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ROAD CONDITIONS AND EROSION POTENTIAL IN THE UPPER REDWOOD CREEK WATERSHED

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INTRODUCTION

The Redwood Creek watershed is the home of internationally recognized stands of old-growth redwood forest contained within Redwood National and State Parks (RNSP) in the lower watershed. The upper two-thirds of the watershed are in private ownership, and are used primarily for commercial timber production and ranching.

Within the past 50 years, the watershed has been affected by both land use and large storms. Sediment carried into the creek has caused widespread aggradation and widening of the channel, resulting in the death of streamside redwoods and a major reduction in the amount of suitable rearing and spawning habitat for anadromous fish.

Roads are a major cause of accelerated erosion in the watershed (RNSP, 1997). Over 1,000 miles of roads are located on private lands upstream of the park, and of these, only about half are maintained. Old and unmaintained roads are particularly prone to erosional failure during large storms as a result of inadequate culvert sizes, rusted culverts, lack of culverts, rotting logs included in road and landing fills, inadequate road surface drainage, and diversion of streams at road crossings when culverts fail.

In recent years, RNSP have cooperated with private landowners in the Redwood Creek watershed to reduce erosion along roads. Projects to date have included improvement of crossings and drainage along roads that are still in use and partial removal (planned abandonment) of roads no longer in use.

In 1995, a framework for future cooperative projects was established through cooperative agreements (CAs) between RNSP, the U.S. Fish and Wildlife Service (USFWS), and the Humboldt County Resource Conservation District (RCD), and Memorandums of Understanding (MOUs) between RNSP and all major landowners in the Redwood Creek watershed. In these MOUs, RNSP and private landowners agreed to cooperatively and voluntarily locate and treat sites along roads that are likely to erode.

This report presents the results of the second road erosion inventory completed under the MOUs. The primary landowner involved in this inventory was Sierra Pacific Industries. Adjacent landowners, including Simpson Timber Company, Louisiana-Pacific Corporation, the U.S. Forest Service, the Russ Ranch, and the Russ Estate also participated.

Project Area

The project area is located in the upper Redwood Creek watershed and encompasses roughly 8,700 acres. Because of mixed land ownership, the project area included two separate units. We have designated these the southern and northern inventory units (Figure 1).

The climate of the project area is Mediterranean, with cool, moist winters and warm, dry summers. Annual precipitation varies between 80 and 100 inches, on average. Most precipitation falls between October and April. Snow is common at altitudes greater than 2,000 feet. Due to the relatively low altitudes and the proximity to the coast, however, snow cover rarely persists throughout the winter except at the highest altitudes. Rain falling onto a wet snowpack can result in rapid increases in streamflow during winter, as happened during the devastating 1964 flood.

With the exception of a few homes, the entire project area is used for timber production and livestock grazing. The area was first harvested in the 1950s. Scattered old-growth forest remains, but most of the trees within the area are second-growth.

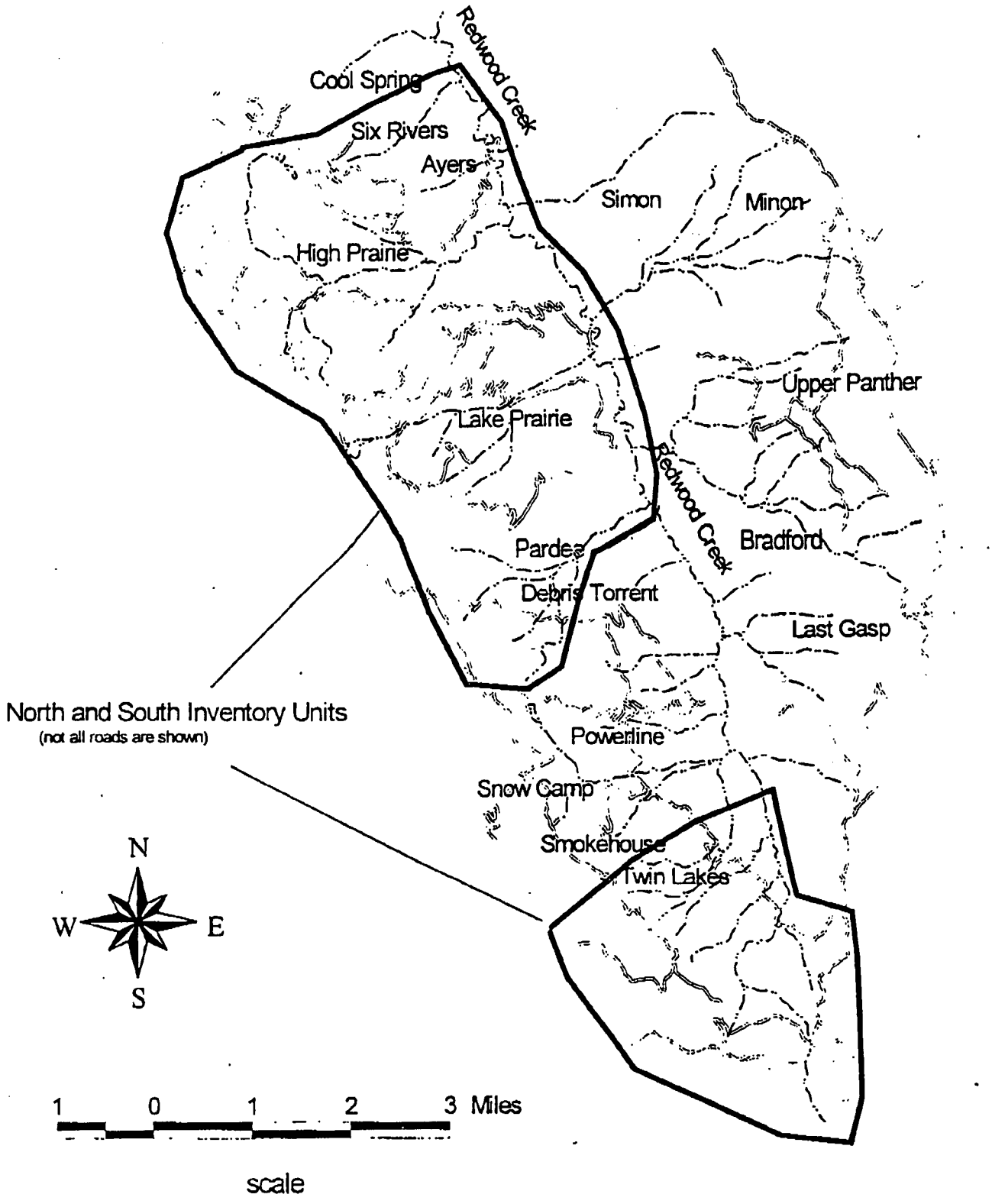
Southern Unit

The southern unit includes the headwaters of the mainstem of Redwood Creek from the western watershed divide on Snow Camp Mountain to the eastern divide, and extends north along the west side of Redwood Creek to approximately Twin Lakes Creek. Altitudes range from 2,160 to 4,975 feet above sea level.

The bedrock of the southern unit is primarily Franciscan sandstone and melange (Cashman and others, 1995). An ancient earthflow landslide developed on the melange is still apparent in the topography between the upper mainstem of Redwood Creek and Twin Lakes Creek (Cashman and others, 1995). Earthflow movement appears to affect much of the southern unit that is underlain by melange, and soils developed on the melange are very prone to deep gully erosion. The melange is bounded on the east by the Grogan Fault and on the north by the Snow Camp Creek fault.

The southern unit is mainly covered with mixed evergreen forest, including white fir, red fir, incense cedar, tanbark oak, and madrone. Prairies and oak woodlands cover part of the west-facing slopes to the east of Redwood Creek.

Figure 1. Areas Inventoried by Redwood National Park, Upper Redwood Creek



Northern Unit

The northern unit is completely on the west side of Redwood Creek. It extends from Redwood Creek on the east to the western watershed divide, and from Pardee Creek on the south to Six Rivers Creek (unofficial, RNSP publications) to the north. Altitudes range from 1,200 to 4,637 feet above sea level.

The northern unit is underlain by Redwood Creek schist, a metamorphic rock unit (Cashman and others, 1995). This schist is less prone to earthflow movement and gully erosion than is the melange to the south. Due to the presence of shrink-swell clays, however, road and landing fills constructed of soils developed on the schist tend to develop cracks that can lead to fill failures, debris slides and debris torrents.

Vegetation of the northern unit is similar to that of the southern unit except that trees restricted to higher altitudes, such as red fir and incense cedar, are absent. Common trees include Douglas fir, tanbark oak, madrone, bay laurel, red alder, and bigleaf maple. Several prairies are found within the unit, including High Prairie, Lake Prairie, and Murphy Meadow.

PURPOSE AND METHODS

The primary purpose of this road inventory was to identify potential erosion sites along roads that, for the most part, were still intact and/or being used today. Roads severely eroded during past large storms were not inventoried because road failures had already occurred.

Approximately 90 miles of roads within the project area were inventoried for past and potential erosion by walking the roads, identifying sites, locating sites on air photos, and collecting information systematically for each site. A standard inventory form was used to record data (see Appendix A for form and Appendix B for definitions of terms used in the form). Field data included dimensions and slope angles of road fill, type, size, and condition of drainage structure, past erosion and erosion potential (EP) volumes, and possible maintenance or erosion control treatments. Fill dimensions were measured with cloth tapes or by pacing. Slope angles were measured with clinometers. Culvert diameters and headwall heights were measured with cloth tapes or folding rulers. EP volumes were estimated based on nearby erosional features, existing channel dimensions, and projected flow paths for diverted streams. EP estimates were intended to reflect the erosion that could occur during a single, major (50-year) storm event.

Past erosion volumes were recorded only when it was convenient to do so because this was not the primary purpose of the inventory. These volumes were also measured with cloth tapes, by pacing, or on air photos. Past erosion volumes reflect only erosion still visible at the time of the field inventory, and not necessarily all past erosion at the site. Past erosion volumes also do not account for all of the offsite erosion; e.g., streamside landsliding, that may have occurred as a result of erosion at the inventory site.

Total fill volumes at stream crossings were computed by geometrically subdividing fill prisms into regular geometric shapes based on trapezoidal cross sections when viewed along the direction of the channel (see worksheet in Appendix A for details). Total fill volumes at roads and landings were computed using various geometric forms, including triangles, parallelograms and prisms.

All data on field forms were checked and then entered into a computer database. Data in the database were then checked against field forms to guard against keypunching errors. Site locations were transferred from air photos by direct digitizing onto digital orthophotoquads (DOQs) with road and stream themes overlaid. Topographic maps were produced with these themes at scales of 1:12,000 for outlining and computing drainage areas for stream crossings and discharge estimates.

Streamflow from a 50-year recurrence interval flood (Q50) was used as the design flow for sizing culverts at all stream crossings. Q50 estimates were computed using the Rational Formula for drainage areas less than 80 acres, and with the method of Waananen and Crippen (1978) for drainage areas greater than 80 acres. Hydraulic information for each existing culvert was exported from the database to a computer spreadsheet. The spreadsheet computed the Q50 estimates and capacity of each culvert using a lookup table created with values from the standard nomogram for sizing culverts developed by the Bureau of Public Roads.

Culvert diameter recommendations presented in this report were based on the premise that culverts should pass the Q50 without exceeding barrel-full conditions because we believe the potential for a culvert to plug increases significantly once the inlet becomes submerged. However, if a culvert was found to be undersized using the above methods, we tested its diameter/capacity again in an [illegible] rent size, because we recognize the inherent errors in estimati[illegible] et science). The test was as follows: if the headwater height rat[illegible] n undersized culvert was greater than or equal to two, the capaci[illegible] ted using half of the crossing's headwall height (HW). If t[illegible] :se conditions was within 15% of the Q50, then the culvert was c[illegible] ılverts whose barrel-full capacities were less than the Q50 and [illegible] this test were considered undersized, and a new culve[illegible] based only upon barrel-full flow.

129,100 YD³ / 8700 AC = 14.8

RESULTS

Over 500 potential erosion sites were identified. Of these, fluvial erosion sites accounted for 443 sites, including 224 stream crossings, 126 swale crossings, and 93 ditch relief pipes. Mass movement sites accounted for the remainder of potential erosion. The total EP volume was estimated to be 129,100 cubic yards, including 85,500 cubic yards of fluvial-erosion (66%) and 43,600 cubic yards of mass movement (34%). Road density for the project area was 6.6 mi/mi^2 (minimum value). Crossing densities were 16 stream crossings/mi^2 and 26 stream-swale crossings/mi^2. The total volume of past erosion measured along inventoried

roads in the project area was estimated to be 146,035 cubic yards, including 123,381 cubic yards of fluvial erosion (84%) and 22,654 cubic yards of mass movement (16%).

Fluvial Erosion

Almost all of the EP at fluvial sites (81,700 cubic yards, or 96% of fluvial EP) was associated with stream crossings rather than with swale crossings or ditch relief pipes. Erosion potential volumes for stream crossings ranged from 0 - 6,780 cubic yards, and averaged 365 cubic yards per crossing. Of the 224 stream crossings, 178 crossings were part of the current road system. The other 46 crossings were either on very old roads and had washed-out, or had been removed during road abandonment. Of the 178 crossings, 9 were bridge crossings and 145 were culvert crossings. Of the culvert crossings, 90 (62%) contained culverts that were considered adequately sized, in good condition, and unlikely to cause significant (greater than 50 cubic yards) erosion or road maintenance problems.

Table 1 lists 102 stream crossings where significant erosion and road problems are likely to occur during the next major storm. Table 1a describes culvert conditions. It shows which culverts were considered undersized or damaged and in need of repair or replacement. Crossings which lacked any culverts are also shown. In summary, 43 crossings had undersized culverts, 46 had culverts in poor condition due to crushing, plugging, rusting, holes, and band separation, and 24 crossings lacked any culvert. Table 1b lists additional treatments, if any, that were noted during the road inventory for the same crossings. The EP associated with these crossings, identified as needing urgent maintenance, is about 54,200 cubic yards, equivalent to 42% of total EP and 63% of the fluvial EP volumes.

Of the 224 stream crossings, 60 had diversion potentials (streams could divert down the road, away from their natural drainage if culverts failed) with EP greater than 100 cubic yards (Table 2). The total EP estimate for these crossings with stream diversions was about 39,100 cubic yards of which the offsite erosion potential (erosion occurring away from the crossing because of the diversion) was 32,300 cubic yards. It is interesting to note that the erosion potential volume from these crossings was nearly twice the fill volume contained within these crossings. This is consistent with findings in other mapped areas that stream diversions can be a significant erosion problem when culverts fail. The EP associated with diversion potentials at 60 crossings is equivalent to 30% of the total EP and 46% of the fluvial EP. In all, over 100 crossings had diversion potentials (total EP = 41,120 yds^3).

Tables 1 and 2 "overlap" in that some crossings are listed in both tables in order to present data in their most useable form. The total number of individual crossings represented by the two tables is 118 sites. Total EP for these sites is about 65,100 cubic yards. The combined treatments to repair/upgrade culverts and eliminate diversion potentials accounts for 50% of the total EP and 76% of the fluvial EP. The remaining 24% of fluvial EP was either contained in relatively stable crossing sites, or was considered unpreventable because of the size and nature of the erosion problems. Figures 2-4 show the locations of these sites. Appendix C lists all stream crossing with an EP greater than 50 cubic yards. Appendix E shows the locations of these sites.

Table 1a. Condition of Culverts and Erosion Potentials at Stream Crossings with Urgent Maintenance Needs.

ID #	Road	Site #	DP	Add New	Undersized	Replace	% Crushed	% Plugged	DA (ac)	Q50	Current Dia. (in)	Recm'd Dia. (in)	EP (yds^3)
1001003	B	3			X				246	189	60	Bridge	436
1001006	B	6				X		100	11	8	18	18	181
1001009	B	9	X					5	12	9	24	24	637
1001011	B	11			X	X		100	18	14	24	30	156
1001016	B	16	X		X	X	40		11	8	18	24	900
1001017	B	17	X	X					5	4		24	995
1001019	B	19	X	X					9	7		24	920
1001020	B	20			X	X		10	18	14	24	30	115
1001025	B	25			X	X		60	6	5	24	36*	103
1001026	B	26				X		50	6	5	24	24	137
1001028	B	28			X	X		100	7	6	18	24	101
1001045	B	45	X		X	X		100	5	4	12	18	57
1007001	E-1	1	X						3	2	18	18	267
1007003	E-1	3	X		X			5	94	72	36	54	1,145
1007010	E-1	10			Replace failing Humboldt Crossing/Bridge				437	336		Bridge	164
1008001	F-3-2	1				X		100	14	12	24	24	80
1008002	F-3-2	2	X		X	X			17	15	18	30	323
1009001	F-3-3-1	1	X			X		100	5	4	18	18	754
1011001	B-4	1	X			X		60	16	12	24	24	100
1011003	B-4	3						5	12	9	24	24	159
1011006	B-4	6				X		50	36	28	36	36	80
1011007	B-4	7			X			50	17	13	24	30	966
1017003	F-3	3	X			X		100	130	100	60	60	2,070
1017006	F-3	6	X		X				47	41	36	42	164
1020001	B-4-1	1						20	13	10	30	30	280
1021007	F-8	7	X					10	18	16	30	30	489
1022001	F-7	1	X						4	3	18	18	83
1022002	F-7	2	X	X					9	7		24	73
1023001	F-5	1	X		X	X		25	125	96	42	60	248
1023005	F-5	5	X	X					6	5		24	169
1023007	F-5	7	X		X				109	84	48	54	210
1035003	F-4	3		X					6	5		24	1,645
1047001	F3.5	1	X						7	5			460
1048001	F-5-1	1	X			X		100	85	65	48	48	1,930

General Note: this table represents stream crossings that have erosion potentials greater than 50 yds^3; urgent maintenance needs as noted in the inventory form, and undersized culverts as determined by culvert sizing methods discussed on page 5. Also included are crossings where existing culverts should be replaced and crossings where new culverts (crossings without culverts) should be installed. These recommendations are also based on field observations and responses in the road inventory form.

* Culvert diameter has been sized based on stream channel dimensions or comments in the inventory form instead of drainage area or Q50.

Table 1a. Condition of Culverts and Erosion Potentials at Stream Crossings with Urgent Maintenance Needs (Cont'd).

ID #	Road	Site #	DP	Add New	Undersized	Replace	% Crushed	% Plugged	DA (ac)	Q50	Current Dia. (in)	Recm'd Dia. (in)	EP (yds^3)
1052003	NROD	3			X				181	139	36	72	126
1052006	NROD	6	X		X		10	50	93	72	18	54	210
1052007	NROD	7		X					12	9		24	104
1052009	NROD	9	X	X					57	44		42	506
1052013	NROD	13	X		X			5	53	41	18	42	276
1052021	ROD	21	X		X				31	24	24	36	988
1052022	ROD	22		X	Old Humboldt Crossing/Bridge likely to plug/fail				117	90	Bridge	Bridge	1,000
1052023	ROD	23			X				278	214	60	84/Bridge	537
1052030	ROD	30		X	Old Humboldt Crossing/Bridge likely to plug/fail				203	156	Bridge	Bridge	2,282
1052036	ROD	36							995	766	Bridge	Bridge	1,210
1052046	ROD	46	X		X			50	18	14	18	30	83
1052047	ROD	47	X		X		15		6	5	18	30*	67
1053006	NROD-2	6			X			25	60	46	30	42	109
1056003	480	3						10	5	4	36	36	202
1056005	480	5			X				153	118	24	72	732
1056011	480	11			X			25	9	7	18	24*	474
1056013	480	13				X		40	5	4	18	18	75
1056022	480	22			X				23	18	18	30	813
1056026	480	26			X				67	52	30	48	323
1056030	480	30			Replace failing Humboldt Crossing/Bridge				300	231	Bridge	Bridge	360
1052001	480-6	1		X					20	15		30	150
1056003	485	3	X		X				31	24	18	36	80
1068001	487	1	X		X	X		30	50	39	24	42	907
1068008	487	8			X				100	77	36	54	1,150
1068010	487	10	X			X		100	7	5	18	18	174
1068012	487	12			X			90	133	102	54	54	907
1068017	487	17			X				80	62	36	48	572
1068018	487	18		X					15	12		24	5,950
1073005	460	5	X		X			20	20	15	24	30	328
1073007	460	7	X	X					4	3		24	180
1073013	460	13	X		X				34	26	18	36	69
1073021	460	21	X		X				95	73	24	54	713
1073025	460	25			Replace failing Bridge				1380	1063	Bridge	Bridge	800
1073030	460	30	X			X	75	15	4	3	24	24	122
1073031	460	31			X	X	15	25	59	45	24	42	210
1073034	460	34	X		X			50	58	43	24	42	255
1073040	460	40	X			X		75	3	2	18	18	315
1073049	460	49			X			20	59	45	24	42	540

General Note: this table represents stream crossings that have erosion potentials greater than 50 yds^3, urgent maintenance needs as noted in the inventory form, and undersized culverts as determined by culvert sizing methods discussed on page 5. Also included are crossings where existing culverts should be replaced and crossings where new culverts (crossings without culverts) should be installed. These recommendations are also based on field observations and responses in the road inventory form.

* Culvert diameter has been sized based on stream channel dimensions or comments in the inventory form instead of drainage area or Q50.

Table 1a. Condition of Culverts and Erosion Potentials at Stream Crossings with Urgent Maintenance Needs (Cont'd).

ID #	Road	Site #	DP	Add New	Undersized	Replace	% Crushed	% Plugged	DA (ac)	Q50	Current Dia. (in)	Recm'd Dia. (in)	EP (yd^3)
1073058	460	58	X		X			10	69	53	18	48	590
1073060	460	60			X			20	18	14	18	30	400
1076006	460-1N	6	X		X	X		60	32	28	18	36	4,420
1076008	460-1N	8			X	X			25	22	8	36	105
1076011	460-1N	11			X	X		100	48	42	6	30*	150
1076012	460-1N	12		X					24	21		36	190
1077001	463	1	X		X				87	67	30	54	203
1079006	450	6	X	X					25	19		30	516
1097002	430	2	X		X	X		100	29	22	18	36	110
1097003	430	3	X	X					46	35		36	60
1097005	430	5	X	X					164	126		72	590
1097006	430	6	X	X					33	25		36	1,816
1097007	430	7		X					12	9		24	192
1097008	430	8	X	X					54	42		42	105
1097009	430	9		X					32	25		36	190
1097011	430	11	X	X					3	2		24	315
1097012	430	12	X	X					4	3		24	187
1098007	300	7	X						9	7	24	24	1,327
1098008	300	8	X						3	2	18	18	162
1098013	300	13	X						21	16	36	36	223
1098021	300	21	X			X			15	12	24	24	216
1098022	300	22			X	X			100	77	30	54	170
1098026	300	26	X		X	X		20	28	22	12	24*	90
1103002	305	2			X			5	60	46	18	24*	88
1106002	320	2	X	X					8	6		24	520
1106004	320	4			X				64	49	42	48	255
1106006	320	6	X			X			49	38	24	24*	80
1106007	320	7	X						42	32	24	24*	163
1106008	320	8	X					10	5	4	18	18	70
1113002	324	2							56	43	36	36	590
												Total Erosion Potential =	54,162 yds^3

General Note: this table represents stream crossings that have erosion potentials greater than 50 yds^3, urgent maintenance needs as noted in the inventory form, and undersized culverts as determined by culvert sizing methods discussed on page 5. Also included are crossings where existing culverts should be replaced and crossings where new culverts (crossings without culverts) should be installed. These recommendations are also based on field observations and responses in the road inventory form.

* Culvert diameter has been sized based on stream channel dimensions or comments in the inventory form instead of drainage area or Q50.

Table 1b. Other Urgent Maintenance Needs at or near Stream Crossings Listed in Table 1a.

ID #	Road Name	Site #	IBD	Sediment	Brush Inlet	TrashRk	Berm	Rolling Dip	PBF	CD	DR
1001003	B	3									
1001006	B	6		X							
1001009	B	9						X			
1001011	B	11		X							
1001016	B	16						X			
1001017	B	17									
1001019	B	19						X			
1001020	B	20		X							
1001025	B	25									
1001026	B	26		X	X						
1001028	B	28		X				X			
1001045	B	45	X	X				X			
1007001	E-1	1						X		X	
1007003	E-1	3		X		X		X			
1007010	E-1	10									
1008001	F-3-2	1		X							
1008002	F-3-2	2						X			
1009001	F-3-3-1	1		X				X			
1011001	B-4	1		X				X			
1011003	B-4	3		X							
1011006	B-4	6		X				X			
1011007	B-4	7		X			X				
1017003	F-3	3		X							
1017006	F-3	6						X			
1020001	B-4-1	1		X		X					
1021007	F-8	7		X		X		X			
1022001	F-7	1		X				X			
1022002	F-7	2									
1023001	F-5	1		X		X					
1023005	F-5	5						X			
1023007	F-5	7						X			
1035003	F-4	3									
1047001	F3.5	1								X	
1048001	F-5-1	1		X				X			

IBD = re-establish the inboard ditch; **Sediment** = excavate accumulated sediment from the culvert inlet area; **Brush Inlet** = remove brush from culvert inlet area; **TrashRk** = install trash rack at culvert inlet; **Berm** = construct a berm near the culvert inlet to prevent bypass flow; **Rolling Dip** = construct a rolling dip at crossing to prevent stream diversion if culvert fails; **PBF** = pull back fill at crossing, fill failure is likely to occur; **CD** = correct diversion near crossing site; **DR** = drain road to reduce amount of surface water directed toward crossing.

Table 1b. Other Urgent Maintenance Needs at or near Stream Crossings Listed in Table 1a (Cont'd).

ID #	Road Name	Site #	IBD	Sediment	Brush Inlet	TrashRk	Berm	Rolling Dip	PBF	CD	DR
1052003	NROD	3									
1052006	NROD	6		X			X	X			
1052007	NROD	7									
1052009	NROD	9						X			
1052013	NROD	13						X			
1052021	ROD	21						X			
1052022	ROD	22									
1052023	ROD	23		X							
1052030	ROD	30						X			
1052036	ROD	36							X		
1052046	ROD	46		X				X			
1052047	ROD	47						X			
1053006	NROD-2	6		X							
1056003	480	3		X		X					
1056005	480	5									
1056011	480	11	X	X							
1056013	480	13									
1056022	480	22	X								
1056026	480	26									
1056030	480	30									
1062001	480-6	1									
1066003	485	3		X				X			X
1068001	487	1		X				X			
1068008	487	8									
1068010	487	10	X	X				X			
1068012	487	12		X							
1068017	487	17									
1068018	487	18			X				X		
1073005	460	5		X				X	X	X	
1073007	460	7						X			
1073013	460	13						X			
1073021	460	21						X			
1073025	460	25	X								
1073030	460	30						X			
1073031	460	31	X	X				X			
1073034	460	34	X	X							
1073040	460	40	X					X			
1073049	460	49		X	X			X	X		

IBD = re-establish the inboard ditch; **Sediment** = excavate accumulated sediment from the culvert inlet area; **Brush Inlet** = remove brush from culvert inlet area; **TrashRk** = install trash rack at culvert inlet; **Berm** = construct a berm near the culvert inlet to prevent bypass flow; **Rolling Dip** = construct a rolling dip at crossing to prevent stream diversion if culvert fails; **PBF** = pull back fill at crossing, fill failure is likely to occur; **CD** = correct diversion near crossing site; **DR** = drain road to reduce amount of surface water directed toward crossing.

Table 1b. Other Urgent Maintenance Needs at or near Stream Crossings Listed in Table 1a (Cont'd).

ID #	Road Name	Site #	IBD	Sediment	Brush Inlet	TrashRk	Berm	Rolling Dip	PBF	CD	DR
1073058	460	58		X				X			
1073060	460	60	X	X				X	X		X
1076006	460-1N	6						X			
1076008	460-1N	8						X			
1076011	460-1N	11		X				X			
1076012	460-1N	12						X			
1077001	463	1						X			
1079006	450	6						X			
1097002	430	2		X				X			
1097003	430	3						X			
1097005	430	5	X					X			
1097006	430	6						X			
1097007	430	7									
1097008	430	8	X	X				X			
1097009	430	9									
1097011	430	11	X		X			X		X	X
1097012	430	12						X		X	
1098007	300	7				X	X	X			
1098008	300	8		X	X			X			
1098013	300	13						X			
1098021	300	21						X			
1098022	300	22									
1098026	300	26	X		X		X	X			
1103002	305	2		X							
1106002	320	2	X					X			
1106004	320	4	X	X							
1106006	320	6						X			
1106007	320	7						X			
1106008	320	8	X					X			
1113002	324	2							X		X

IBD = re-establish the inboard ditch; **Sediment** = excavate accumulated sediment from the culvert inlet area; **Brush Inlet** = remove brush from culvert inlet area; **TrashRk** = install trash rack at culvert inlet; **Berm** = construct a berm near the culvert inlet to prevent bypass flow; **Rolling Dip** = construct a rolling dip at crossing to prevent stream diversion if culvert fails; **PBF** = pull back fill at crossing, fill failure is likely to occur; **CD** = correct diversion near crossing site; **DR** = drain road to reduce amount of surface water directed toward crossing.

Table 2. Stream Crossings with Diversion Potentials and EP's >100 yds

ID #	Road Name	Site #	Undersized Culvert	EP (yd^3)
1001009	B	9		637
1001013	B	13		970
1001015	B	15		1,857
1001016	B	16	X	900
1001017	B	17	X	995
1001019	B	19	X	920
1004007	B-2	7		109
1007001	E-1	1		267
1007003	E-1	3	X	1,145
1008002	F-3-2	2	X	323
1009001	F-3-3-1	1		754
1017003	F-3	3	X	2,070
1017006	F-3	6	X	164
1021007	F-8	7		489
1023001	F-5	1	X	248
1023005	F-5	5		169
1023007	F-5	7	X	210
1046001	F-3.5	1		460
1047001	F-3.5	1		460
1048001	F-5-1	1	X	1,930
1052006	NROD	6		210
1052009	NROD	9		506
1052013	NROD	13		276
1052016	ROD	16		158
1052021	ROD	21	X	988
1052026	ROD	26		1,249
1052037	ROD	37		844
1052044	ROD	44		344
1053005	NROD-2	5		351
1056002	480	2		130
1066005	485	5		585
1066006	485	6		980
1066007	485	7		170
1068001	487	1	X	907
1068010	487	10	X	174
1068020	487	20		173
1073003	460	3		720
1073005	460	5		328
1073007	460	7		180
1073021	460	21	X	713
1073030	460	30	X	122
1073034	460	34	X	255
1073040	460	40	X	315
1073058	460	58	X	590
1076006	460-1N	6	X	4,420
1077001	463	1	X	203
1079006	450	6	X	516
1089008	457	8		1,850
1097002	430	2	X	110
1097005	430	5	X	590
1097006	430	6	X	1,816
1097008	430	8	X	105
1097011	430	11		315
1097012	430	12		187
1098007	300	7		1,327
1098008	300	8		162
1098013	300	13		223
1098021	300	21	X	216
1106002	320	2	X	520
1106007	320	7	X	163
			Total Erosion Potential = 39, 068 yds.^{3}	

Figure 2. Erosion Potential Sites with Urgent Maintenance Needs, North Area

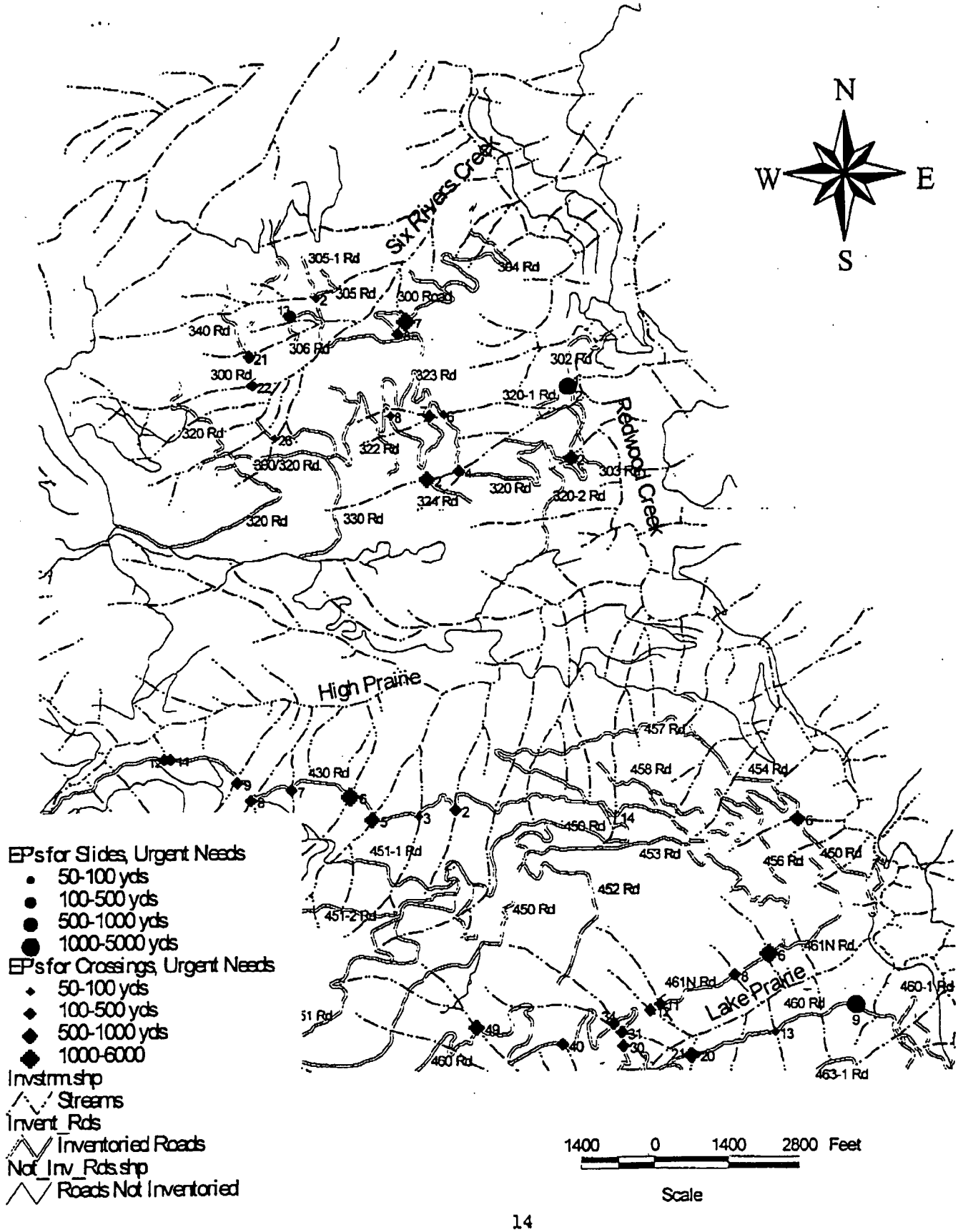


Figure 3. Erosion Potential Sites with Urgent Maintenance Needs, North Area (Cont'd)

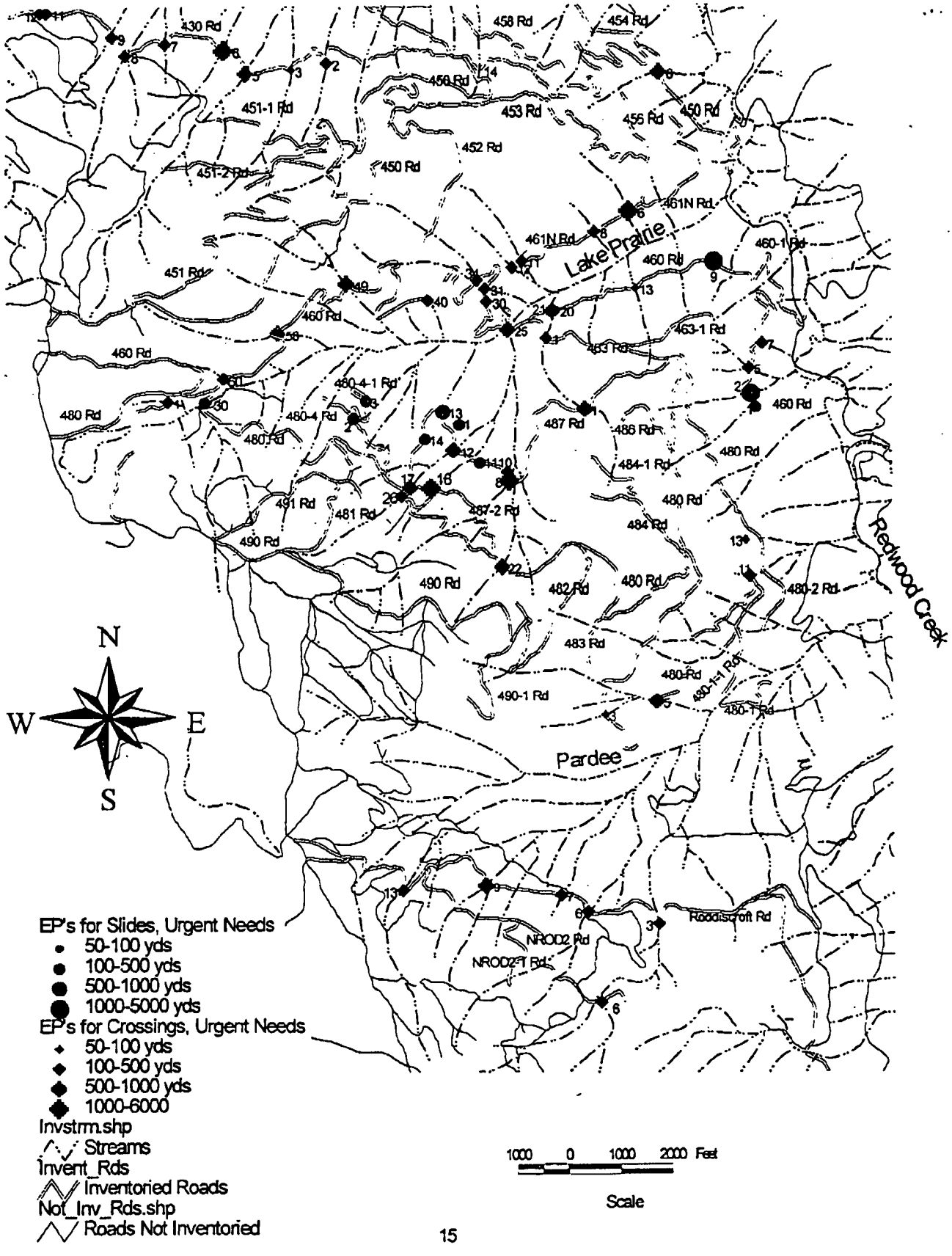
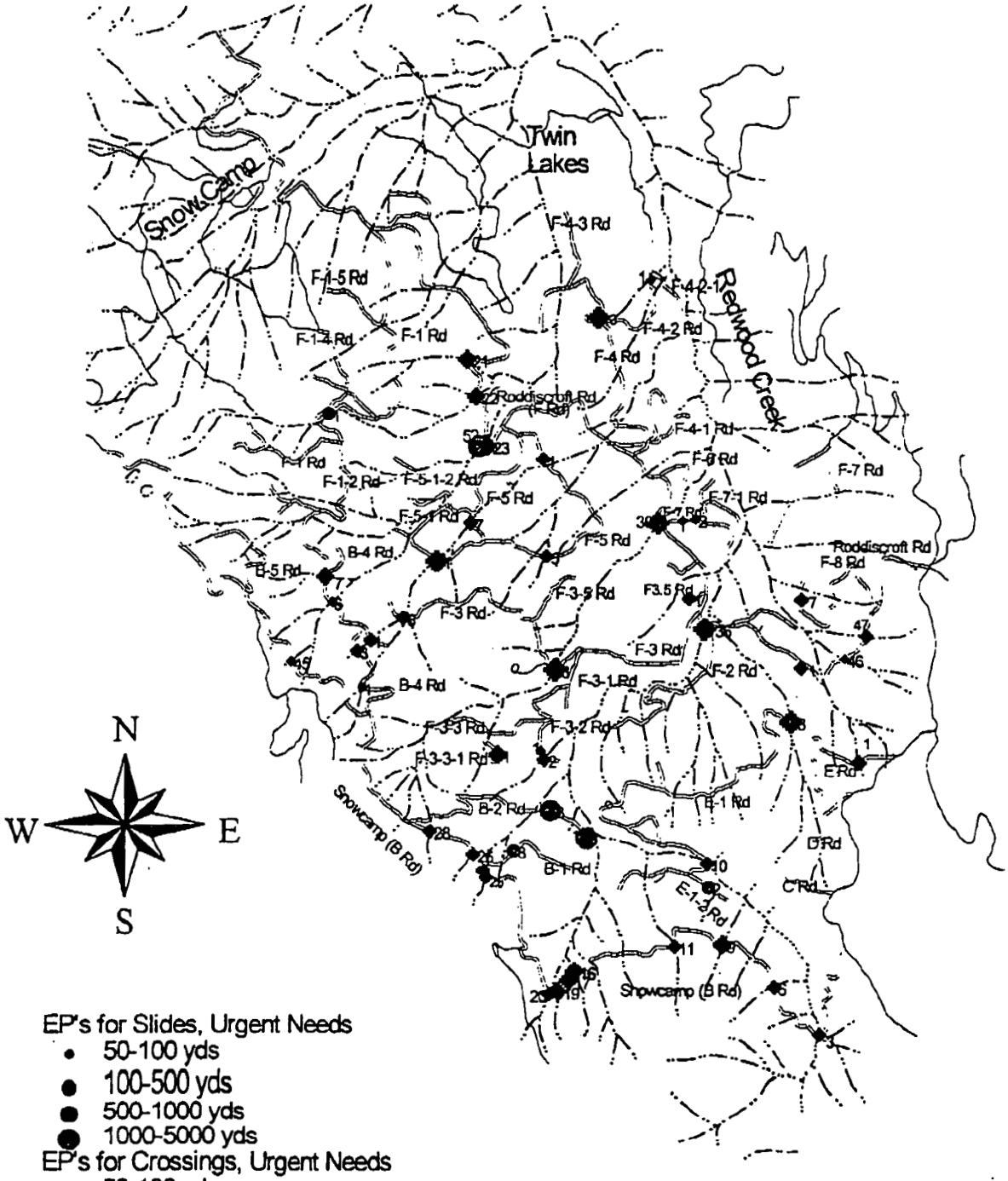


Figure 4. Erosion Potential Sites with Urgent Maintenance Needs, South Area



EP's for Slides, Urgent Needs
- 50-100 yds
- 100-500 yds
- 500-1000 yds
- 1000-5000 yds

EP's for Crossings, Urgent Needs
- 50-100 yds
- 100-500 yds
- 500-1000 yds
- 1000-6000

Invstrm.shp
Streams
Invent_Rds
Inventoried Roads
Not_Inv_Rds.shp
Roads Not Inventoried

960 0 960 1920 Feet
Scale

Mass Movement

Of the total number of 41 mass movement sites, 25 were considered significant in terms of EP volumes and treatment needs (Table 3). These 25 sites account for about 31,900 cubic yards, or 73% of total mass movement EP. EP at these sites could be reduced by excavating oversteepened fillslopes and draining water from roads and landings. Figures 2-4 show the locations of these sites. Appendix D lists all mass movement sites with an EP greater than 50 cubic yards. Appendix E shows the location of these sites. Appendix F lists the site identification number for each potential erosion site with land ownership.

DISCUSSION

The significance of potential erosion in the project area can best be understood in relation to past basinwide sediment production during major storms. Total sediment production from all sources for the Redwood Creek watershed during the period 1954-80 has been estimated at 40,800,000 tons (RNSP, 1997), equivalent to 229 tons per acre. Sediment production related to roads for the same period has been estimated at 11,272,000 tons (RNSP, 1997), equivalent to 63 tons per acre. Using a bulk density of 1.6 tons per cubic yard (RNSP, 1997) to convert EP volumes to tons, total road-related EP in the project area can be converted to about 206,500 tons, or roughly 24 tons per acre. Total estimated road-related EP in the project area on a unit area basis, is therefore about 10% of long-term basinwide sediment yield, and about 38% of basinwide road-related sediment yield between 1954 and 1980, a period that included 5 major storms and significant erosion.

RECOMMENDATIONS

Tables 1, 2, and 3 list sites where treatments could effectively protect roads and reduce the likelihood of erosion during the next major storm. We recommend these sites be treated as soon as possible. As a first course of action, however, we recommend that all diversion potentials be eliminated from stream crossings listed in Table 2. Construction of rolling dips is relatively simple and inexpensive, and would quickly reduce the fluvial EP by 55% and the total EP by 25%. RNSP is willing to work with private landowners to seek funding for erosion control on these roads, and can provide technical assistance for this project.

Table 3. Mass Movement Sites with Erosion Potentials >50yds and Urgent Maintenance Needs.

ID #	Road Name	Site #	Feature	Slope Position	Extrm. EP	EP (yds^3)
1001010	B	10	road reach	inner gorge	X	1,040
1003003	B-1	3	landing	hillslope		230
1004001	B-2	1	landing	streamside	X	1,025
1002002	E-1-2	2	road reach	inner gorge		150
1016005	F-2	5	road reach	streamside	X	1,150
1004003	B-2	3	road reach, landing	hillslope		2,800
1036001	F-1.5	1	road reach	streamside		200
1060002	480-4	2	road reach, cutbank	hillslope		290
1060004	480-4	4	swale, road reach	hillslope		70
1061003	480-4-1	3	swale, road reach	hillslope	X	180
1068011	487	11	road reach, landing, cutbank	hillslope		190
1068013	487	13	landing	hillslope	X	720
1068014	487	14	road reach	hillslope	X	372
1068018	487	18	swale, landing	streamside	X	5,950
1069001	487-1	1	road reach, landing, cutbank	hillslope		200
1073001	460	1	landing	inner gorge	X	280
1073002	460	2	road reach, hillslope	hillslope	X	2470
1073009	460	9	landing	inner gorge	X	2,500
1075001	460-1-1	1	landing	inner gorge	X	1,105
1076002	460-1N	2	road reach	hillslope	X	150
1073020	460	20	road reach	hillslope		70
1100001	302	1	road reach	inner gorge	X	5,000
1100002	302	2	road reach	inner gorge	X	2,000
1052036	F	36	stream crossing, road reach	inner gorge		1,210
1052052	F	52	road reach	streamside	X	2,540
					Total Erosion Potential =	31,892 yds^3

General Notes:

1. Extreme Erosion Potential (Extrm. EP) identifies the sites that could, in the worst case scenario, yield significantly more sediment than predicted by the estimate for Erosion Potential (EP). The Extreme Erosion Potential associated with these sites equals 39,500 yds.
2. Pulling-back over-steepened fill, and properly draining road and/or landing surfaces would be required at nearly all of these mass movement sites.
3. Site #1068018 would require a 24-inch culvert to be installed at the swale crossing along with pulling-back the adjacent landing.
4. Sites 1073001 and 1073002 were not originally assigned an urgent maintenance need during the road inventory. However, this field was later upgraded to urgent because of the potential for extreme erosion, geologic materials, and the slope position of these sites.
5. Appendix D is an expanded version of this table with "urgent maintenance needs" removed from the selection criteria.

REFERENCES CITED

Cashman, S.M., Kelsey, H.M., and Harden, D.R., 1995, Geology of the Redwood Creek basin, Humboldt County, California, p. B1-B13 in: Nolan, K.M., Kelsey, H.M., and Marron, D.C. (eds.), Geomorphic processes and aquatic habitat in the Redwood Creek basin, Northwestern California, U.S. Geological Survey Professional Paper 1454.

Redwood National and State Parks, 1997, Redwood Creek Watershed Analysis, National Park Service, Orick, California, 84 p.

Waananen, A.O., and Crippen, J.R., 1977, Magnitude and Frequency of Floods in California: U.S. Geological Survey Water Resources Investigation Report 77-21, 96 p.

APPENDIX A

INFORMATION ON THIS FORM IS FOR THE EXPRESS PURPOSES OF EROSION CONTROL WORK

UPPER REDWOOD CREEK BASIN ROAD INVENTORY

Redwood National Park, January 14, 1997

SECTION I: GENERAL SITE INFORMATION

1. ((ID#_____)) 2. Site # _____ 3. Date Mapped:_____ 4. Mapped By: _____
5. ((Altitude Index:_____ ft)) 6. Watershed:_____
7. Bedrock_____ 8. Land Ownership:_____

9. Quad ID:_____ 10. Township/Range/Section_____/_____/_____
11. Photo Number:_____ 12. Photo Date:_____ 13. Scale: 1:_____

ROAD INFORMATION

14. Road Name:_____ 15. Alternate Road Name:_____
16. Abandoned per CDF Standards? T F 17. Drivable? T F 18. Maintained? T F
19. Major Rebuild? T F 20. Year of Constr._____

21. TYPE OF SITE: Fluvial Erosion Site (Section II) or Mass Movement Site (Section III)

SECTION II: FLUVIAL EROSION SITE

22. FEATURE TYPE: Stream Xing Swale Ditch/Road Relief Spring

23. EROSIONAL PROCESS: None Eroding Rill Gully Streambank/channel Erosion Collapsing

24. DRAINAGE STRUCTURE: None Culvert Humboldt Bridge Rolling Dip @ Crossing Fill

25. CULVERT TYPE: CMP Conc Alum Wall Casing Box (conc.or wood) Plastic

Culvert Inlet Information:

26. Culvert Diam:_____in. 27. Headwall Ht:_____in. (from bottom of inlet to top of fill)
28. Upstream Channel Width: _____ ft. 29. High Bedload ? T F
30. Is the approach to this culvert likely to accumulate sediment or woody debris? T F

((31. Drainage Area _____ac. 32. Culvert Capacity _____cfs. 33. 50 yr. Q _____cfs.))

34. Culvert Inlet Condition: OK Rusted Holes Bend Separation Trash Rack Drop Inlet
35. % Crushed_____ 36. % Plugged:_____ 37. Plug Potential: H M L

38. Culvert Outlet Condition: OK Rusted Holes Functional Half-Round
39. % Crushed:_____ 40. % Plugged:_____ 41. Shotgun
42. Culvert Rust Line Width _____ in. 43. Downstream Channel Width:_____ ft.

DIVERSION POTENTIAL

44. DP? T F 45. Exit Basin? T F 46. Rd Grade:_____% 47. Now Diverted? T F

48. XING HISTORY: Diverted Washed-Out Rebuilt No Past Erosion Unknown

49. CONDITION OF FILL: Intact Washed-out Fill Failure Potential (cracks, scarps, sags, holes, wet vegetation, ponded water, leaning trees) Debris Torrent Potential (same, but steeper slopes)

50. *TREATMENTS:* Add Culvert Replace Culvert Larger Culvert Clear/est. IBD
Remove Sed. @ Culvert Inlet Brush Inlet Area Add Trash Rack Add Berm @ Inlet/IBD
Add Rolling Dip Pull Fill @ Xing Add Half-Round Waterbar None Other

51. MAINTENANCE NEEDS? T F 52. URGENT? T F

SECTION III: MASS MOVEMENT SITE

53. PROCESS: Deep Seated Shallow Debris Slide Debris Torrent Fill Failure

54. FEATURE: Stream Xing Swale Road Reach Landing Cutbank Hillslope

55. LOCATION: Hillslope Streamside Inner Gorge

56. ACTIVITY: Active (or) Waiting Partially Evacuated (or) Totally Evacuated

57. CAUSE: Natural Road Related Water onto Feature Spring Stream Undercutting

58. TREATMENTS: Pull-back fill Correct Diversion Drain Road None Other

59. MAINTENANCE NEEDS? T F 60. URGENT? T F

SECTION IV: TOTAL FILL AND EROSION VOLUMES

61. TOTAL FILL VOLUME: _____ yd³ (a geomorphic consideration) See Worksheet on Back

EROSION POTENTIAL VOLUMES	Past		Future	
I. FLUVIAL EROSION				
ONSITE EROSION - Road Fill at Crossing:				
Erosion at Crossing with DP	62 %	yd³	63 %	yd³
Erosion at Crossing with No DP (confine failure to crossing only)	64 %	yd³	65 %	yd³
OFFSITE EROSION - from diversion or downstream impacts of crossing failure.				
Road surface, ditch, fillslope	66	yd³	67	yd³
Gullied Natural Slope	68	yd³	69	yd³
Fill Failure (e.g., landing or road bench)	70	yd³	71	yd³
Hillslope Failure	72	yd³	73	yd³
Stream Erosion	74	yd³	75	yd³
Total Offsite Erosion	76	yd³	77	yd³
II. MASS MOVEMENT				
Total Volume Mobilized:	78	yd³	79	yd³

____ Road Length X ____ Vol/L.Ft. (from chart) or Dimensions of Failure.
Show Dimensions:

TOTAL PAST EROSION AND FUTURE EROSION POTENTIAL VOLUMES:

Total Volume Mobilized = (62 or 64 + 76 + 78) and/or (63 or 65 + 77 + 79)	80	yd³	81	yd³
Percent Delivery to Channel	82	%	83	%
Erosion & Potential (80x82) and/or (81x83)	84	yd³	85	yd³

IMPACT SUMMARY

86. Significant Offsite Impacts if Future Erosion Occurs? T F
87. Erosion Potential: H M L 88. Extreme EP? T F 89. Extreme Eros Vol:_____ yd³
90. Comments: (Provide comments on anything, but especially on Extreme EP (nature & likelihood))

APPENDIX B
UPPER REDWOOD CREEK ROAD INVENTORY:
DEFINITION OF TERMS USED ON SURVEY FORM

GENERAL SITE INFORMATION

1. **ID#** -- A unique identification number assigned to each potential erosion site during data entry for data management purposes. The number will generally identify the road and site; e.g., 1052003 is road 1052 at site 003.
2. **Site #** -- A number assigned in the field to each potential erosion site. Sites are numbered sequentially from one end of the road.
3. **Date Mapped** -- Date of field data collection, in MM/DD/YY format.
4. **Mapped By:** -- Initials of person collecting field data.
5. **Altitude Index:** -- The altitude index, as defined by Waananen and Crippen, 1977, p. 16 for purpose of estimating Q50. Determined by measuring the length of the drainage basin along the channel from the potential erosion site to the basin divide, estimating the altitude at points 10% and 85% along this distance, and averaging the two altitudes. Reported in thousands, for example, an average altitude of 3,500 feet would be reported as 3.5.
6. **Watershed:** -- Name of the watershed or subwatershed where the potential erosion site is located.
7. **Bedrock** -- The general bedrock type underlying the potential erosion site. Generally reported using the four-letter geologic map abbreviations, for example, KJfr.
8. **Land Ownership:** -- Name of the company, agency, family, or individual that owns the land where the potential erosion site is located.
9. **Quad ID:** -- Name of the USGS 7.5 minute topographic quadrangle map that includes the location of the potential erosion site. Reported as two-letter abbreviations based on the quad name, for example, Maple Creek quad is reported as MC.
10. **Township/Range/Section** -- legal location description from the quad map.
11. **Photo Number:** -- Flight line and photo number for the air photo used in field mapping the potential erosion site, for example, 20-18. Photo numbers are generally printed on photos.
12. **Photo Date:** -- Date of the aerial photography, usually printed on each photo in MM/DD/YY format.
13. **Scale:** -- The number of inches on the ground represented by an inch on the air photo. Common scales are 1:6,000 and 1:12,000. Scales are usually printed on each photo.
14. **Road Name:** -- The name assigned to the road on which the potential erosion site is located. Existing names listed on maps or used by landowners are used if available. Otherwise, arbitrary names similar to road-naming conventions used by timber companies can be used, for example, C Line, C-1, C-1-1 to represent main haul and "tributary" roads.

15. **Alternate Road Name:** -- Used for main haul roads that extend beyond the boundaries of individual road inventory areas if arbitrary names were used during the individual road inventories, to allow data retrieval for the entire road.

NOTE: Questions 16-20 apply to the road between the potential erosion site and the nearest junction with another road.

16. **Abandoned per CDF standards? T F** -- Record as T if road is blocked to vehicular access, fills and culverts have been removed from stream crossings, unstable fills have been pulled-back, and permanent road drainage is provided by outsloping, rolling dips or deep water bars. Otherwise record as F.
17. **Drivable? T F** – Record as T if road is passable to a standard four-wheel drive vehicle during dry weather without clearing brush or making other improvements. Otherwise, record as F.
18. **Maintained? T F** -- Record as T is road shows evidence of recent (within the past year or so) maintenance, including cleaning of culvert inlets, trash racks, and inboard ditches, grading, rolling dip or waterbar reconstruction, brushing, culvert replacement, or reconstruction of fills. Otherwise, record as F.
19. **Major Rebuild? T F** -- Record as T if the road would require major reconstruction (for example, rebuilding of a stream crossing or road bench) to allow equipment access to the potential erosion site. Otherwise, record as F.

20. **Year of Constr.** – The year that the road was built. In most cases, this cannot be determined precisely, but approximate dates can be estimated from sequential air photos, culvert conditions, crossing construction standards, crossing conditions, and culvert manufacture dates printed on culverts.
21. **Type of Site:** -- Record as **Fluvial Erosion Site** or **Mass Movement Site.** Fluvial erosion sites are sites where erosion by the action of running water is likely, as at a stream crossing. Mass movement sites are sites where failure of the road prism by landsliding is likely. Mass movement processes can also occur at fluvial sites and visa versa. Choose the type of site based upon the primary characteristic of the site.

SECTION I: FLUVIAL EROSION SITE

22. **Feature Type:** -- Record as **Stream Xing, Swale, Ditch/Road Relief,** and/or **Spring** (circle those that apply). **Stream Xing** (crossing) includes all locations where a road crosses a channel, whether water is flowing or not, and whether any drainage structure is provided. **Swale** includes locations where roads cross valley forms that lack developed channels. **Ditch/Road Relief** refers to locations where culverts are installed within road fill to carry water from inboard ditches or the road surface to the outboard edge of the road fill. **Spring** refers to locations where roads cross areas of emergent groundwater.

23. **Existing Erosion Feature:** – Record as **None, Rill, Gully, Streambank/channel Erosion,** or **Eroding Crossing.**
24. **Drainage Structure:** -- Record as **None, Culvert, Humboldt, Bridge, Rolling Dip @ Crossing,** or **Fill.**
25. **Culvert Type:** -- Record as **CMP** (corrugated metal pipe), **Conc** (concrete), **Alum** (aluminum), **Well Casing, Box** (conc. or wood), or **Plastic.**

Culvert Inlet Information

26. **Culvert Diam:** -- The culvert diameter at the inlet in inches.

27. **Headwall Ht.:** -- The headwall height measured in inches from the bottom of the culvert inlet to the lowest point on the road fill at the crossing. This is the vertical distance between the point where water can enter the culvert and the point where water will overtop the fill. If the culvert is plugged or partially plugged, headwall height is still measured from the bottom of the inlet, and the plugging is noted in field 36. Headwall height is used to assess the culvert capacity for each site.
28. **Upstream channel width:** -- Measured from active channel bank to bank, at a height of one foot above the channel bed. Reported in feet.
29. **High Bedload? T F** – Record as T if gravel and fine sediment have accumulated on the upstream side of the fill, or there are obvious signs of high bedload transport.
30. **Is the approach to this culvert likely to accumulate sediment or woody debris? T F** -- Record as T if the culvert inlet is above the channel bed and grade creating a gentle long profile upstream of the inlet that would encourage sediment deposition. Culvert approaches likley to accumulate sediment also have unconfined channels.

Questions 31-33 require office measurements and calculations.

31. **Drainage Area** -- Measured in the office using a dot grid, planimeter, or digitizer, reported in acres. Drainage area is used to compute the design flow and the correct culvert size.
32. **Culvert Capacity** -- The maximum flow that the existing culvert can pass, in cubic feet per second. Determined from culvert diameter using Bureau of Roads (1963) nomograph.
33. **50 yr. Q** -- The estimated 50-year recurrence interval flood discharge at the potential erosion site. May be determined using any of a number of available empirical runoff formulae, for example, the rational formula. This is the design flow for the site.
34. **Culvert Inlet Condition:** Record **OK, Rusted, Holes, Band Separation, Trash Rack,** and **Drop Inlet** as appropriate.
35. **% Crushed:** -- The percentage of the culvert inlet area that is no longer available to carry water as a result of crushing of the pipe. An answer of 100% indicates that the pipe is completely flattened.

36. **% Plugged:** -- The percentage of the culvert inlet area that is no longer available to carry water as a result of plugging with sediment or woody debris. An answer of 100% indicates that the pipe is completely plugged.
37. **Plug Potential: H M L.** Record as H (high) if sediment or woody debris is likely to plug the culvert inlet, for example, if the pipe is already partially filled with sediment, if the grade of the pipe is substantially less than the grade of the natural channel, or if the channel upstream contains large amounts of woody debris subject to transport in high flows. Record as L (low) if none of these conditions exist. Record as M (medium) if conditions are intermediate between H and L.
38. **Culvert Outlet Condition:** -- Record **OK, Rusted. Holes, Crushed.** and **Functional Half-Round** as appropriate.
39. **% Crushed:** -- The percentage of the culvert outlet area that is no longer available to carry water as a result of crushing of the pipe.
40. **% Plugged:** -- The percentage of the culvert outlet area that is no longer available to carry water as a result of plugging of the pipe.
41. **Shotgun** -- Circle if culvert outlet is above the channel bed.
42. **Culvert Rust Line Width** -- Measured in inches at the culvert oulet, the distance from the upper extent of rust on the left side of the culvert across to the upper extent of rust on the right side of the culvert. This information may be used to develop empirical relations between rust line widths and design flows.
43. **Downstream Channel Width:** -- Measured from active channel bank to bank, at a height of one foot above the channel bed. Reported in feet.

Diversion Potential (DP)

44. **DP? T F** -- Record T if the road grade is continuous through the crossing so that streamflow could flow down the road beyond the crossing if a culvert plugged and streamflow overtopped the fill. Record F if the crossing is the low point in the road (road slopes uphill away from both sides of the stream) or the road is flat and the stream cannot divert if the culvert plugs.

45. **Exit basin? T F** -- Record T if streamflow would flow down the road and out of its natural basin or subbasin if streamflow overtopped the fill during high flow.
46. **Road Grade:** -- The slope of the road through the crossing, in percent. Measured with a clinometer or Abney level. Record 0% if the road dips into the crossing.
47. **Now Diverted? T F** -- Record T if streamflow is presently diverted from its natural channel.
48. **Xing History:** -- Record the crossing history as **Diverted, Washed-Out. Rebuilt, No Past Erosion**, or **Unknown.** More than one response may apply, for example, a crossing that washed out and was later rebuilt. Indications of rebuilt crossings include old and abandoned culverts in the channel and logs of former Humboldt crossings below existing culverts.

49. **Condition of Fill:** -- Record as **Intact, Washed-out, Fill Failure Potential (cracks, scarps, sags, holes, wet vegetation, ponded water leaning tree),** or **Debris Torrent Potential (same, but steeper slopes).** Record **Washed-out** as a response to this question only if the crossing has not been rebuilt.
50. **Possible Treatments:** -- Circle as many as apply from the following: Add culvert Replace Culvert Larger Culvert Clear/establish Inboard Ditch Remove sediment @ Culvert Inlet Brush Inlet Area Add Trash Rack Add Berm@Inlet Add Rolling Dip Pull fill @ at Crossing Add half-round Waterbar None. Circle Other when additional treatments are entered as in the Comment section.
51. **Maintenance Needs: T F** -- Record T if potential erosion site requires maintenance to reduce/prevent erosion and to protect the road.
52. **Urgent? T F** -- Record T if maintenance is needed before the next wet season. Failure is likely without maintenance.

SECTION II: MASS MOVEMENT SITE

53. **Process:** -- Record **Earthflow, Shallow Debris Slide, Rotational Slump. Debris Torrent,** or **Fill Failure.**
54. **Feature:** -- Record **Stream Crossing, Swale, Road Reach, Landing, Cutbank, Hillslope,** as applies, based on the primary characteristics of the site.
55. **Location:** -- Record **Hillslope, Streamside,** or **Inner Gorge.**

56. **Activity:** -- Record **Active, Waiting, Partially Evacuated,** or **Totally Evacuated.**
57. **CAUSE:** -- Record **Natural, Road Related, Water onto Feature, Stream Undercutting,** or **Spring.**
58. **Possible Treatments:** -- Record **Pull-back fill, Correct Diversion,** or **Dewater Road.** Choose **Other** if additional treatments are specified in the **Comment** Field.
59. **Maintenance Needs: T F** -- Record T if potential erosion site requires maintenance to reduce/prevent erosion and to protect the road.
60. **Urgent? T F** -- Record T if maintenance is needed before the next wet season. Failure is likely without maintenance.

SECTION III: TOTAL FILL AND EROSION VOLUMES

61. **Total Fill Volume:** -- The total volume of road fill at the potential erosion site, in cubic yards. At stream crossings, this volume includes all road fill placed within the natural valley form. Total fill volume is computed from field measurements made with a tape and clinometer or Abney level. The computation requires measurements of slope angles and distances on upstream and downstream fillslopes, the width of the road surface, and the valley width at the upstream and downstream edges of the road surface (see worksheet and schematic drawing on back side of inventory form). Volumes are

generally computed from field measurements using scale drawings prepared in the office after completion of field work.

EROSION POTENTIAL VOLUMES

I. Fluvial Erosion -- Use this section only if Section 1 of the form was completed.

Onsite Erosion - Road Fill at Crossing:

62. **Past Erosion at Crossing with DP** -- The amount of fill material eroded from a stream crossing, based on measurements of existing voids. Generally recorded as a percent of total fill volume in the field and converted to cubic yards after total fill volume has been computed.

Note: Separate responses are required for crossings with and without diversion potential (DP) because crossings that divert streamflow are generally eroded less than crossings that do not. Streams diverted at crossings may cause significant off-site erosion, but because the water flows along the road and away from the crossing, erosion of the crossing itself is limited.

63. **Future Erosion at Crossing with DP** -- The amount of fill estimated to erode from the crossing if the culvert and/or crossing fail. Generally recorded as a percent of total fill volume in the field and converted to cubic yards after total fill volume has been computed.
64. **Past Erosion at Crossing with No DP** -- The amount of fill material eroded from a stream crossing, based on measurements of existing voids. Generally recorded as a percent of total fill volume in the field and converted to cubic yards after total fill volume has been computed.
65. **Future Erosion at Crossing with No DP** -- The amount of fill estimated to erode from the crossing if the culvert and /or crossing fail. Generally recorded as a percent of total fill volume in the field and converted to in cubic yards after total fill volume has been computed.

Offsite Erosion-from stream diversion or downstream impacts of crossing failure

66. **Past road surface, ditch, and fillslope erosion** -- based on field measurement of erosional voids, and reported in cubic yards, the amount of erosion that has occurred on the road surface, ditch and/or fillslope of the road prism.

Note: when evaluating offsite impacts or predicting future impacts, recording the dimensions of voids alongside the appropriate fields or in margins is recommended.

67. **Future road surface, ditch, and fillslope erosion** -- estimated future erosion if stream diversion occurs, in cubic yards, between the diversion at the crossing and the point that streamflow would leave the road surface.

68. **Past gullied natural slope** -- based on measurement of erosional voids in the field, in cubic yards, gully erosion that has occurred on the hillslope.

69. **Future gullied natural slope** -- estimated future erosion along the path that diverted streamflow would follow between the point that it left the road and the point that it re-entered a natural stream channel, reported in cubic yards. Estimates are often based on dimensions of existing nearby gullies and the dimensions of the natural stream channel, as well as field or air photo measurements of the approximate flow path length.

70. **Past fill failure** -- mass movement of landing or road fill material related to erosion or diversion at crossing, in cubic yards.

Note: Do not include fill failure of the crossing itself, which should be included in field 62 or 64.

71. **Future fill failure** -- estimated volume of mass movement of road benches or landings caused by erosion or diversion at crossing, in cubic yards.

72. **Past hillslope failure** -- measured volume of mass movement on the hillslope, away from road, reported in cubic yards, related to erosion or diversion at crossing. For example, accelerated earthflow movement caused by increased saturation due to diverted streamflow. Do not include fill failures of roads or landings, which should be included in field 69.

73. **Future Hillslope failure** -- estimated volume, in cubic yards, of mass movement on hillslope related to erosion or diversion at crossing. Generally based on observed dimensions of existing hillslope failures in nearby terrain with similar characteristics (slope position, geology, etc.)

74. **Past Stream Erosion** -- measured or estimated volume of material eroded from streambanks and/or channel as a result of erosion or diversion at crossing, in cubic yards. Includes increased bank erosion or channel downcutting caused by increased streamflow following diversion and streamside landslides aggravated by deposition of eroded fill material.

75. **Future Stream Erosion** -- predicted volume of bank and/or bed erosion and streamside landsliding attributable to erosion or diversion at crossing, in cubic yards.

76. **Past Total Offsite Erosion** -- sum of volumes reported for fields 66, 68, 70, 72, and 74, in cubic yards.

77. **Future Total Offsite Erosion** -- sum of volumes reported for fields 67, 69, 71, 73, and 75, in cubic yards.

II. Mass Movement -- Use this section only if Section II was completed.

78. **Past Total Volume Mobilized:** -- Volume of material eroded by mass movement processes from road bench or landing, in cubic yards, based on field measurements of dimensions. Include only mass movements that are unrelated to erosion or diversions at

stream crossings. Do not include fill failures at crossings, which should be included in fields 62 or 64, or fill failures or hillslope failures related to erosion or diversions at crossings, which should be included in fields 70, 72, and 74.

79. **Future Total Volume Mobilized** -- Estimated erosion volume caused by mass movement unrelated to erosion or diversions at crossings, in cubic yards.

TOTAL PAST EROSION AND FUTURE EROSION POTENTIAL VOLUMES:

80. **Past Total Volume Mobilized** -- Sum of volumes reported in fields 62 or 64, plus 76, and 78, in cubic yards. Represents all past erosion at the site.
81. **Future Total Volume Mobilized** -- Sum of volumes reported in fields 63 or 65, plus 77, and 79, in cubic yards. Represents all future erosion at the site during the next major storm.
82. **Past Percent Delivery to Channel** -- The percentage of the volume reported in field 80 that was transported to a stream channel. Based on visual estimates of re-deposited sediment between the site and channel.
83. **Future Percent Delivery to Channel** -- The percentage of the volume reported in field 81 that will be transported to a stream channel. Usually the same as the percentage reported in field 82 unless conditions affecting sediment transport have changed significantly since the last major storm.
84. **Past Erosion, Total Yield to Channel** -- The past total volume mobilized (field 80) multiplied by the percent delivery to channel (field 82). Represents total past sediment delivery to the channel system from the site.
85. **Erosion Potential, Future Total Yield to Channel** -- The future total volume mobilized (field 81) multiplied by the percent delivery to channel (field 83). Represents total future sediment delivery to the channel system from the site in the next major storm.

IMPACT SUMMARY

86. **Significant Offsite Impacts If Future Erosion Occurs? T F** -- Record as T if future erosion at this site will significantly affect hillslopes, channels, or roads at other locations. For example, if the site would fail as a debris torrent and scour a tributary channel, or if hillslope erosion caused by streamflow diversion at the site would lead to channel aggradation and possible streambank landslides, record T. If erosion at the site will be limited to the site itself, or if offsite erosion will be minor, record F.
87. **Erosion Potential: H M L** -- Subjective and relative ranking of the **LIKELIHOOD**, rather than the magnitude, of erosion at the site during the next major storm (high, medium, low).
88. **Extreme EP? T F** -- Record as T if the site has potential for to erode significantly more volume than estimated by the erosion potential. This is a worst case scenario that identifies the potential for an unusually large MAGNITUDE failure. This field should be used for "flagging" critical erosion potential sites. An example might be a diversion onto a road without waterbars, that obliterates inboard ditches, relief pipes, and other crossings

during a major storm, or a landing or crossing that may fail catastrophically scouring hillslopes or channels below. If T is recorded, supporting information must be provided in fields 89 and 90.

89. **Extreme Erosion Vol:** -- If field 88 is marked T, report in cubic yards the estimated volume of erosion associated with an extreme erosion event. This volume should be larger than the future total volume mobilized reported in field 81, and should represent a "worst-case" scenario.

90. **Comments:** -- Use this field to provide comments on anything of significance not reported elsewhere on the form, but especially to provide a description of extreme EP. Keep comments short and to the point.

Appendix C. Condition of Culverts and Erosion Potentials at All Stream Crossings (a complete list of all crossings).

ID #	Road	Site	Maint.	Urgent	New Culvert	Replace	Larger	IBD	Sediment	Brush	Trash	Berm	Dip	Xtrm. EP	EP	EP
1000001	A-1	1	X												H	185
1001001	B	1	X	X		X			X	X					M	32
1001002	B	2													M	141
1001003	B	3													M	436
1001005	B	5	X										X		M	92
1001006	B	6	X	X			X		X						M	181
1001009	B	9	X				X						X		M	637
1001011	B	11	X	X			X		X						H	156
1001013	B	13	X						X				X		M	970
1001014	B	14													L	0
1001015	B	15												X	M	1,857
1001016	B	16	X	X		X							X		H	900
1001017	B	17	X	X	X										H	995
1001019	B	19	X	X	X								X		M	920
1001020	B	20	X	X		X	X		X						H	115
1001024	B	24	X	X	X										H	38
1001025	B	25	X	X			X								H	103
1001026	B	26	X	X		X	X		X	X					M	137
1001028	B	28	X	X		X	X		X				X		H	101
1001030	B	30	X	X		X	X		X				X		M	45
1001040	B	40	X	X		X	X		X						L	75
1001045	B	45	X	X		X	X	X	X				X		H	57
1002001	E-1-2	1	X												M	0
1003001	B-1	1													M	20
1004002	B-2	2													L	5
1004004	B-2	4	X												H	50
1004007	B-2	7											X		M	109
1007001	E-1	1	X	X									X		H	267
1007003	E-1	3	X	X					X		X		X	X	H	1,145

Maint. = maintenance is needed; **Urgent** = the maintenance is urgent, i.e., failure is likely unless maintenance occurrs; **New Culvert** = a new culvert is needed at this crossing; **Replace** = the existing culvert is worn, damaged, and/or obviously undersized and should be replaced; **Larger** = the existing culvert is obviously undersized (water and sediment) and should be replaced by a large one; **IBD** = reestablish the inboard ditch; **Sediment** = excavate the accumulated sediment from the culvert inlet; **Brush** = remove brush from culvert inlet; **Trash** = install trash rack at culvert inlet; **Berm** = construct a berm near the culvert inlet to prevent bypass flow; **Dip** = construct a rolling dip at crossing to prevent stream diversion if culvert fails; **Xtrm. EP.** = sites that could yield significantly more sediment than predicted by the Erosion Potential (EP) estimate.

Appendix C. Condition of Culverts and Erosion Potentials at All Stream Crossings (Cont'd).

ID #	Road	Site	Maint.	Urgent	New Culvert	Replace	Larger	IBD	Sediment	Brush	Trash	Berm	Dip	Xtrm. EP	EP	EP
1007009	E-1	9													L	0
1007010	E-1	10	X												H	164
1008001	F-3-2	1	X	X					X						H	80
1008002	F-3-2	2	X			X							X		H	323
1009001	F-3-3-1	1	X	X					X				X	X	H	754
1011001	B-4	1	X			X	X		X				X		M	100
1011003	B-4	3	X	X					X						M	159
1011006	B-4	6	X			X	X		X				X		H	80
1011007	B-4	7	X				X		X			X			H	966
1014001	E	1					X								L	297
1016002	F-2	2													L	25
1016003	F-2	3													L	31
1016004	F-2	4													L	15
1016008	F-2	8			X										M	0
1017003	F-3	3	X	X		X	X		X					X	H	2,070
1017004	F-3	4	X						X						M	16
1017005	F-3	5	X			X	X		X				X		M	24
1017006	F-3	6	X				X						X		H	164
1018001	F-3-1	1	X		X								X		L	8
1020001	B-4-1	1	X	X					X		X				H	280
1021004	F-8	4													L	21
1021005	F-8	5													L	26
1021006	F-8	6													M	404
1021007	F-8	7	X	X					X		X		X		H	489
1022001	F-7	1	X				X		X				X		M	83
1022002	F-7	2	X		X										M	73
1022004	F-7	4													L	0
1022006	F-7	6													M	260
1022007	F-7	7													L	42

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Appendix C. Condition of Culverts and Erosion Potentials at All Stream Crossings (Cont'd).

ID #	Road	Site	Maint.	Urgent	New Culvert	Replace	Larger	IBD	Sediment	Brush	Trash	Berm	Dip	Xtrm. EP	EP	EP
1022009	F-7	9											X		L	4
1022010	F-7	10													L	12
1022011	F-7	11													L	3
1022013	F-7	13													L	38
1023001	F-5	1	X	X		X	X		X		X				M	248
1023002	F-5	2	X		X								X		M	26
1023003	F-5	3	X						X						L	98
1023005	F-5	5	X		X								X		H	169
1023006	F-5	6	X	X	X								X		H	35
1023007	F-5	7	X	X									X	X	H	210
1024001	F-5-1-2	1													L	229
1024002	F-5-1-2	2													L	1
1025001	F-5-1-1	1												X	H	6,780
1025002	F-5-1-1	2													L	100
1026003	F-1-2	3													H	20
1026005	F-1-2	5													L	5
1035001	F-4	1													L	5
1035002	F-4	2													L	15
1035003	F-4	3			X										H	1,645
1035004	F-4	4													L	0
1036002	F-1.5	2													M	50
1036004	F-1.5	4													M	250
1037006	F-1	6													M	153
1037007	F-1	7													L	0
1041001	F-421	1													M	202
1041002	F-4-2-1	2													L	156
1042001	F-4-2	1													M	53
1045001	F-4-2-3	1													L	2
1046001	F-3.5	1	X												M	460

Maint. = maintenance is needed; **Urgent** = the maintenance is urgent, i.e., failure is likely unless maintenance occurrs; **New Culvert** = a new culvert is needed at this crossing; **Replace** = the existing culvert is worn, damaged, and/or obviously undersized and should be replaced; **Larger** = the existing culvert is obviously undersized (water and sediment) and should be replaced by a large one; **IBD** = reestablish the inboard ditch; **Sediment** = excavate the accumulated sediment from the culvert inlet; **Brush** = remove brush from culvert inlet; **Trash** = install trash rack at culvert inlet; **Berm** = construct a berm near the culvert inlet to prevent bypass flow; **Dip** = construct a rolling dip at crossing to prevent stream diversion if culvert fails; **Xtrm. EP.** = sites that could yield significantly more sediment than predicted by the Erosion Potential (EP) estimate.

Appendix C. Condition of Culverts and Erosion Potentials at All Stream Crossings (Cont'd).

ID #	Road	Site	Maint.	Urgent	New Culvert	Replace	Larger	IBD	Sediment	Brush	Trash	Berm	Dip	Xtrm. EP	EP	EP
1047001	F3.5	1	X	X											M	460
1048001	F-5-1	1	X	X		X	X		X				X	X	H	1,930
1052003	NROD	3					X								M	126
1052006	NROD	6	X	X					X			X	X		M	210
1052007	NROD	7	X		X										M	104
1052009	NROD	9	X		X								X	X	H	506
1052013	NROD	13	X				X						X	X	M	276
1052014	NROD	14													L	34
1052016	ROD	16	X			X									H	158
1052017	ROD	17													L	26
1052021	ROD	21	X	X									X		H	988
1052022	ROD	22	X	X	X										H	1,000
1052023	ROD	23	X	X					X						H	537
1052026	ROD	26	X									X	X		M	1,249
1052027	ROD	27	X				X				X				L	436
1052029	ROD	29	X						X						L	0
1052030	ROD	30	X	X	X								X		H	2,282
1052033	ROD	33													L	46
1052035	ROD	35			X										L	0
1052036	ROD	36	X												H	1,210
1052037	ROD	37													M	844
1052044	ROD	44													M	344
1052046	ROD	46	X	X			X		X						M	83
1052047	ROD	47	X	X			X								M	67
1052048	ROD	48	X		X										M	35
1053002	NROD-2	2	X										X		L	107
1053004	NROD-2	4											X		L	71
1053005	NROD-2	5	X										X		L	351
1053006	NROD-2	6	X						X						M	109

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Appendix C. Condition of Culverts and Erosion Potentials at All Stream Crossings (Cont'd).

ID #	Road	Site	Maint.	Urgent	New Culvert	Replace	Larger	IBD	Sediment	Brush	Trash	Berm	Dip	Xtrm. EP	EP	EP
1056002	480	2	X										X		M	130
1056003	480	3	X	X					X		X				H	202
1056005	480	5					X								M	732
1056006	480	6	X										X		M	50
1056011	480	11	X	X			X	X	X						M	474
1056013	480	13	X	X		X									H	75
1056022	480	22	X	X				X							M	813
1056024	480	24													L	203
1056025	480	25	X	X					X				X		M	30
1056026	480	26													M	323
1056028	480	28	X						X				X		M	58
1056029	480	29							X						L	153
1056030	480	30	X	X											H	360
1060001	480-4	1	X												M	408
1060006	480-4	6	X										X		L	40
1062001	480-6	1	X		X										M	150
1066003	485	3	X						X				X		M	80
1066004	485	4											X		L	25
1066005	485	5	X										X	X	L	585
1066006	485	6	X	X					X			X	X		L	980
1066007	485	7	X						X				X		L	170
1068001	487	1	X	X		X	X		X				X	X	H	907
1068007	487	7											X		M	1,630
1068008	487	8													M	1,150
1068010	487	10	X	X		X	X	X	X				X		H	174
1068012	487	12	X	X			X		X					X	H	907
1068017	487	17	X												M	572
1068018	487	18	X	X	X					X				X	H	5,950
1068020	487	20	X			X									L	173

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Appendix C: Condition of Culverts and Erosion Potentials at All Stream Crossings (Cont'd).

ID #	Road	Site	Maint.	Urgent	New Culvert	Replace	Larger	IBD	Sediment	Brush	Trash	Berm	Dip	Xtrm. EP	EP	EP
1073003	460	3	X			X							X		M	720
1073005	460	5	X	X			X		X				X		H	328
1073006	460	6										X	X		M	56
1073007	460	7	X		X								X		H	180
1073013	460	13	X				X						X		M	69
1073021	460	21					X						X	X	M	713
1073025	460	25	X	X				X							H	800
1073030	460	30	X	X		X							X		H	122
1073031	460	31	X	X		X	X	X	X				X		H	210
1073034	460	34	X	X			X	X	X						H	255
1073040	460	40	X	X		X		X					X		H	315
1073049	460	49	X						X	X			X		H	540
1073058	460	58	X	X			X		X				X		H	590
1073060	460	60	X	X			X	X	X				X		H	400
1073061	460	61													M	25
1076006	460-1N	6	X	X		X	X						X	X	H	4,420
1076008	460-1N	8	X	X		X							X		H	105
1076011	460-1N	11	X	X		X	X		X				X		H	150
1076012	460-1N	12			X								X		H	190
1077001	463	1					X								M	203
1079001	450	1													L	0
1079006	450	6	X	X	X									X	M	516
1079008	450	8	X		X										L	0
1079009	450	9	X										X		M	25
1079013	450	13								X			X		L	45
1079014	450	14	X	X						X			X		M	50
1080002	451	2													L	40
1081001	451-1	1													L	0
1088001	456	1													L	0

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Appendix C. Condition of Culverts and Erosion Potentials at All Stream Crossings (Cont'd).

ID #	Road	Site	Maint.	Urgent	New Culvert	Replace	Larger	IBD	Sediment	Brush	Trash	Berm	Dip	Xtrm. EP	EP	EP
1089003	457	3													M	10
1089004	457	4													L	21
1089005	457	5													M	284
1089006	457	6													L	0
1089007	457	7													L	0
1089008	457	8			X									X	L	1,850
1090001	458	1													M	85
1090002	458	2													L	35
1092001	490	1	X										X		L	50
1097001	430	1	X		X										M	15
1097002	430	2	X	X		X	X		X				X		M	110
1097003	430	3	X	X	X								X		M	60
1097005	430	5	X	X	X			X					X		M	590
1097006	430	6	X	X	X								X		H	1,816
1097007	430	7	X	X	X										H	192
1097008	430	8	X	X	X			X	X				X		M	105
1097009	430	9	X	X	X										H	190
1097011	430	11	X		X			X		X			X	X	M	315
1097012	430	12	X		X								X		M	187
1097014	430	14	X		X								X		L	8
1097015	430	15	X		X										M	43
1098002	300	2	X						X				X		M	80
1098007	300	7	X	X							X	X	X		H	1,327
1098008	300	8	X						X	X			X		M	162
1098011	300	11													L	430
1098012	300	12	X										X		M	55
1098013	300	13	X	X									X		M	223
1098014	300	14	X									X	X		M	48
1098021	300	21	X	X		X							X		M	216

Maint. = maintenance is needed; **Urgent** = the maintenance is urgent, i.e., failure is likely unless maintenance occurs; **New Culvert** = a new culvert is needed at this crossing; **Replace** = the existing culvert is worn, damaged, and/or obviously undersized and should be replaced; **Larger** = the existing culvert is obviously undersized (water and sediment) and should be replaced by a large one; **IBD** = reestablish the inboard ditch; **Sediment** = excavate the accumulated sediment from the culvert inlet; **Brush** = remove brush from culvert inlet; **Trash** = install trash rack at culvert inlet; **Berm** = construct a berm near the culvert inlet to prevent bypass flow; **Dip** = construct a rolling dip at crossing to prevent stream diversion if culvert fails; **Xtrm. EP.** = sites that could yield significantly more sediment than predicted by the Erosion Potential (EP) estimate.

Appendix C. Condition of Culverts and Erosion Potentials at All Stream Crossings (Cont'd).

ID #	Road	Site	Maint.	Urgent	New Culvert	Replace	Larger	IBD	Sediment	Brush	Trash	Berm	Dip	Xtrm. EP	EP	EP
1098022	300	22	X			X									M	170
1098024	300	24	X	X		X	X		X			X	X		H	43
1098025	300	25	X										X		M	48
1098026	300	26	X	X		X	X	X		X		X	X		H	90
1099001	301	1	X												L	13
1100003	302	3	X												L	290
1100004	302	4													L	393
1102001	304	1	X										X		M	51
1103001	305	1	X							X			X		L	92
1103002	305	2	X						X						M	88
1105002	306	2						X							L	80
1106002	320	2	X	X	X			X					X		M	520
1106004	320	4	X	X				X	X						H	255
1106006	320	6	X			X							X		M	60
1106007	320	7	X	X									X		M	163
1106008	320	8	X	X				X					X		H	70
1106010	320	10													L	110
1107001	320-1	1	X			X									L	170
1113002	324	2	X	X										X	M	590
1115001	340	1	X									X	X		L	57
1117001	F-9	1													L	0
														Total Erosion Potential =		81,712 yds^3

Maint. = maintenance is needed; **Urgent** = the maintenance is urgent, i.e., failure is likely unless maintenance occurs: **New Culvert** = a new culvert is needed at this crossing; **Replace** = the existing culvert is worn, damaged, and/or obviously undersized and should be replaced: **Larger** = the existing culvert is obviously undersized (water and sediment) and should be replaced by a large one; **IBD** = reestablish the inboard ditch; **Sediment** = excavate the accumulated sediment from the culvert inlet; **Brush** = remove brush from culvert inlet; **Trash** = install trash rack at culvert inlet; **Berm** = construct a berm near the culvert inlet to prevent bypass flow; **Dip** = construct a rolling dip at crossing to prevent stream diversion if culvert fails; **Xtrm. EP.** = sites that could yield significantly more sediment than predicted by the Erosion Potential (EP) estimate.

Appendix D. Mass Movement Sites with Erosion Potentials >50 yds.

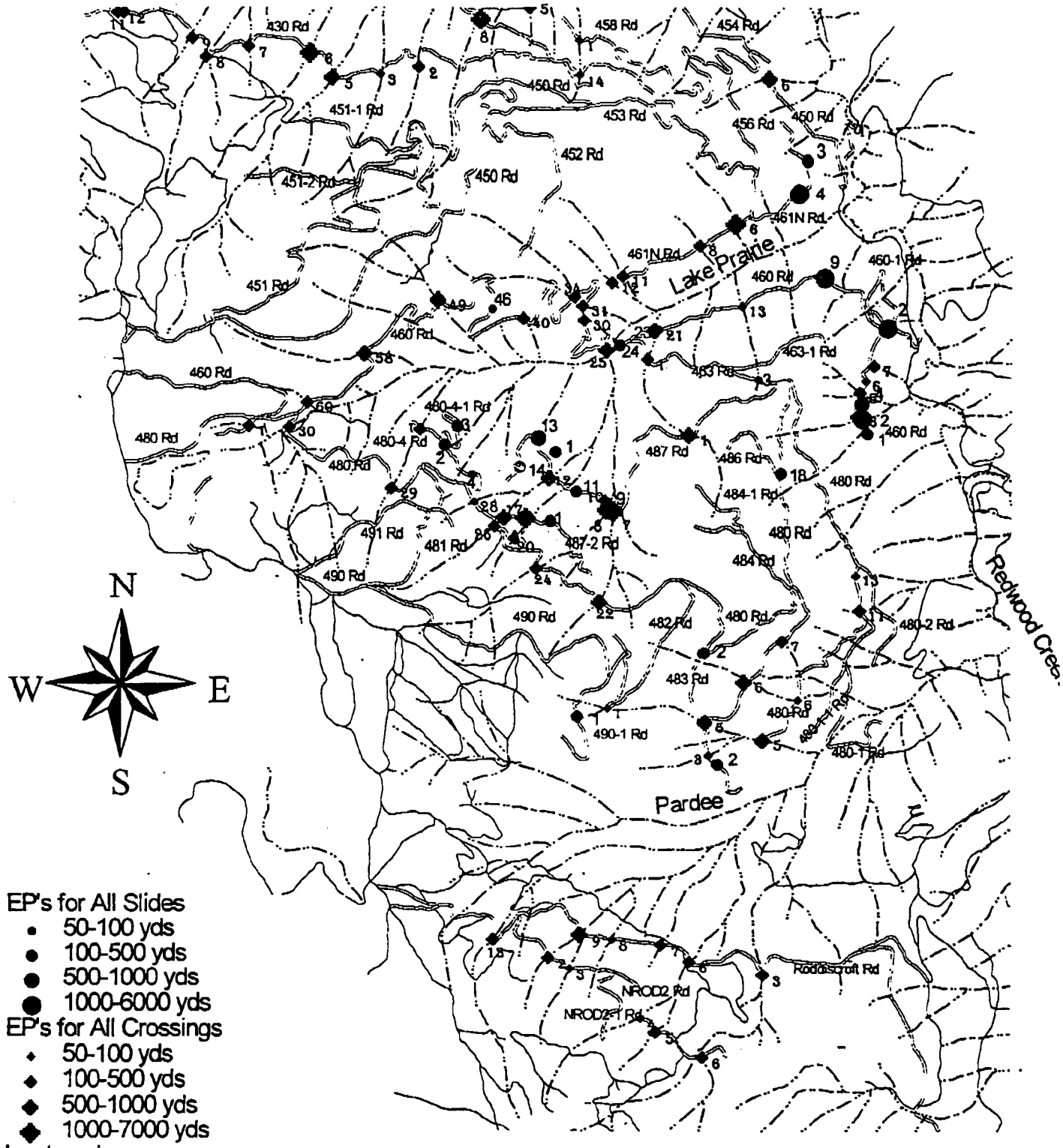
This table is an expanded version of Table 3. The "urgent maintenance" criteria for site selection has been removed, producing a larger number of sites.

ID #	Road Name	Site #	Feature	Slope Position	Extrm. EP	EP (yd^3)
1000002	A-1	2	road reach	hillslope	X	300
1000003	A-1	3	swale, landing	inner gorge		100
1001010	B	10	road reach	inner gorge	X	1,040
1003003	B-1	3	landing	hillslope		230
1004001	B-2	1	landing	streamside	X	1,025
1002002	E-1-2	2	road reach	inner gorge		150
1016005	F-2	5	road reach	streamside	X	1,150
1004003	B-2	3	road reach, landing	hillslope		2,800
1036001	F-1.5	1	road reach	streamside		200
1036003	F-1.5	3	road reach, cutbank	inner gorge		90
1022005	F-7	5	road reach	inner gorge	X	600
1056018	480	18	road reach, cutbank	hillslope		300
1060002	480-4	2	road reach, cutbank	hillslope		290
1060004	480-4	4	swale, road reach	hillslope		70
1061003	480-4-1	3	swale, road reach	hillslope	X	180
1068009	487	9	road reach, landing	hillslope		65
1068011	487	11	road reach, landing, cutbank	hillslope		190
1068013	487	13	landing	hillslope	X	720
1068014	487	14	road reach	hillslope	X	372
1068018	487	18	swale, landing	streamside	X	5,950
1069001	487-1	1	road reach, landing, cutbank	hillslope		200
1070001	487-2	1	landing	hillslope	X	300
1073001	460	1	landing	inner gorge		280
1073002	460	2	road reach, cutbank, hillslope	hillslope	X	2,470
1073004	460	4	landing	hillslope		1,000
1073009	460	9	landing	inner gorge	X	2,500
1073017	460	17	road reach	inner gorge		75
1074001	460-1	1	landing	inner gorge	X	5,555
1075001	460-1-1	1	landing	inner gorge	X	1,105
1077003	463	3	road reach	hillslope	X	75
1076002	460-1N	2	road reach	hillslope	X	150
1076004	460-1N	4	swale, landing	streamside	X	1,620
1073020	460	20	road reach	hillslope		70
1073023	460	23	road reach	inner gorge		197
1093001	490-1	1	swale, landing	hillslope	X	480
1097013	430	13	swale, road reach	hillslope		100
1100001	302	1	road reach	inner gorge	X	5,000
1100002	302	2	road reach	inner gorge	X	2,000
1111001	322	1	landing	hillslope		111
1052036	F	36	stream crossing, road reach	inner gorge		1,210
1052052	F	52	road reach	streamside	X	2,540
					Total Erosion Potential =	42,623

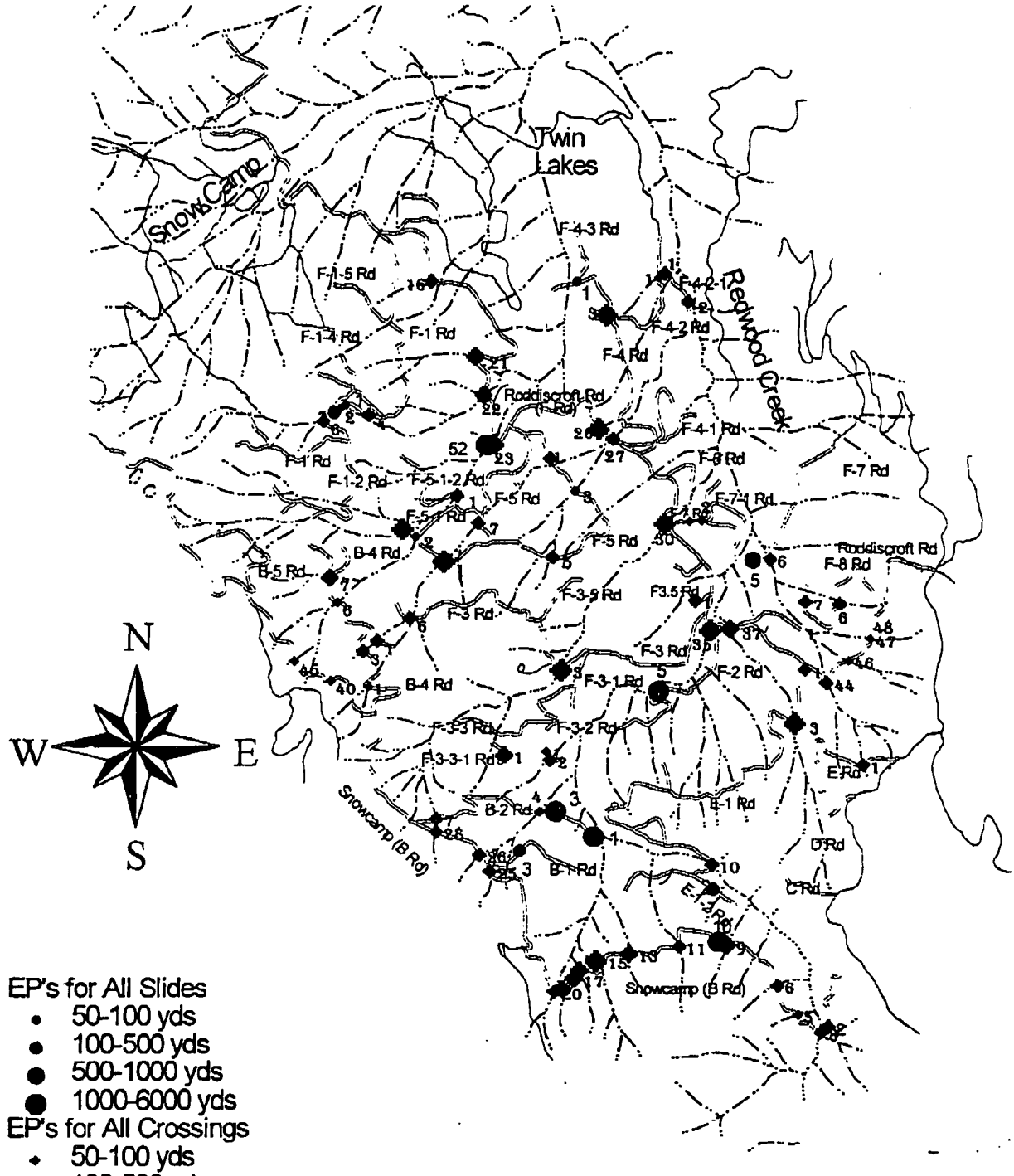
General Notes:

1. Extreme Erosion Potential (Extrm. EP) identifies the sites that could, in the worst case scenario, yield significantly more sediment than predicted by the estimate for Erosion Potential (EP). The Extreme Erosion Potential associated with these sites equals 64,860 yds.
2. Pulling-back over-steepened fill, and properly draining road and/or landing surfaces would be required at nearly all of these mass movement sites.
3. Site #1068018 would require a 24-inch culvert to be installed at the swale crossing along with pulling-back the adjacent landing.

Appendix E: Erosion Potential Sites with EP > 50 yds, North Area, (Cont'd)



Appendix E: Erosion Potential Sites with EP > 50 yds, South Area



EP's for All Slides
- 50-100 yds
- 100-500 yds
- 500-1000 yds
- 1000-6000 yds

EP's for All Crossings
- 50-100 yds
- 100-500 yds
- 500-1000 yds
- 1000-7000 yds

Invstrm.shp
Streams

Invent_Rds
Inventoried Roads

Not_Inv_Rds.shp
Roads Not Inventoried

950 0 950 1900 Feet

Scale

Appendix F. Site Identification Numbers and Land Ownership

ID #	Road Name	Site #	Ownership	ID #	Road Name	Site #	Ownership
1000001	A-1	1	USFS	1004002	B-2	2	LP
1000002	A-1	2	USFS	1004003	B-2	3	LP
1000003	A-1	3	USFS	1004004	B-2	4	LP
1001001	B	1	USFS	1004005	B-2	5	LP
1001002	B	2	USFS	1004006	B-2	6	LP
1001003	B	3	USFS	1004007	B-2	7	LP
1001004	B	4	USFS	1007001	E-1	1	SPI
1001005	B	5	USFS	1007002	E-1	2	SPI
1001006	B	6	USFS	1007003	E-1	3	SPI
1001007	B	7	USFS	1007004	E-1	4	SPI
1001008	B	8	USFS	1007005	E-1	5	SPI
1001009	B	9	USFS	1007006	E-1	6	SPI
1001010	B	10	SPI	1007007	E-1	7	SPI
1001011	B	11	USFS	1007008	E-1	8	SPI
1001012	B	12	USFS	1007009	E-1	9	SPI
1001013	B	13	USFS	1007010	E-1	10	SPI
1001014	B	14	USFS	1008001	F-3-2	1	SPI
1001015	B	15	USFS	1008002	F-3-2	2	SPI
1001016	B	16	USFS	1008003	F-3-2	3	SPI
1001017	B	17	USFS	1009001	F-3-3-1	1	SPI
1001018	B	18	USFS	1010001	F-3-3	1	SPI
1001019	B	19	USFS	1010002	F-3-3	2	SPI
1001020	B	20	USFS	1010003	F-3-3	3	SPI
1001021	B	21	USFS	1011001	B-4	1	SIMPSON
1001022	B	22	USFS	1011002	B-4	2	SIMPSON
1001023	B	23	USFS	1011003	B-4	3	SIMPSON
1001024	B	24	USFS	1011004	B-4	4	SIMPSON
1001025	B	25	USFS	1011005	B-4	5	SIMPSON
1001026	B	26	LP	1011006	B-4	6	SIMPSON
1001027	B	27	LP	1011007	B-4	7	SIMPSON
1001028	B	28	LP	1014001	E	1	SPI
1001029	B	29	SPI	1014002	E	2	SPI
1001030	B	30	SPI	1016001	F-2	1	SPI
1001031	B	31	SPI	1016002	F-2	2	SPI
1001032	B	32	SPI	1016003	F-2	3	SPI
1001033	B	33	SPI	1016004	F-2	4	SPI
1001034	B	34	SPI	1016005	F-2	5	SPI
1001035	B	35	SPI	1016006	F-2	6	SPI
1001036	B	36	SPI	1016007	F-2	7	SPI
1001037	B	37	SIMPSON	1016008	F-2	8	SPI
1001038	B	38	SIMPSON	1016009	F-2	9	SPI
1001039	B	39	SIMPSON	1017001	F-3	1	SPI
1001040	B	40	SIMPSON	1017002	F-3	2	SPI
1001041	B	41	SIMPSON	1017003	F-3	3	SPI
1001042	B	42	SIMPSON	1017004	F-3	4	SPI
1001043	B	43	SIMPSON	1017005	F-3	5	SPI
1001044	B	44	SIMPSON	1017006	F-3	6	SPI
1001045	B	45	SIMPSON	1018001	F-3-1	1	SPI
1001046	B	46	SIMPSON	1020001	B-4-1	1	SIMPSON
1001047	B	47	SIMPSON	1021001	F-8	1	SPI
1001048	B	48	SIMPSON	1021002	F-8	2	SPI
1002001	E-1-2	1	SPI	1021003	F-8	3	SPI
1002002	E-1-2	2	SPI	1021004	F-8	4	SPI
1003001	B-1	1	LP	1021005	F-8	5	SPI
1003002	B-1	2	LP	1021006	F-8	6	SPI
1003003	B-1	3	LP	1021007	F-8	7	SPI
1003004	B-1	4	LP	1022001	F-7	1	SPI
1004001	B-2	1	LP	1022002	F-7	2	SPI

Appendix F. Site Identification Numbers and Land Ownership (Cont'd)

ID #	Road Name	Site #	Ownership	ID #	Road Name	Site #	Ownership
1053003	NROD-2	3	SIMPSON	1068001	487	1	SPI
1053004	NROD-2	4	SIMPSON	1068002	487	2	SPI
1053005	NROD-2	5	SIMPSON	1068003	487	3	SPI
1053006	NROD-2	6	SIMPSON	1068004	487	4	SPI
1054001	NROD-2-1	1	SIMPSON	1068005	487	5	SPI
1056001	480	1	SPI	1068006	487	6	SPI
1056002	480	2	SPI	1068007	487	7	SPI
1056003	480	3	SPI	1068008	487	8	SPI
1056004	480	4	SPI	1068009	487	9	SPI
1056005	480	5	SPI	1068010	487	10	SPI
1056006	480	6	SPI	1068011	487	11	SPI
1056007	480	7	SPI	1068012	487	12	SPI
1056008	480	8	SPI	1068013	487	13	SPI
1056009	480	9	SPI	1068014	487	14	SPI
1056010	480	10	SPI	1068015	487	15	SPI
1056011	480	11	SPI	1068016	487	16	SPI
1056012	480	12	SPI	1068017	487	17	SPI
1056013	480	13	SPI	1068018	487	18	SPI
1056014	480	14	SPI	1068019	487	19	SPI
1056015	480	15	SPI	1068020	487	20	SPI
1056016	480	16	SPI	1069001	487-1	1	SPI
1056018	480	18	SPI	1070001	487-2	1	SPI
1056019	480	19	SPI	1073001	460	1	SPI
1056020	480	20	SPI	1073002	460	2	SPI
1056021	480	21	SPI	1073003	460	3	SPI
1056022	480	22	SPI	1073004	460	4	SPI
1056023	480	23	SPI	1073005	460	5	SPI
1056024	480	24	SPI	1073006	460	6	SPI
1056025	480	25	SPI	1073007	460	7	SPI
1056026	480	26	SPI	1073008	460	8	SPI
1056027	480	27	SPI	1073009	460	9	SPI
1056028	480	28	SPI	1073010	460	10	SPI
1056029	480	29	SPI	1073011	460	11	SPI
1056030	480	30	SPI	1073012	460	12	SPI
1056031	480	31	SPI	1073013	460	13	SPI
1056170	480	17	SPI	1073014	460	14	SPI
1056171	480	17	SPI	1073015	460	15	SPI
1060001	480-4	1	SPI	1073016	460	16	SPI
1060002	480-4	2	SPI	1073017	460	17	SPI
1060003	480-4	3	SPI	1073018	460	18	SPI
1060004	480-4	4	SPI	1073019	460	19	SPI
1060005	480-4	5	SPI	1073020	460	20	SPI
1060006	480-4	6	SPI	1073021	460	21	SPI
1061001	480-4-1	1	SPI	1073022	460	22	SPI
1061002	480-4-1	2	SPI	1073023	460	23	SPI
1061003	480-4-1	3	SPI	1073024	460	24	SPI
1062001	480-6	1	SPI	1073025	460	25	SPI
1063001	483	1	SPI	1073026	460	26	SPI
1063002	483	2	SPI	1073027	460	27	SPI
1066001	485	1	SPI	1073028	460	28	SPI
1066002	485	2	SPI	1073029	460	29	SPI
1066003	485	3	SPI	1073030	460	30	SPI
1066004	485	4	SPI	1073031	460	31	SPI
1066005	485	5	SPI	1073032	460	32	SPI
1066006	485	6	SPI	1073033	460	33	SPI
1066007	485	7	SPI	1073034	460	34	SPI
1067001	486	1	SPI	1073035	460	35	SPI

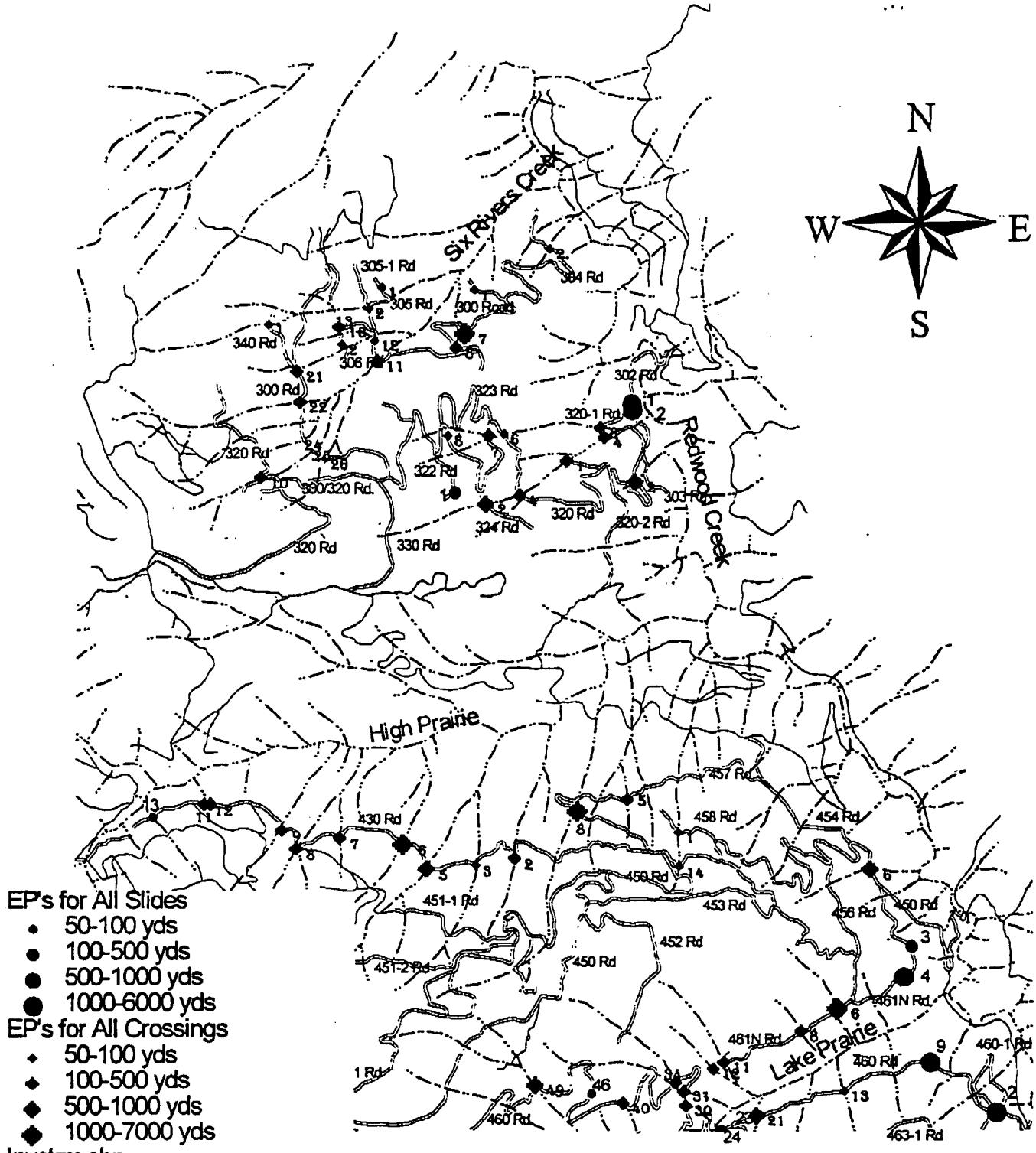
Appendix F. Site Identification Numbers and Land Ownership (Cont'd)

ID #	Road Name	Site #	Ownership	ID #	Road Name	Site #	Ownership
1073036	460	36	SPI	1079010	450	10	SPI
1073037	460	37	SPI	1079011	450	11	SPI
1073038	460	38	SPI	1079012	450	12	SPI
1073039	460	39	SPI	1079013	450	13	SPI
1073040	460	40	SPI	1079014	450	14	SPI
1073041	460	41	SPI	1079015	450	15	SPI
1073042	460	42	SPI	1079016	450	16	SPI
1073043	460	43	SPI	1080001	451	1	SPI
1073044	460	44	SPI	1080002	451	2	ANVICK
1073045	460	45	SPI	1081001	451-1	1	ANVICK
1073046	460	46	SPI	1084001	452	1	SPI
1073047	460	47	SPI	1088001	456	1	SPI
1073048	460	48	SPI	1088002	456	2	SPI
1073049	460	49	SPI	1088003	456	3	SPI
1073050	460	50	SPI	1089001	457	1	SPI
1073051	460	51	SPI	1089002	457	2	SPI
1073052	460	52	SPI	1089003	457	3	SPI
1073053	460	53	SPI	1089004	457	4	SPI
1073054	460	54	SPI	1089005	457	5	SPI
1073055	460	55	SPI	1089006	457	6	SPI
1073056	460	56	SPI	1089007	457	7	SPI
1073057	460	57	SPI	1089008	457	8	SPI
1073058	460	58	SPI	1089009	457	9	SPI
1073059	460	59	SPI	1089010	457	10	SPI
1073060	460	60	SPI	1089011	457	11	SPI
1073061	460	61	SPI	1090001	458	1	SPI
1074001	460-1	1	SPI	1090002	458	2	SPI
1074002	460-1	2	SPI	1092001	490	1	SPI
1074003	460-1	3	SPI	1093001	490-1	1	SPI
1075001	460-1-1	1	SPI	1093002	490-1	2	SPI
1075002	460-1-1	2	SPI	1094001	490-2	1	SPI
1075003	460-1-1	3	SPI	1095001	491	1	SPI
1076001	460-1N	1	SPI	1097001	430	1	SPI
1076002	460-1N	2	SPI	1097002	430	2	SPI
1076003	460-1N	3	SPI	1097003	430	3	RUSS
1076004	460-1N	4	SPI	1097004	430	4	RUSS
1076005	460-1N	5	SPI	1097005	430	5	RUSS
1076006	460-1N	6	SPI	1097006	430	6	RUSS
1076007	460-1N	7	CARSON	1097007	430	7	SPI
1076008	460-1N	8	CARSON	1097008	430	8	SPI
1076009	460-1N	9	CARSON	1097009	430	9	SPI
1076010	460-1N	10	SPI	1097010	430	10	SPI
1076011	460-1N	11	SPI	1097011	430	11	SPI
1076012	460-1N	12	SPI	1097012	430	12	SPI
1077001	463	1	SPI	1097013	430	13	SPI
1077002	463	2	SPI	1097014	430	14	SPI
1077003	463	3	SPI	1097015	430	15	SPI
1078001	463-1	1	SPI	1098001	300	1	SPI
1079001	450	1	SPI	1098002	300	2	SPI
1079002	450	2	SPI	1098003	300	3	SPI
1079003	450	3	SPI	1098004	300	4	SPI
1079004	450	4	SPI	1098005	300	5	SPI
1079005	450	5	SPI	1098006	300	6	SPI
1079006	450	6	SPI	1098007	300	7	SPI
1079007	450	7	SPI	1098008	300	8	SPI
1079008	450	8	SPI	1098009	300	9	SPI
1079009	450	9	SPI	1098010	300	10	SPI

Appendix F. Site Identification Numbers and Land Ownership (Cont'd)

ID #	Road Name	Site #	Ownership
1098011	300	11	SPI
1098012	300	12	SPI
1098013	300	13	SPI
1098014	300	14	SPI
1098015	300	15	SPI
1098016	300	16	SPI
1098017	300	17	SPI
1098018	300	18	SPI
1098019	300	19	SPI
1098020	300	20	SPI
1098021	300	21	SPI
1098022	300	22	SPI
1098023	300	23	SPI
1098024	300	24	SPI
1098025	300	25	SPI
1098026	300	26	SPI
1098027	300	27	SPI
1099001	301	1	SPI
1100001	302	1	SPI
1100002	302	2	SPI
1100003	302	3	SPI
1100004	302	4	SPI
1102001	304	1	SPI
1103001	305	1	SPI
1103002	305	2	SPI
1105001	306	1	SPI
1105002	306	2	SPI
1106001	320	1	SPI
1106002	320	2	SPI
1106003	320	3	SPI
1106004	320	4	SPI
1106005	320	5	SPI
1106006	320	6	SPI
1106007	320	7	SPI
1106008	320	8	SPI
1106009	320	9	SPI
1106010	320	10	SPI
1107001	320-1	1	SPI
1111001	322	1	SPI
1113001	324	1	SPI
1113002	324	2	SPI
1115001	340	1	SPI
1117001	F-9	1	SPI

Appendix E: Erosion Potential Sites with EP > 50 yds, North Area



EP's for All Slides
- 50-100 yds
- 100-500 yds
- 500-1000 yds
- 1000-6000 yds

EP's for All Crossings
- 50-100 yds
- 100-500 yds
- 500-1000 yds
- 1000-7000 yds

Invstrm.shp
Streams
Invent_Rds
Inventoried Roads
Not_Inv_Rds.shp
Roads Not Inventoried