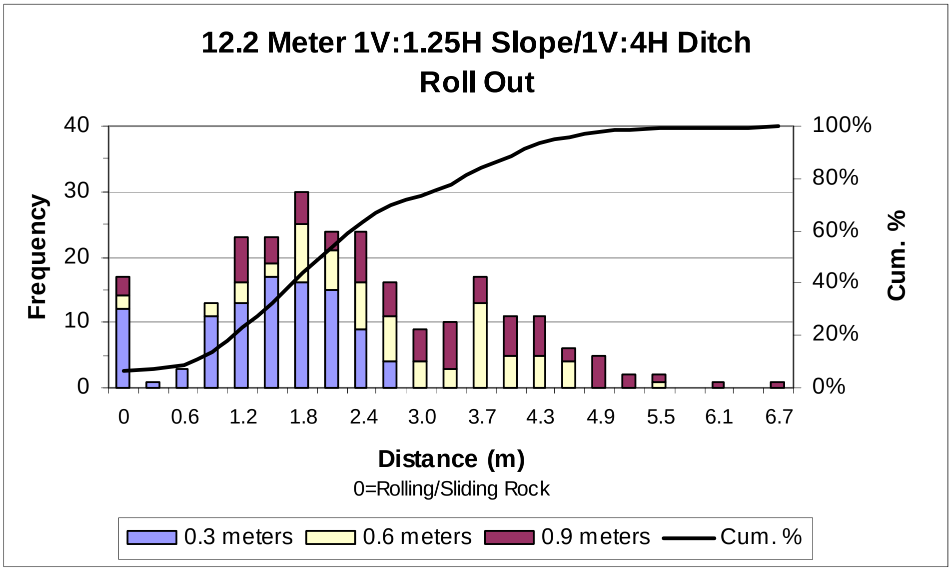

18.3 Meter 1V:1H Slope/1V:6H Ditch
Roll Out
25
20
15
10
5
0
100%
80%
60%
40%
20%
0%
Frequency
Cum. %
0
1.5
3.0
4.6
6.1
7.6
9.1
10.7
12.2
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %


18.3 Meter 1V:1H Slope/Flat Ditch
Roll Out
15
10
5
0
100%
80%
60%
40%
20%
0%
Frequency
Cum. %
0
1.8
3.7
5.5
7.3
9.1
11.0
12.8
14.6
16.5
18.3
20.1
Distance (m)
0.3 meters
0.6 meters
0.9 meters
Cum. %


24.4 Meter 1V:1H Slope/1V:4H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0 1.2 2.4 3.7 4.9 6.1 7.3 8.5 9.8 11.0
0 5 10 15 20
0% 20% 40% 60% 80% 100%
0.3 meters
0.6 meters
0.9 meters
Cum. %


24.4 Meter 1V:1H Slope/1V:6H Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0 1.5 3.0 4.6 6.1 7.6 9.1 10.7 12.2 13.7 15.2 16.8
0 5 10 15
0% 20% 40% 60% 80% 100%
0.3 meters
0.6 meters
0.9 meters
Cum. %


24.4 Meter 1V:1H Slope/Flat Ditch
Roll Out
Frequency
Cum. %
Distance (m)
0 1.8 3.7 5.5 7.3 9.1 11.0 12.8 14.6 16.5 18.3 20.1 21.9 23.8
0 5 10 15
0% 20% 40% 60% 80% 100%
0.3 Meters
0.6 meters
0.9 meters
Cum. %



Note: This was the only 1V:1.25H slope tested. Insufficient funds available to test additional slopes.

APPENDIX E: ROCKFALL ENERGY DATA

ROCKFALL ENERGY DATA

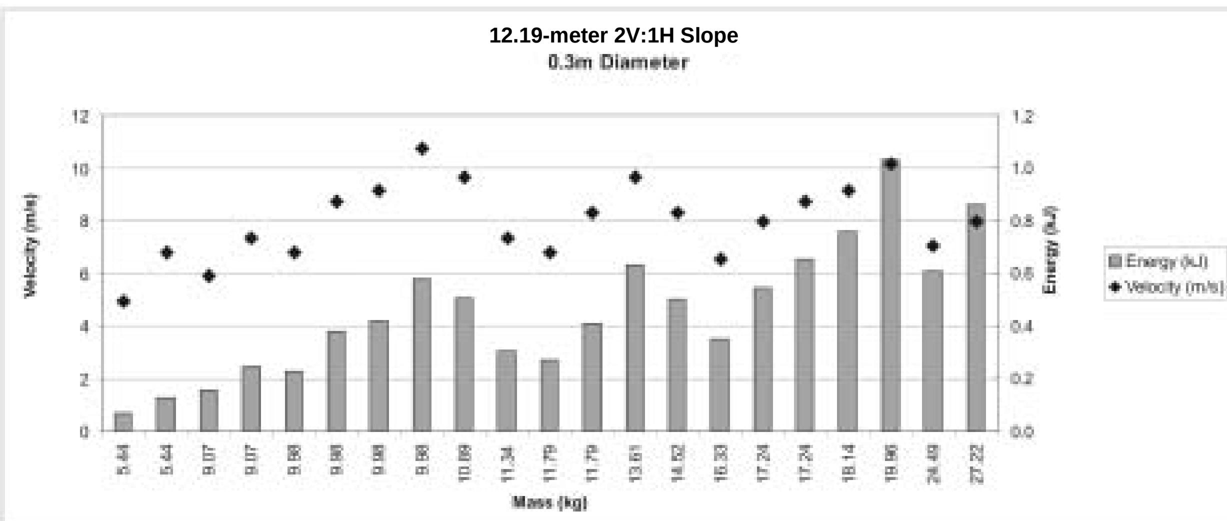
Selected rockfall energy data was recorded for the 2V:1H and 1.33V:1H slopes from the three heights tested. Sets of reference marks were placed on the slopes just above the toe of slope. Rocks within the 0.3-, 0.6-, and 0.9-meter categories were weighed and video taped during rolling. By analyzing the video data, the time it took the rolling rocks to pass through the reference marks was used to determine the rockfall velocity. The weight and velocity data was used to calculate the kinetic energy of the falling rocks upon entering the catchment area.

The rockfall velocities are a function of cutslope angle and height and the amount of time the rocks are in contact with the slope. Velocities tended to be within a narrow range of values for each of the two slope angles tested with slight increases as the slope height increased. The variations are primarily attributable to the path taken by the rockfall during descent.

In general, when in contact with the slope, friction slows the rocks and lowers the resulting energies. Because the rocks are less often in contact with the slope (bouncing not rolling) on the 2V:1H slopes, the resulting velocities and energies are higher than for the 1.33V:1H slopes. This relationship explains why rolling rocks will come to a complete stop on flatter slopes and not make it to the catchment area.

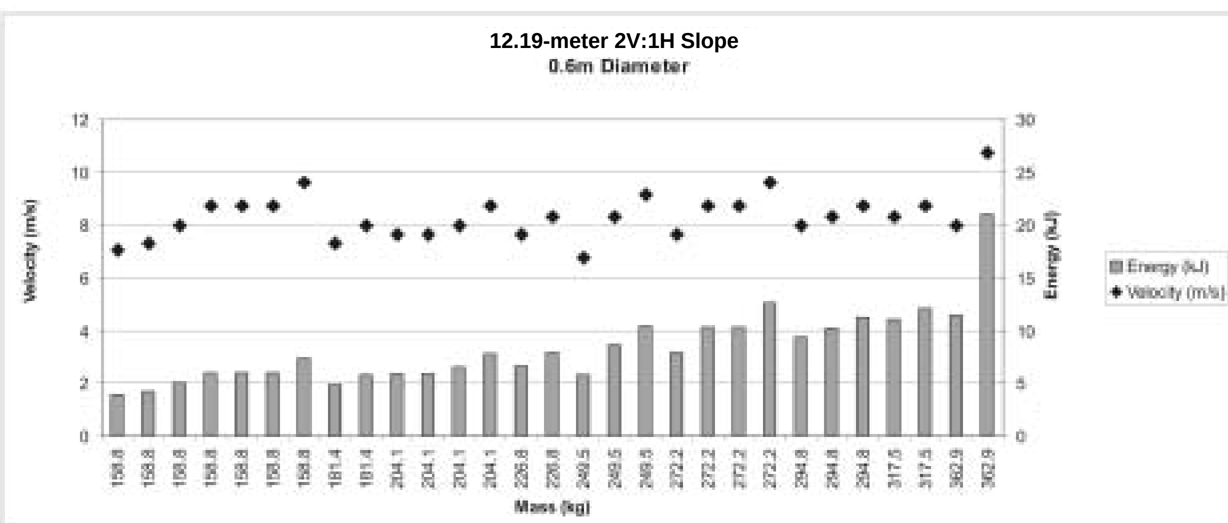
ENERGY OF 0.3-METER DIAMETER ROCKS
12.2-METER, 2V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
5.44	6.10	37	1.23	4.94	0.07
5.44	6.10	27	0.90	6.77	0.12
9.07	6.10	31	1.03	5.90	0.16
9.07	6.10	25	0.83	7.32	0.24
9.98	6.10	27	0.90	6.77	0.23
9.98	6.10	21	0.70	8.71	0.38
9.98	6.10	20	0.67	9.14	0.42
9.98	6.10	17	0.57	10.76	0.58
10.88	6.10	19	0.63	9.63	0.50
11.34	6.10	25	0.83	7.32	0.30
11.79	6.10	27	0.90	6.77	0.27
11.79	6.10	22	0.73	8.31	0.41
13.61	6.10	19	0.63	9.63	0.63
14.51	6.10	22	0.73	8.31	0.50
16.33	6.10	28	0.93	6.53	0.35
17.23	6.10	23	0.77	7.95	0.54
17.23	6.10	21	0.70	8.71	0.65
18.14	6.10	20	0.67	9.14	0.76
19.95	6.10	18	0.60	10.16	1.03
24.49	6.10	26	0.87	7.03	0.61
27.21	6.10	23	0.77	7.95	0.86



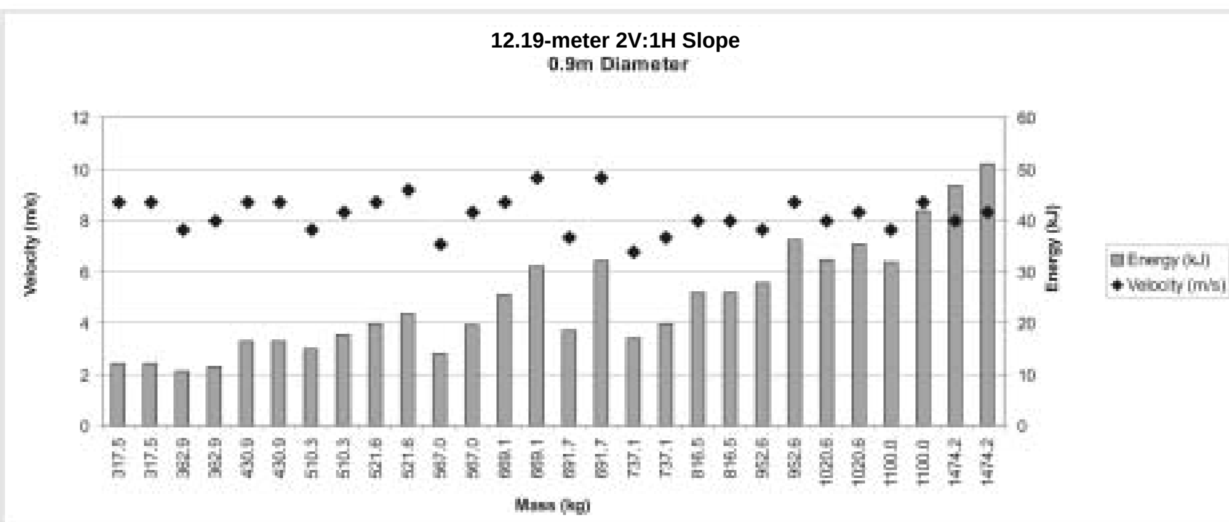
ENERGY OF 0.6-METER DIAMETER ROCKS
12.2-METER, 2V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
158.73	6.10	26	0.87	7.03	3.93
158.73	6.10	25	0.83	7.32	4.25
158.73	6.10	23	0.77	7.95	5.02
158.73	6.10	21	0.70	8.71	6.02
158.73	6.10	21	0.70	8.71	6.02
158.73	6.10	21	0.70	8.71	6.02
158.73	6.10	19	0.63	9.63	7.35
181.41	6.10	25	0.83	7.32	4.85
181.41	6.10	23	0.77	7.95	5.73
204.08	6.10	24	0.80	7.62	5.92
204.08	6.10	24	0.80	7.62	5.92
204.08	6.10	23	0.77	7.95	6.45
204.08	6.10	21	0.70	8.71	7.74
226.76	6.10	24	0.80	7.62	6.58
226.76	6.10	22	0.73	8.31	7.83
249.43	6.10	27	0.90	6.77	5.72
249.43	6.10	22	0.73	8.31	8.62
249.43	6.10	20	0.67	9.14	10.43
272.11	6.10	24	0.80	7.62	7.90
272.11	6.10	21	0.70	8.71	10.32
272.11	6.10	21	0.70	8.71	10.32
272.11	6.10	19	0.63	9.63	12.60
294.78	6.10	23	0.77	7.95	9.32
294.78	6.10	22	0.73	8.31	10.19
294.78	6.10	21	0.70	8.71	11.18
317.46	6.10	22	0.73	8.31	10.97
317.46	6.10	21	0.70	8.71	12.04
362.81	6.10	23	0.77	7.95	11.47
362.81	6.10	17	0.57	10.76	20.99



ENERGY OF 0.9-METER DIAMETER ROCKS
12.2-METER, 2V:1H SLOPE

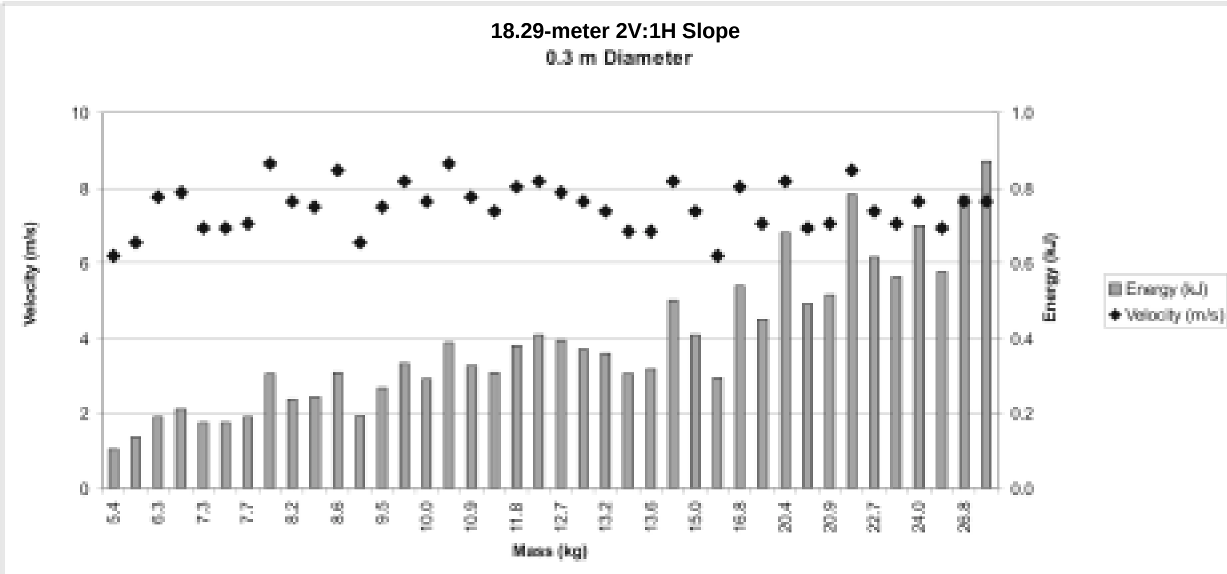
Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
317.46	6.10	21	0.70	8.71	12.04
317.46	6.10	21	0.70	8.71	12.04
362.81	6.10	24	0.80	7.62	10.53
362.81	6.10	23	0.77	7.95	11.47
430.84	6.10	21	0.70	8.71	16.34
430.84	6.10	21	0.70	8.71	16.34
510.20	6.10	24	0.80	7.62	14.81
510.20	6.10	22	0.73	8.31	17.63
521.54	6.10	21	0.70	8.71	19.78
521.54	6.10	20	0.67	9.14	21.80
566.89	6.10	26	0.87	7.03	14.02
566.89	6.10	22	0.73	8.31	19.59
668.93	6.10	21	0.70	8.71	25.37
668.93	6.10	19	0.63	9.63	30.99
691.61	6.10	25	0.83	7.32	18.50
691.61	6.10	19	0.63	9.63	32.04
736.96	6.10	27	0.90	6.77	16.91
736.96	6.10	25	0.83	7.32	19.72
816.33	6.10	23	0.77	7.95	25.81
816.33	6.10	23	0.77	7.95	25.81
952.38	6.10	24	0.80	7.62	27.65
952.38	6.10	21	0.70	8.71	36.11
1020.41	6.10	23	0.77	7.95	32.26
1020.41	6.10	22	0.73	8.31	35.26
1099.77	6.10	24	0.80	7.62	31.93
1099.77	6.10	21	0.70	8.71	41.70
1473.92	6.10	23	0.77	7.95	46.59
1473.92	6.10	22	0.73	8.31	50.93



ENERGY OF 0.3-METER DIAMETER ROCKS
18.3-METER, 2V:1H SLOPE

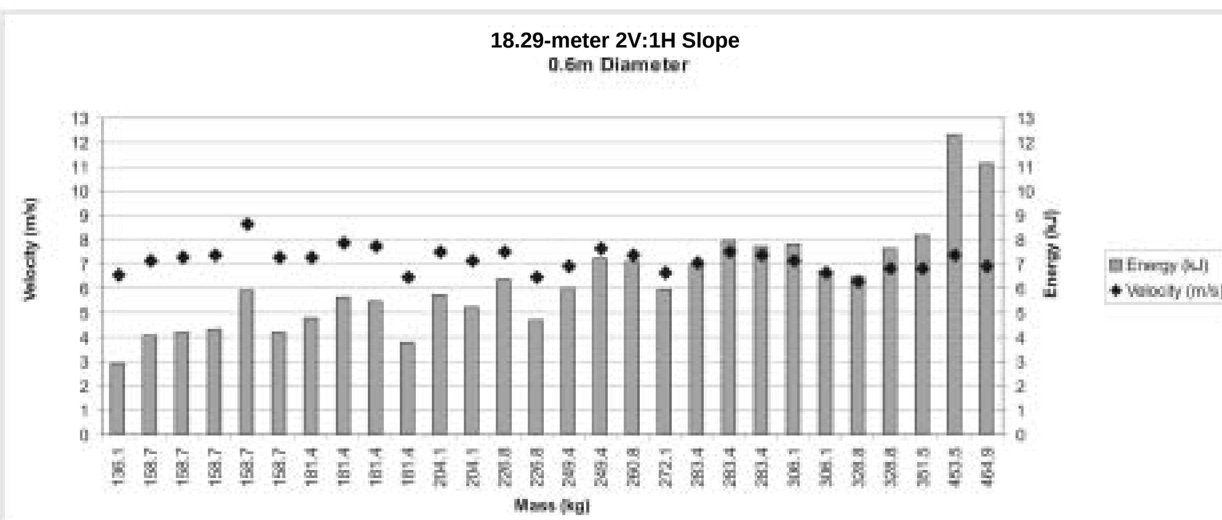
Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
5.44	15.24	74	2.47	6.18	0.10
6.35	15.24	70	2.33	6.53	0.14
6.35	15.24	59	1.97	7.75	0.19
6.80	15.24	58	1.93	7.88	0.21
7.26	15.24	66	2.20	6.93	0.17
7.26	15.24	66	2.20	6.93	0.17
7.71	15.24	65	2.17	7.03	0.19
8.16	15.24	53	1.77	8.63	0.30
8.16	15.24	60	2.00	7.62	0.24
8.62	15.24	61	2.03	7.50	0.24
8.62	15.24	54	1.80	8.47	0.31
9.07	15.24	70	2.33	6.53	0.19
9.52	15.24	61	2.03	7.50	0.27
9.98	15.24	56	1.87	8.16	0.33
9.98	15.24	60	2.00	7.62	0.29
10.43	15.24	53	1.77	8.63	0.39
10.88	15.24	59	1.97	7.75	0.33
11.34	15.24	62	2.07	7.37	0.31
11.79	15.24	57	1.90	8.02	0.38
12.24	15.24	56	1.87	8.16	0.41
12.70	15.24	58	1.93	7.88	0.39
12.70	15.24	60	2.00	7.62	0.37
13.15	15.24	62	2.07	7.37	0.36
13.15	15.24	67	2.23	6.82	0.31
13.61	15.24	67	2.23	6.82	0.32
14.97	15.24	56	1.87	8.16	0.50
14.97	15.24	62	2.07	7.37	0.41
15.42	15.24	74	2.47	6.18	0.29
16.78	15.24	57	1.90	8.02	0.54
18.14	15.24	65	2.17	7.03	0.45
20.41	15.24	56	1.87	8.16	0.68
20.41	15.24	66	2.20	6.93	0.49
20.86	15.24	65	2.17	7.03	0.52
21.77	15.24	54	1.80	8.47	0.78
22.68	15.24	62	2.07	7.37	0.62
22.68	15.24	65	2.17	7.03	0.56
24.04	15.24	60	2.00	7.62	0.70
24.04	15.24	66	2.20	6.93	0.58
26.76	15.24	60	2.00	7.62	0.78
29.93	15.24	60	2.00	7.62	0.87

ENERGY OF 0.3-METER DIAMETER ROCKS
18.3-METER, 2V:1H SLOPE



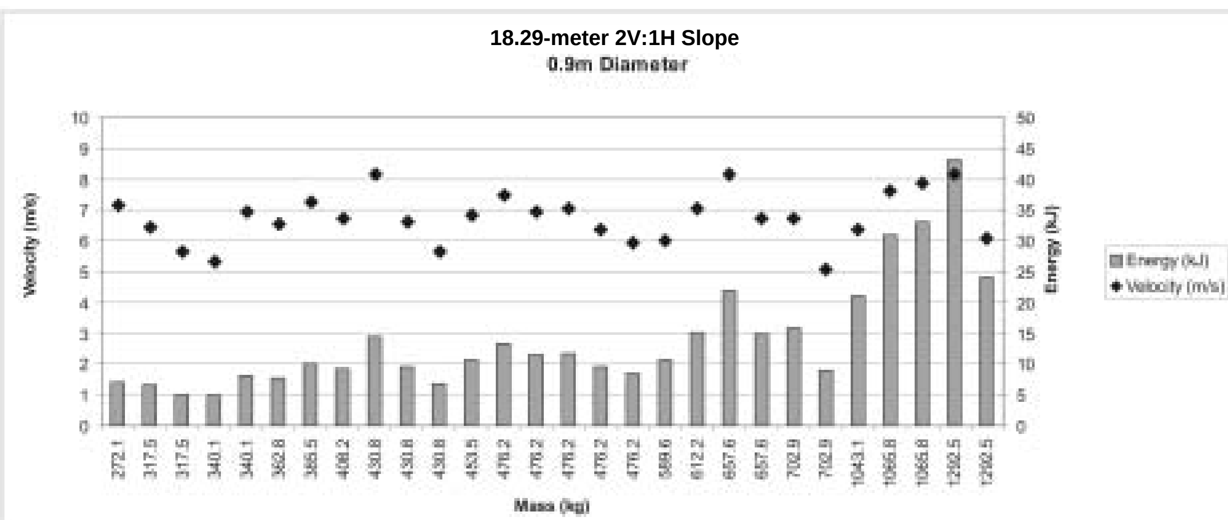
ENERGY OF 0.6-METER DIAMETER ROCKS
18.3-METER, 2V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
136.05	15.24	70	2.33	6.53	2.90
158.73	15.24	64	2.13	7.14	4.05
158.73	15.24	63	2.10	7.26	4.18
158.73	15.24	62	2.07	7.37	4.32
158.73	15.24	53	1.77	8.63	5.91
158.73	15.24	63	2.10	7.26	4.18
181.41	15.24	63	2.10	7.26	4.78
181.41	15.24	58	1.93	7.88	5.64
181.41	15.24	59	1.97	7.75	5.45
181.41	15.24	71	2.37	6.44	3.76
204.08	15.24	61	2.03	7.50	5.73
204.08	15.24	64	2.13	7.14	5.21
226.76	15.24	61	2.03	7.50	6.37
226.76	15.24	71	2.37	6.44	4.70
249.43	15.24	66	2.20	6.93	5.98
249.43	15.24	60	2.00	7.62	7.24
260.77	15.24	62	2.07	7.37	7.09
272.11	15.24	69	2.30	6.63	5.97
283.45	15.24	65	2.17	7.03	7.01
283.45	15.24	61	2.03	7.50	7.96
283.45	15.24	62	2.07	7.37	7.71
306.12	15.24	64	2.13	7.14	7.81
306.12	15.24	69	2.30	6.63	6.72
328.80	15.24	73	2.43	6.26	6.45
328.80	15.24	67	2.23	6.82	7.66
351.47	15.24	67	2.23	6.82	8.18
453.51	15.24	62	2.07	7.37	12.33
464.85	15.24	66	2.20	6.93	11.15



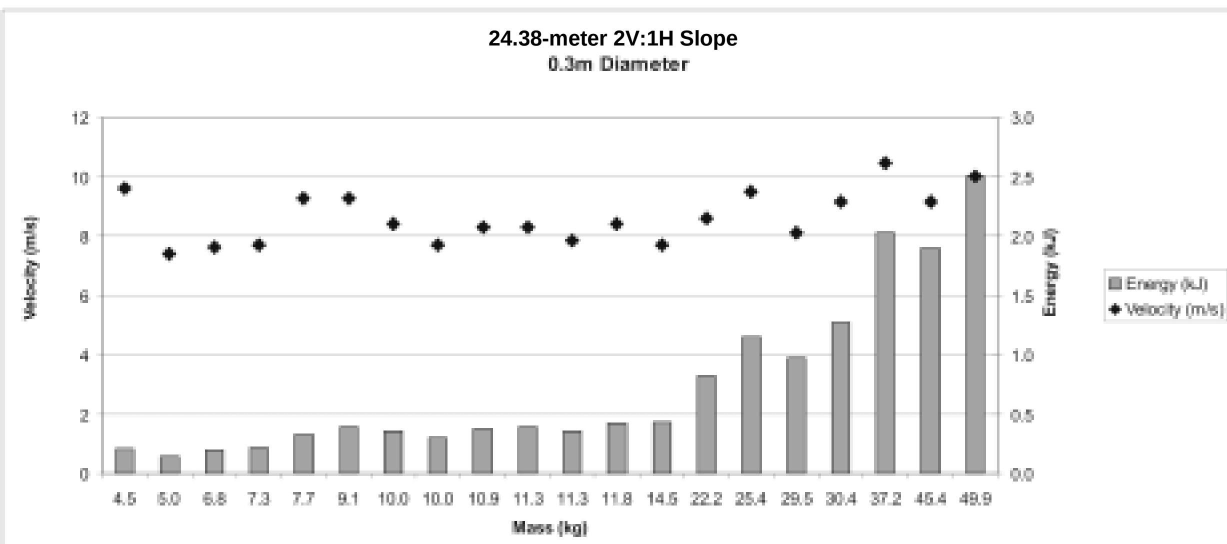
ENERGY OF 0.9-METER DIAMETER ROCKS
18.3-METER, 2V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
272.11	15.24	64	2.13	7.14	6.94
317.46	15.24	71	2.37	6.44	6.58
317.46	15.24	81	2.70	5.64	5.06
340.14	15.24	86	2.87	5.32	4.81
340.14	15.24	66	2.20	6.93	8.16
362.81	15.24	70	2.33	6.53	7.74
385.49	15.24	63	2.10	7.26	10.15
408.16	15.24	68	2.27	6.72	9.23
430.84	15.24	56	1.87	8.16	14.36
430.84	15.24	69	2.30	6.63	9.46
430.84	15.24	81	2.70	5.64	6.86
453.51	15.24	67	2.23	6.82	10.56
476.19	15.24	61	2.03	7.50	13.38
476.19	15.24	66	2.20	6.93	11.43
476.19	15.24	65	2.17	7.03	11.78
476.19	15.24	72	2.40	6.35	9.60
476.19	15.24	77	2.57	5.94	8.39
589.57	15.24	76	2.53	6.02	10.67
612.24	15.24	65	2.17	7.03	15.15
657.60	15.24	56	1.87	8.16	21.92
657.60	15.24	68	2.27	6.72	14.86
702.95	15.24	68	2.27	6.72	15.89
702.95	15.24	90	3.00	5.08	9.07
1043.08	15.24	72	2.40	6.35	21.03
1065.76	15.24	60	2.00	7.62	30.94
1065.76	15.24	58	1.93	7.88	33.11
1292.52	15.24	56	1.87	8.16	43.08
1292.52	15.24	75	2.50	6.10	24.02



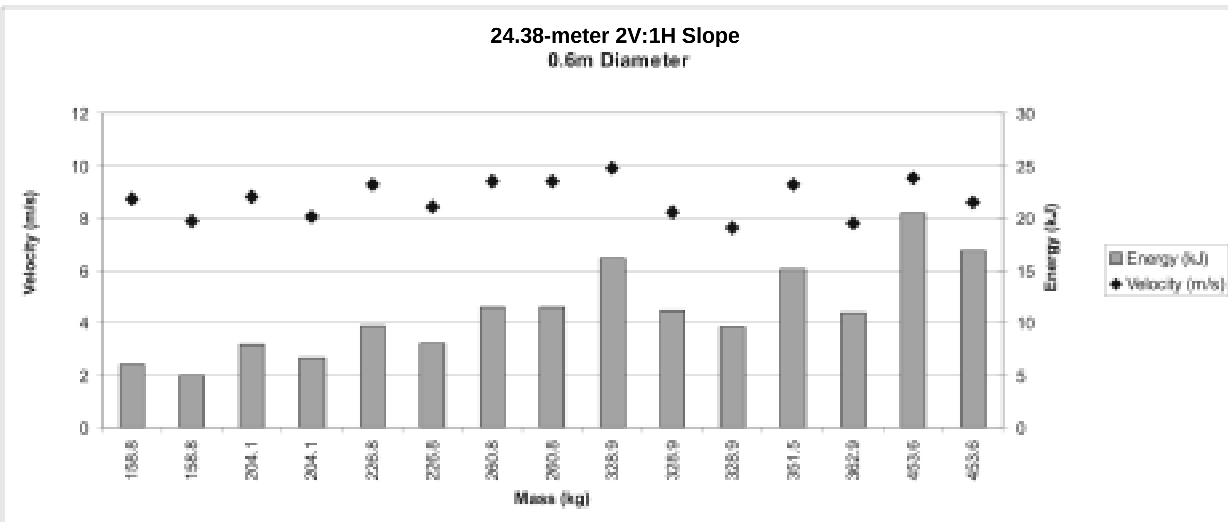
ENERGY OF 0.3-METER DIAMETER ROCKS
24.4-METER, 2V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
4.54	24.38	76	2.53	9.63	0.21
4.99	24.38	99	3.30	7.39	0.14
6.80	24.38	96	3.20	7.62	0.20
7.26	24.38	95	3.17	7.70	0.22
7.71	24.38	79	2.63	9.26	0.33
9.07	24.38	79	2.63	9.26	0.39
9.98	24.38	87	2.90	8.41	0.35
9.98	24.38	95	3.17	7.70	0.30
10.88	24.38	88	2.93	8.31	0.38
11.34	24.38	88	2.93	8.31	0.39
11.34	24.38	93	3.10	7.87	0.35
11.79	24.38	87	2.90	8.41	0.42
14.51	24.38	95	3.17	7.70	0.43
22.22	24.38	85	2.83	8.61	0.82
25.40	24.38	77	2.57	9.50	1.15
29.48	24.38	90	3.00	8.13	0.97
30.39	24.38	80	2.67	9.14	1.27
37.19	24.38	70	2.33	10.45	2.03
45.35	24.38	80	2.67	9.14	1.90
49.89	24.38	73	2.43	10.02	2.50



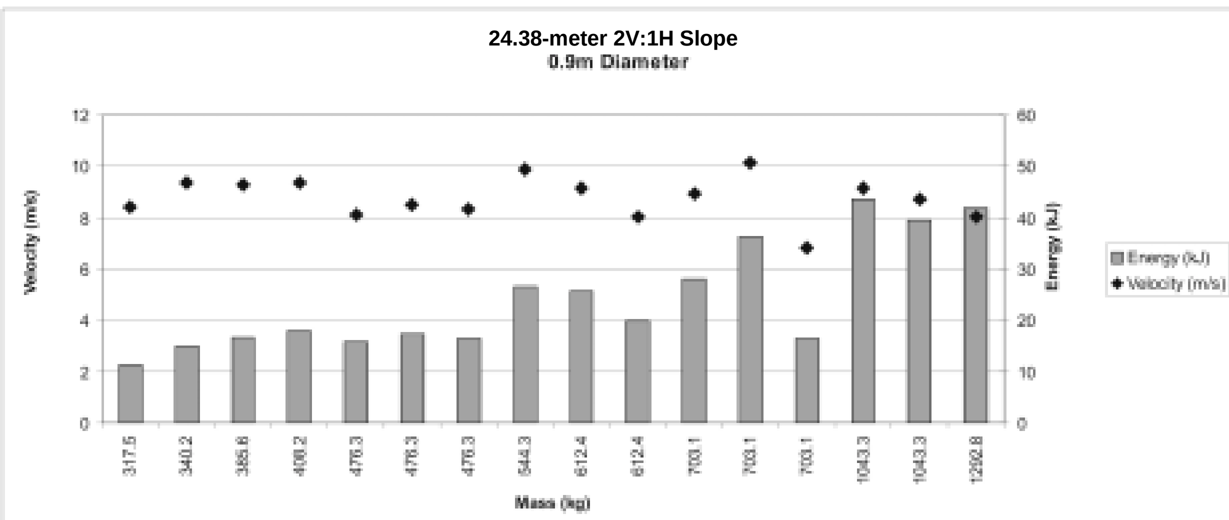
ENERGY OF 0.6-METER DIAMETER ROCKS
24.4-METER, 2V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
158.73	24.38	84	2.80	8.71	6.02
158.73	24.38	93	3.10	7.87	4.91
204.08	24.38	83	2.77	8.81	7.93
204.08	24.38	91	3.03	8.04	6.59
226.76	24.38	79	2.63	9.26	9.72
226.76	24.38	87	2.90	8.41	8.02
260.77	24.38	78	2.60	9.38	11.47
260.77	24.38	78	2.60	9.38	11.47
328.80	24.38	74	2.47	9.89	16.07
328.80	24.38	89	2.97	8.22	11.11
328.80	24.38	96	3.20	7.62	9.55
351.47	24.38	79	2.63	9.26	15.07
362.81	24.38	94	3.13	7.78	10.99
453.51	24.38	77	2.57	9.50	20.47
453.51	24.38	85	2.83	8.61	16.79



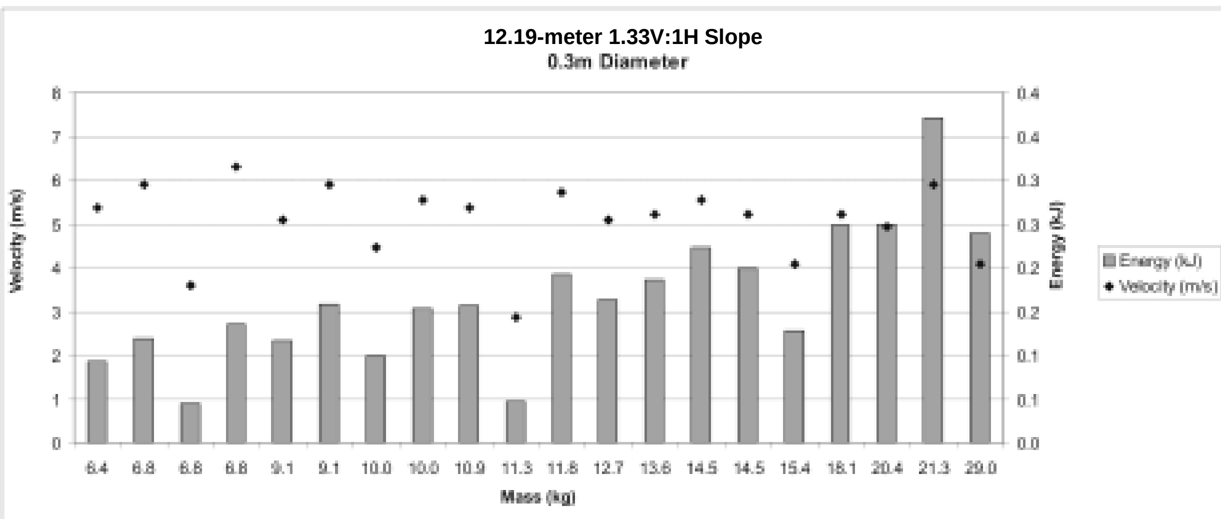
ENERGY OF 0.9-METER DIAMETER ROCKS
24.4-METER, 2V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
317.46	24.38	87	2.90	8.41	11.22
340.14	24.38	78	2.60	9.38	14.96
385.49	24.38	79	2.63	9.26	16.53
408.16	24.38	78	2.60	9.38	17.95
476.19	24.38	90	3.00	8.13	15.73
476.19	24.38	86	2.87	8.51	17.23
476.19	24.38	88	2.93	8.31	16.45
544.22	24.38	74	2.47	9.89	26.59
612.24	24.38	80	2.67	9.14	25.60
612.24	24.38	91	3.03	8.04	19.78
702.95	24.38	82	2.73	8.92	27.97
702.95	24.38	72	2.40	10.16	36.28
702.95	24.38	107	3.57	6.84	16.43
1043.08	24.38	80	2.67	9.14	43.61
1043.08	24.38	84	2.80	8.71	39.55
1292.52	24.38	91	3.03	8.04	41.76



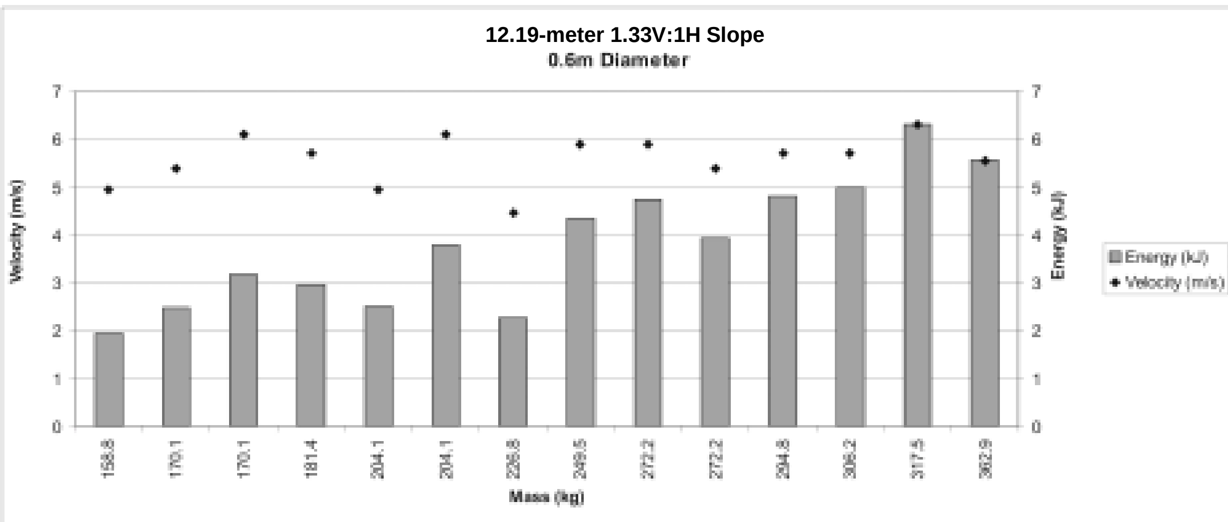
ENERGY OF 0.3-METER DIAMETER ROCKS
12.2-METER, 1.33V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
6.35	6.10	34	1.13	5.38	0.09
6.80	6.10	31	1.03	5.90	0.12
6.80	6.10	51	1.70	3.59	0.04
6.80	6.10	29	0.97	6.31	0.14
9.07	6.10	36	1.20	5.08	0.12
9.07	6.10	31	1.03	5.90	0.16
9.98	6.10	41	1.37	4.46	0.10
9.98	6.10	33	1.10	5.54	0.15
10.88	6.10	34	1.13	5.38	0.16
11.34	6.10	64	2.13	2.86	0.05
11.79	6.10	32	1.07	5.72	0.19
12.70	6.10	36	1.20	5.08	0.16
13.61	6.10	35	1.17	5.23	0.19
14.51	6.10	33	1.10	5.54	0.22
14.51	6.10	35	1.17	5.23	0.20
15.42	6.10	45	1.50	4.06	0.13
18.14	6.10	35	1.17	5.23	0.25
20.41	6.10	37	1.23	4.94	0.25
21.32	6.10	31	1.03	5.90	0.37
29.02	6.10	45	1.50	4.06	0.24



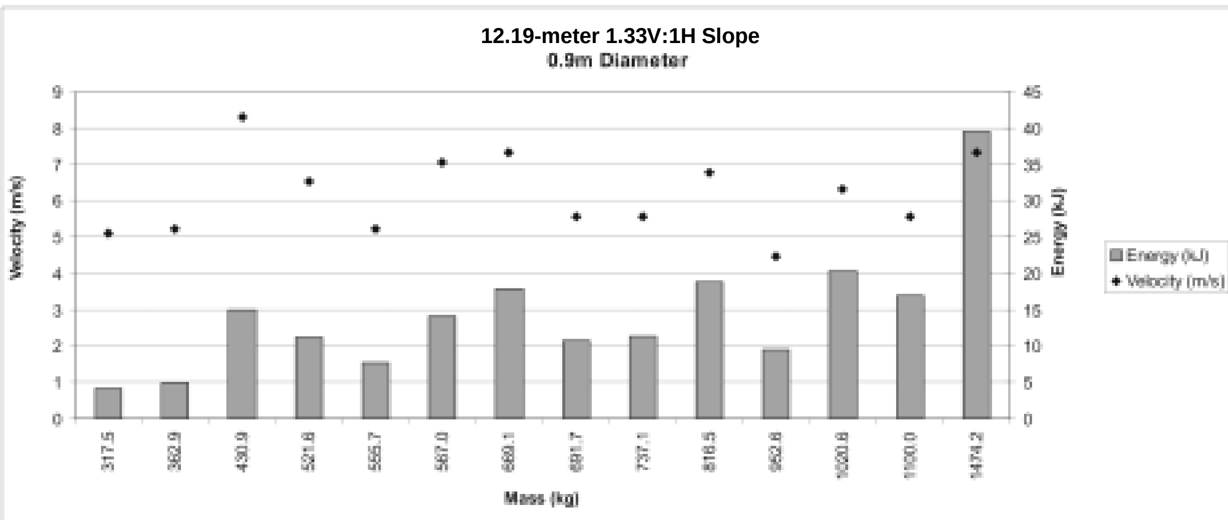
ENERGY OF 0.6-METER DIAMETER ROCKS
12.2-METER, 1.33V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
158.73	6.10	37	1.23	4.94	1.94
170.07	6.10	34	1.13	5.38	2.46
170.07	6.10	30	1.00	6.10	3.16
181.41	6.10	32	1.07	5.72	2.96
204.08	6.10	37	1.23	4.94	2.49
204.08	6.10	30	1.00	6.10	3.79
226.76	6.10	41	1.37	4.46	2.26
249.43	6.10	31	1.03	5.90	4.34
272.11	6.10	31	1.03	5.90	4.74
272.11	6.10	34	1.13	5.38	3.94
294.78	6.10	32	1.07	5.72	4.81
306.12	6.10	32	1.07	5.72	5.00
317.46	6.10	29	0.97	6.31	6.31
362.81	6.10	33	1.10	5.54	5.57



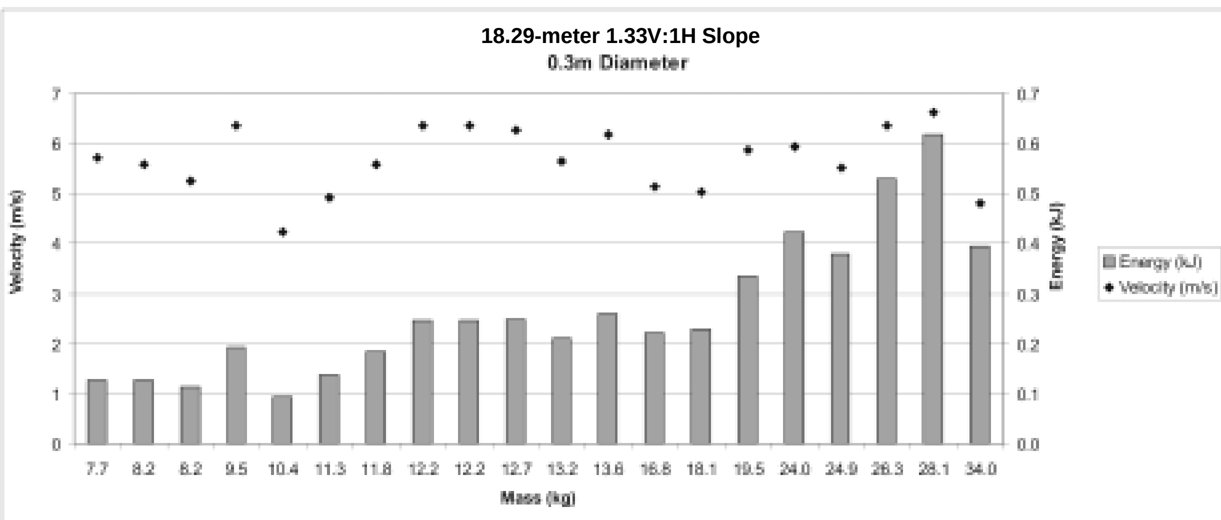
ENERGY OF 0.9-METER DIAMETER ROCKS
12.2-METER, 1.33V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
317.46	6.10	36	1.20	5.08	4.10
362.81	6.10	35	1.17	5.23	4.95
430.84	6.10	22	0.73	8.31	14.89
521.54	6.10	28	0.93	6.53	11.12
555.56	6.10	35	1.17	5.23	7.58
566.89	6.10	26	0.87	7.03	14.02
668.93	6.10	25	0.83	7.32	17.90
691.61	6.10	33	1.10	5.54	10.62
736.96	6.10	33	1.10	5.54	11.32
816.33	6.10	27	0.90	6.77	18.73
952.38	6.10	41	1.37	4.46	9.47
1020.41	6.10	29	0.97	6.31	20.29
1099.77	6.10	33	1.10	5.54	16.89
1473.92	6.10	25	0.83	7.32	39.44



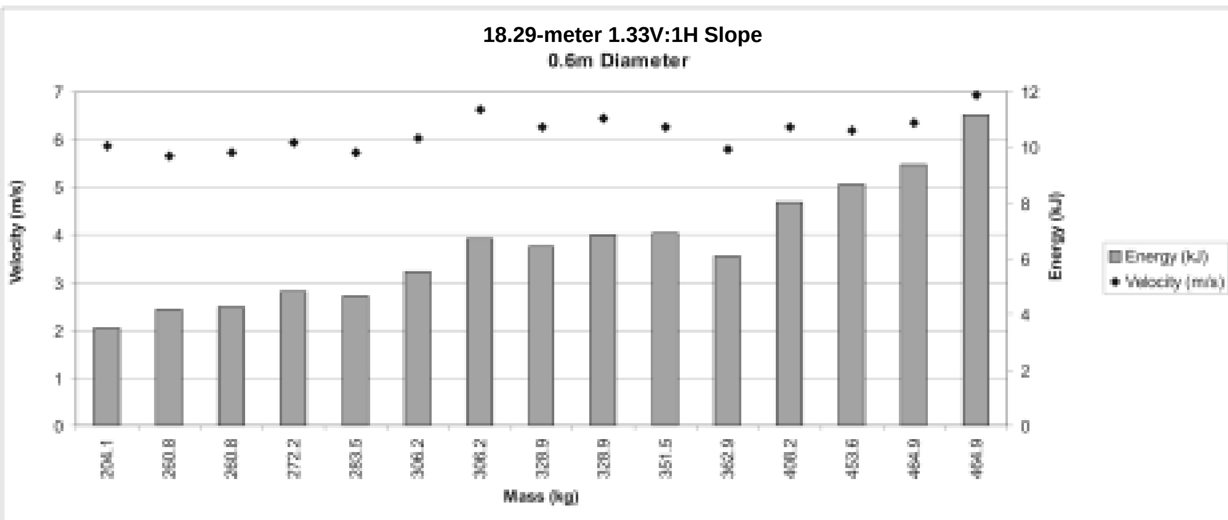
ENERGY OF 0.3-METER DIAMETER ROCKS
18.3-METER, 1.33V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
5.44	15.24	80	2.67	5.72	0.13
6.80	15.24	82	2.73	5.58	0.13
7.26	15.24	87	2.90	5.26	0.11
7.71	15.24	72	2.40	6.35	0.19
8.16	15.24	108	3.60	4.23	0.09
9.52	15.24	93	3.10	4.92	0.14
9.98	15.24	82	2.73	5.58	0.18
10.43	15.24	72	2.40	6.35	0.25
11.34	15.24	72	2.40	6.35	0.25
11.79	15.24	73	2.43	6.26	0.25
11.79	15.24	81	2.70	5.64	0.21
14.06	15.24	74	2.47	6.18	0.26
14.97	15.24	89	2.97	5.14	0.22
14.97	15.24	91	3.03	5.02	0.23
15.87	15.24	78	2.60	5.86	0.34
17.69	15.24	77	2.57	5.94	0.42
18.14	15.24	83	2.77	5.51	0.38
18.14	15.24	72	2.40	6.35	0.53
29.93	15.24	69	2.30	6.63	0.62
30.84	15.24	95	3.17	4.81	0.39



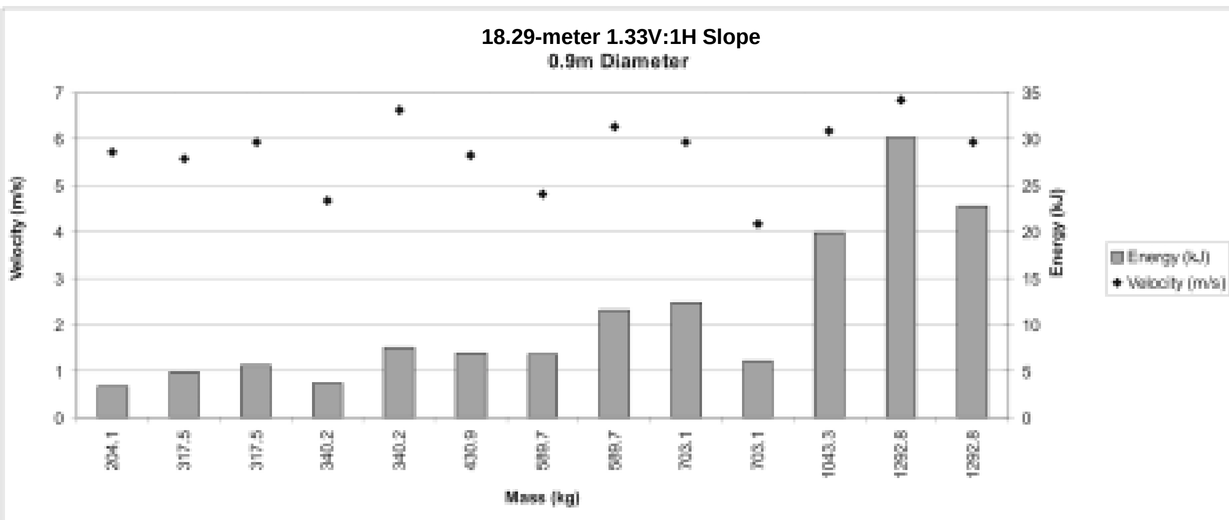
ENERGY OF 0.6-METER DIAMETER ROCKS
18.3-METER, 1.33V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
204.08	15.24	78	2.60	5.86	3.51
260.77	15.24	81	2.70	5.64	4.15
260.77	15.24	80	2.67	5.72	4.26
272.11	15.24	77	2.57	5.94	4.80
283.45	15.24	80	2.67	5.72	4.63
306.12	15.24	76	2.53	6.02	5.54
306.12	15.24	69	2.30	6.63	6.72
328.80	15.24	73	2.43	6.26	6.45
328.80	15.24	71	2.37	6.44	6.82
351.47	15.24	73	2.43	6.26	6.89
362.81	15.24	79	2.63	5.79	6.08
408.16	15.24	73	2.43	6.26	8.01
453.51	15.24	74	2.47	6.18	8.66
464.85	15.24	72	2.40	6.35	9.37
464.85	15.24	66	2.20	6.93	11.15



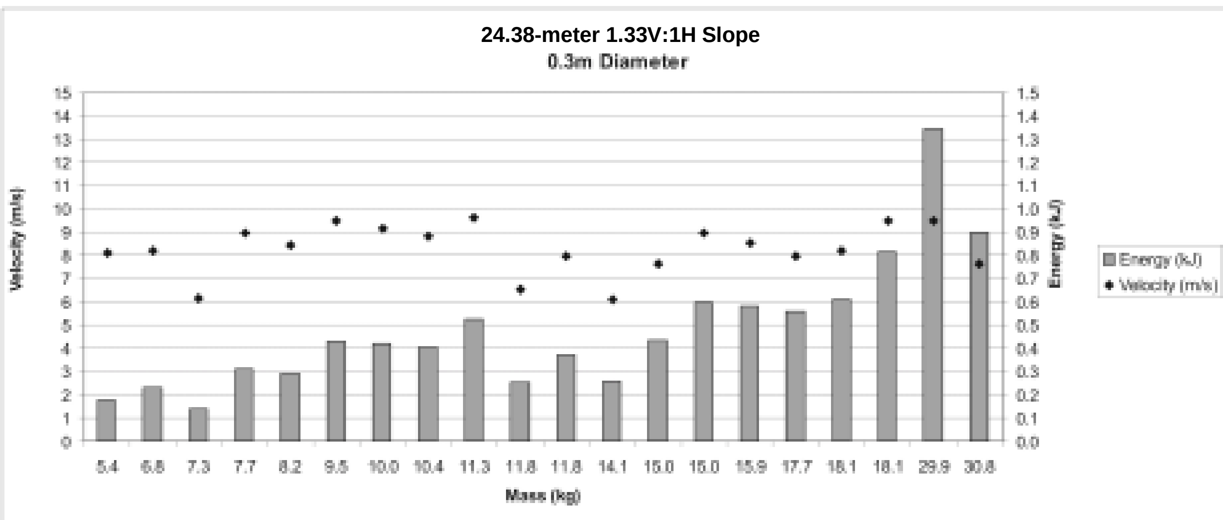
ENERGY OF 0.9-METER DIAMETER ROCKS
18.3-METER, 1.33V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
204.08	15.24	80	2.67	5.72	3.33
317.46	15.24	82	2.73	5.58	4.93
317.46	15.24	77	2.57	5.94	5.60
340.14	15.24	98	3.27	4.67	3.70
340.14	15.24	69	2.30	6.63	7.47
430.84	15.24	81	2.70	5.64	6.86
589.57	15.24	95	3.17	4.81	6.83
589.57	15.24	73	2.43	6.26	11.56
702.95	15.24	77	2.57	5.94	12.39
702.95	15.24	110	3.67	4.16	6.07
1043.08	15.24	74	2.47	6.18	19.91
1292.52	15.24	67	2.23	6.82	30.09
1292.52	15.24	77	2.57	5.94	22.78



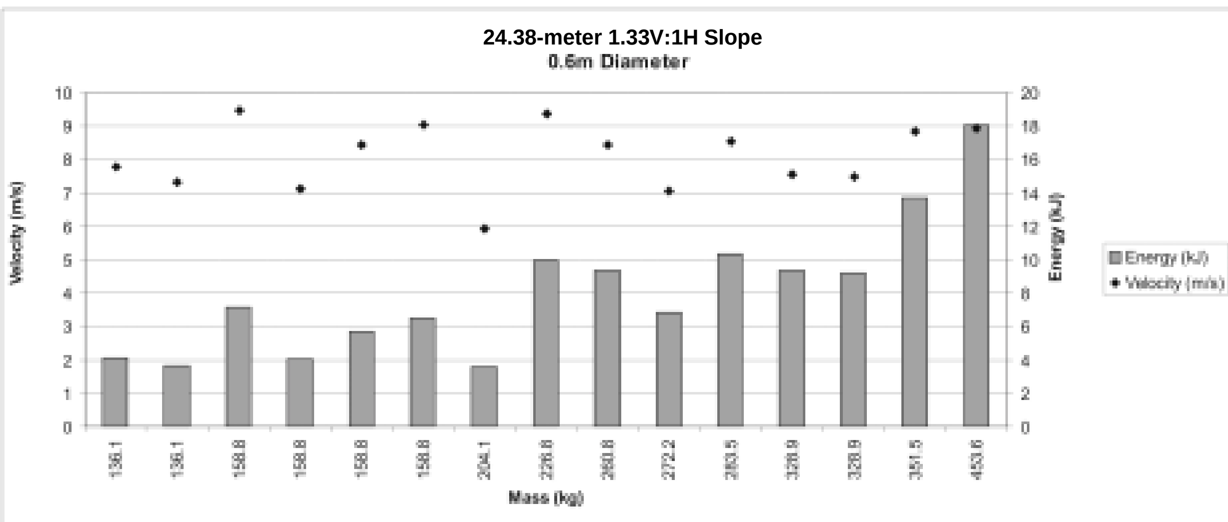
ENERGY OF 0.3-METER DIAMETER ROCKS
24.4-METER, 1.33V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
5.44	25.91	96	3.20	8.10	0.18
6.80	25.91	95	3.17	8.18	0.23
7.26	25.91	127	4.23	6.12	0.14
7.71	25.91	87	2.90	8.93	0.31
8.16	25.91	92	3.07	8.45	0.29
9.52	25.91	82	2.73	9.48	0.43
9.98	25.91	85	2.83	9.14	0.42
10.43	25.91	88	2.93	8.83	0.41
11.34	25.91	81	2.70	9.60	0.52
11.79	25.91	119	3.97	6.53	0.25
11.79	25.91	98	3.27	7.93	0.37
14.06	25.91	128	4.27	6.07	0.26
14.97	25.91	102	3.40	7.62	0.43
14.97	25.91	87	2.90	8.93	0.60
15.87	25.91	91	3.03	8.54	0.58
17.69	25.91	98	3.27	7.93	0.56
18.14	25.91	95	3.17	8.18	0.61
18.14	25.91	82	2.73	9.48	0.81
29.93	25.91	82	2.73	9.48	1.34
30.84	25.91	102	3.40	7.62	0.90



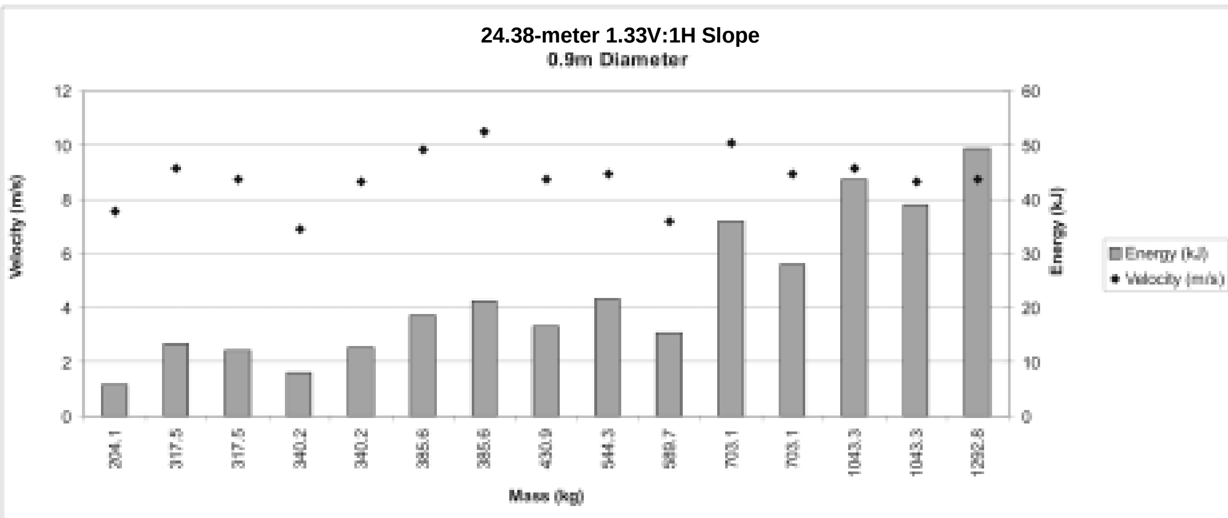
ENERGY OF 0.6-METER DIAMETER ROCKS
24.4-METER, 1.33V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
136.05	25.91	100	3.33	7.77	4.11
136.05	25.91	106	3.53	7.33	3.66
158.73	25.91	82	2.73	9.48	7.13
158.73	25.91	109	3.63	7.13	4.04
158.73	25.91	92	3.07	8.45	5.66
158.73	25.91	86	2.87	9.04	6.48
204.08	25.91	131	4.37	5.93	3.59
226.76	25.91	83	2.77	9.36	9.94
260.77	25.91	92	3.07	8.45	9.31
272.11	25.91	110	3.67	7.07	6.79
283.45	25.91	91	3.03	8.54	10.34
328.80	25.91	103	3.43	7.55	9.36
328.80	25.91	104	3.47	7.47	9.18
351.47	25.91	88	2.93	8.83	13.71
453.51	25.91	87	2.90	8.93	18.10



ENERGY OF 0.9-METER DIAMETER ROCKS
24.4-METER, 1.33V:1H SLOPE

Mass (kg)	Distance (m)	Frames	Time (sec)	Velocity (m/s)	Energy (kJ)
204.08	25.91	103	3.43	7.55	5.81
317.46	25.91	85	2.83	9.14	13.27
317.46	25.91	89	2.97	8.73	12.11
340.14	25.91	113	3.77	6.88	8.05
340.14	25.91	90	3.00	8.64	12.68
385.49	25.91	79	2.63	9.84	18.66
385.49	25.91	74	2.47	10.50	21.26
430.84	25.91	89	2.97	8.73	16.43
544.22	25.91	87	2.90	8.93	21.72
589.57	25.91	108	3.60	7.20	15.27
702.95	25.91	77	2.57	10.09	35.81
702.95	25.91	87	2.90	8.93	28.05
1043.08	25.91	85	2.83	9.14	43.61
1043.08	25.91	90	3.00	8.64	38.90
1292.52	25.91	89	2.97	8.73	49.29



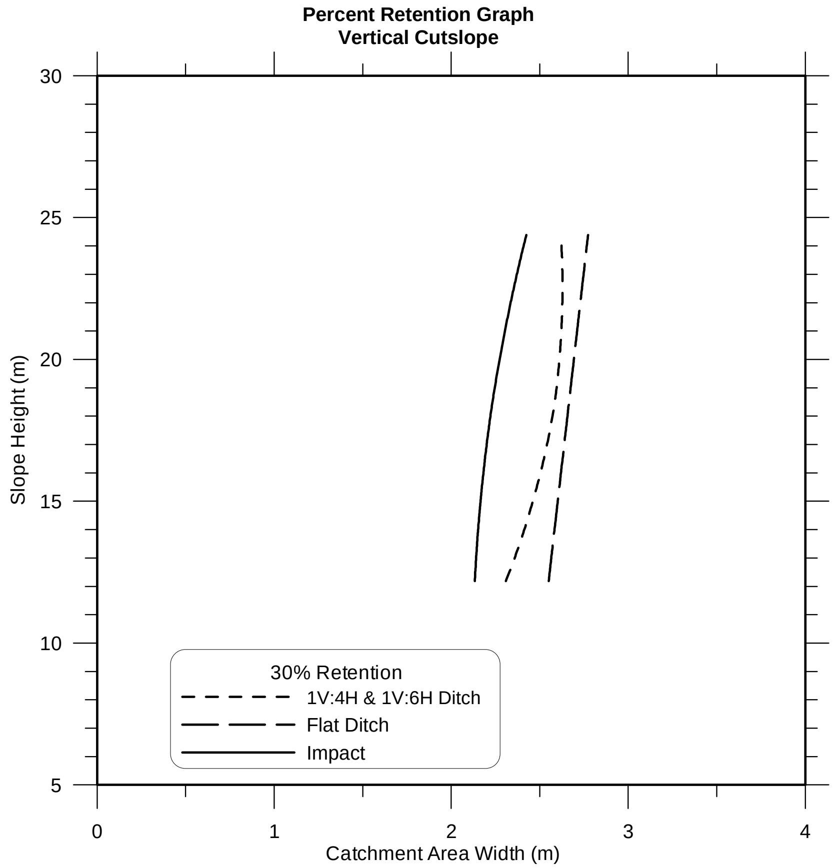
APPENDIX F: CATCHMENT AREA PERCENT RETENTION GRAPHS

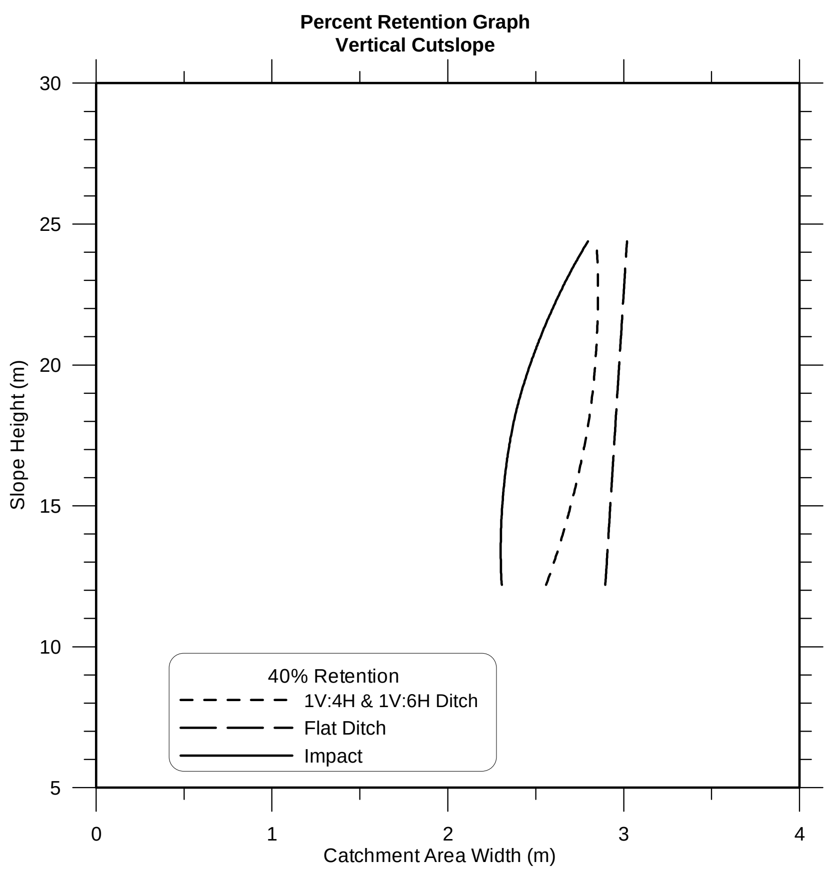
CATCHMENT AREA PERCENT RETENTION GRAPHS

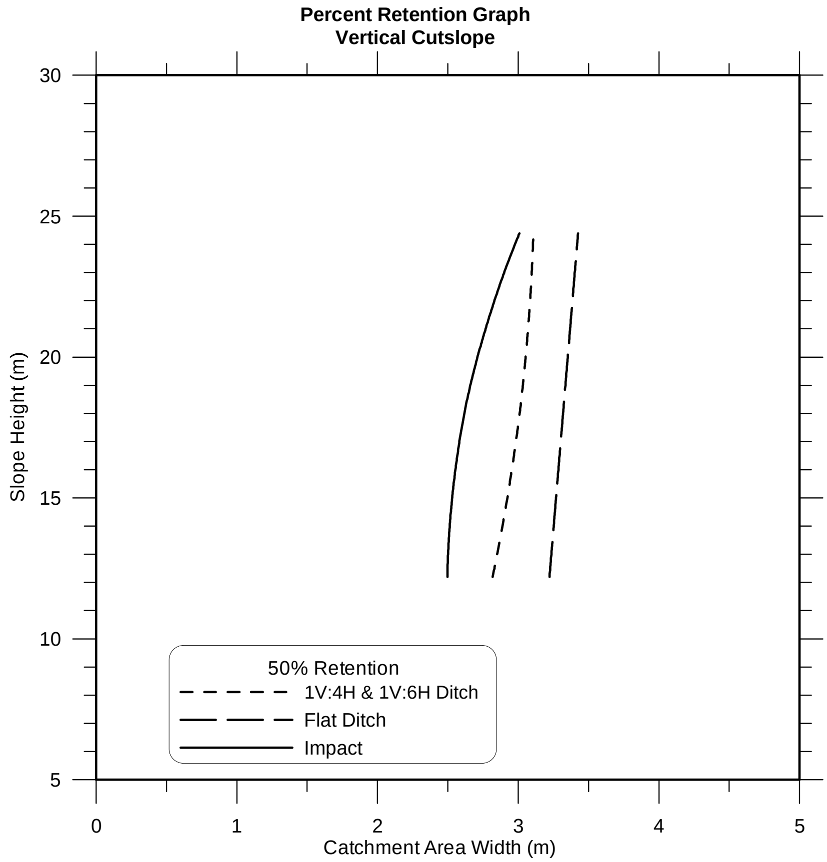
Complete sets of Catchment Area Percent Retention Graphs are included here for the vertical, 4V:1H, 2V:1H, 1.33V:1H, and 1V:1H cutslopes. These graphs are a compilation of the research results from the 12.2-, 18.3- and 24.4-meter high slopes for the flat-bottom, 1V:6H and 1V:4H slope catchment area configurations. The retention graphs incorporate the maximum impact and roll out measurements for each percentage indicated as described in the text in Section 4.2.

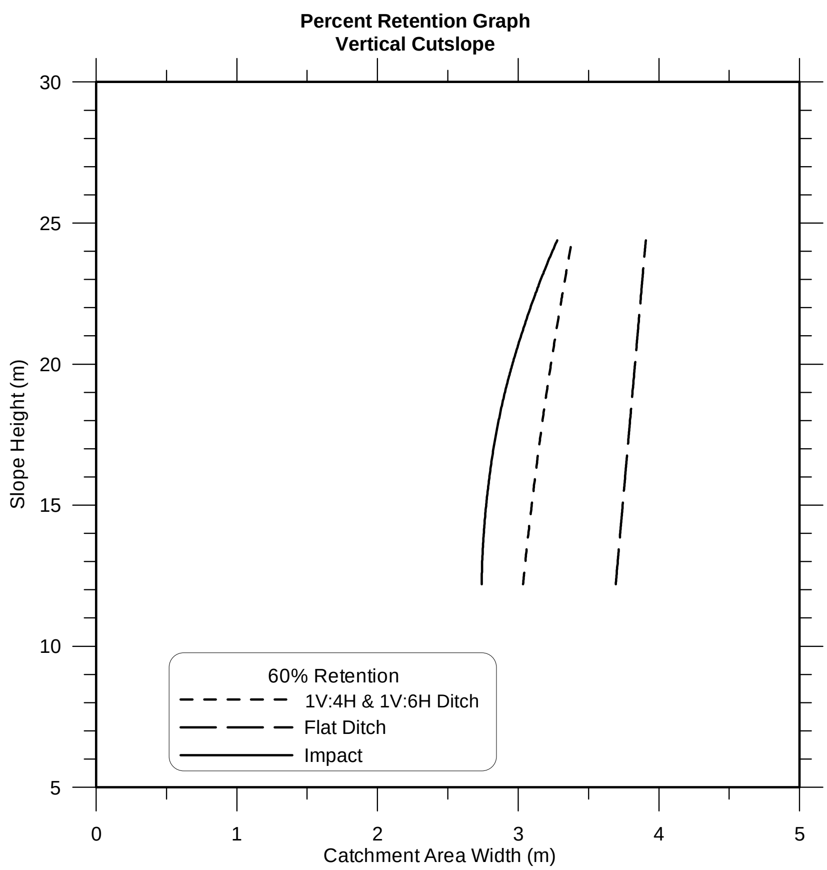
In some cases, the results were similar enough that the results plotted as a single curve. For example, this can be seen on the vertical slope, 99% retention graphs. The results from the 1V:6H and 1V:4H catchment area slopes were very similar. Only one curve was developed for these two catchment area slopes on this graph.

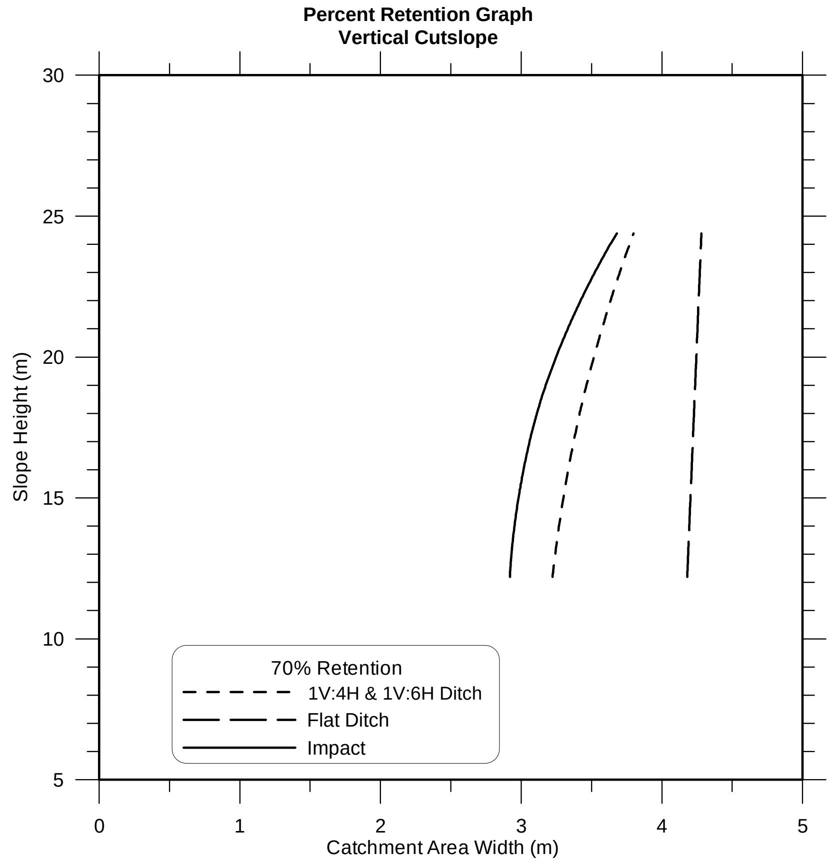
NOTE: To facilitate practical design usage, the field measured catchment area impact and roll out slope distances have been converted to horizontal catchment area width on the percent retention graphs.

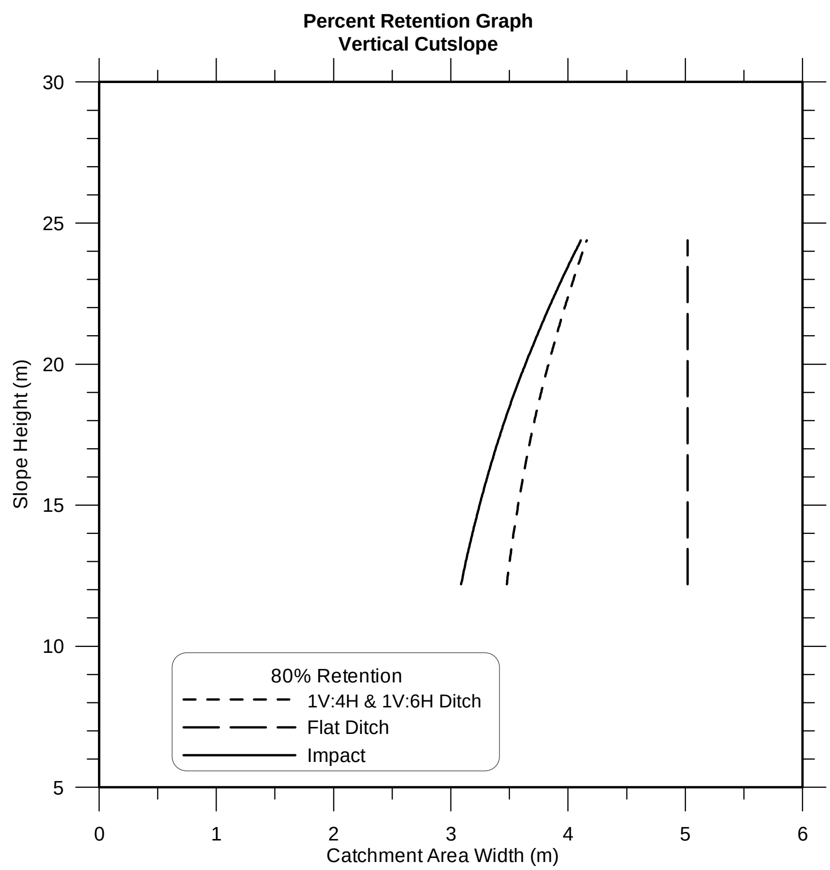

Percent Retention Graph
Vertical Cutslope
30
25
20
15
10
5
Slope Height (m)
0
1
2
3
4
Catchment Area Width (m)
30% Retention
1V:4H & 1V:6H Ditch
Flat Ditch
Impact

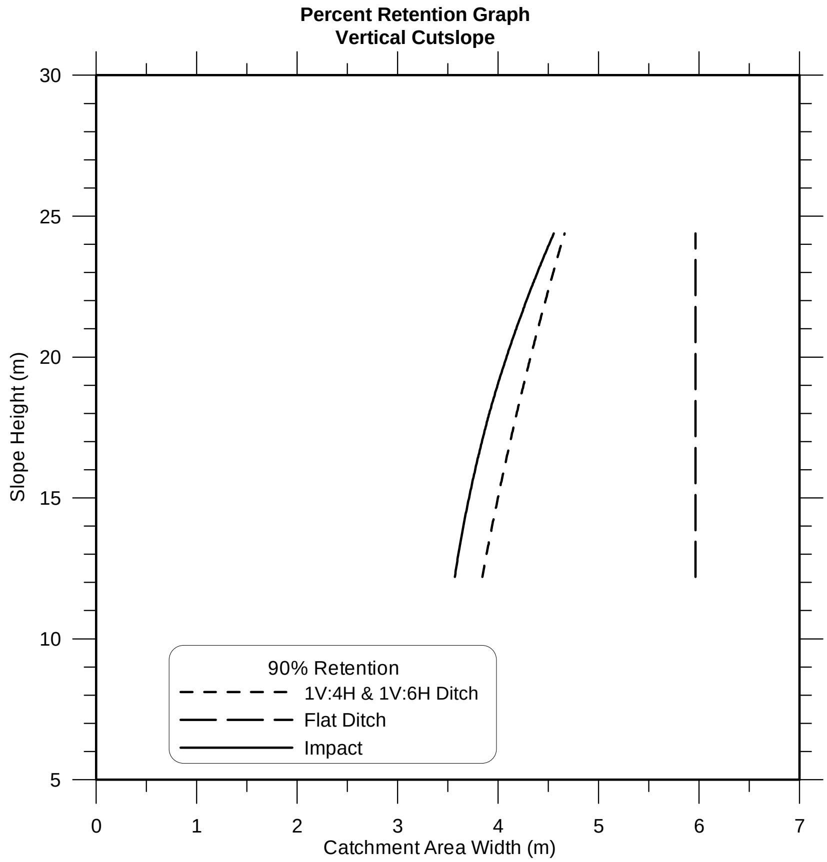

Percent Retention Graph
Vertical Cutslope
30
25
20
15
10
5
Slope Height (m)
0
1
2
3
4
Catchment Area Width (m)
40% Retention
1V:4H & 1V:6H Ditch
Flat Ditch
Impact


Percent Retention Graph
Vertical Cutslope
Slope Height (m)
Catchment Area Width (m)
30
25
20
15
10
5
0
1
2
3
4
5
50% Retention
1V:4H & 1V:6H Ditch
Flat Ditch
Impact

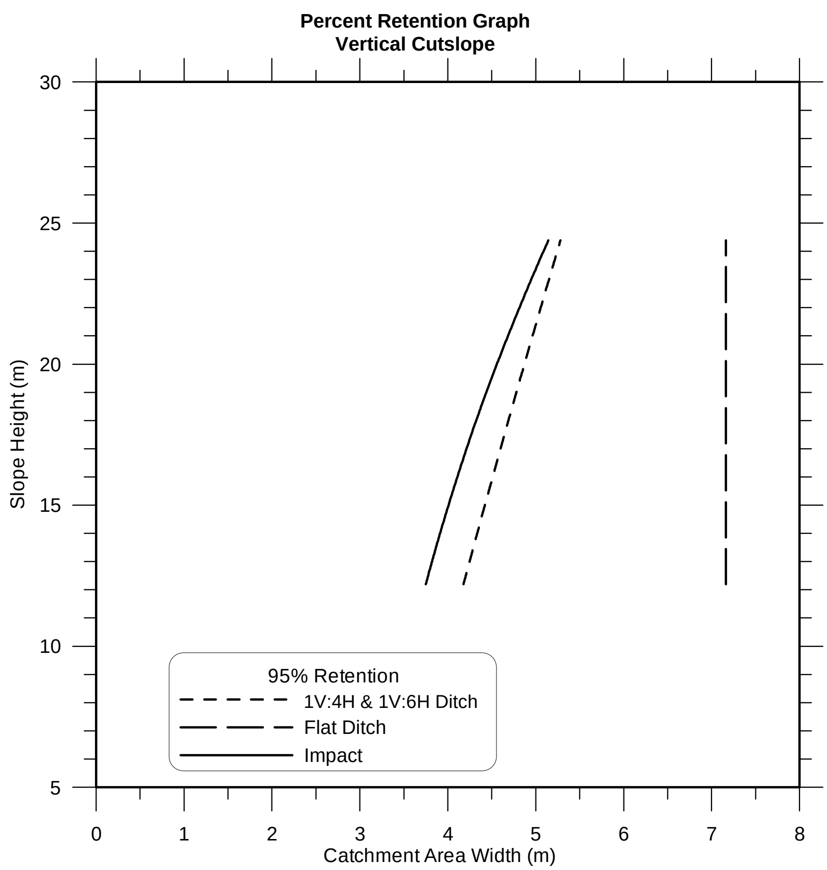

Percent Retention Graph
Vertical Cutslope
Slope Height (m)
Catchment Area Width (m)
30
25
20
15
10
5
0
1
2
3
4
5
60% Retention
1V:4H & 1V:6H Ditch
Flat Ditch
Impact


Percent Retention Graph
Vertical Cutslope
Slope Height (m)
Catchment Area Width (m)
70% Retention
1V:4H & 1V:6H Ditch
Flat Ditch
Impact
30
25
20
15
10
5
0
1
2
3
4
5

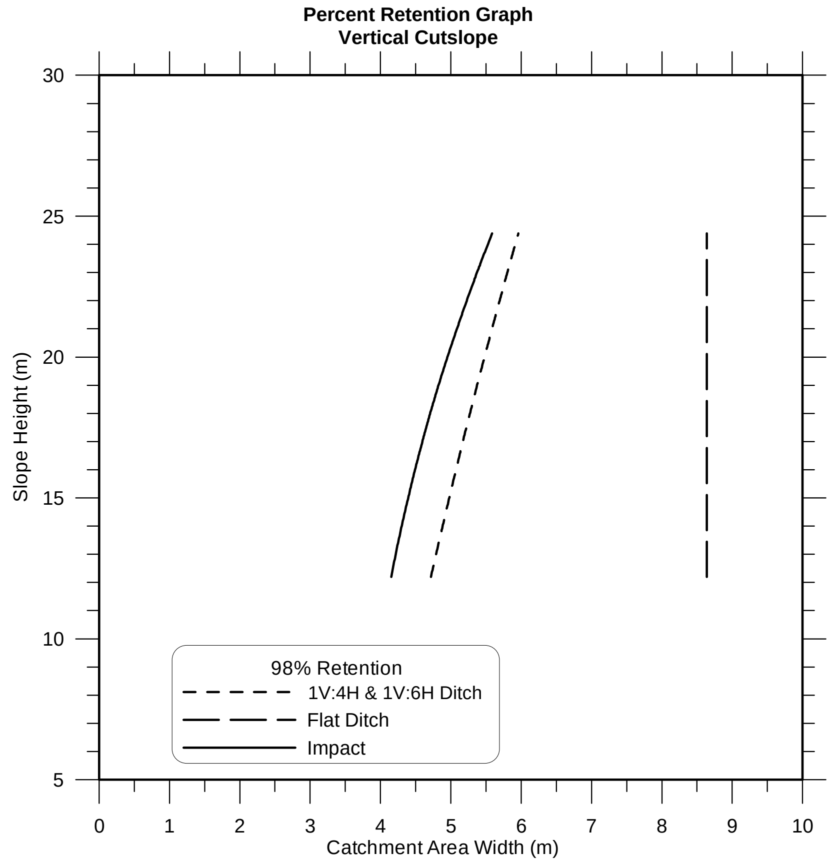

Percent Retention Graph
Vertical Cutslope
Slope Height (m)
Catchment Area Width (m)
80% Retention
1V:4H & 1V:6H Ditch
Flat Ditch
Impact
30
25
20
15
10
5
0
1
2
3
4
5
6



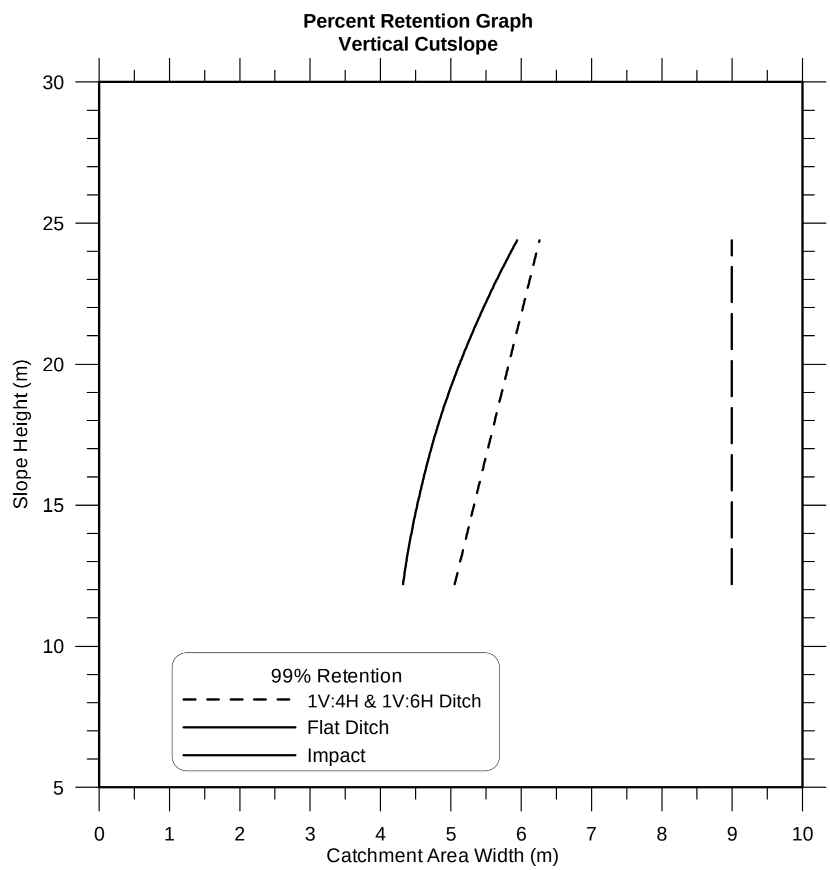
Percent Retention Graph
Vertical Cutslope
30
25
20
15
10
5
Slope Height (m)
0
1
2
3
4
5
6
7
Catchment Area Width (m)
90% Retention
1V:4H & 1V:6H Ditch
Flat Ditch
Impact



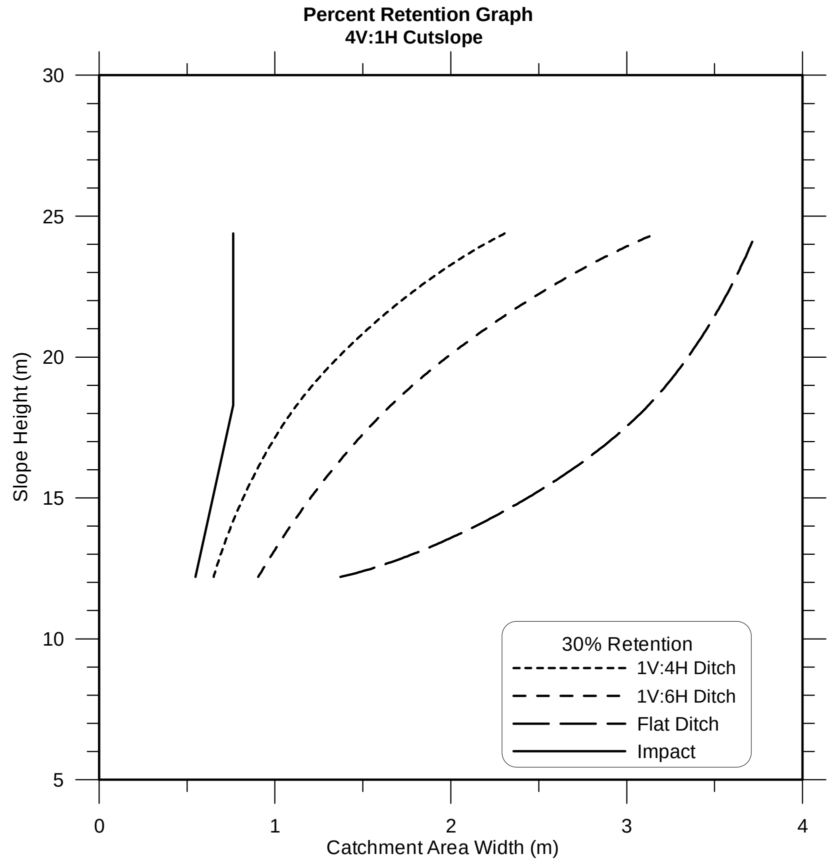
Percent Retention Graph
Vertical Cutslope
30
25
20
15
10
5
Slope Height (m)
0
1
2
3
4
5
6
7
8
Catchment Area Width (m)
95% Retention
1V:4H & 1V:6H Ditch
Flat Ditch
Impact

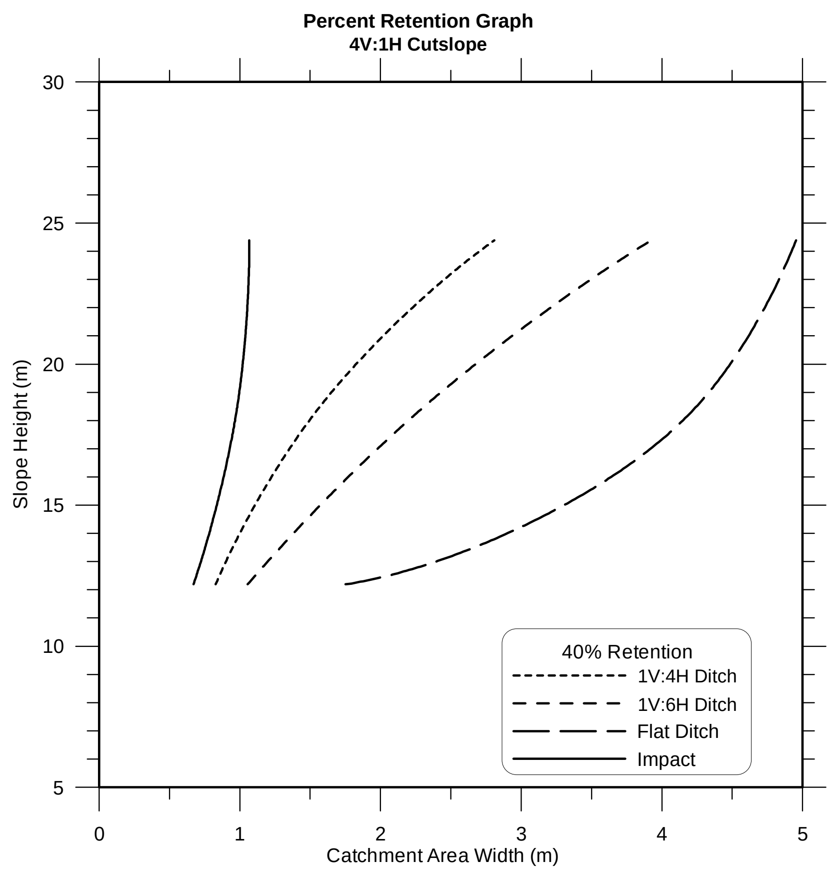


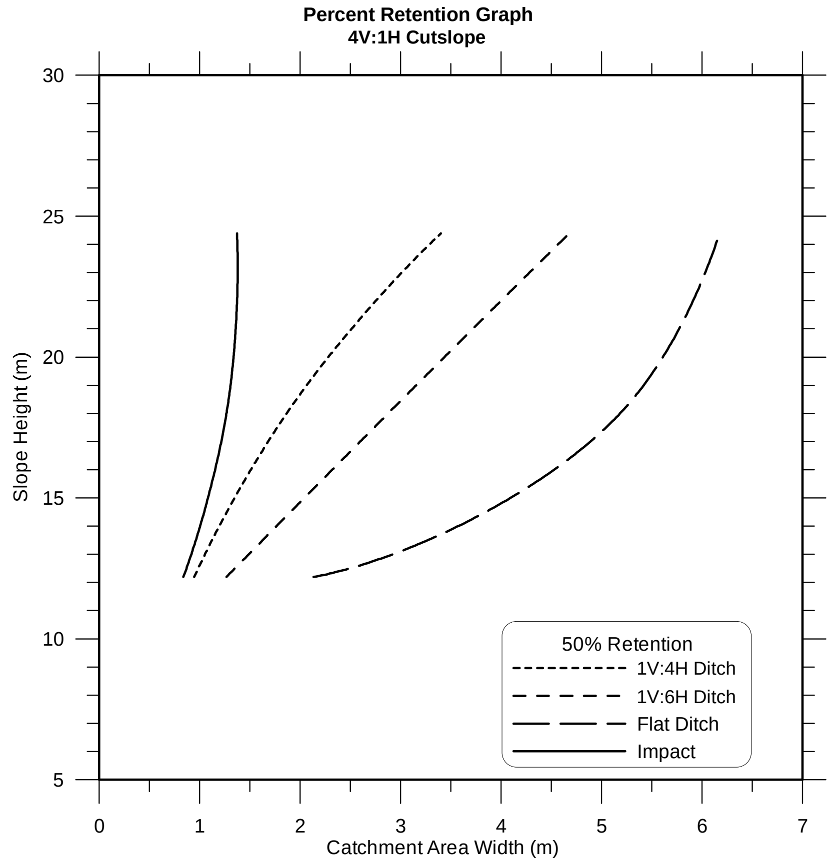
Percent Retention Graph
Vertical Cutslope
Slope Height (m)
Catchment Area Width (m)
98% Retention
1V:4H & 1V:6H Ditch
Flat Ditch
Impact

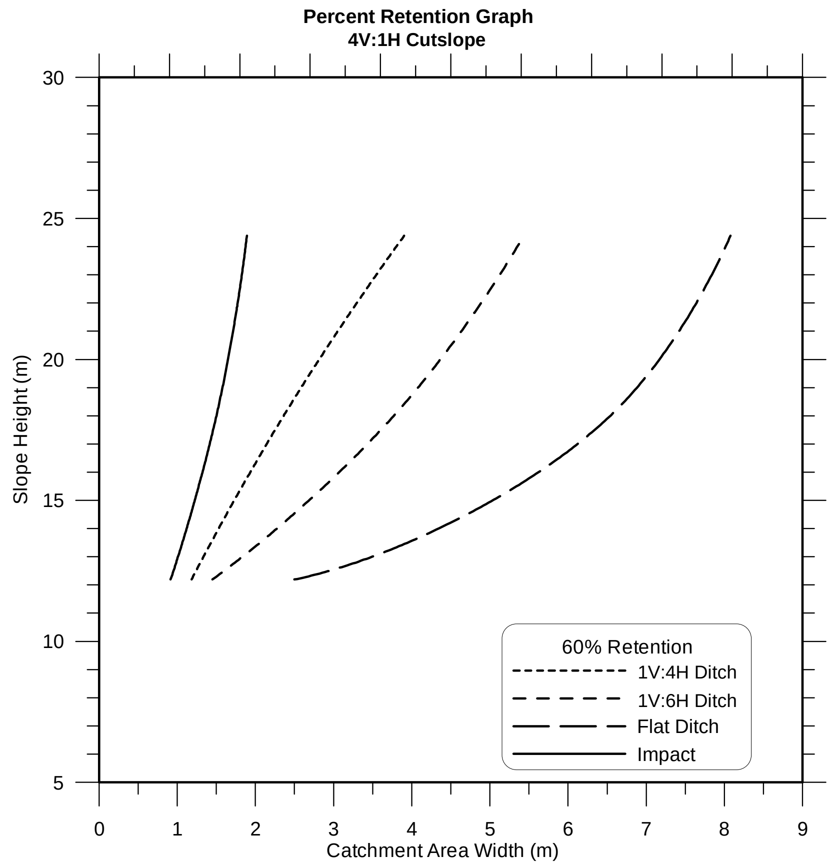


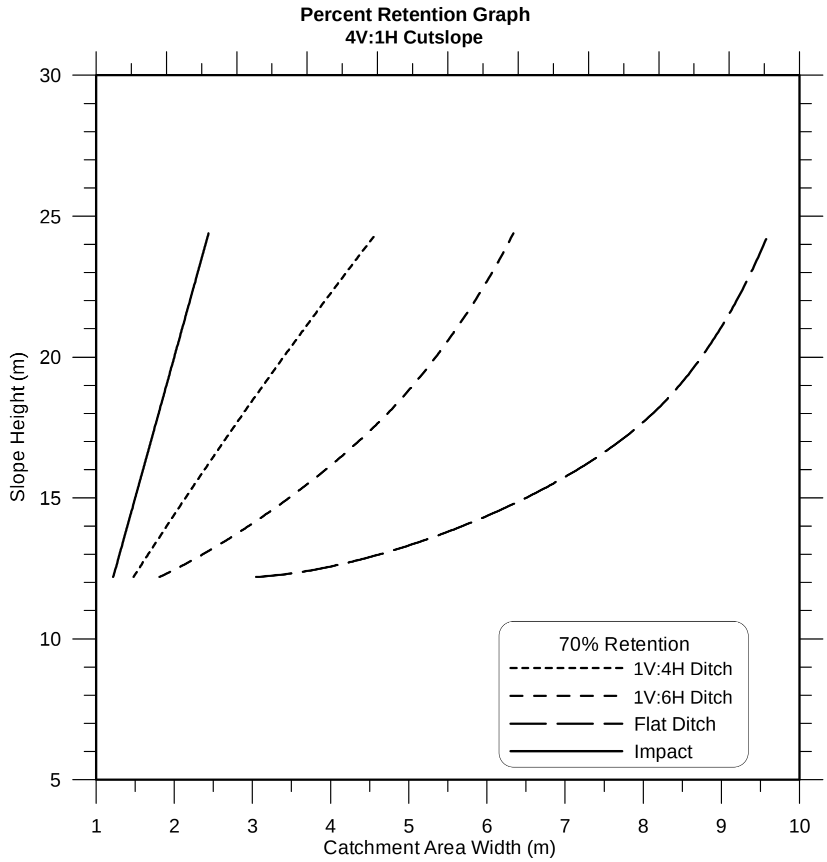
Percent Retention Graph
Vertical Cutslope
Slope Height (m)
Catchment Area Width (m)
99% Retention
1V:4H & 1V:6H Ditch
Flat Ditch
Impact

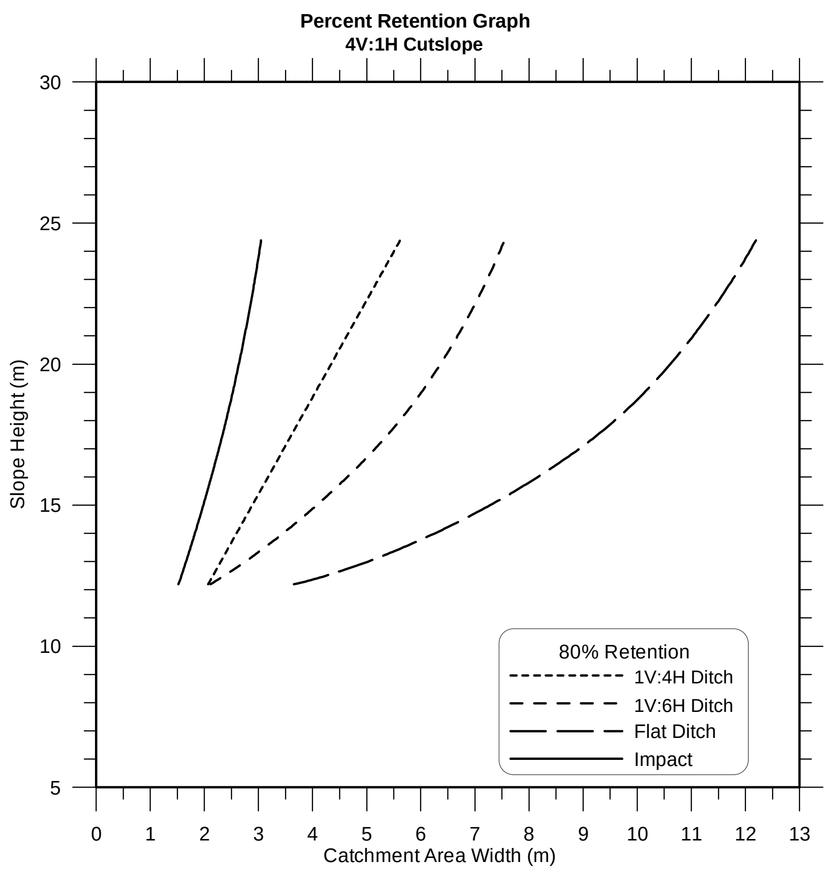

Percent Retention Graph
4V:1H Cutslope
30
25
20
15
10
5
Slope Height (m)
0
1
2
3
4
Catchment Area Width (m)
30% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact

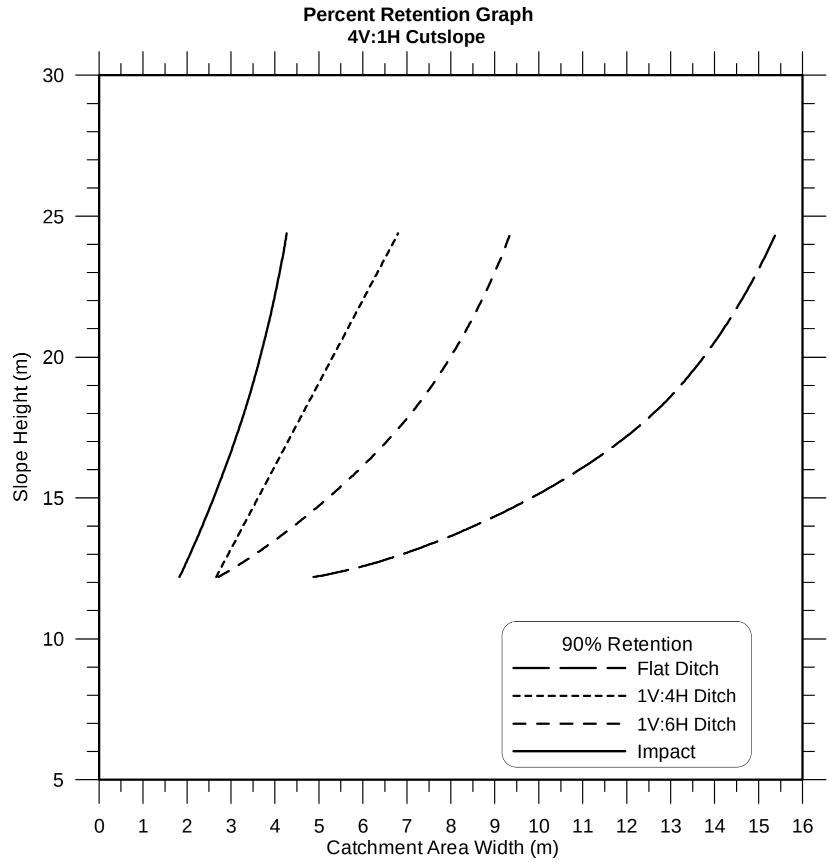

Percent Retention Graph
4V:1H Cutslope
30
25
20
15
10
5
Slope Height (m)
0
1
2
3
4
5
Catchment Area Width (m)
40% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact

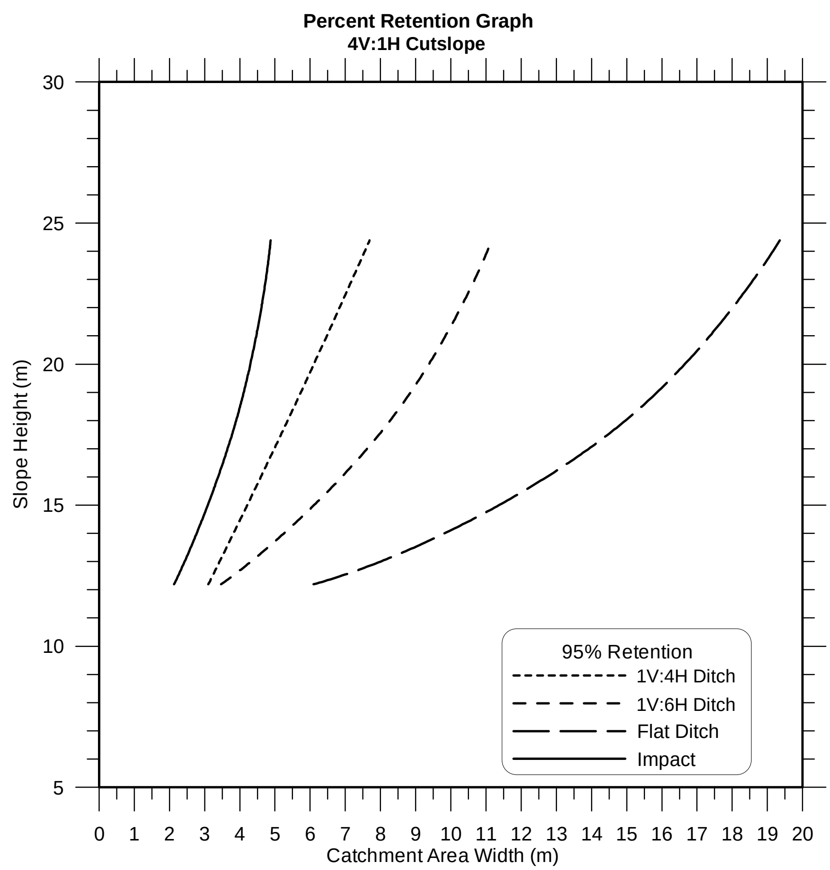

Percent Retention Graph
4V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
50% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact

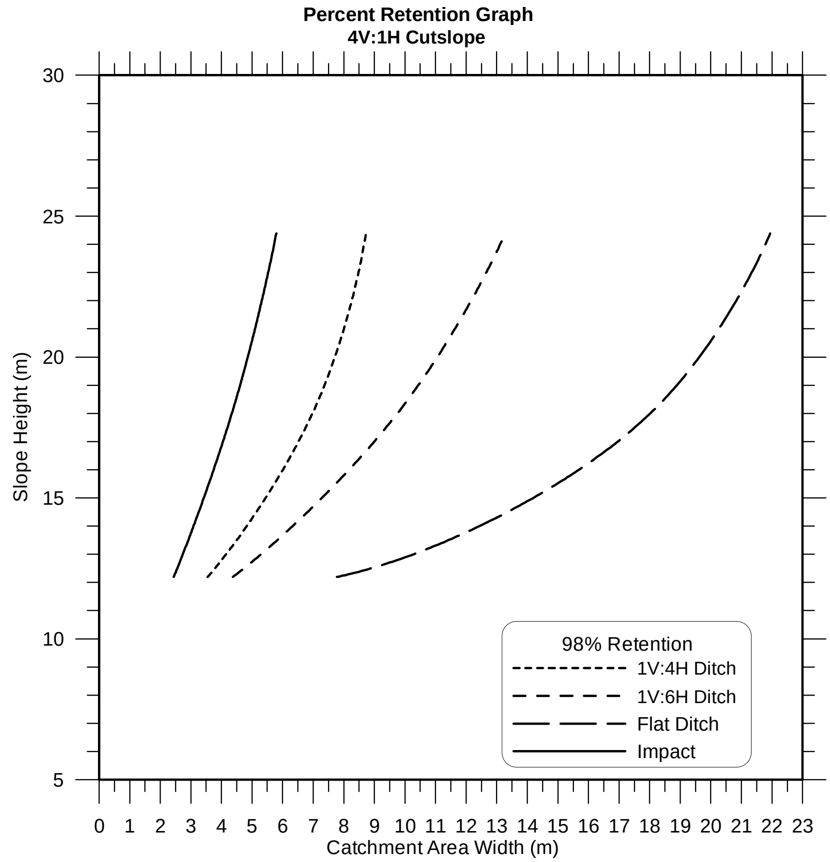

Percent Retention Graph
4V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
60% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact

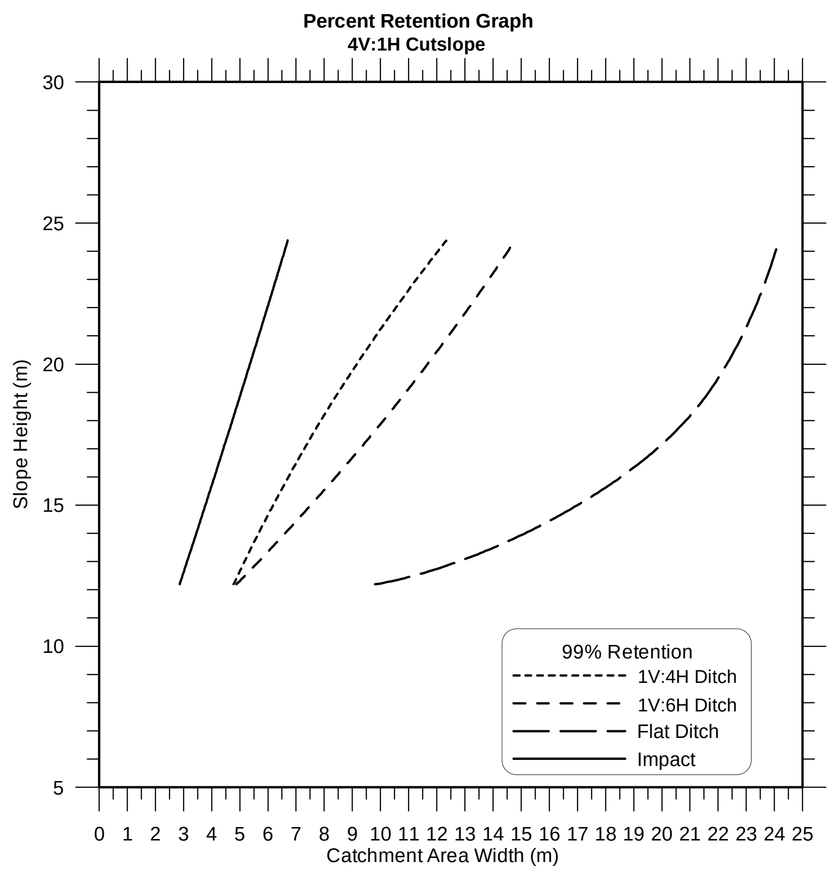

Percent Retention Graph
4V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
70% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
30
25
20
15
10
5
1
2
3
4
5
6
7
8
9
10

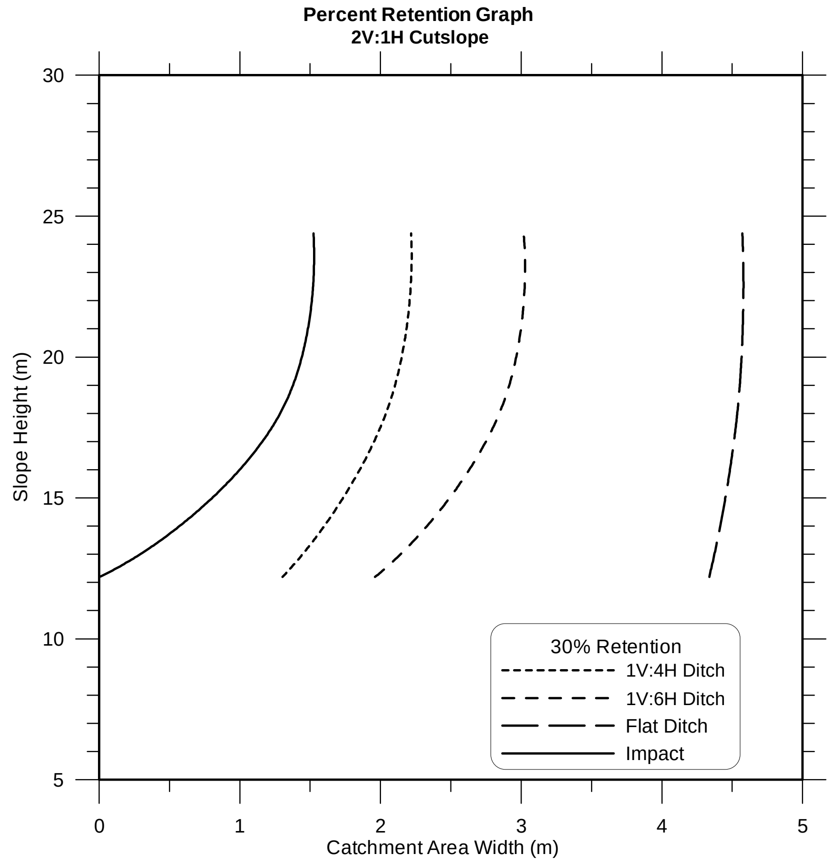

Percent Retention Graph
4V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
80% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
13

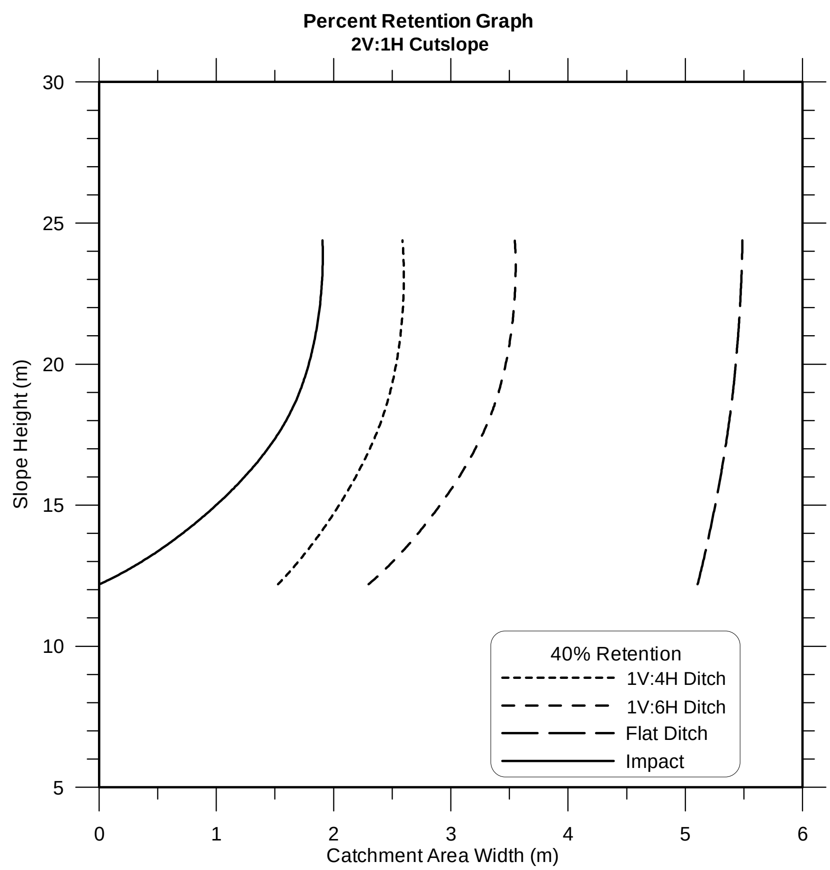

Percent Retention Graph
4V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
90% Retention
Flat Ditch
1V:4H Ditch
1V:6H Ditch
Impact

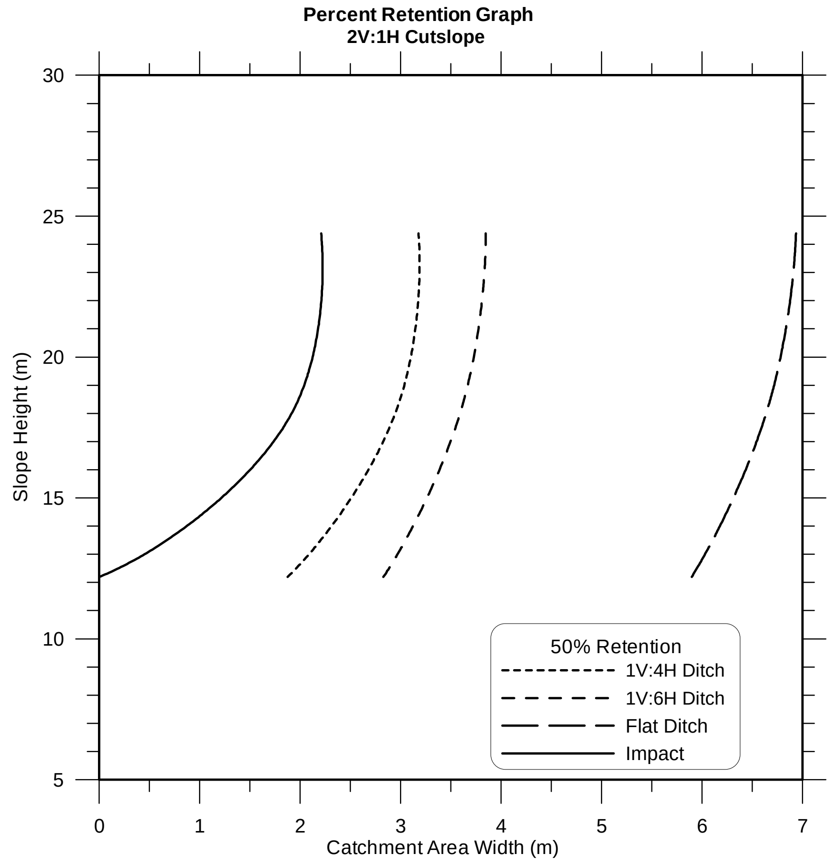

Percent Retention Graph
4V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
95% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact


Percent Retention Graph
4V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
98% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact


Percent Retention Graph
4V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
99% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact


Percent Retention Graph
2V:1H Cutslope
30% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
Slope Height (m)
Catchment Area Width (m)
30
25
20
15
10
5
0
1
2
3
4
5


Percent Retention Graph
2V:1H Cutslope
40% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
Slope Height (m)
Catchment Area Width (m)
30
25
20
15
10
5
0
1
2
3
4
5
6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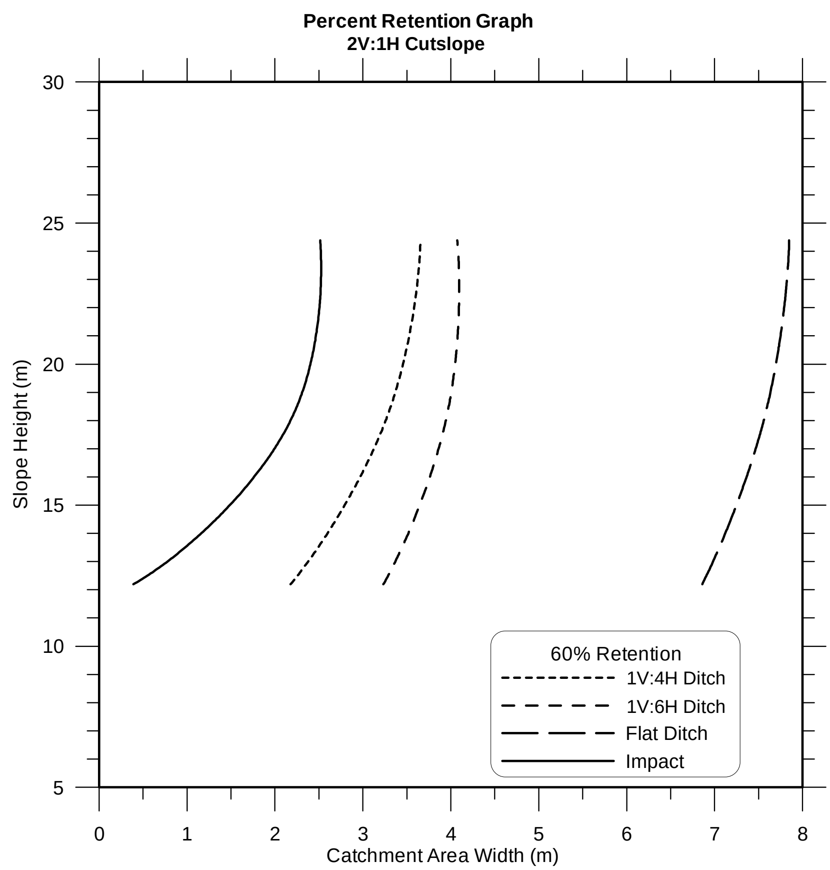
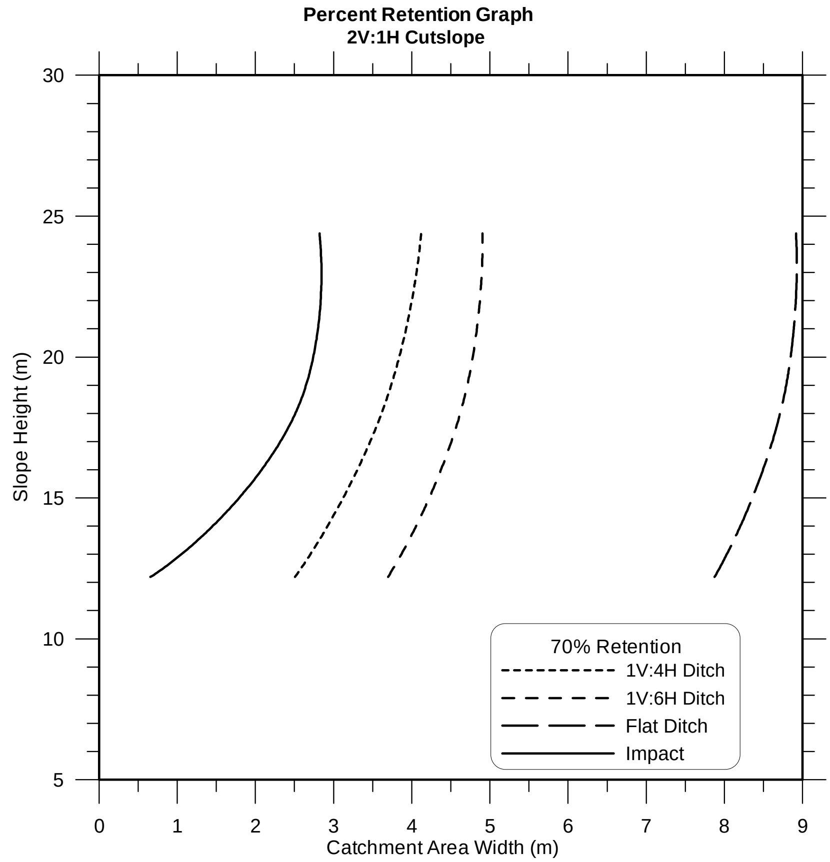
2V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
50% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
30
25
20
15
10
5
0
1
2
3
4
5
6
7


Percent Retention Graph
2V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
60% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8


Percent Retention Graph
2V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
70% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
30
25
20
15
10
5
0
1
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4
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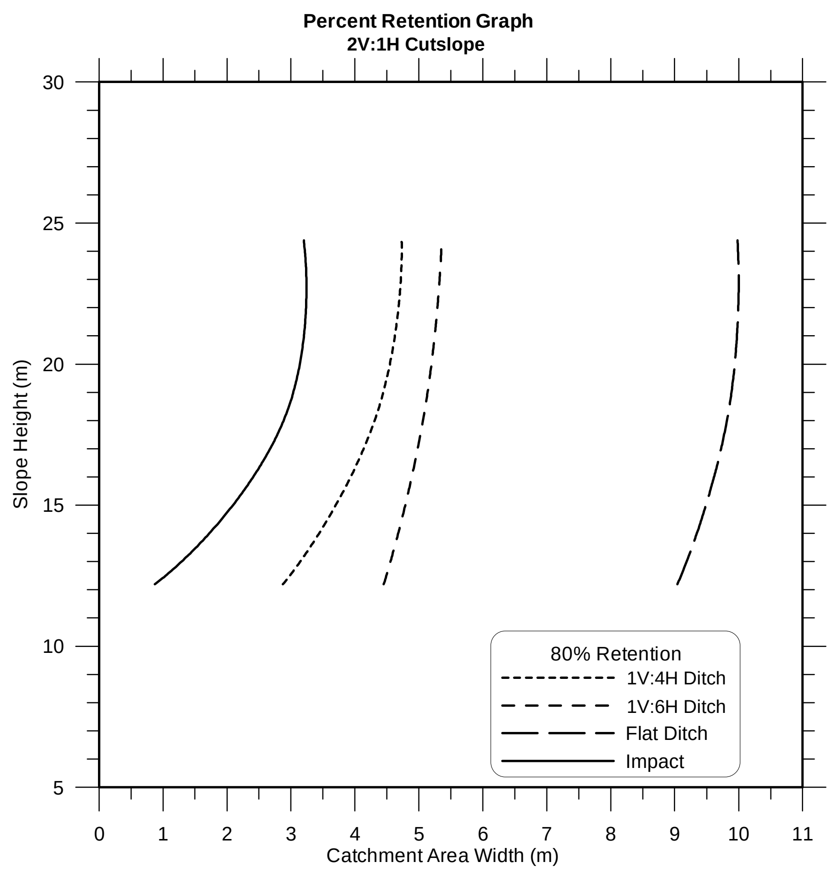
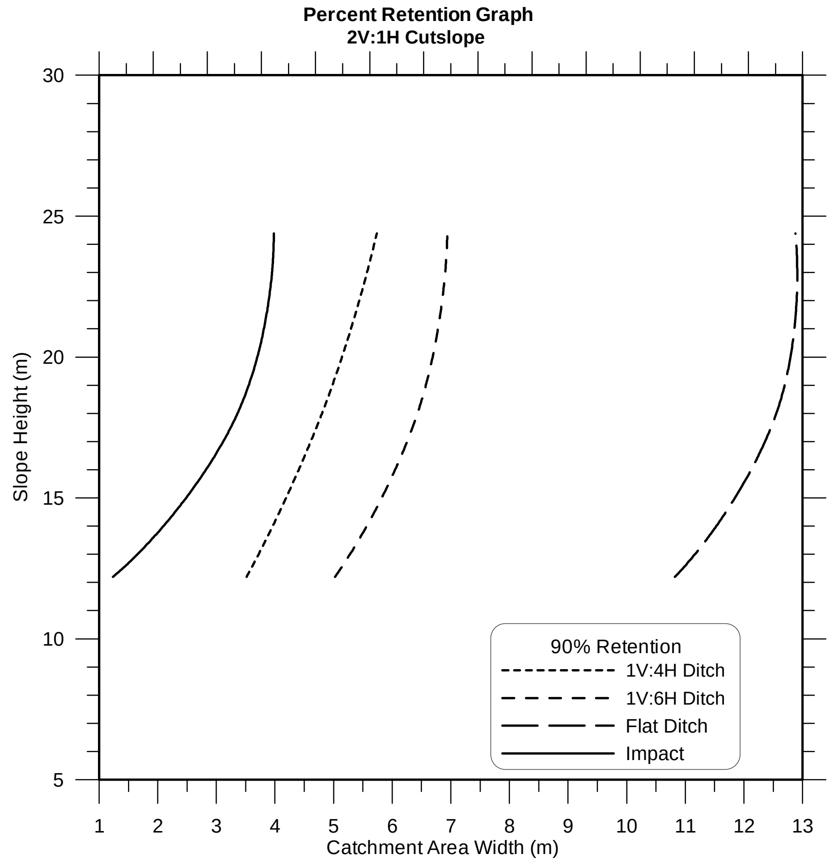
8
9


Percent Retention Graph
2V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
80% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11



Percent Retention Graph
2V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
90% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
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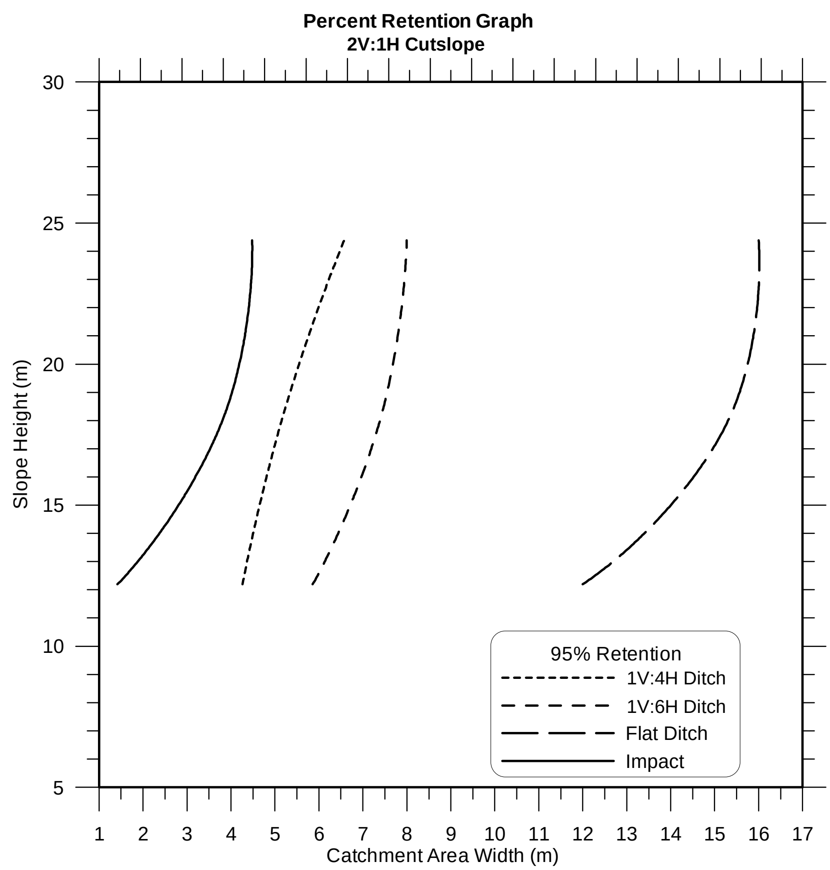
10
11
12
13



Percent Retention Graph
2V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
95% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
5
10
15
20
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16
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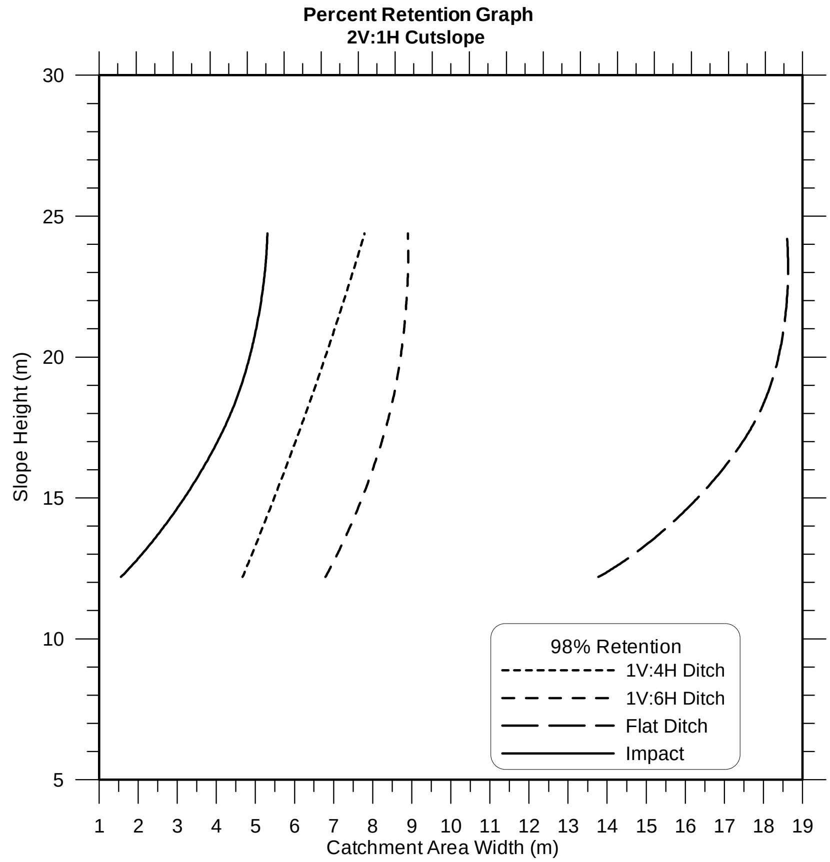
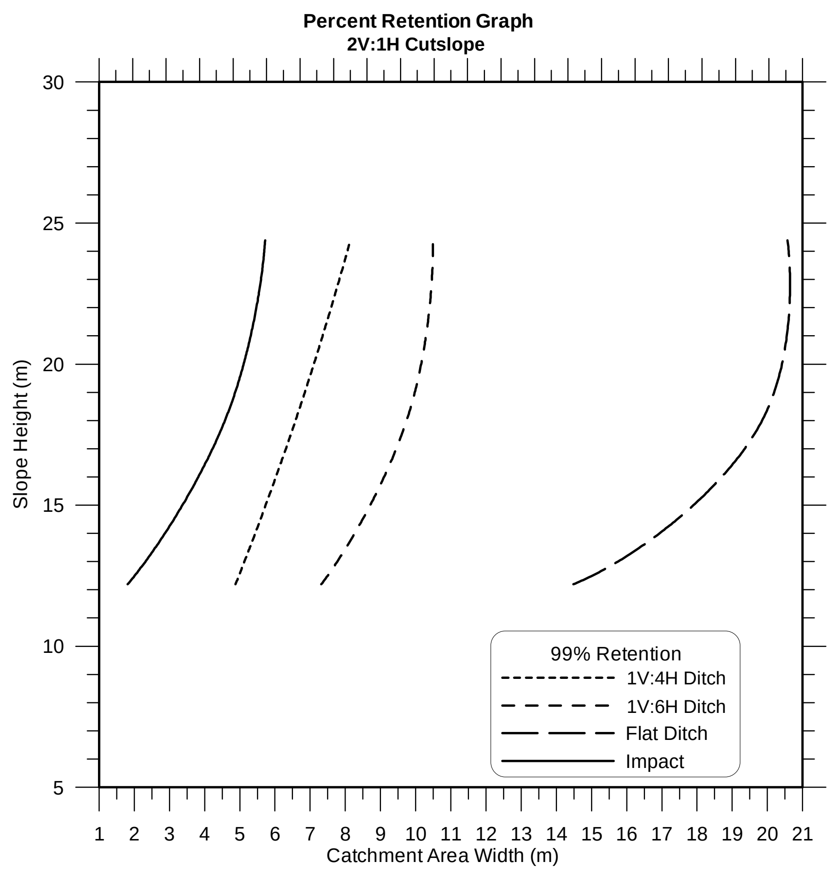
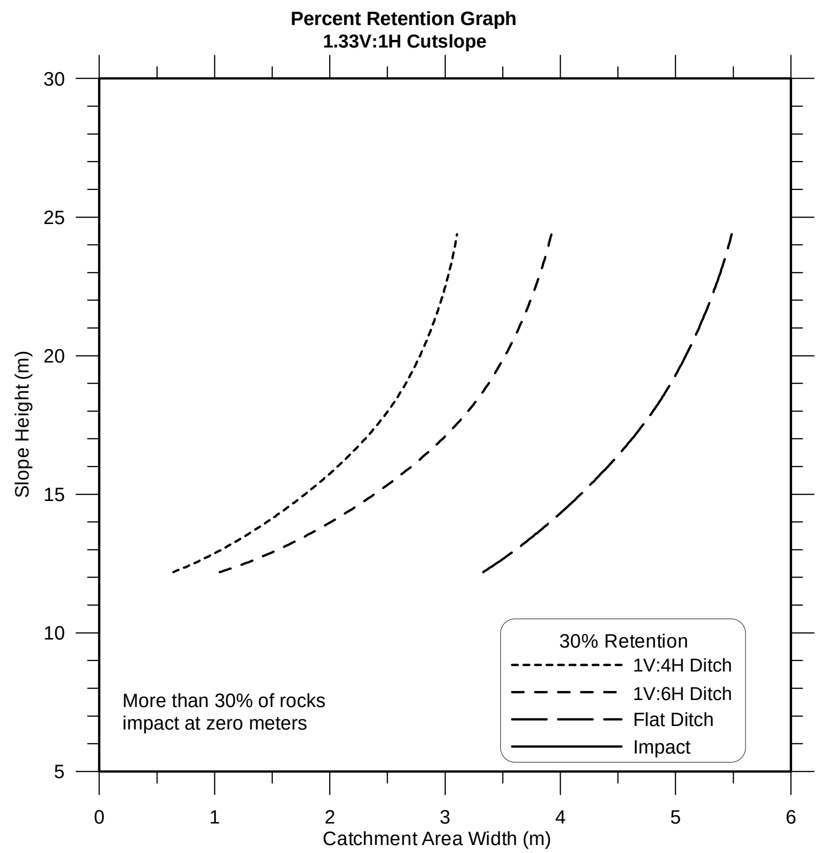
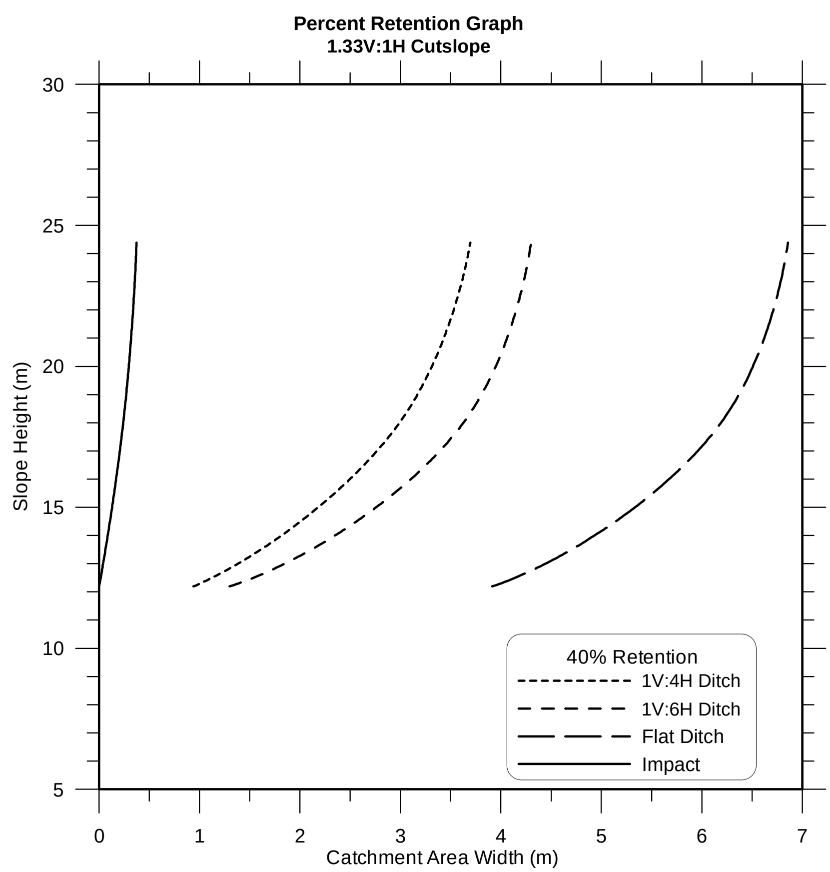
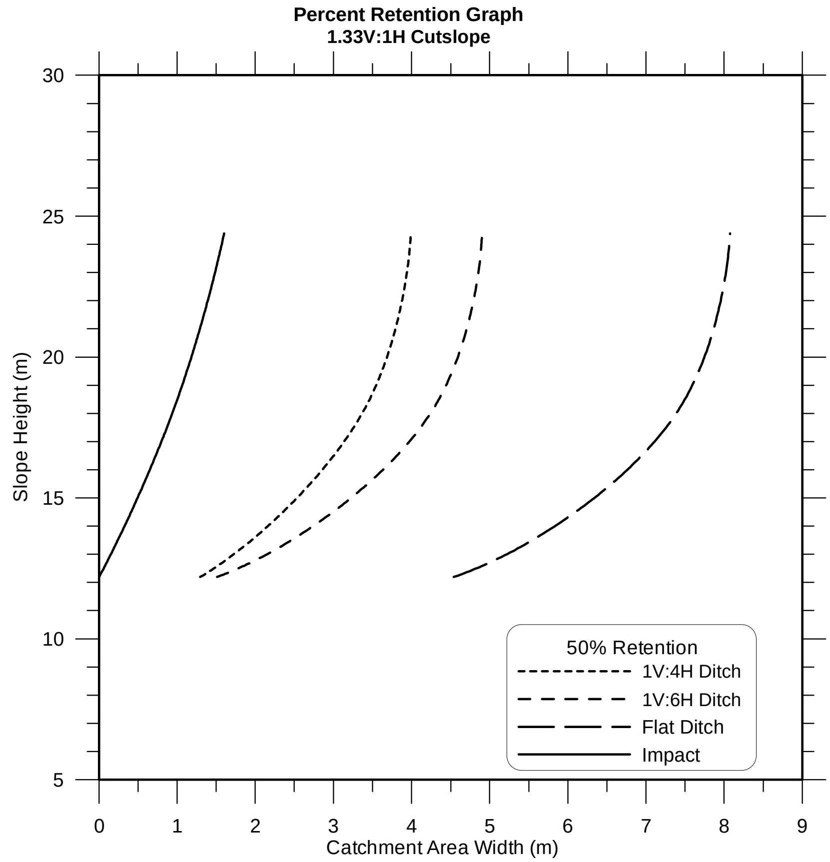

Percent Retention Graph
2V:1H Cutslope
30
25
20
15
10
5
Slope Height (m)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Catchment Area Width (m)
98% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact

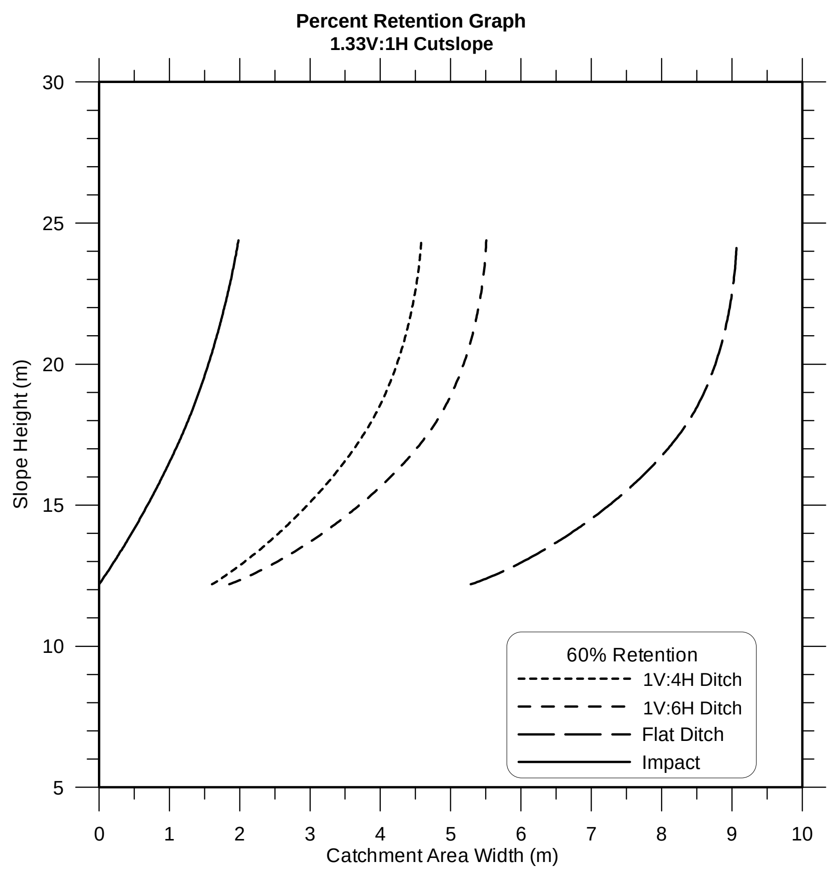

Percent Retention Graph
2V:1H Cutslope
30
25
20
15
10
5
Slope Height (m)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Catchment Area Width (m)
99% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact


Percent Retention Graph
1.33V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
30% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
More than 30% of rocks
impact at zero meters


Percent Retention Graph
1.33V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
40% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact

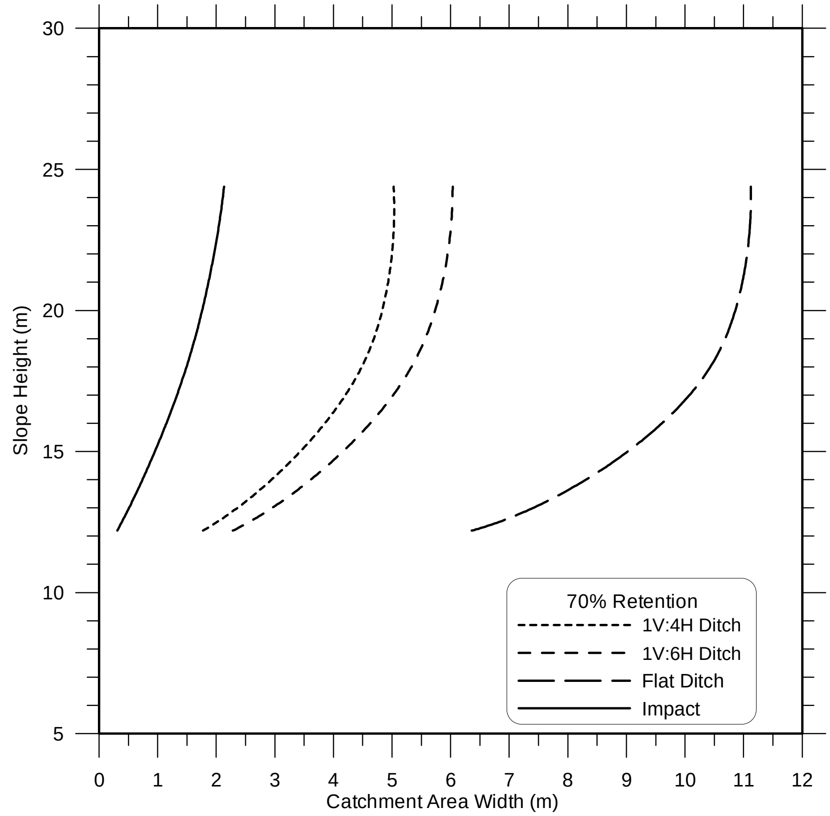


Percent Retention Graph
1.33V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
50% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact

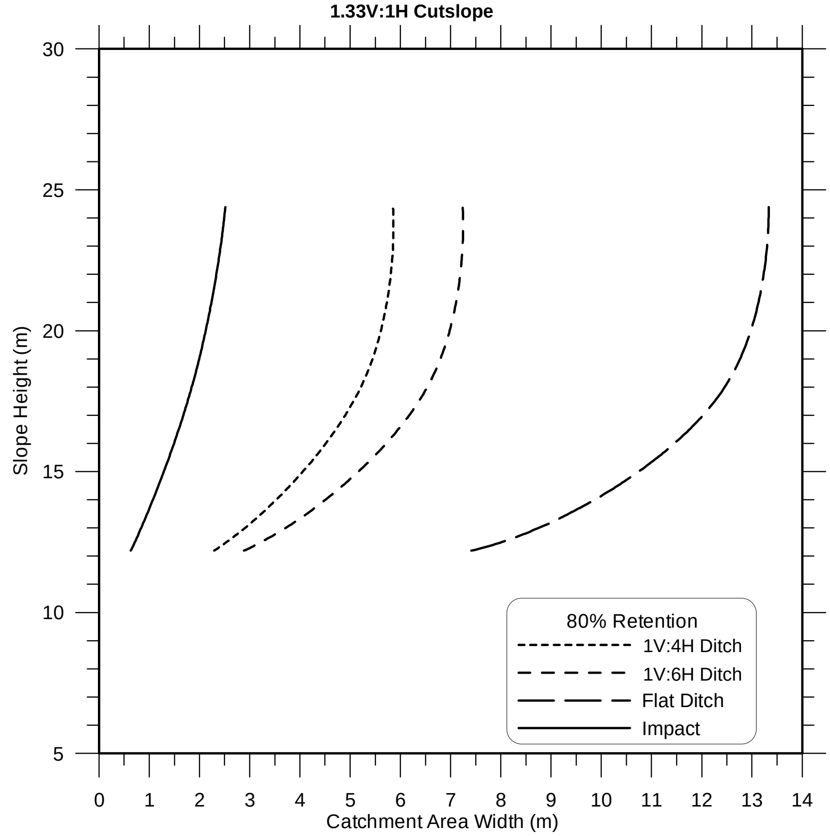


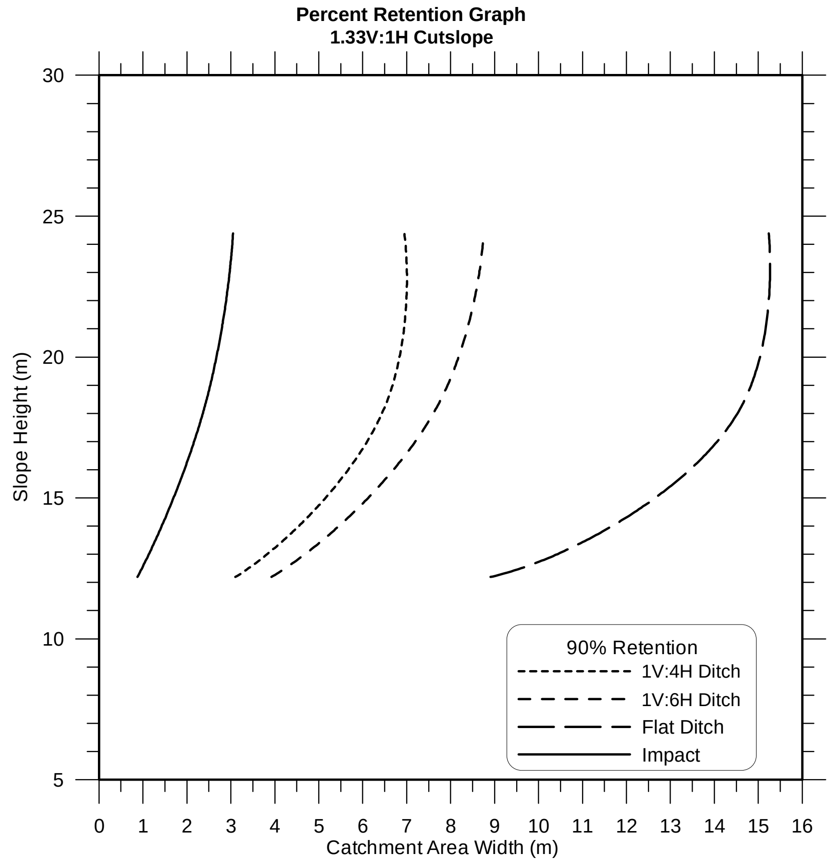
Percent Retention Graph
1.33V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
60% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact

Percent Retention Graph
1.33V:1H Cutslope

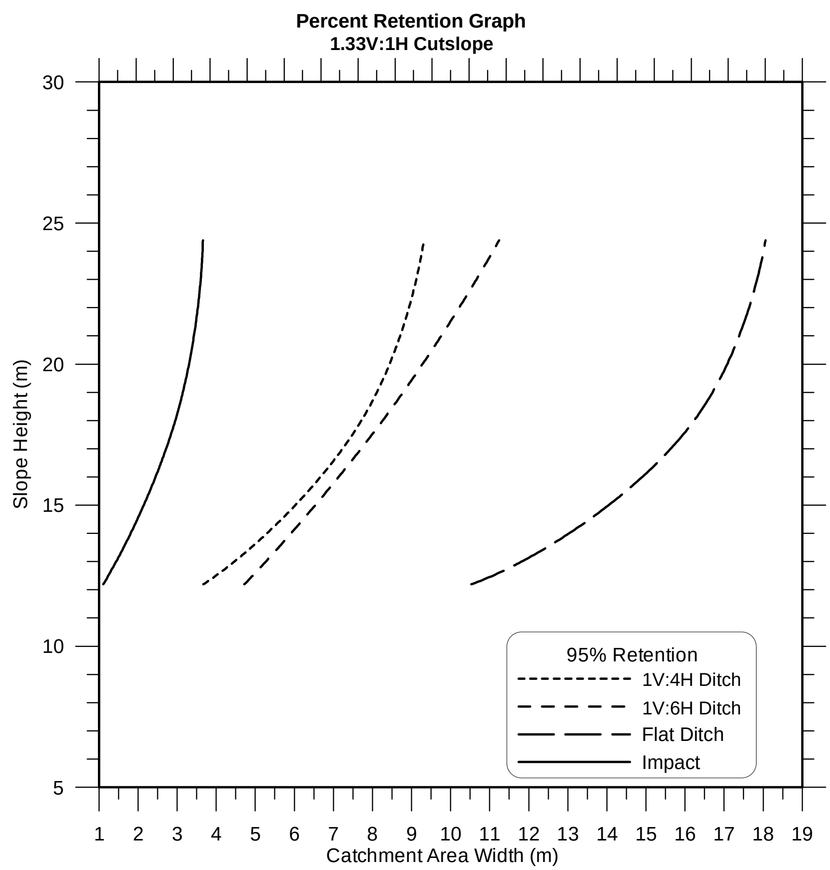


Percent Retention Graph
1.33V:1H Cutslope



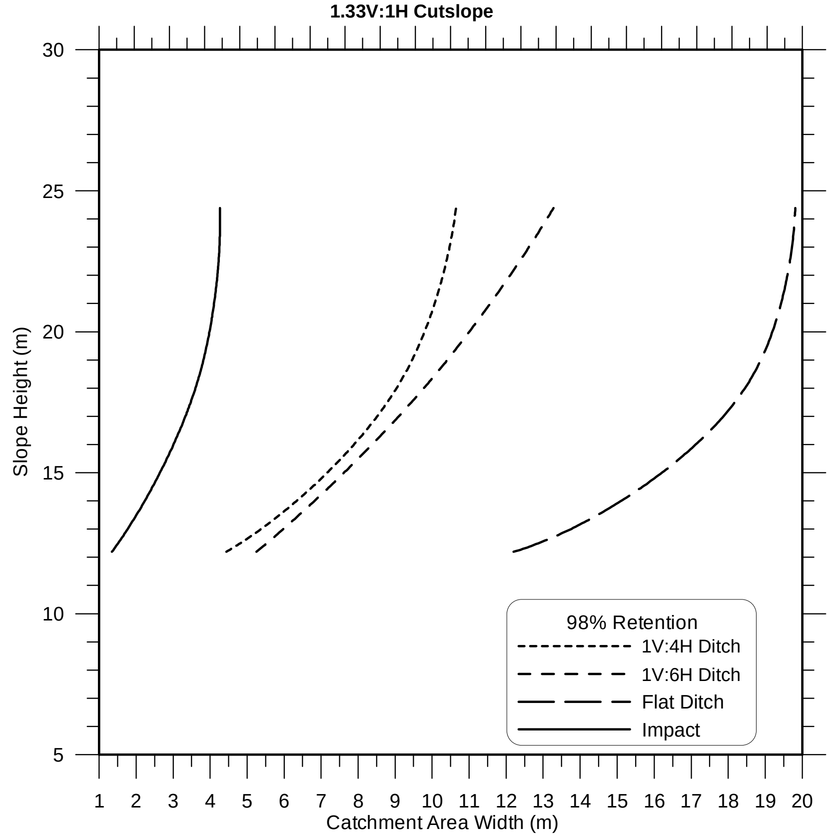


Percent Retention Graph
1.33V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
90% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact

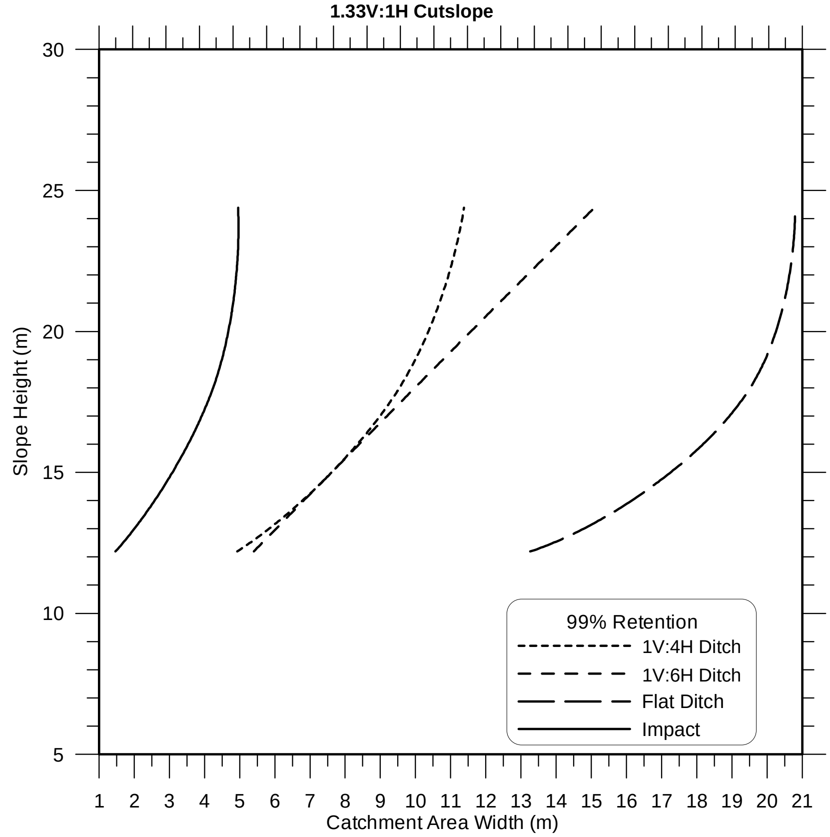


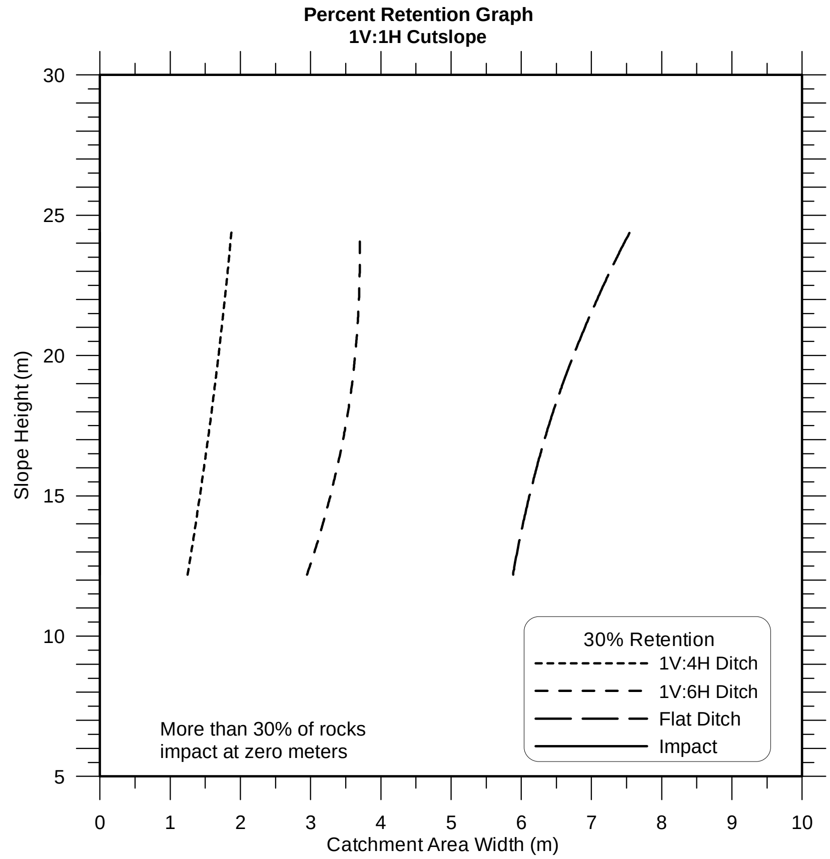
Percent Retention Graph
1.33V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
95% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact

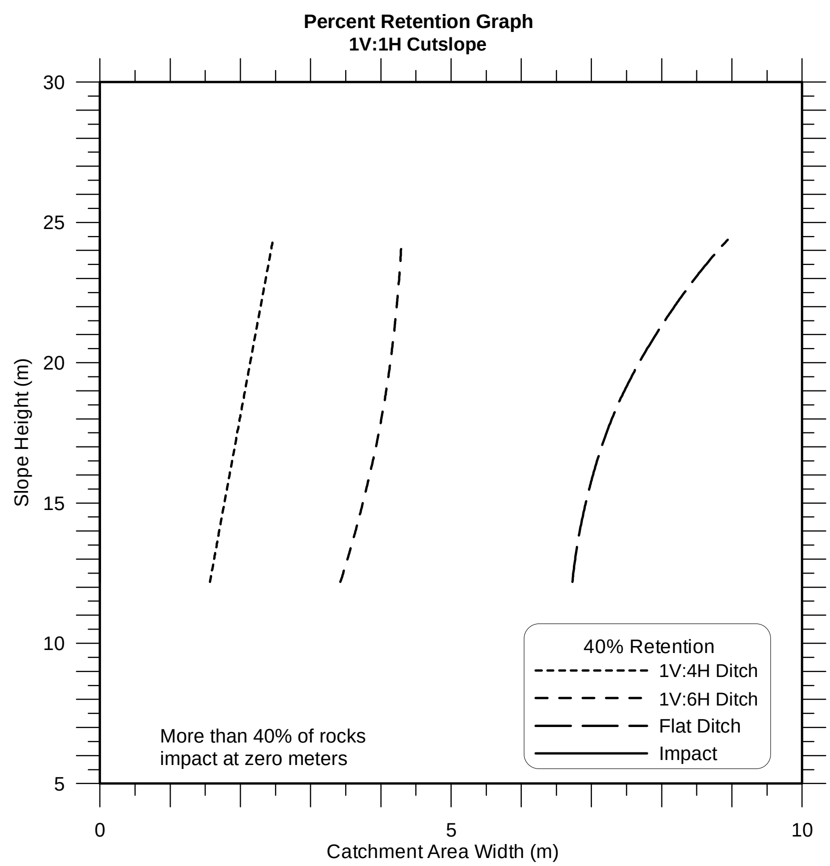
Percent Retention Graph
1.33V:1H Cutslope

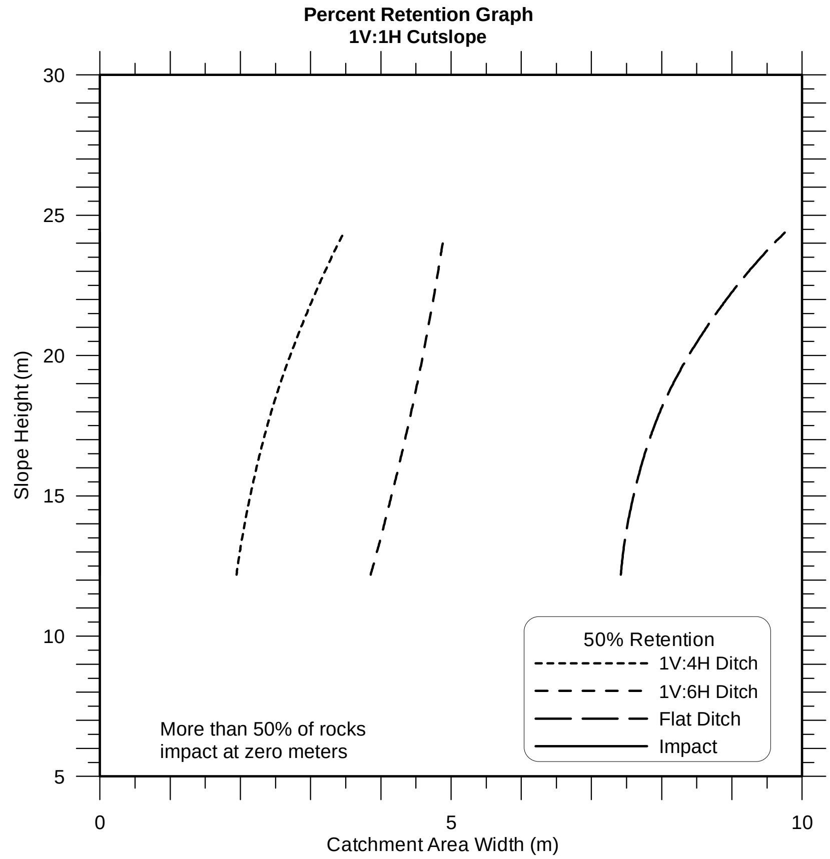


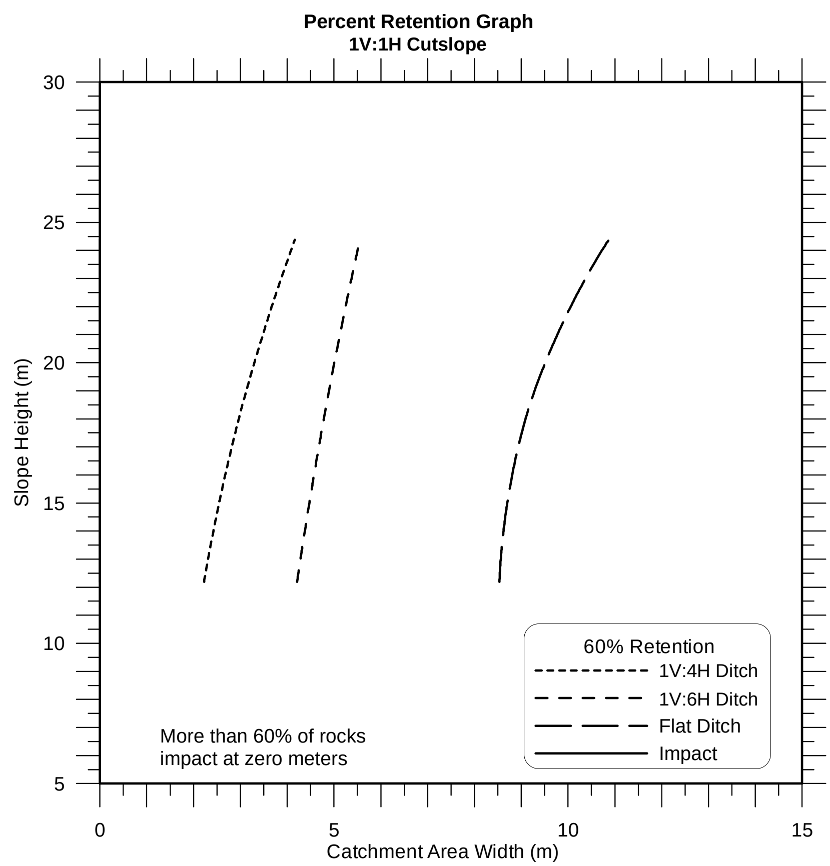
Percent Retention Graph
1.33V:1H Cutslope

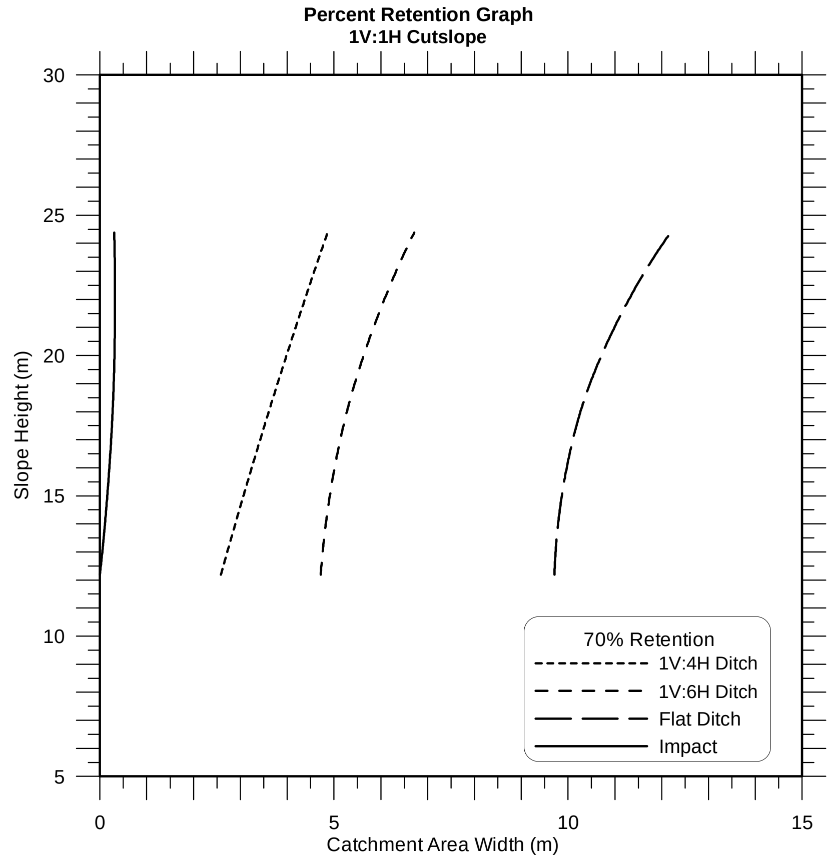


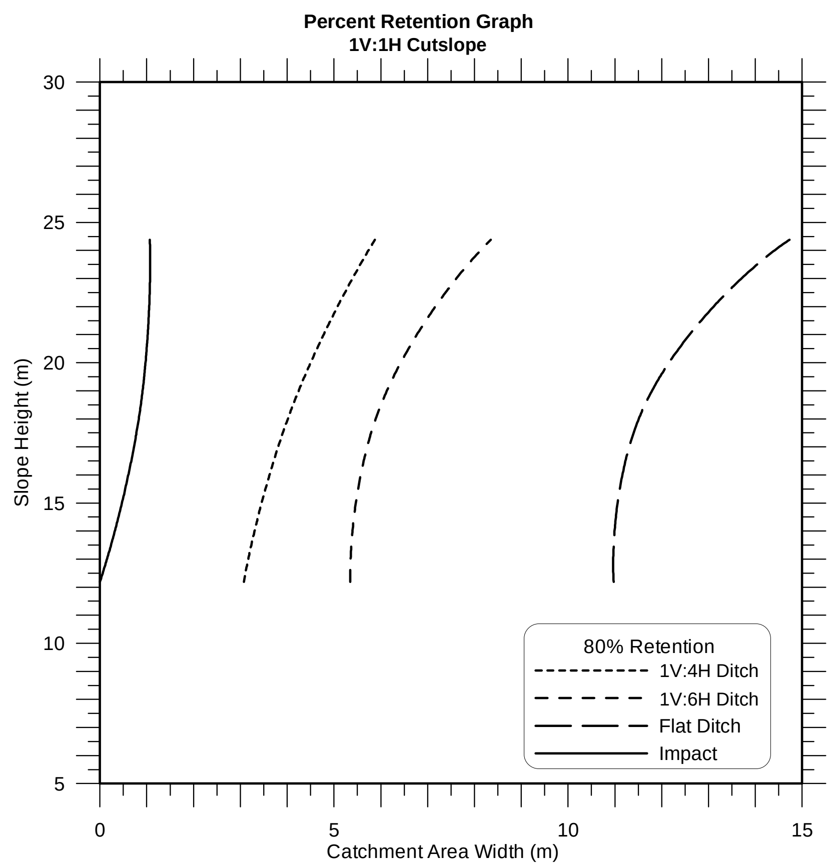

Percent Retention Graph
1V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
30% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
More than 30% of rocks
impact at zero meters

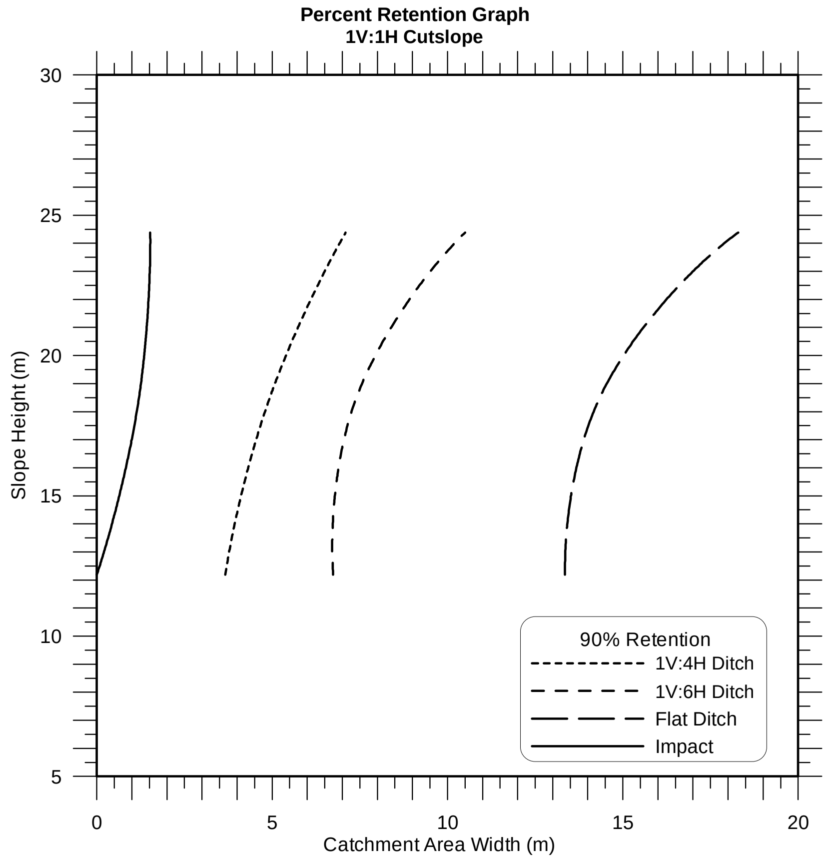

Percent Retention Graph
1V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
40% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
More than 40% of rocks
impact at zero meters

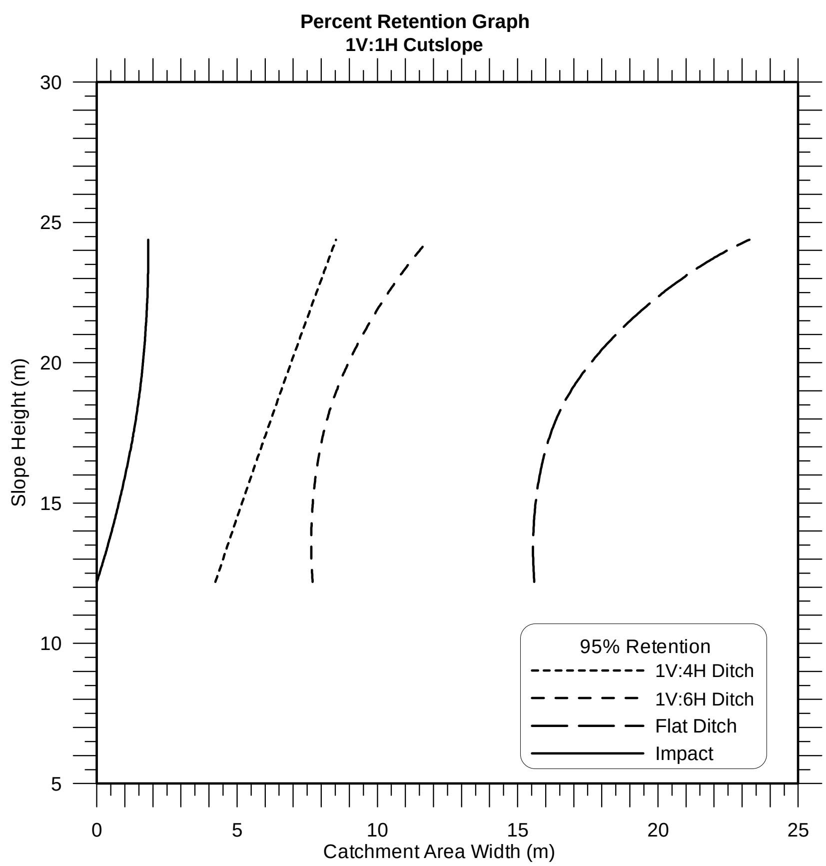

Percent Retention Graph
1V:1H Cutslope
30
25
20
15
10
5
Slope Height (m)
0
5
10
Catchment Area Width (m)
50% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
More than 50% of rocks
impact at zero meters


Percent Retention Graph
1V:1H Cutslope
30
25
20
15
10
5
Slope Height (m)
0
5
10
15
Catchment Area Width (m)
60% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
More than 60% of rocks
impact at zero meters


Percent Retention Graph
1V:1H Cutslope
30
25
20
15
10
5
Slope Height (m)
0
5
10
15
Catchment Area Width (m)
70% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact


Percent Retention Graph
1V:1H Cutslope
30
25
20
15
10
5
Slope Height (m)
0
5
10
15
Catchment Area Width (m)
80% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact


Percent Retention Graph
1V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
90% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
30
25
20
15
10
5
0
5
10
15
20


Percent Retention Graph
1V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
95% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact
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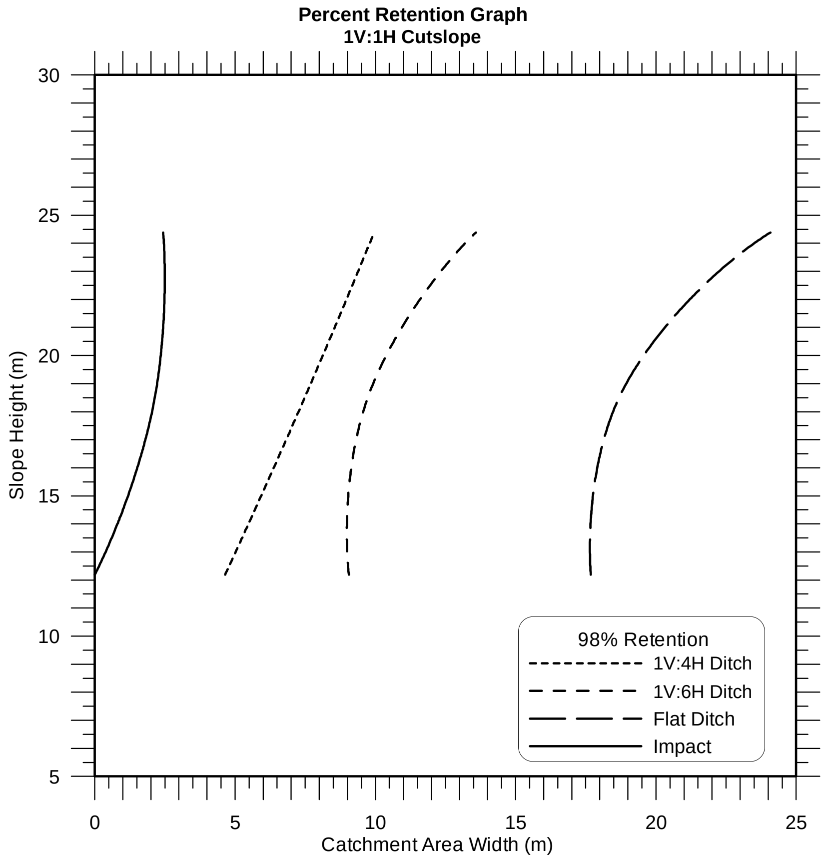
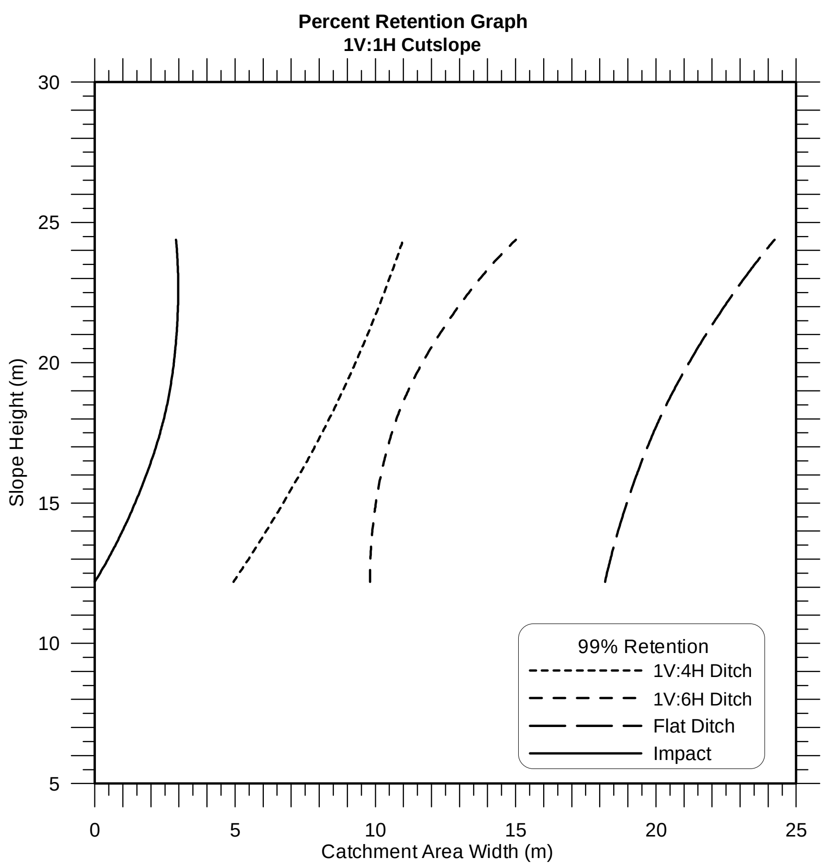
5
10
15
20
25


Percent Retention Graph
1V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
98% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact


Percent Retention Graph
1V:1H Cutslope
Slope Height (m)
Catchment Area Width (m)
99% Retention
1V:4H Ditch
1V:6H Ditch
Flat Ditch
Impact

APPENDIX G: PROJECT CASE STUDY APPLICATION EXAMPLES

PROJECT CASE STUDY APPLICATION EXAMPLES

Case study examples from Arizona, California, Federal Highway Administration - Central Federal Lands Highway Division (FHWA-CFLHD), New York, Oregon, Washington and Wyoming have been provided to further illustrate the practical application and use of the rockfall catchment area design charts to dimension rockfall catchment areas. The Technical Advisory Committee members contributed case studies from their agency's actual projects where the new design criteria and design charts have been used for new designs or as part of a comparison between past design practice and the new design guidelines. Two of the projects (Arizona and New York) included the use of site specific rock rolling, combined with computer simulation, to aid in the rockfall mitigation design. The case histories also illustrate the types of benefit/cost comparisons and judgment applied by experienced geotechnical practitioners to arrive at final catchment area design recommendations.

The **Arizona** project involves highway widening of a portion of US 191 near the town of Morenci, AZ. Existing cutslopes generate substantial rockfall onto the road during rainstorms. Interesting features of this project include the use of actual rock rolling from one of the cutslopes during construction, combined with computer simulation using CRSP, to determine the extent of draped slope mesh required. This was necessitated by a roadway design decision to reduce the rockfall catchment area width and depth below that called for by the Ritchie criteria. ADOT also provides a comparison to the new design charts.

The **California** project involves a curve correction along State Route 101 near the Monterey and San Benito county line by Caltrans District 5. The California project illustrates benefits of the new design charts to estimate percent rockfall retention and use of a flatter slope catchment versus a very deep Ritchie ditch.

The **FHWA-CFLHD** project includes a cut widening for a realignment of New Mexico Forest Highway, Route 45 near Sunspot, New Mexico.

The **Oregon** project is a cut widening being done as part of a roadway alignment improvement project on US 26 in the Mt. Hood National Forest.

The Oregon and FHWA-CFLHD examples are projects where the rockfall catchment areas had already been designed prior to the new design charts becoming available. These case studies illustrate "after the fact" catchment area width and cost comparisons of the as designed catchment area widths based on the Ritchie criteria to the widths given by the new design charts.

The **New York** (Corning Bypass) project involves highway widening on State Route 17. This project utilized site specific rock rolling, combined with computer simulation, to determine the required height of a rockfall catchment fence, when roadway design changes reduced the available catchment area width.

The **Washington** project involves highway widening on a project on SR-243 in eastern Washington. The Washington case study compares use of the new design charts to current WSDOT rockfall ditch criteria (modified after Ritchie) to dimension new rockfall catchment areas and illustrates benefits of the new design charts. The Washington case study also illustrates the importance and benefit of paying attention to constructibility considerations as part of design.

The **Wyoming** project illustrates use of the new design charts to dimension a new rockfall catchment area constructed as part of a highway-widening project on US 26-89 in the Snake River Canyon.

Regional Pooled Fund Study SPR-3 (032)

Arizona Case History

INTRODUCTION

In 1999, The Arizona Department of Transportation was in the process of designing the reconstruction of 2.5 miles of US 191, just south of the mining town of Morenci, located in the eastern portion of the state. The purpose of the reconstruction was to widen the road from two to three lanes and to allow for a larger radius in a horseshoe curve in the middle of the project. The existing cuts are 40 to 60 feet high, ¼H:1V slopes, with 2 to 3 foot wide ditches. During the rainy season, the slopes in this area shed a large quantity of rounded cobbles and boulders 6 to 18 inches in diameter. Maintenance forces patrol the road with a snowplow to keep the rocks cleared off the road surface.

GEOLOGY

The site is located in the Central Mountain Region of the state, between the Basin and Range Providence and the Colorado Plateau. The predominant geological unit encountered in this area is the Gila Conglomerate; a Pliocene age geologic unit made up of sand, gravel, cobbles, and boulders in a lithified, reddish-brown to brown matrix of silt and clay. The area is hilly and the elevation ranges from 3,320 to 4,280 feet. The principal drainages in the area are narrow, deeply incised channels, with vertical walls.

DESIGN METHODOLOGY

A consultant was retained to do the geotechnical design portion of this project. Cuts ranging from 50 to 130 feet high, were designed at ¼ (H): 1(V). The consultant used the Ritchie criteria to develop a design consisting of a 25 foot wide flat-bottomed ditch with a depth of 8 feet. The Colorado Rockfall Simulation Program (CRSP) was used to verify the adequacy of the design.

Mid-way through the design process, a managerial decision was made to eliminate the Ritchie style ditches and to narrow them to 17 foot width with a 4H:1V foreslope. The ADOT Geotechnical Design Section was directed to check the slopes during construction and to determine empirically if the rockfall would encroach on the roadway. If it did, draped mesh would be added to the slopes.

After construction had begun, a team from the ADOT Geotechnical Design Section went to the site and selected a slope that was approximately 90 feet high, on which to perform the rock rolling. Since the excavation was not complete, the impact area was flat soil and the only compactive effort applied was through the passing of the excavation equipment. The newly cut slopes were relatively uniform and contained an abundance of loose, 12 to 18 inch size boulders, at the crest. (See Photos 1 and 2.)

Photo 1:Arizona US 191 project. This shows the cut that the rocks were rolled from. Construction is in progress. View is Southbound.

Photo 2: Arizona US 191 project. Close-up of the slope the rocks were rolled off.

The plan was to see how many of the rolled rocks would roll through the 25 foot wide catchment area (17 foot ditch plus future 8 foot paved shoulder width) and encroach onto the future traveled portion of the roadway. A total of twenty boulders were released from the top of the cut and eight of them (40%) came to rest in excess of 25 feet from the base of the slope.

This data was used to further calibrate the CRSP and the final geometry was then entered into CRSP. The simulation predicted that 24% of the rockfall from the top of a 90 foot cut would encroach onto the traveled lanes of the roadway, compared to 40% from the field rock rolling trial.

Since it was known that there is a high volume of rocks that are shed from the existing cuts in this area during a rainstorm, it was decided to design for a 99% containment of the rockfall in the cut ditch. CRSP was once again used to simulate various heights of rockfall origination and the results indicated that mesh installed from the top of the slope to a distance of 40 feet above the toe of the slope would provide the containment desired.

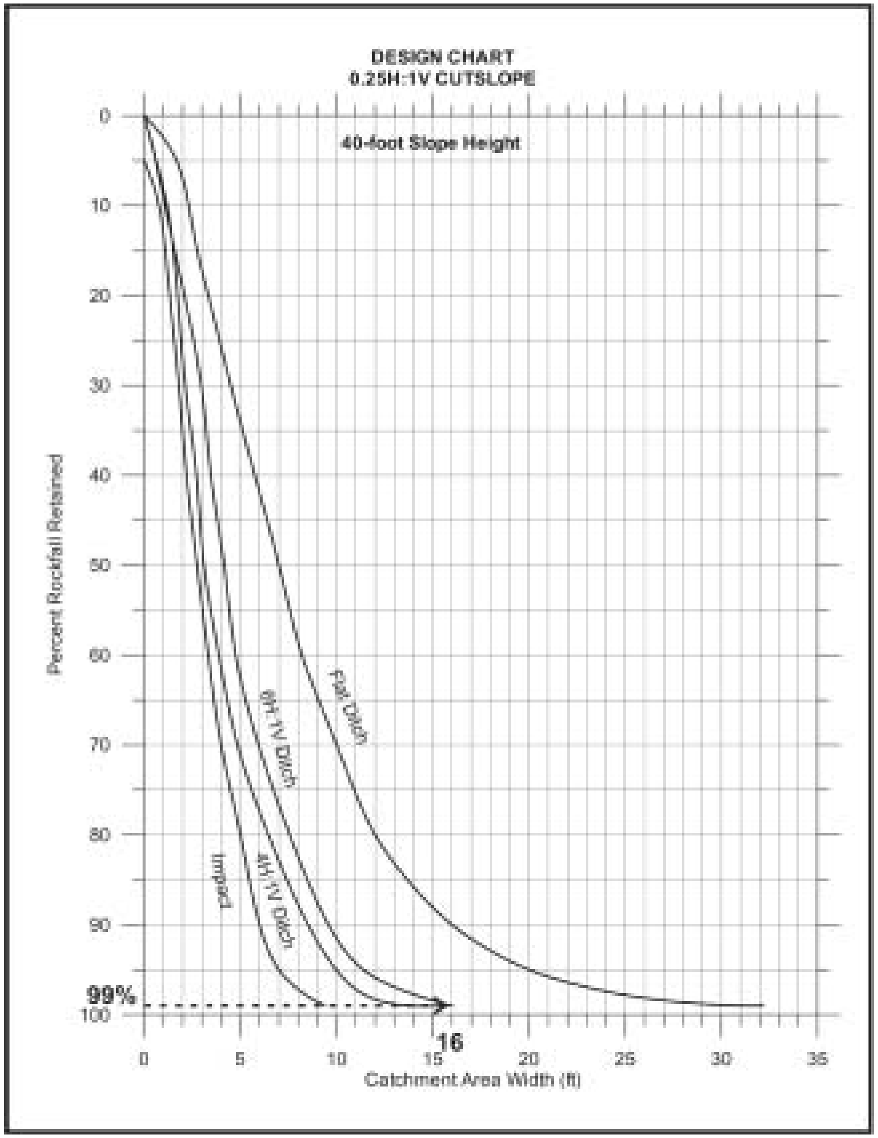
This section of roadway has been opened to traffic prior to the mesh being installed (See Photo 3). It does experience a high volume of rocks on the road during a rainstorm but not as many as prior to the construction of the wider ditches.

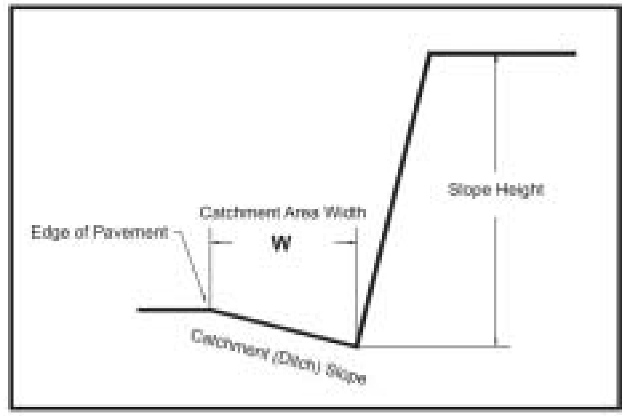
A construction contract has been awarded to install the mesh and mesh installation will start in October of 2001.

Photo 3: Arizona US 191 project. Shows the completed cut slopes and rockfall catchment ditches just prior to opening for traffic. Draped mesh not yet installed. View is Northbound.

COMPARISON TO DESIGN CHARTS

If the design charts included in this new Design Guide had been available and used for design for this project instead of CRSP, an almost identical design height for the mesh would have been chosen. If an assumption is made that when a rockfall falls from the bottom of the wire mesh drape, it has a very low velocity or angular momentum, then the chart for the forty foot high ¼H:1V cut slope could be used to verify that a sixteen foot wide ditch would contain 99% of the rockfall (see Figure 1). This provides the ADOT Geotechnical Design Section confidence in the validity of the new Design Charts. The complete suite of Design Charts adds significantly to our ability to prepare improved rockfall mitigation designs.





Quick Reference - 40-Ft Slope Catchment Area Width - **W**				
Percent Rockfall Retained	Impact	Catchment Area Slope		
		4H:1V	6H:1V	Flat
	W (ft)	**W** (ft)	**W** (ft)	**W** (ft)
50%	3	3	4	7
75%	4	6	7	11
80%	5	6	8	12
85%	5	7	8	14
90%	6	9	10	16
95%	7	10	11	20
99%	9	16	16	32

Figure 1: Arizona Case Study Design Chart

Case Study of a Fallout Area Using New Design Charts
Regional Pooled Fund Study SPR-3 (032)
California Case History

Introduction

In 1998 California Department of Transportation (Caltrans) District 5 proposed a curve correction along State Route 101 near the Monterey and San Benito county line. Route 101 is a major north south corridor. Part of the upgrade was to realign the southbound corridor through the existing undeveloped median via a through cut. This area is comprised of rolling hills, steep drainage, and oak groves. A cut slope investigation was performed which included geologic field mapping, a subsurface boring investigation, a discontinuity analysis and a seismic refraction study.

Photo 1: Cut Slope with Catchment

Geology

The cut area is within the Pinecate Formation, which is comprised of medium to coarse-grained quartzose sandstone with lenses of pebble conglomerate. The sandstone is massive and exposed as large blocks on the surface. Studies indicated that the major controlling structural discontinuities have a favorable orientation for global stability. Minor fracturing could create small blocks of rock up to 2 feet in dimension. Slope raveling could generate rockfalls within the cut slope face. Typical seismic velocities for this material ranges between 4200 to 5700 feet per second to between 6500 and 10,000 feet per second.

Design and Risk Considerations

Realigning through undeveloped natural land poses many challenges one of which is to minimize the corridor footprint and balance the earthwork. Environmental personnel needed to reduce impacts to terrestrial resources, cultural resources, visual resources, and associated costs of mitigation. Reduction of the impact on cultural resources was of particular importance.

Cut slope design approach was to steepen the cut slopes to the maximum allowable slope inclination and maintain global stability. The associated risk is accepting local instabilities such as rockfalls. It was observed that similar road cuts within this formation were globally stable but local stability was marginal creating occasional rockfall. Rockfall control on the new cuts is provided by a catchment ditch. In cross section steeper cuts with catchment indicated reduced quantities and minimized land impacts (Figure 1). Ditch dimensioning was done using the Ritchie criteria.

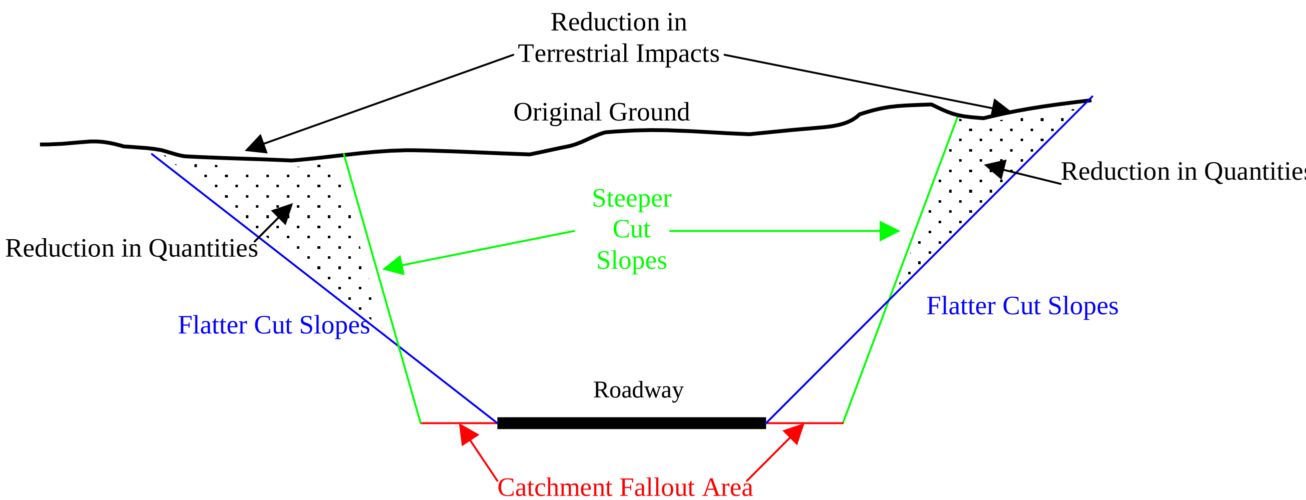


Figure 1: Cross Section

Recommendations

Maximum slope height is 45 feet. Average slope height was 40 feet or less. The recommended design for this location was to excavate the cut slope at a 1/4: 1 slope ratio and provide 16 feet of catchment area at grade with a 10:1 backslope. Including the 5-foot shoulder total available catchment between the base of the slope and the edge of traveled way increased to 21 feet. Catchment area is defined as the distance from the base of the cut slope to the edge of traveled way. The proposed catchment is designed to contain rock from free falling onto the traveled way.

The Ritchie Criteria was used to determine rockfall fallout width. A Ritchie depth was not recommended due to the hazard a roadside ditch presents. Instead a backslope was incorporated into the rockfall fallout area design. The final backslope is 10:1 due to increasing rock hardness and associated excavation difficulties. Comparison of the designed ditch to the new design chart (Figure 2) indicates that the recommended ditch will contain 100 percent of the free falling rocks and 90-95 percent of the rocks rolling away from the slope. Increasing the ditch to 100 % for roll out would have required removal of cultural and environmental resources. The design slopes preserve these resources. Obtaining 100 % containment catchment would have increased excavation costs and impacts on local landfills. Mitigation costs for resource loss would have been significant both in dollars and time to complete the project. Resource dollar amounts are not available.

Results

During the course of the excavation rocks were dislodged from the slope face. Most of these rocks were less than or equal to 1 foot in dimension. Of those all were contained within the proposed catchment width. The cut was completed in June 2001.

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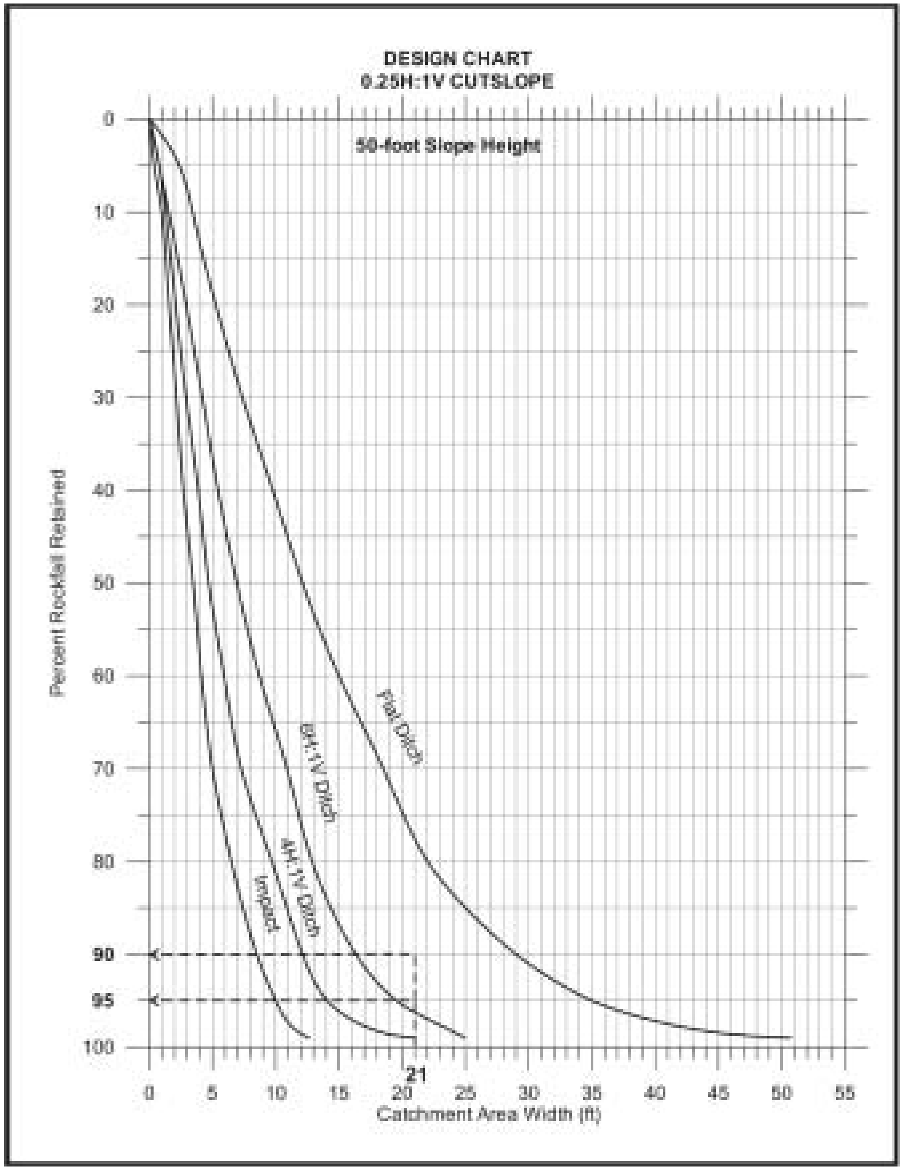
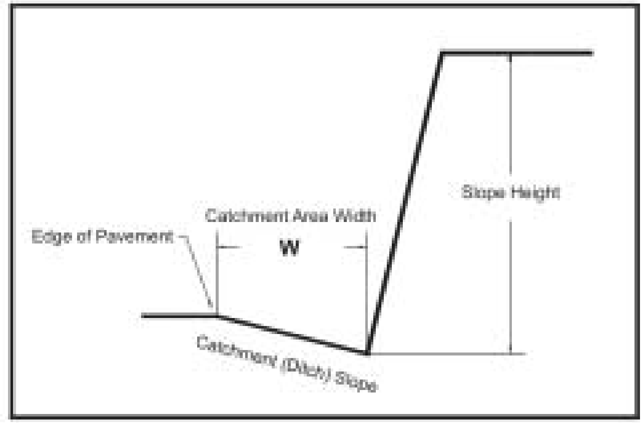




Quick Reference - 50-Ft Slope Catchment Area Width - **W**				
Percent Rockfall Retained	Impact	Catchment Area Slope		
		4H:1V	6H:1V	Flat
	W (ft)	**W** (ft)	**W** (ft)	**W** (ft)
50%	3	5	7	12
75%	6	8	12	20
80%	7	10	13	22
85%	7	11	14	25
90%	8	12	16	29
95%	10	14	19	35
99%	13	21	25	51

Figure 2: California Case Study Design Chart

REGIONAL POOLED FUND STUDY SPR-3 (032)

FHWA-CFLHD CASE HISTORY

PROJECT DESCRIPTION

The Sacramento River Road project, also referred to as the Sunspot Road project, includes a proposed realignment of New Mexico Forest Highway Route 45 beginning near Timberon and continuing northwesterly 21.5 km to the intersection with State Highway 6563 near Sunspot, New Mexico. The Sacramento River Road is being designed as two construction projects. The first project, PFH 45-1(4), begins as project Station 12+480 and continues 9.2 km northwest to the intersection with State Highway 6563 at Station 21+700. The second project, PFH 45-1(5), begins near Timberon and continues about 12.3 km to the beginning of Project PFH 45-1(4). This case study deals with the rock cuts associated with the first project, PFH 45-1(4).

This project, located east of Alamogordo, New Mexico contains approximately 2.2 km of rock cut of up to 20 m in height. The Average Daily Traffic in the year 2000 is 860.

GEOLOGY

Bedrock along the alignment consists of thinly bedded to massive limestone with a gentle bedding dip and appears to be variable in magnitude and direction. The thinly bedded limestone is visible in existing road cuts and as colluvium on the slopes. Where exposed in road cuts, the limestone appears clayey and in some locations interbedded with thin beds of mudstone. The massive limestone outcrops naturally on both sides of the valley at various locations along the alignment. The road cuts down through the stratigraphy and, consequently, the character of the limestone is expected to vary along the alignment. Cuts may expose cavities and caves up to several meters in size, and open discontinuities created from solution weathering.

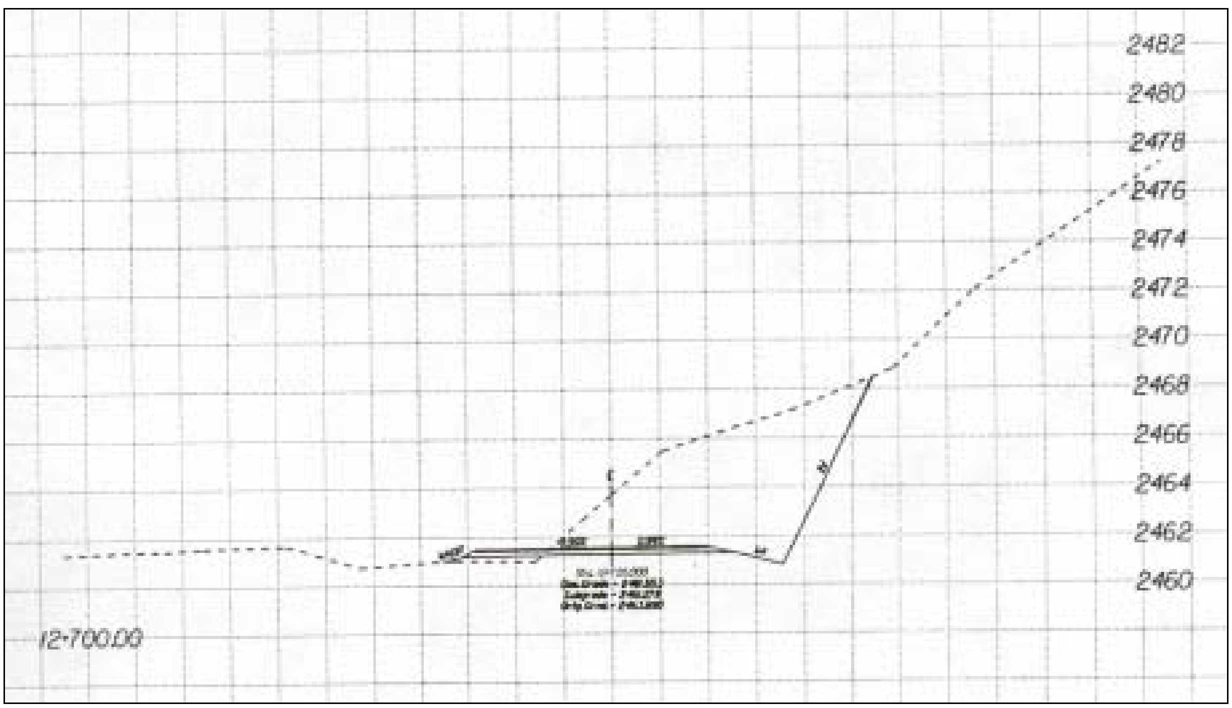
Rock cuts through the massive limestone beds with discontinuity spacing of more than 0.5 m, should perform satisfactorily with cut ratios near vertical, and a slope ratio of 8V:1H is appropriate for design. It is possible that portions of the proposed rock cuts (up to 20 m in height) will be comprised of both massive and thinly bedded strata.   The thinly bedded strata of limestone may not have the necessary rock mass strength to stand as steeply as the massive strata. Furthermore, rockfall frequency will be undesirably high. A slope ratio of 2V:1H is appropriate for the thinly bedded strata.

ROCK SLOPE DESIGN

For overall slope stability and practicality of construction, a uniform 2V:1H slope ratio was selected for design.

ROCKFALL PROTECTION MEASURES

Other than ditch design, no rockfall protection such as rock bolting, strapping, mid-slope fences, draped wire mesh nor rockfall collection fences were designed for this project.



DITCH WIDTH DESIGN

Many design criteria are modifications of the Ritchie criteria developed in 1963 (Ritchie, A. M., 1963, “Evaluation of Rockfall and its Control,” Highway Research Board, No. 17, pp.13-28). Using the Ritchie criteria, the collection ditch’s width and depth is evaluated based on the slope ratio and height of the rock cut.

The Oregon Department of Transportation (ODOT) published a report (FHWA-OR-GT-95-05, “The Nature of Rockfall as the Basis for a New Fallout Area Design Criteria for 0.25:1 Slopes”, 1994) presenting findings form a study analyzing the performance of several rockfall collection ditches.

An evaluation of the ditch design for a 2V:1H cut slope ratio and two slope heights (12.5 m and 18.5 m) was conducted by comparing three alternate design criteria: 1) the Modified Ritchie criteria; 2) a 1:4 ditch with a width of 3 m; and 3) ODOT data for a 1:4 ditch and 90% rockfall retained.

For this project, the design criteria used for ditches below cut slopes was a 3 m wide ditch with a 1:4 ditch slope. The slope/ditch design typical section is attached.

12.5 m is approximately the average height of the proposed rock cuts. 18.5 m is approximately the maximum height of the proposed rock cuts. The Modified Ritchie ditch has a flat bottom and steep side slope next to the roadway. Ritchie based his design criteria on the ditch being wide enough to have the rockfall impact within the ditch width and then relying on the deep ditch depth to prevent the rock from rolling up onto the highway. The % retention given for the Ritchie ditch width in the following comparison tables is estimated using the ODOT based IMPACT distance chart for 2V:1H slopes. Refer to Figures 1 and 2.

Table 1
Comparison of Ditch Design Alternatives for 12.5 m High Rock Slope

Design Criteria	Slope Ratio (v:h)	Ditch Width m	Comments
Modified Ritchie (flat ditch bottom at design depth below road	2:1	5.1	Ditch depth = 1.8 m **Est. 99% rockfall retention**
3 m ditch width 1:4 ditch slope	2:1	3	**Est. 82% rockfall retention** From ODOT data based 2:1 slope
ODOT criteria **for 90% rockfall retention** 1:4 ditch slope	2:1	3.5	**Est. 90% rockfall retention** From ODOT data for 2:1 slope

Table 2
Comparison of Ditch Design Alternatives for 18.5 m High Rock Slope

Design Criteria	Slope Ratio (v:h)	Ditch Width m	Comments
Modified Ritchie (flat ditch bottom at design depth below road	2:1	6	Ditch depth = 2 m **Est. 99% rockfall retention**
3 m ditch width 1:4 ditch slope	2:1	3	**Est. 52% rockfall retention** From ODOT data based 2:1 slope
ODOT criteria for **90% rockfall retention** 1:4 ditch slope	2:1	5.1	**Est. 90% rockfall retention** From ODOT data based 2:1 slope

BENEFIT/COST COMPARISON

For this project, there was no separate bid item for Rock Excavation, but was included in the bid item for Roadway Excavation. There was also no bid item for Rock Blasting, however the Special Contract Documents included specifications concerning rock blasting that directed the contractor to use controlled blasting techniques. The bid quantity for Roadway Excavation was 200,000 m^3 and the bid price was $5.00/$m^3$.

The following tables show a cost comparison for the project design ditch versus the Modified Ritchie and the ODOT criteria ditches. The cost is expressed as a ratio of the cost of the project design ditch and was determined by calculating the additional excavation that would be necessary for the additional ditch width required by the Modified Ritchie and the ODOT criteria as compared to 3 m for the project design ditch.

Table 3
Cost Comparison of Alternatives for 12.5 m High Rock Slope

Design Criteria	Slope Ratio (v:h)	Ditch Width m	Cost Ratio
Modified Ritchie (flat ditch bottom at design depth below road	2:1	5.1	1.67
3 m ditch width 1:4 ditch slope	2:1	3	1.00
ODOT criteria for **90% rockfall retention** 1:4 ditch slope	2:1	3.5	1.23

Table 4
Cost Comparison of Alternatives for 18.5 m High Rock Slope

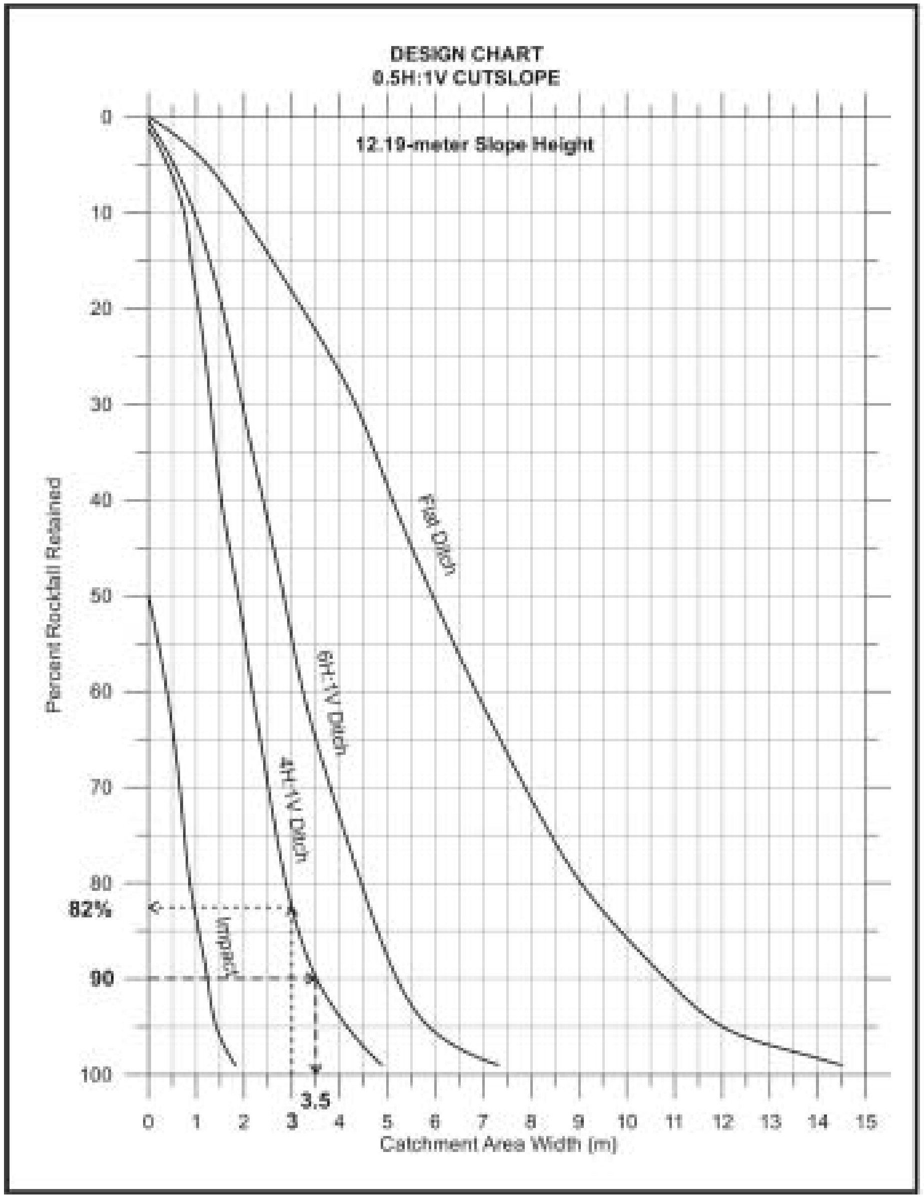
Design Criteria	Slope Ratio (v:h)	Ditch Width m	Cost Ratio
Modified Ritchie (flat ditch bottom at design depth below road	2:1	6	1.95
3 m ditch width 1:4 ditch slope	2:1	3	1.00
ODOT criteria for **90% rockfall retention** 1:4 ditch slope	2:1	5.1	1.56

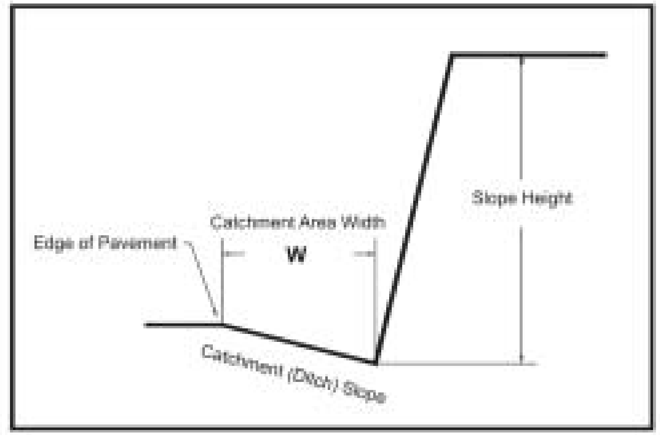
CONCLUSIONS

The Ritchie ditch design, while giving the most conservative ditch width and depth is not preferred because it is much more costly the deep ditch immediately adjacent to the roadway does not meet current roadside safety clear zone requirements. A 2 m deep ditch would require a barrier, such as concrete jersey barrier or metal guard rail along the shoulder.

The 3 m wide ditch is unconservative, providing only an estimated 52% and 82% rockfall retention for the 18.5 m and 12.5 m high slopes, respectively.

For a new design, the ODOT based 90% rockfall retention ditch design calling for 3.5 m and 5.1 m wide 1:4 sloped ditches for the 12.5 m and 18.5 m slope heights, respectively, appears to provide the best cost/benefit and would be the preferred design.

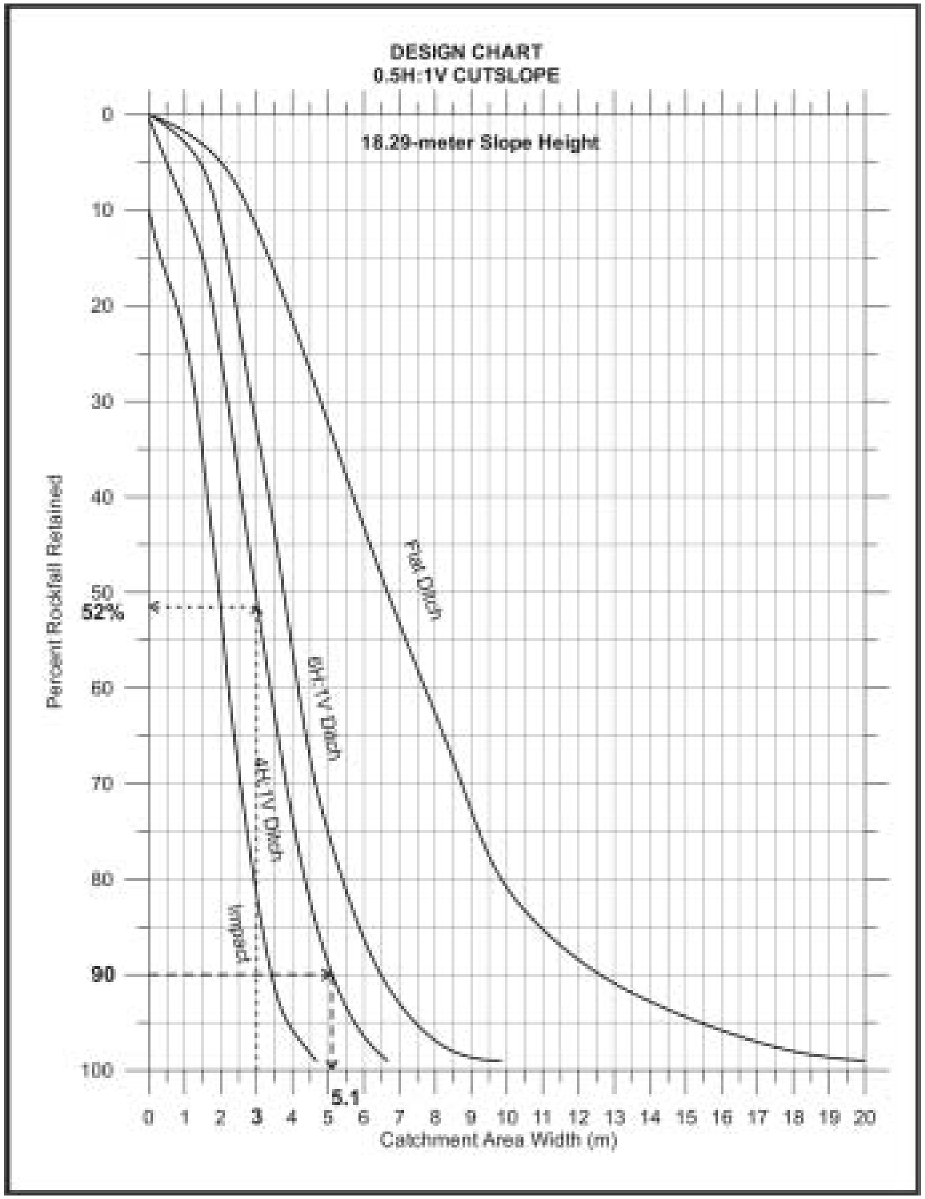


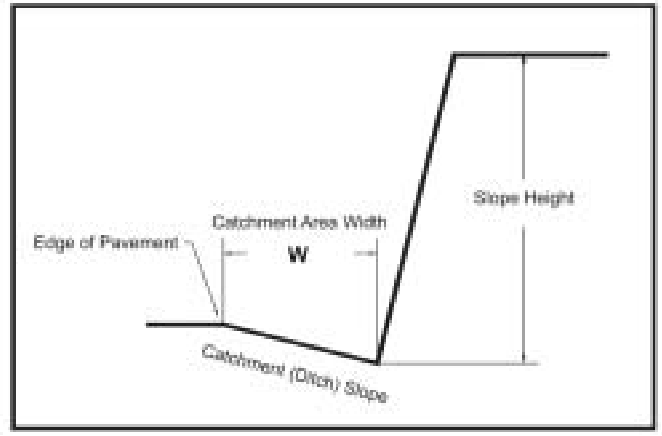


Quick Reference - 12-Meter Slope
Catchment Area Width - **W**

Percent Rockfall Retained	Impact	Catchment Area Slope		
		4H:1V	6H:1V	Flat
	W (m)	**W (m)**	**W (m)**	**W (m)**
50%	0.0	1.9	2.8	5.9
75%	0.8	2.7	4.1	8.5
80%	0.9	2.9	4.5	9.0
85%	1.0	3.3	4.8	9.8
90%	1.2	3.5	5.2	10.8
95%	1.4	4.3	5.9	12.0
99%	1.8	4.9	7.3	14.5

Figure 1: FHWA - CFHLD Case Study





Quick Reference - 18-Meter Slope Catchment Area Width - **W**				
Percent Rockfall Retained	Impact	Catchment Area Slope		
		4H:1V	6H:1V	Flat
	W (m)	**W (m)**	**W (m)**	**W (m)**
50%	2.0	3.0	3.6	6.7
75%	2.7	4.0	4.9	9.3
80%	2.9	4.4	5.4	9.8
85%	3.3	4.8	5.8	11.0
90%	3.4	4.9	6.5	12.6
95%	3.9	5.8	7.4	15.4
99%	4.7	6.7	9.8	20.0

Figure 2: FHWA - CFHLD Case Study

Oregon Department of Transportation
GEOHYDRO SECTION
Geotechnical Unit

INTEROFFICE MEMO
986-3778 986-3407 FAX

TO: Liz Hunt, P.E.
Research Coordinator

October 31, 2000

FROM: Don Turner, C.E.G.
Geotechnical Designer

SUBJECT: Case Study of a Fallout Area Using New Design Charts
Regional Pooled Fund Study SPR-3 (032)

As you requested, the following is a case study of a rock cut comparing the existing rock slope, the new design charts for rock slopes, and the Ritchie Chart criteria. The format follows the one you outlined in your request for case studies from other state DOT's. The case study is pulled from a project that was already designed in 1999 and will be constructed in 2001.

Introduction

The project is located in high elevation, mountainous terrain near Mt. Hood at milepoint 49.1. The existing 3-lane highway section was constructed in a through-cut in the 1960's.

The highway experiences high use periods during the summer and winter due to its proximity to recreational activities and as the main travel route between Portland and Central Oregon. The 1997 ADT is 8,100, and is projected to rise to 13,000 in 2017. The proposed design is a realignment of the highway by moving away from the existing rockcut on the inside of the curve and making a new cut on the outside of the curve, which will create larger fallout areas on both sides of the highway. See the attached design cross-section (Figure 1).

Geology and Geologic Structure

The cut for the case study is located on the outside of a curve. The cut is up to 25 meters high and was originally constructed with uncontrolled (“coyote”) blasting methods, so the resulting slope is variable between 1V:0.5H and vertical. The rock is andesite from flows of the Laurel Hill Formation. The rock is fine-grained, has some to no vesicles, and is generally gray to light brown. The rock is slightly weathered to fresh, and medium hard to hard (R-3 to R-4). The cut exhibits two predominant joint sets: one set where the joint dip direction is generally parallel to the highway and a second set where the joints are generally perpendicular to the highway. The joints are steeply dipping between 70 and 90 degrees and are moderately closely spaced (0.3 m to 1 m) with some spacing greater than 3 meters. The joints are tight (closed) to open with up to a 5 mm width. The joint surfaces show a slight amount of surface staining. Infilling in the open joints is composed of silt and soft clay.

Rockfall History/Risk Considerations

The rockfall history of the cut is that infrequent rockfall events occur, but that the site has a high rockfall hazard potential because of the high, steep, blast damaged cut and the existing narrow, shallow ditch. The ODOT Rockfall Hazard Rating System has rated the cut as a “B” type hazard, which means that the cut does not rise to the level where an RHRS score is determined. The site is on an 8-degree curve, 6 percent grade where snow and ice are a major factor in the winter months. The snow storage is limited with the narrow ditch, causing rock to sometimes deflect off the snow and land in the travel lanes. Maintenance cleanout is difficult with the short sight distance of the curve. The maximum size of the rock observed in the ditch was about 0.6 meters in diameter, and it appeared that much of the rock in the ditch had been larger pieces that broke into smaller ones during their fall. The conclusions made for the new rock slope design were that since the overall rockfall frequency was generally low, a fallout ditch and slope design should be made that will retain over 90 percent of the 0.6-meter size rock, and that the fallout zone backslope should be flat enough for easy access by cleanout equipment.

Design Considerations

Level of Risk Evaluated

The basis for ODOT geotechnical design of rock slopes is to retain at least 90 percent of the anticipated maximum sized rock when designing new rockfall areas. That percentage can be adjusted up or down based on cost or other factors of the project. In addition, the ditch design is generally recommended to be a maximum of 1.2 meters deep so that the shoulder slope is 1V:4H or flatter for Maintenance cleanout purposes. A further design consideration is that, in some cases, the paved shoulder area between the EP (edge of pavement) and fog line can be considered as additional fallout width since a rock stopping in the paved shoulder area is not the same degree of hazard when compared to rock in a travel lane. However, on this project, with it's curved roadway alignment, the roadway pavement will have a pretty steep superelevation slope away from the cut, and any rock that rolled onto the paved shoulder has a pretty good chance of continuing to roll into the travel lane. Therefore, for this project, the additional 1.8 meter paved shoulder width between the fog line and EP was <u>not</u> included as part of the design fallout area width.

The rock cut for this project had already been designed prior to the research project 1V:0.5H slope new design charts becoming available. The fallout area design was arrived at through the use of the ODOT earlier developed design chart for 1V:0.25H slope, comparison to Ritchie design chart, experience, judgement and constructibility considerations. The rock cut for this project was designed with a 1V:0.5H slope for stability and with a minimum 6-meter wide fallout area for rockfall retention and to provide sufficient width for access of drill and excavation equipment to actually construct the cut widening. The fallout area was designed with a 1:6 slope.

<u>Cost Analysis</u>

Approximately 40,000 cubic meters of rock excavation is estimated for the cut. Controlled blasting will be used for the construction of a stable slope face, and approximately 3,200 lineal meters of control blast holes is estimated. Traffic control and limited road closure periods will be a major factor during blasting and cleanup. The heavy use of the highway during the summer and the large amount of loaded truck traffic means that the closure times will need to be the shortest time possible. This will increase the need for a well planned blasting operation in order to prevent flyrock onto the travel lanes. Rock excavation costs are estimated to be about $15.00 per cubic meter and the controlled blast holes are estimated to cost about $10.00 per lineal meter. Actual bid prices will be known when the project bids in 2001.

<u>Discussion of Recommended Design</u>

The recommended design ditch width and shoulder slope angle was 6 meters with a 1V:6H slope. This was judged to be adequate rockfall mitigation for a cut that will be excavated with control blast methods and wider paved shoulder widths than those that exist presently. Rockfall produced from the new cut should be minimal for many years, until the cut begins to age and additional stress relief cracks behind the new cut face.

<u>Comparison of the Design Ditch to the Ritchie Chart</u>

The recommended fallout area width of 6 meters of ditch is narrower than the "Ritchie" design chart shows for a 25-meter high cut with a 1V:0.5H slope. The Ritchie chart shows that the required ditch design would be about 6.9 meters wide and 1.5 meters deep. See the attached Ritchie Chart (Figure 2). Such a deep ditch is undesirable from both a roadside safety and maintenance standpoint and would require a roadside barrier (concrete or guard rail) along the EP.

Comparison of the Designed Ditch to the New Design Chart

Upon becoming available, the new 80-foot 0.5H:1V slope/6:1 Design charts for both Impact and Roll Out were compared to the above as designed ditch. See the attached Design Chart (Figure 3). For a design ditch width of 6 meters, the new chart for Impact shows 99% of rocks retained, and for Roll Out it shows 83% of rocks retained.

If the new Roll Out Design Chart had been used in the design of the ditch, and the goal is to retain a minimum of 90%, then a fallout area of about 7 meters wide with a 6:1 slope or about 6 meters wide with a 4:1 slope, would be used. This means that the as designed ditch is about 1 meter narrower than the new 6:1 Roll Out Design Chart shows.

Benefit/Cost Comparison

A comparison was also made to a wider ditch providing 99% retention versus 90%. Using the new 80 foot, 0.5H:1V slope/6:1 ditch Roll Out chart gives a required ditch width of 10.5 meters (see Figure 3). That is 4.5 meters wider than the as designed ditch. The added 4.5 meter width results in an increase in excavation quantity of about 25% from the current design. Extrapolating that quantity to the entire cut section, the excavation quantity increases from 40,000 cubic meters to 50,000 cubic meters, with an additional cost increase of about $250,000.

In summary, If the new charts had been used in the design, the design very likely would have been either 6 meters with a 4:1 shoulder slope, or 7 meters with 6:1 slope, providing at least an estimated 90% rockfall retention. From a construction cost comparison viewpoint, it would be less expensive to excavate a deeper ditch with a 4:1 slope, than to excavate an additional 1-meter into the rockcut and have a 6:1 shoulder slope. Therefore, the final choice would be a 6-m wide ditch with a 4:1 shoulder slope.

Attachments:

- Figure 1: Design Cross Section
- Figure 2: Ritchie Design Chart
- Figure 3: Impact and Roll Out Design Chart (metric units)

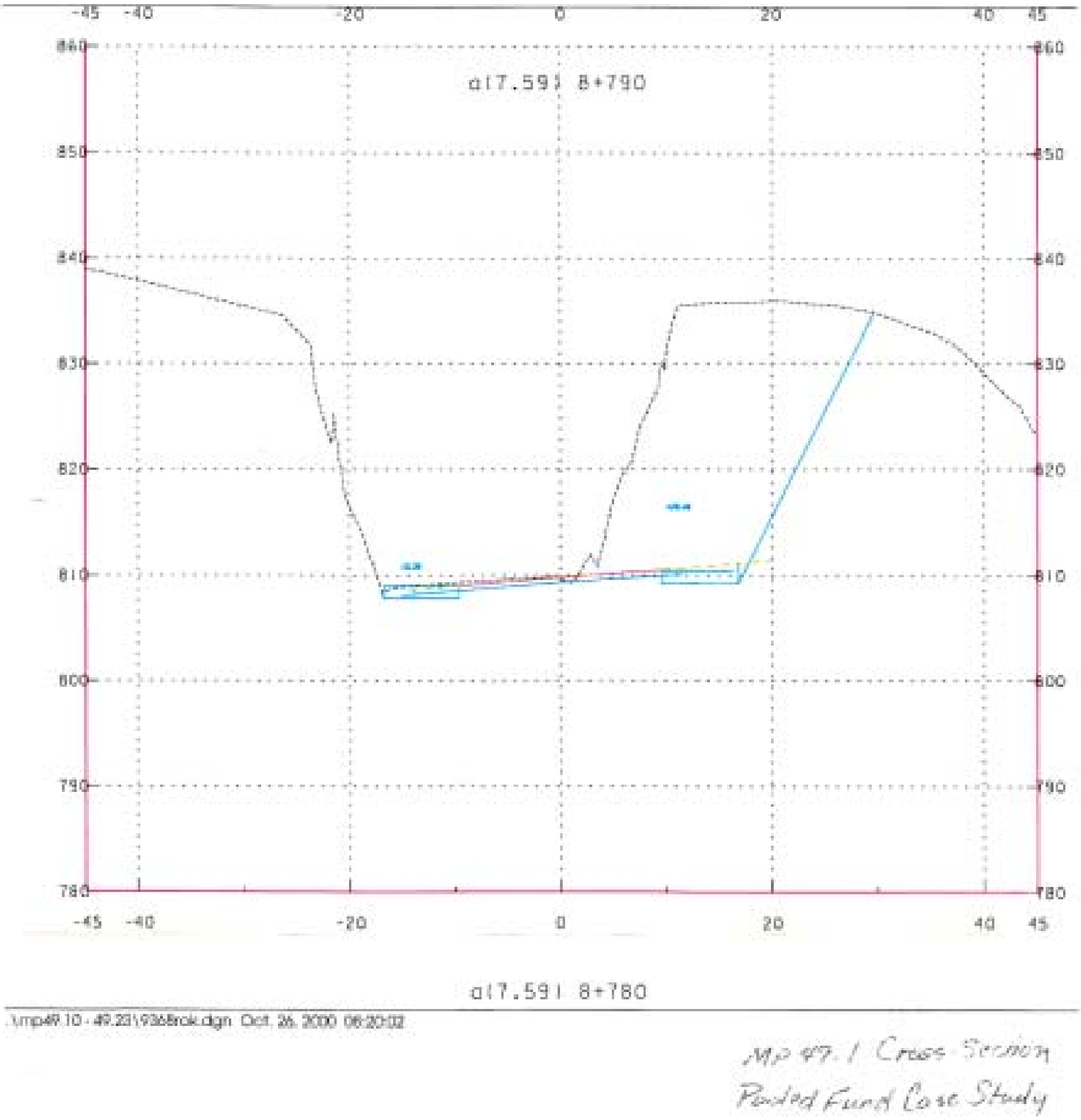


Figure 1: Design Cross Section

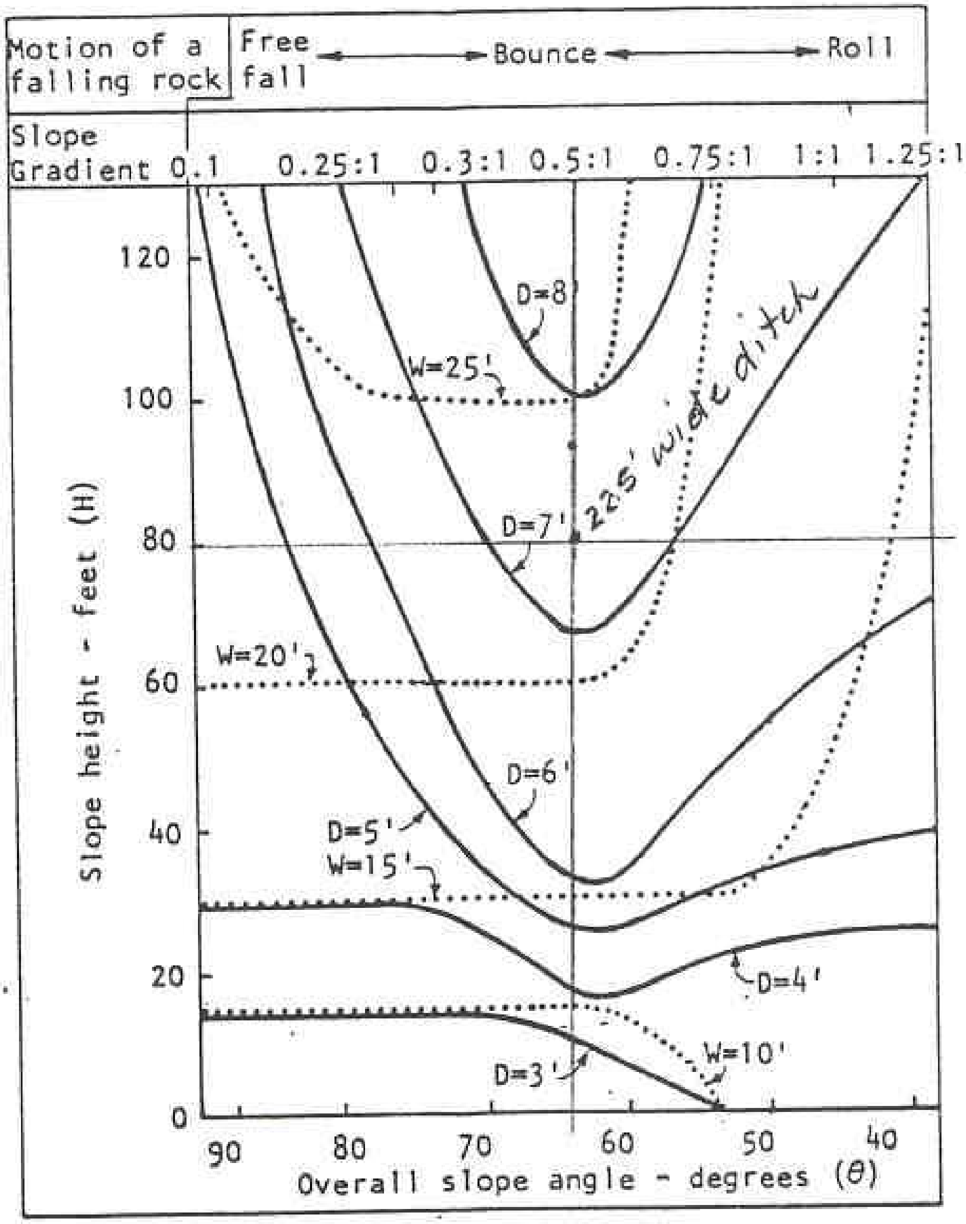
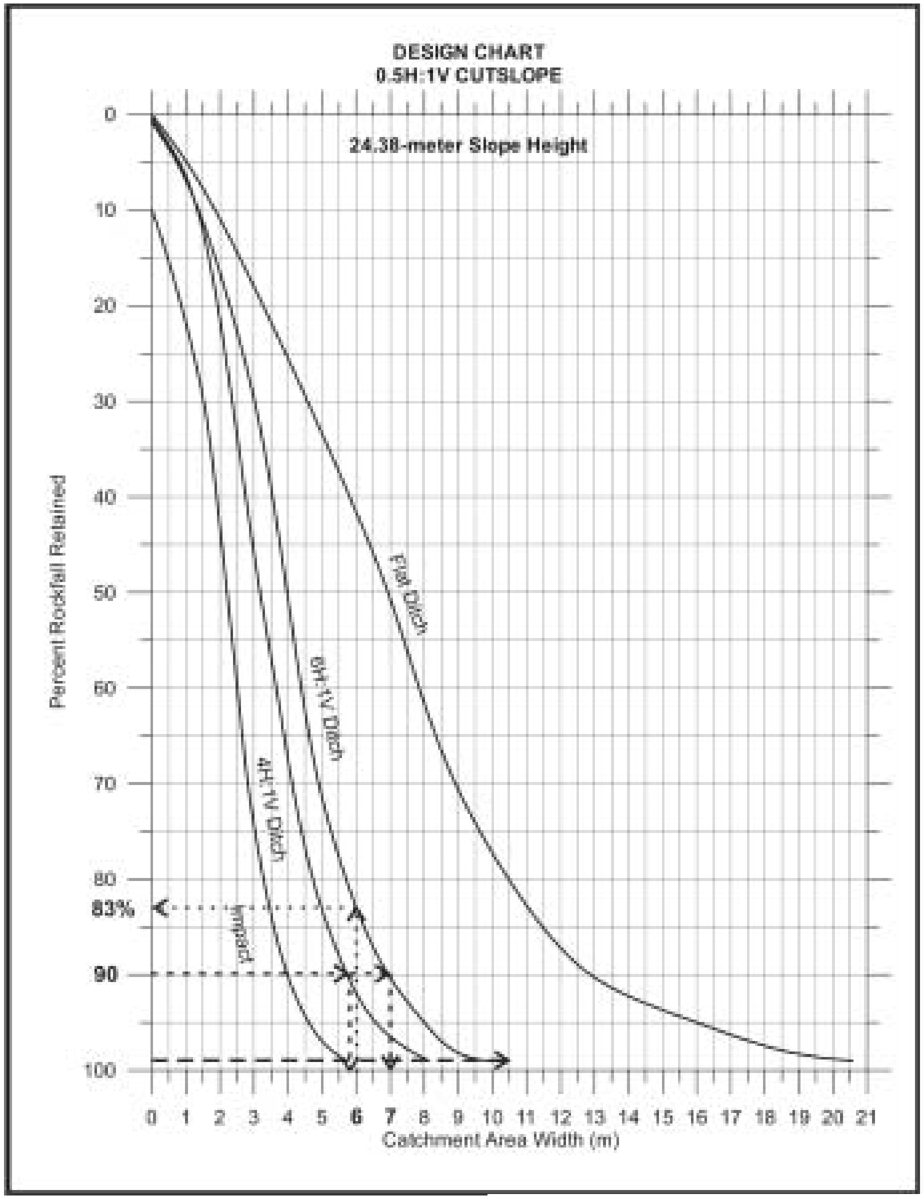
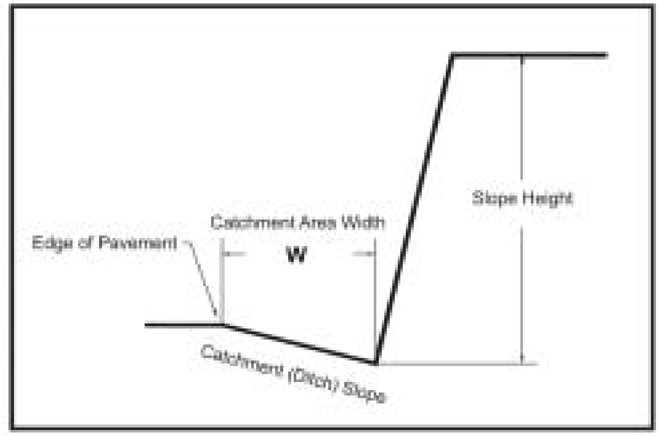


Figure 12.10(a): Ditch design chart.

Figure 2: Ritchie Design Chart





Quick Reference - 24-Meter Slope Catchment Area Width - **W**				
Percent Rockfall Retained	Impact	Catchment Area Slope		
		4H:1V	6H:1V	Flat
	W (m)	**W (m)**	**W (m)**	**W (m)**
50%	2.2	3.2	4.0	6.9
75%	3.0	4.4	5.1	9.6
80%	3.2	4.7	5.7	10.5
85%	3.5	5.3	6.3	11.5
90%	4.0	5.7	6.9	12.9
95%	4.5	6.6	8.0	16.0
99%	5.7	8.1	10.5	20.6

Figure 3: Impact and Roll Out Design Chart (metric units)

NEW YORK STATE DEPARTMENT OF TRANSPORTATION CASE HISTORY

REGIONAL POOLED FUND RESEARCH STUDY SPR-3 (032)

Prepared by
Alexander Yatsevitch, Engineering Geologist 3
and
Michael P. Vierling, Engineering Geologist 2 (NYS Thruway Authority)

INTRODUCTION

The State Route 17, Corning By-Pass Project is located in Steuben County, in the Southern Tier region of central New York State along the border with Pennsylvania. The purpose of the project was to provide an interstate-level travel-way for the large volume of commercial east-west through traffic to avoid the bottleneck of downtown routing. The project involved a massive side-hill cut along the southern flank of Pine Hill north of the City of Corning. The final length of the cut is approximately 1500 feet and the height is approximately 305 feet. The maximum height of the exposed rock slope is approximately 250 feet.

Corning By-Pass Slope: Westbound

Corning By-Pass Slope: View from the top

The location is typified by broad valleys of glacial origin. The overburden is till with associated deposits, and the bedrock, typical of the region, a monotonous, thick, sequence of essentially horizontally bedded siltstones and sandstones interbedded with shales belonging to the West Falls Group of Upper Devonian age.

AADT is 25500 and expected to increase.

DESIGN

Risk considerations per se were not a basis for the original design or subsequent changes. It is NYSDOT policy to provide the most technically sound rock slope recommendations and build the safest product within the constraints in effect at the time. NYSDOT does not target an absolute risk number, nor has one considered to be acceptable.

Investigations for cut design included shallow seismic refraction and core drilling. The final design recommendation was for a slope of 1 vertical on 2 horizontal for the overburden backslope and 1 vertical on 1 horizontal for the rock slope face. At the beginning of slope excavation the contractor encountered what he claimed to be large, 6 to 8 foot boulders at the design top of rock elevation which resulted in a claim for additional payment for the excavation of the "boulders" and for redoing the earthwork at the top of slope to accommodate the lowered intercept with the revised elevation of the top of the rock slope. The claim is a side issue pertinent to the constructed maximum height of the finished rock slope as a product of redesign during construction.

All NYSDOT rock slope design is done by the Engineering Geology Section of the Geotechnical Engineering Bureau, Technical Services Division. Engineering geologists conduct pertinent investigations and research and make recommendations to project designers in the Regions who resolve constraints and generate the final plans. The Engineering Geology Section has in-house capability to determine rock depths by resistivity and seismic refraction methods. Core drilling is usually done by Regional forces. The initial "best" design recommendations for this project were changed primarily for economic considerations. New York State Department of Transportation Standard Specifications require presplit drilling and blasting for construction of rock slopes designed at 1 vertical on 1 horizontal or steeper. A maximum lift height of 60 feet is allowed, with lifts of approximately equal height. The original rock slope design included benches at regular intervals for drilling and blasting of the lifts. In an attempt to reduce the cost of excavation, the Region responsible for the project proposed that the rock could be ripped and excavated by mechanical means and requested dispensing with the requirement for presplit blasting. Accommodation was made by redesigning the rock slope excavation to a 1 vertical on 1.1 horizontal, thus also eliminating the previously included benches. Toe of slope setback from the edge of pavement remained as originally recommended at approximately 25 feet with a non-Ritchie drainage ditch profile.

Soon after beginning excavation of the redesigned rock slope the contractor was unable to rip the rock even with the largest excavators available. The operation changed to non-presplit production blasting to the projected rock slope plane followed by ripping of the loosened material to the final slope. After final cleaning, the resulting rock slope was a stair-step series of more durable sandstone/siltstone beds sandwiched between thinner shale beds. Before completion of the rock slope construction, it was also decided to add a climbing lane against the slope by eliminating the shoulder and reducing the set-back to a maximum of 10 feet, including the ditch. Also before the completion of the slope construction, a block of sandstone approximately the size of a wastebasket bounced down the slope, across the ditch area and across almost 3 lanes of the future roadway before stopping. That prompted a request for an evaluation of the slope and recommendations for rockfall mitigation.

Due to the unusually great height and flatter than normal angle of the constructed rock slope, there was no pertinent experience to rely on as a basis for mitigation recommendations. Stabilization by rock bolting or shotcreting was excluded due to the type of rock, cost and aesthetics. Reconfiguration of the catchment area profile and setback was not an option due to lane and drainage requirements. Slope mesh and drapes were eliminated on the basis of cost, constructibility and aesthetics. Barriers were the remaining option, with a catchment fence left as the only serious consideration.

The recommendations for an effective catchment fence configuration were based on actual slope field test results. Engineering geologists from NYSDOT devised a program to obtain pertinent rock rolling data utilizing available state resources. A corridor down the slope was delineated. Surveyed marker stakes color coded to chosen elevations and slope irregularities were located and measured in plan and section. Various sized and shaped rocks representative of those likely to separate from the slope were marked with high visibility paint, rolled from the top of the slope, and videotaped and measured to determine points of contact with the slope, bounce heights, impact points and resting points in relation to the toe of slope and edge of pavement. As a light aside, two bowling balls were included in the mix of rolled rocks. Contrary to everyone's intuition, but in accordance with applicable physics, neither made it half way down the slope.

The analysis of the results was used in combination with the CRSP modeling of the slope to arrive at a recommendation for the most effective location and height combination for a catchment fence, which was added to the project and installed. Due to the special restrictions on available space and edge of pavement drainage requirements in the fence location, Brugg Cable Products, Inc., technical personnel provided valuable assistance in designing a unique base for the installation of the post anchors for their product. The installed fence consisted of ninety-two 12'-8" X 15' nets mounted on embedded concrete cast-in-place foundation blocks producing a total height of fifteen feet. The final paid length was 1380 feet at an all inclusive cost of $308.89 per linear foot.

The rock slope work was started in May 1992 and the fence installation was completed in September 1995. At that time there was no reference data for even ball-park figures for important rockfall mitigation design parameters such as slope height and angle rock trajectory relationships, impact distances and final resting locations. Ritchie criteria and CRSP have applications only in limited configurations. NYSDOT's approach to a responsible solution to this design problem was to essentially perform the same procedure on that specific site as was done in this SPR-3(032) study for a wide range of slope configurations. If the Rockfall Catchment Area Design Guide had been available at that time, the information certainly would have reduced the time necessary to conduct the investigation and finalize the solution.

Regional Pooled Fund Research Study SPR-3 (032)

Washington State Department of Transportation Case Study

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Introduction

The following is a case study comparing current WSDOT rock fall ditch criteria and the new design chart for rock slopes developed through the current Regional Pooled Fund Research Study.

The site selected for this case study is located in Eastern Washington along SR-243. The proposed project is five miles in length and will included realignments to improve the horizontal geometrics, and widening of the roadway prism. A three-mile section of the project will include extensive cuts in rock, with cut heights in excess of 100 feet.

SR-243 is classified as a rural principle arterial with an Average Daily Traffic (1999) of 2306, which includes 436 trucks.

Rock Slope Design

Bedrock along the existing highway alignment consists of dark gray to black basalt of the Columbia River Basalt Group. The predominate geologic structure that controls the stability of the existing rock cuts is the columnar jointing oriented from approximately 75 degrees to near vertical (See Figure 1). Column sizes vary from 0.5 to 2 feet in diameter. Block sizes vary from 1 to 2 feet average. The existing near vertical rock slopes have been extensively damaged from uncontrolled blasting techniques employed in the past to develop the cuts. Rock fall is considered to be low to moderate, although there are areas within the existing cuts that have detached and/or dilated rock blocks several columns wide.

Based on the current conditions of the existing rock slopes and the predominance of high angle columnar jointing a 0.25(h):1(v) rock slope design was selected. Slope heights averaged approximately 80 feet. In addition, controlled blasting techniques, in accordance with WSDOT Standard Specifications, will be utilized to develop the new rock slopes.

Figure 1: Typical conditions of columnar basalt rock slopes along SR-243

Rock Slope Ditch Design

Two design approaches were utilized for the rock slope ditch design. The first approach was to utilize current WSDOT rock fall ditch criteria which is based on slope ratios and heights. This criteria is a modification of the "Ritchie Ditch" originally developed by Art Ritchie (Ritchie, 1963). The second approach was to utilize the new rock fall ditch design criteria developed by ODOT.

The rock fall ditch developed by Ritchie (1963) was a flat bottom ditch with a minimum width of 10 feet. To control run out of the rock fall a steep 1.25 (h):1(v) ditch foreslope was integrated into the design. WSDOT has modified the original Ritchie ditch design to allow for staged development of the rockfall ditch (See Figure 2). The staged development concept for the rock fall ditch is to provide alternates that are based on local site conditions and an estimate of the severity of future rock fall (Lowell, 1987). Based on WSDOT rock slope ditch design criteria (Stage 1) the following information was obtained from the WSDOT design charts:

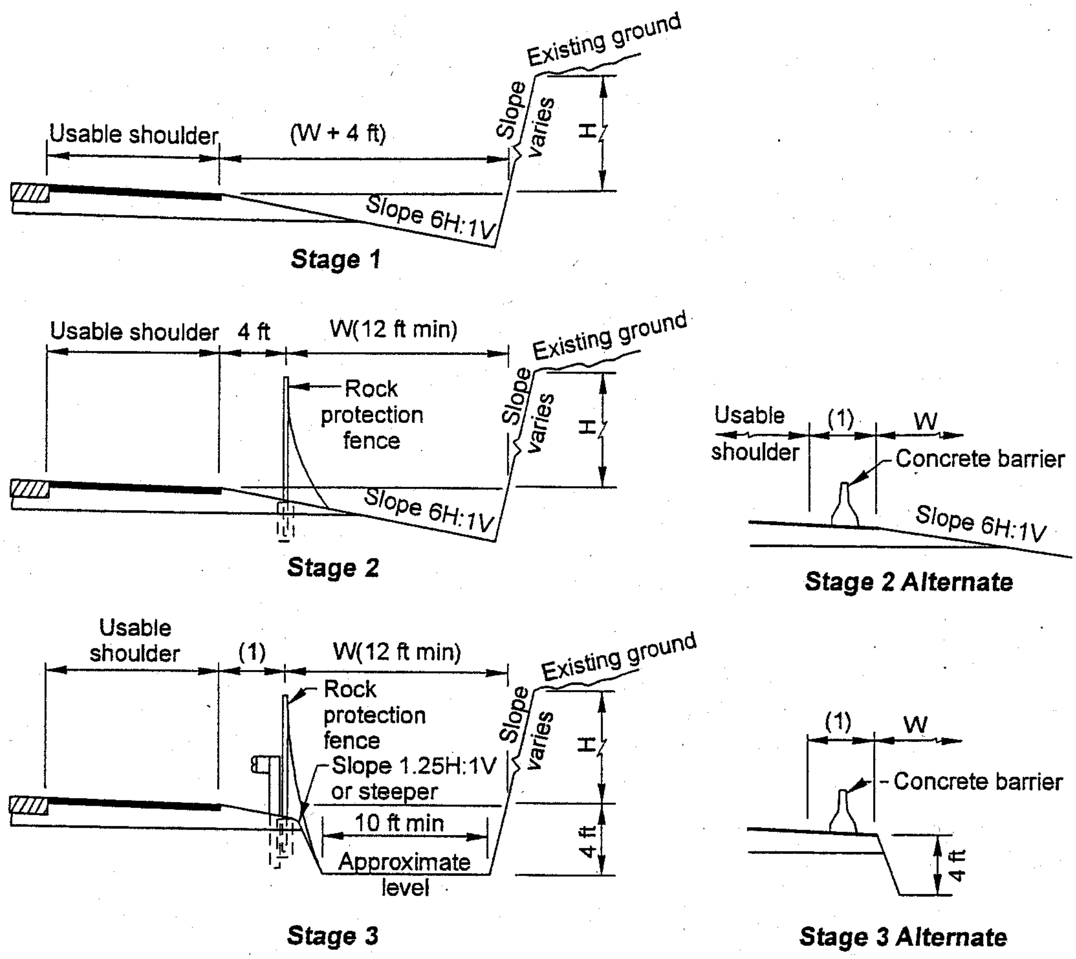
Slope Height	Slope Design	W	W+4	Ditch Slope
80 Feet	0.25(h):1(v)	20 Feet	24 Feet	6(h):1(v)

For this slope configuration a 24 foot wide rock slope ditch with a 6(h):1(v) ditch slope (Alternate A) would be recommended.

The new ODOT based design charts were utilized to provide an alternate design for the proposed rock cuts. It was decided that an appropriate design goal was to retain approximately 90 percent of the rock fall in the proposed rock slope ditch. Both the impact and roll out chart were evaluated. Based on this evaluation it was determined that roll out controlled the rock slope ditch design. The following rock slope ditch criteria was obtained from the ODOT based roll out design chart (see Figure 3):

Slope Height	Slope Design	Percent Retained	Ditch Width	Ditch Slope
80 Feet	0.25(h):1(v)	90	31 Feet	6(h):1(v)
80 Feet	0.25(h):1(v)	90	22 Feet	4(h):1(v)

For this slope configuration two rock slope ditch designs would be recommended. First, a 31 foot wide rock slope ditch with a 6(h):1(v) ditch slope (Alternate B), and second, a 22 foot wide rock slope ditch with a 4(h):1(v) ditch slope (Alternate C).



Rock Slope	H(ft)	W(ft)
Near Vertical	20-30 30-60 >60	12 15 20
0.25H:1V or 0.30H:1V	20-30 30-60 60-100 >100	12 15 20 25

Notes:

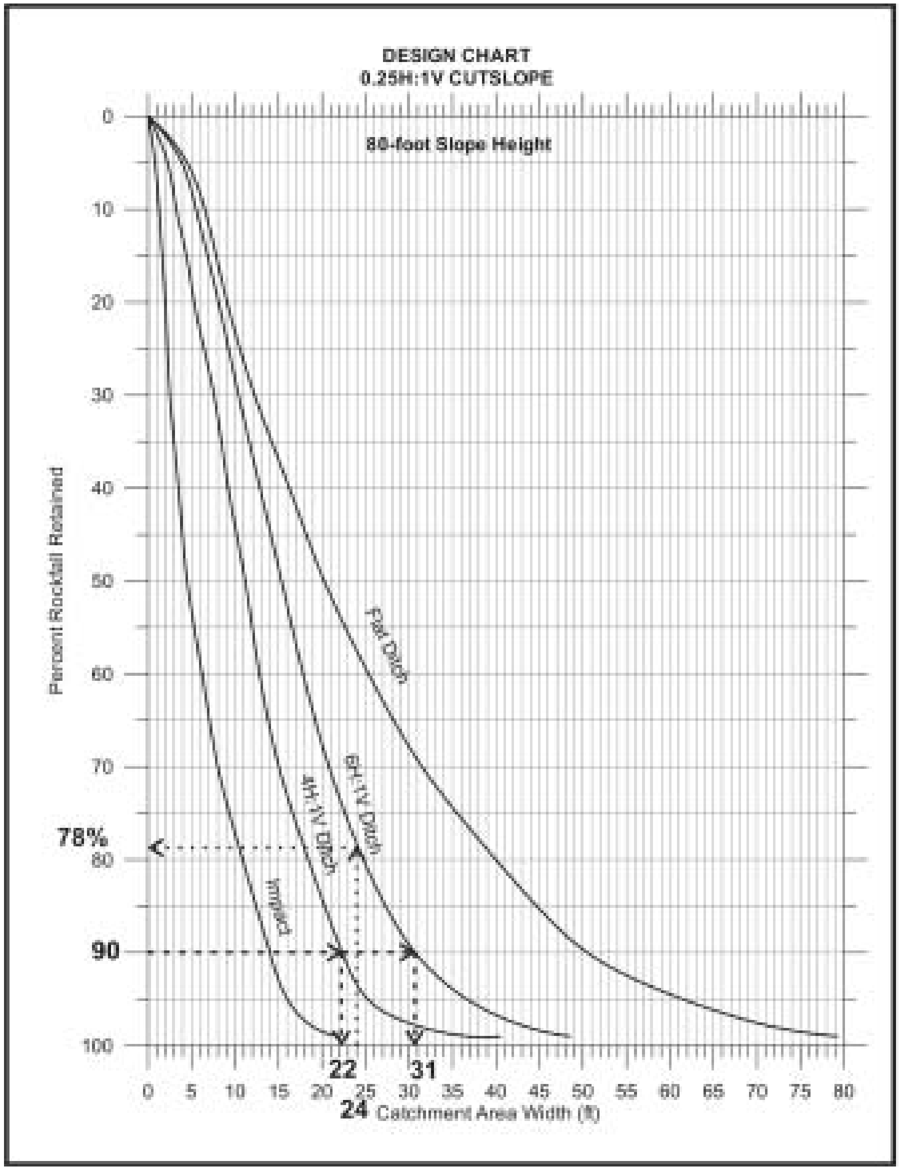
Cut heights less than 20 ft shall be treated as a normal roadway unless otherwise determined by the Region Materials Engineer.

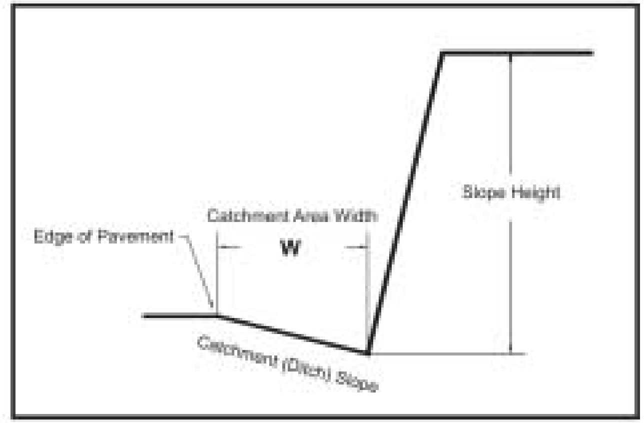
Stage 2 and 3 Alternates may be used when site conditions dictate.

Fence may be used in conjunction with the Stage 3 Alternate. See Chapter 700 for clear zone requirements.

(1) See Chapter 710 for required widening for guardrail and concrete barrier.

Figure 2: Roadway Sections in Rock Cuts, Design A





Quick Reference - 80-Ft Slope
Catchment Area Width - **W**

Percent Rockfall Retained	Impact **W** (ft)	Catchment Area Slope 4H:1V **W** (ft)	Catchment Area Slope 6H:1V **W** (ft)	Catchment Area Slope Flat **W** (ft)
50%	4	11	14	20
75%	9	17	23	36
80%	11	18	25	40
85%	12	20	27	45
90%	14	22	31	51
95%	16	25	37	62
99%	22	41	49	79

Figure 3: Design Chart

Comparison of the WSDOT Rock Slope Ditch Design to the New Design Charts

As detailed in the previous section of this case study, three alternate rock slope ditch designs were developed. Those alternates are summarized in the following table:

Rock Slope Ditch Alternative	Ditch Width	Rockfall Retention	Ditch Slope	Ditch Depth
A	24 Feet	78%	6(h):1(v)	4 Feet
B	31 Feet	90%	6(h):1(v)	5 Feet
C	22 Feet	90%	4(h):1(v)	6 Feet

Alternate A: Alternate A utilized current WSDOT rock slope ditch criteria. When evaluating this ditch design configuration as it applies to this case study a number of design and construction issues were raised. Those issues are detailed as follows:

1) Utilizing the new ODOT based rock slope ditch design charts it was determined that the proposed ditch configuration only retained approximately 78 percent of the rock fall (See Figure 3). This would not meet the design goal to retain approximately 90 percent of the rock fall. To mitigate the roll out problem (using WSDOT design criteria) a Stage 2 Alternate rock slope ditch design, utilizing a concrete jersey barrier on the outside edge of the roadway shoulder, would be employed (See Figure 2). Installation of concrete jersey barrier on the outside edge of the roadway shoulder, to mitigate rock fall roll out, would be undesirable if other alternates were available.

2) When the roadway template design (including the rock slope ditch geometry) was overlaid onto the original ground cross section, it was discovered that the effective bench width for the proposed rock cuts were on the order of approximately 10 feet (See Figure 4). This could present a constructibility issue for two reasons. First, the narrow working bench would present a problem in terms of the size and types of excavation equipment that could work safely on a narrow bench. Secondly, the dilated nature of the rockmass in some of the exterior portions of the existing rock cut makes it unlikely that a 10 foot working bench width could be maintained as the rock cut was brought down to grade. If the exterior portion of the benches failed it would require the slope to be “pushed back” into the slope during construction.

3) The narrow bench width would be difficult to drill and shoot. The narrow burden of the cut would only allow for one row of production blast holes, and the line holes forming the back slope of the cut would be shot as a cushion shot. Due to the dilated nature of the bedrock in portions of the cut it would be anticipated that fragmentation of the bedrock would be poor, and the condition of the final back slope less than desirable.

<u>Alternate B</u>: Alternate B utilizes the new ODOT based rock slope ditch criteria. This alternate provides the desired rock fall retention of 90%. In addition, the ditch section provides a wider more workable cut section (See Figure 4) and mitigates to some extent the construction risks associated with Alternate A.

<u>Alternate C</u>: Alternate C utilizes the new ODOT based rock slope ditch criteria. Although this alternate provided the desired rock fall retention of 90%, the construction risks that were associated with Alternate A would also apply to this rock slope ditch design.

Design Decision

Based on the discussion in the previous section of this case study, Alternate B was selected as the preferred rock slope ditch design. Although the initial cost to construct this rock slope ditch is higher than the other two alternates, the associated construction risks are minimized and the long term performance of the final back slope is enhanced.

References Cited

Lowell, S.M., 1987, <u>Development and Application of Ritchie's Rock Fall Catch Ditch Design</u>, FHWA Rock Fall Mitigation Seminar, Portland, Oregon.

Ritchie, A.M., 1963, <u>Evaluation of Rockfall and Its Control</u>, Highway Research Board, No. 17, pp. 13-28

Pierson, L.A., Davis, S.A., and Pfieffer, T.J., 1994, <u>The Nature of Rockfall as the Basis for a New Fallout Area Design Criteria for 0.25:1 Slopes</u>, FHWA-OR-GT-95-05.

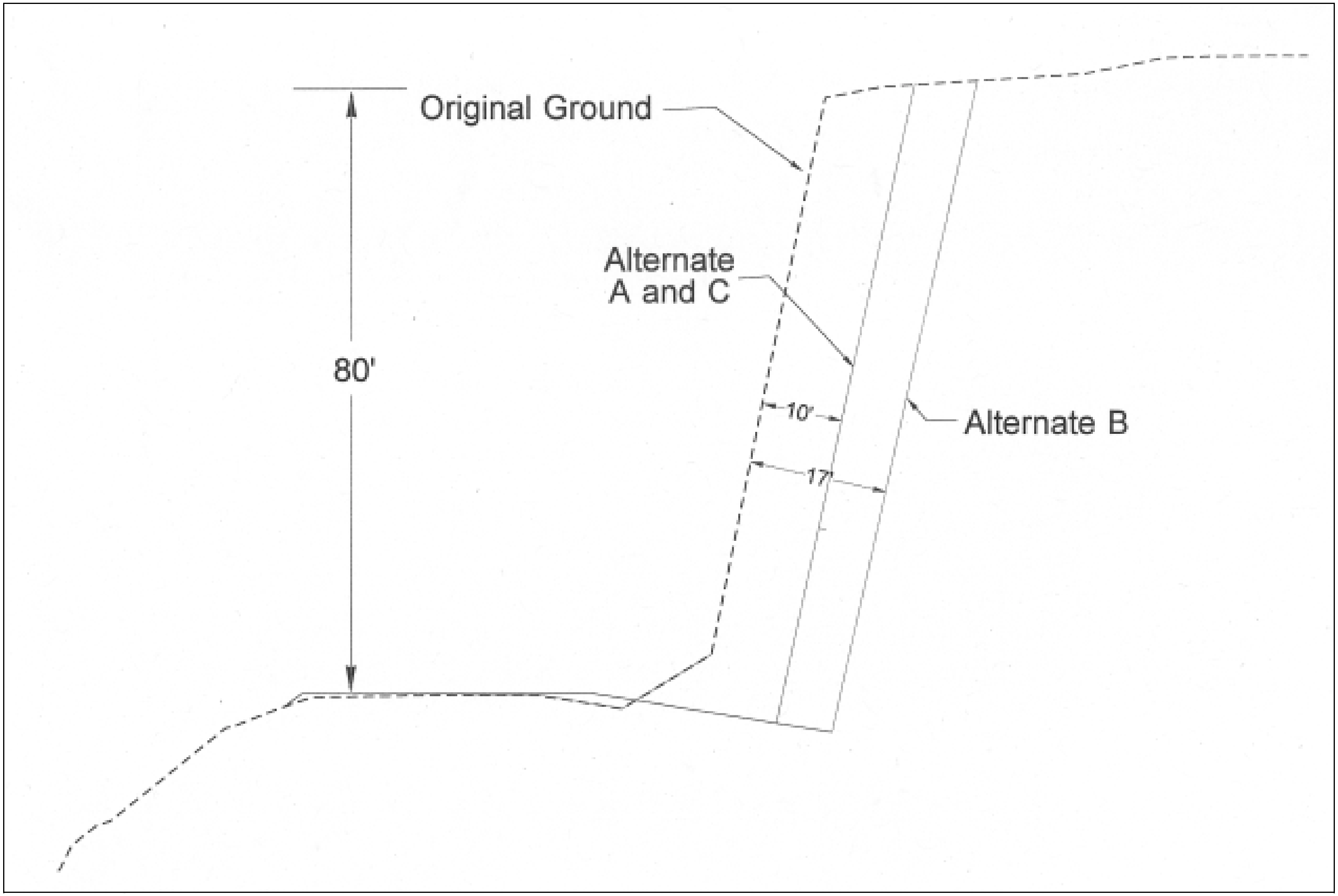


Figure 4: Alternate Rockfall Ditch Designs

Regional Pooled Fund Study SPR-3 (032)

Wyoming Case History

INTRODUCTION

One of the first slopes that WYDOT designed using preliminary information from the rockfall study was part of a highway reconstruction project on US 26-89 through Snake River Canyon approximately 25 miles southwest of the city of Jackson in northwest Wyoming. Due to increased traffic and high accident rate, this road was being upgraded from two 11' wide lanes with no shoulders to two 12' lanes with 8' wide shoulders. This additional increased template width was a design challenge due to the narrow corridor between the Snake River and the steep walls of the canyon. The overall yearly ADT on this road section at the time of construction was 2670, with summer volumes approaching 6000 VPD, making this one of highest volume two-lane primary highways in the state. The accident rate on this road section was approximately 2.5 times the state average for primary highways.

This slope was located at milepost 127.1, which is near the middle of the 24 mile long canyon. The existing backslope had a maximum height of approximately 120' and was near vertical to overhanging in some portions of the cut. The lower 80' of the cut consisted of hard, competent siltstone which dips to the west approximately parallel to the roadway at 20°. Overlying the siltstone is approximately 40' of colluvium consisting of a poorly sorted mixture of clayey sand and gravel with some cobbles and boulders.

The original ditch through the steepest portion of this cut was 3'-4' wide and approximately 1' deep (see Photo 1). This ditch configuration provided very little rock catchment. It was estimated that ditch catchment was on the order of 5-10%. In the five years prior to the reconstruction, there were four rockfall accidents reported at this site. It was observed that about equal amounts of rockfall were being generated from the colluvium and siltstone bedrock. The block size of this rockfall averaged about 12", with the maximum size being 24".

DESIGN CONSIDERATIONS

There are many different factors which affected the design of this slope. Immediately to the east of the slope, a landslide repair had been completed utilizing a combination reticulated mini pile wall and MSE wall. This landslide repair and the roadway geometrics required to meet minimum design standards dictated how far the centerline through this cut had to be moved into the slope. Once the centerline had been determined, the challenge was to design the optimum slope angle to provide the greatest stability of the rock mass while minimizing the amount of material removed from the cut.

Photo 1: The cut slope looking west before construction

Since this roadway is through a very environmentally sensitive area within the national forest, the U.S. Forest Service had a great deal of input into the design of the slope. The two main goals of the Forest Service were to reduce overall impacts or "foot print" of the roadway template and create a natural looking "aesthetically pleasing" slope. The main goal of WYDOT was to create a safe, stable slope that would require less maintenance. The other main concern of WYDOT was the large amount of material that would be generated if the slope was to be laid back. This project already had excess material as designed, and there were no available waste sites within the canyon.

FINAL DESIGN AND BENEFIT/COST COMPARISON

As a compromise to all interested parties, the final slope design configuration at this site was a "broken slope" with the bottom 80' ± of competent siltstone being cut at 0.44H:1V. The overlying 40' thickness of poorly consolidated colluvium was cut at a 1:1. The siltstone in the steep portion of the cut was presplit to avoid back break behind the cut line. The optimum slope angle (22° from vertical) in this material was to match a major joint set which was approximately parallel to the road.

The ditch section was widened from the existing 3'-4' width to a width of 23'. The shoulder ditch was designed at 6:1 slope, which resulted in a ditch approximately 4' deep. According to the rockfall design charts, this ditch should contain 99% of the rocks at impact and approximately 85% of rocks from the roll out. (Since the design slope ratio is 0.44H:1V, the 99% impact and 85% roll out retention values were estimated using interpolation between the 0.25H:1V and 0.5H:1V design charts.) This is a significant improvement from the 5-10% of rock catchment which was present before reconstruction. To go from the 85% catchment at a width of 23' to a catchment of 98% would have required a ditch width of 32'. For this particular slope, an additional 25,000 cubic yards of rock excavation would have been required for a 32' ditch. At the unit cost for rock excavation it would have been an additional $165,000 just for the excavation. In addition, this material would have to have been truck-hauled at least 20 miles to a waste site outside of the canyon. Due to the much higher cost, lack of available waste site close-by and more adverse environmental impact, the 98% catchment design was not selected. The 85% catchment design was judged to provide the better overall risk/cost-benefit.

Additionally, it was determined that although the new ditch section increased the rockfall catchment, rock from the colluvium which was cut at 1:1 could be a hazard. To prevent the rocks from the colluvium starting to roll down the 1:1 slope and being launched at the break in slope, PVC-coated double-twist rockfall mesh was placed over the 1:1 slope. The mesh was attached along the top of the slope with anchors spaced 3' apart. The bottom of the mesh extended about 4' over the break in the slope so that the rock which worked its way out under the mesh would fall nearly straight down and be contained in the ditch.

RESULTS

This slope was completed in the fall of 1998. Since then, no rockfall accidents have been reported at this site. As seen in photos 2-4, the ditch appears to be effective in catching the rocks.

Photo 2: Looking Eastward at the cut after construction note rockfall mesh

Photo 3: Looking eastward after construction note rock catchment

Photo 4: Looking west at the whole cut after construction