BAER Assessment Soils Report – River Complex Fire

Shasta-Trinity and Six Rivers National Forests (R5-SHF, SRF)

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Mixed soil burn severity on Beartooth Mountain and the New River Drainage

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Soil Resource Setting

The River Complex fires occurred in the vicinity of Denny, CA; from the headwaters of Horse Linto Creek and the New River south to Ironside Mountain and Del Loma, CA. NFS lands as well as private ownerships were affected. FS BAER team earth scientists assessed the incident with a whole-watershed approach regardless of ownership. Soil burn severity patterns varied for the fires due to varying topography, fuels, and fire behavior.

Specific dominant soils found in the fire are Chaix, Deadwood, Goulding, Holland, and Neuns primarily resulting in loam and sandy loam soil textures. Coarse fragment rock content in the upper soil horizons is variable across the River Complex landscape, averaging approximately 30 percent by volume. Surface gravels and boulders in many areas of the fire are the only remaining source of groundcover. These soils vary in depth – averaging 68 cm – and are mostly in hydrologic groups B and D. Group B has a moderately low runoff potential, whereas group D has a high runoff potential due in part to slope steepness and proximity to rock outcrops. A soil map of the River fire can be found in Appendix A and a table summarizing soil map characteristics is in Appendix B

Post Fire Condition Assessment

Soil burn severity was assessed following principles described in Parsons et al., 2010. Results of the soil assessment are summarized in Appendix C. Burned Area Reflectance Classification (BARC) imagery from the Remote Sensing Applications Center (RSAC) in Salt Lake City, UT was utilized by the soil scientists, and modified to better reflect actual soil burn severity as observed in the field. Subsequent watershed response modeling efforts use the soil burn severity map as a key input. A summary of soil burn severity is summarized in table 1.

The high and moderate soil burn severity classes have evidence of severe soil heating in a patchy distribution – increased runoff and accelerated erosion are likely. Some of these areas do have good needle-cast potential, which is expected improve groundcover. The low to very low soil burn severity classes still have good soil structure; contain intact fine roots and organic matter with hydrologic function unaltered. Water repellency is present, though not continuous, varying from slight and surficial in all burn classes; consequently, it is expected to exacerbate runoff production. Little to no hydrophobicity was observed in unburned areas within the fire perimeter. Sandy loam soil textures have demonstrated the most consistent and severe water repellency; surface runoff and erosion are expected to be significant in these coarse-grained, steep, sparsely-vegetated slopes. There is high potential for upland soil delivery to the fluvial system, aquatic habitat and water quality will likely experience episodes of sedimentation.

Table 1. Summary of Soil Burn Severity on the River Fire

Soil Burn Severity	Acres	Percent of Fire Area
Unburned/Very Low	29,271	38%
Low	38,244	44%
Moderate	11,917	15%
High	2,373	3%

Figure 1. Photos showing high, moderate, and low soil burn severity

Erosion Hazard Rating

In order to assess the potential risk of a given soil to erode, an erosion hazard rating (EHR) system was developed in R-5 (FSH 2505.22). The EHR system is designed to assess the relative risk of accelerated sheet and rill erosional processes and was developed primarily for land use activities such as agriculture or logging. The rating system is based on soil texture, soil depth, clay content, infiltration, amount of rock fragments, effective surface cover, slope gradient, and climate. The River Complex was calculated to have a 3% low, 82% moderate, and 15% high post-fire, erosion hazard rating (See Table 2). An erosion hazard rating map is located in Appendix C.

Table 2. Erosion Hazard Ratings for the River Complex

Erosion Hazard Rating	Acres	% of Fire
Low	2,446	3
Moderate	63,675	82
High	11,682	15

Erosion Risk Management Tool

Quantitative erosion figures were estimated using the ERMiT batch model. ERMiT (Erosion Risk Management Tool) is a WEPP-based application developed by USFS Rocky Mountain Research Station (USFS, RMRS-GTR-188, 2007) specifically for use with post-fire erosion modeling. The model estimates only sheet and rill erosion, which occurs when rainfall exceeds infiltration rates, and surface runoff entrains surface soil particles. The model does not account for shallow landsliding or gullying, stream-bank erosion, road effects, or fire-line erosion and gullying, which could present large additional sources of sediment entering the fluvial systems.

ERMiT models erosion potential based on single hillslopes, single-storm “runoff events,” and post-fire soil burn severity. Hillslopes include soil and topography inputs. Soil inputs include texture and matrix rock content, which were based upon soil map unit information and field verified in many areas of the fire as part of the assessment. Generalized hillslope gradients and profiles were developed in GIS by soil map unit, subwatershed, and soil burn

severity class to account for fairly site specific differences in topography. 341 hillslopes were modeled for this fire.

As input for storm events, ERMiT uses the PRISM module to generate climatic input parameters; a customized climate interpolated from Shasta Dam CA was generated for this area to refine erosion estimates. Various storm runoff-event magnitudes may be chosen in ERMiT for erosion response estimates; 2-year, 5-year, and 10-year events were run for this analysis, and most of the reported results are based on the 5-year runoff event to be consistent with hydrologic modeling and modeling efforts on other fires for comparative purposes.

Three hundred and forty-one representative hillslopes were modeled in ERMiT for this fire and results extrapolated in Excel for sub-watershed level analysis. Soil erosion estimates are based upon watershed areas within the fire perimeter only; unburned watershed areas outside the fire area were not modeled. A 5-Year storm was modeled in ERMiT to determine if the estimated soil erosion for the fire area would affect soil productivity. For the 5-year event (20% probability); an estimated average 2,225,173 tons of sediment may be produced (29 tons/acre). Increased hillslope erosion is expected to occur throughout the fire area, especially within those areas in the high soil burn severity. Stated model accuracy is +/- 50%. A map of ERMiT results fo the River fire is in Appendix D.

Table 4. Predicted erosion rates and amounts for the River Complex

ERMiT Results			
	2 Yr Storm	**5 Yr Storm**	**10 Yr Storm**
Tons	1,235,429	2,225,173	2,996,812
Tons/Acre	16	29	39

These watersheds were modeled to determine the amount of erosion to a particular value at risk (culvert, bridge, stream, etc.) each with its own watershed size. Table 5 displays predicted sediment rates for each of the main watersheds within the River Complex; Bell, Quinby, and Devils Canyon are expected to receive the highest quantities of sediment, mostly due to the large amount of acres burned within those basins.

Table 5. Modelled hillslope erosion by watershed

6th Field Watershed	**Acres Burned**	**Total Sediment Delivered (tons)** **5 Yr Storm**	**Average Sediment Delivered (tons/acre)** **5 Yr Storm**
Bell Creek- New River	17,768	504,537	28
Quinby Creek- New River	16,809	501,037	30

6th Field Watershed	Acres Burned	Total Sediment Delivered (tons)	Average Sediment Delivered (tons/acre)
Devils Canyon	16,398	503,104	31
Big Creek	11,457	275,985	24
Horse Linto Creek	4,450	137,266	31
Big French Creek	2,998	80,689	27
Don Juan- Trinity River	2,668	76,979	29
Cedar Creek	2,110	52,111	25
East Fork New River	1,582	41,353	26
Virgin Creek	1,501	50,932	34
Sharber Creek-Trinity River	55	1,007	18

Values at Risk – Threats to Life, Property, and Cultural & Natural Resources

Specific to soil productivity, modeled erosion rates are high compared to background conditions, posing a likely impact to soil productivity in 18 percent of the burned area (high and moderate SBS). Water repellency is common, especially in the sandy loams formed from granitic parent material around Happy Camp Mountain, which could exacerbate soil erosion rates. However, erosion rates are expected to recover quickly after year two post-fire and should return to near pre-fire conditions by year five. Risk rating for soils varies according to the likelihood of major soil loss: there is a very likely probability of effects that are recoverable and localized (low risk rating), ranging to a possible probability of considerable long-term effects (intermediate risk rating); neither of these comprise a high or unacceptable risk to soil productivity, and therefore natural recovery should be adequate for the soil resource. The ecosystems in the fire area are fire-adapted, so periodic post-fire erosion is a natural ecological and geomorphic process. The probability of soil productivity loss is confined to the moderate and high soil burn severity patches – 18 percent of the fire area has a high risk to soil productivity – with an overall rating of **intermediate** risk to the soil resource.

Specific to off-site effects of soil erosion, sediment contribution from rill and gully erosion as well as debris flows were considered when determining threats to Coho Salmon, which is listed as threatened under ESA. Off-site effects of soil erosion were also considered in the roads analysis and treatments to address threats to roads infrastructure have been proposed in the engineering report. Additionally, sediment delivery to drainages in the fire area could impact private property and damage permitted water intake systems.

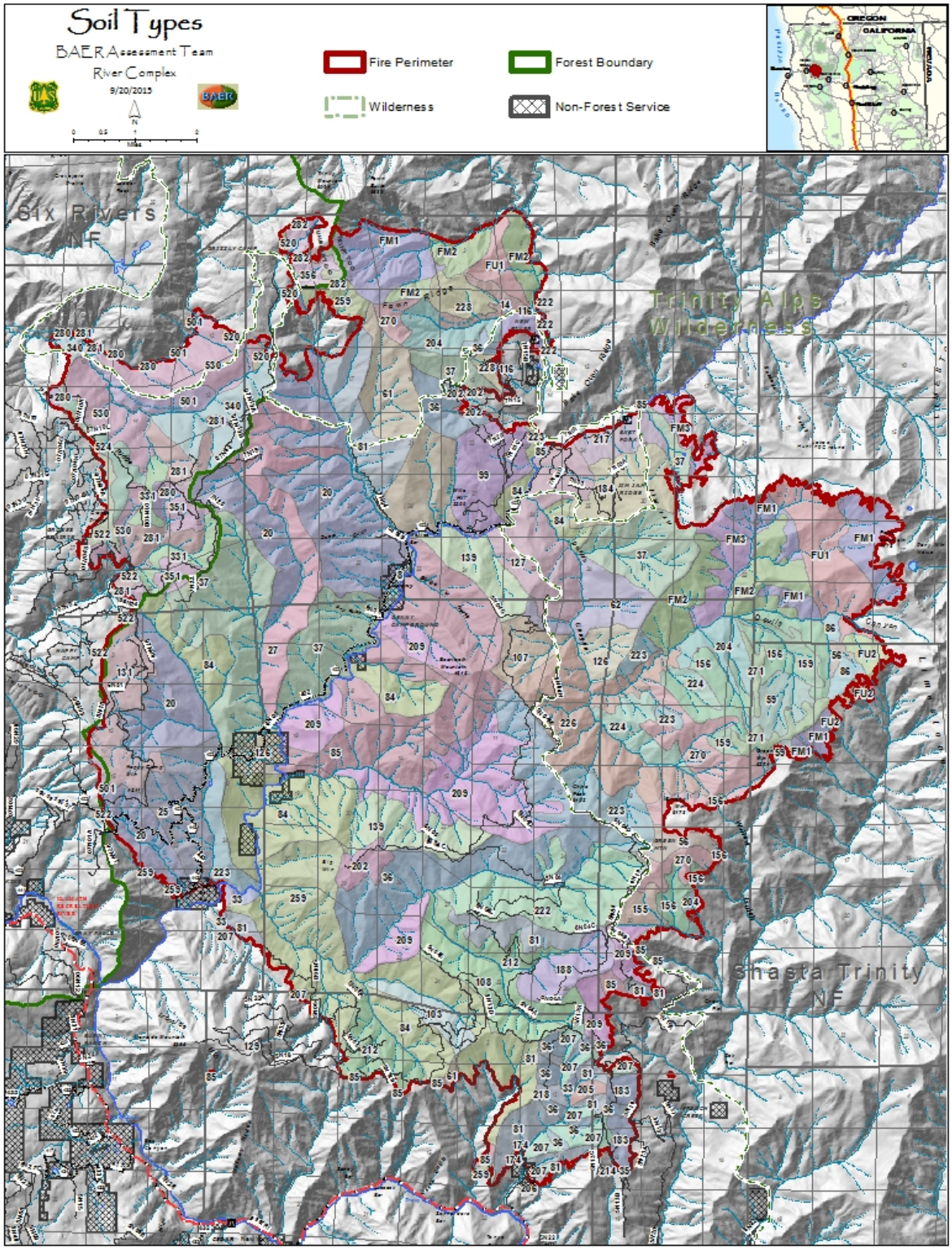
References

Parsons, A, PR Robichaud, SA Lewis, C Napper, JT Clark, 2010. Field Guide for Mapping Post-Fire Soil Burn Severity. USFS Rocky Mountain Research Station, General Technical Report RMRS-GTR-243.

Robichaud, Peter R.; Elliot, William J.; Pierson, Fredrick B.; Hall, David E.; Moffet, Corey A.; Ashmun, Louise E. 2007. Erosion Risk Management Tool (ERMiT) user manual (version 2006.01.18). Gen. Tech. Rep. RMRS-GTR-188. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 24 p.

USDA Forest Service. 1990. Soil erosion hazard rating. Soil and Water Conservation Handbook.

Appendix A Soil Map



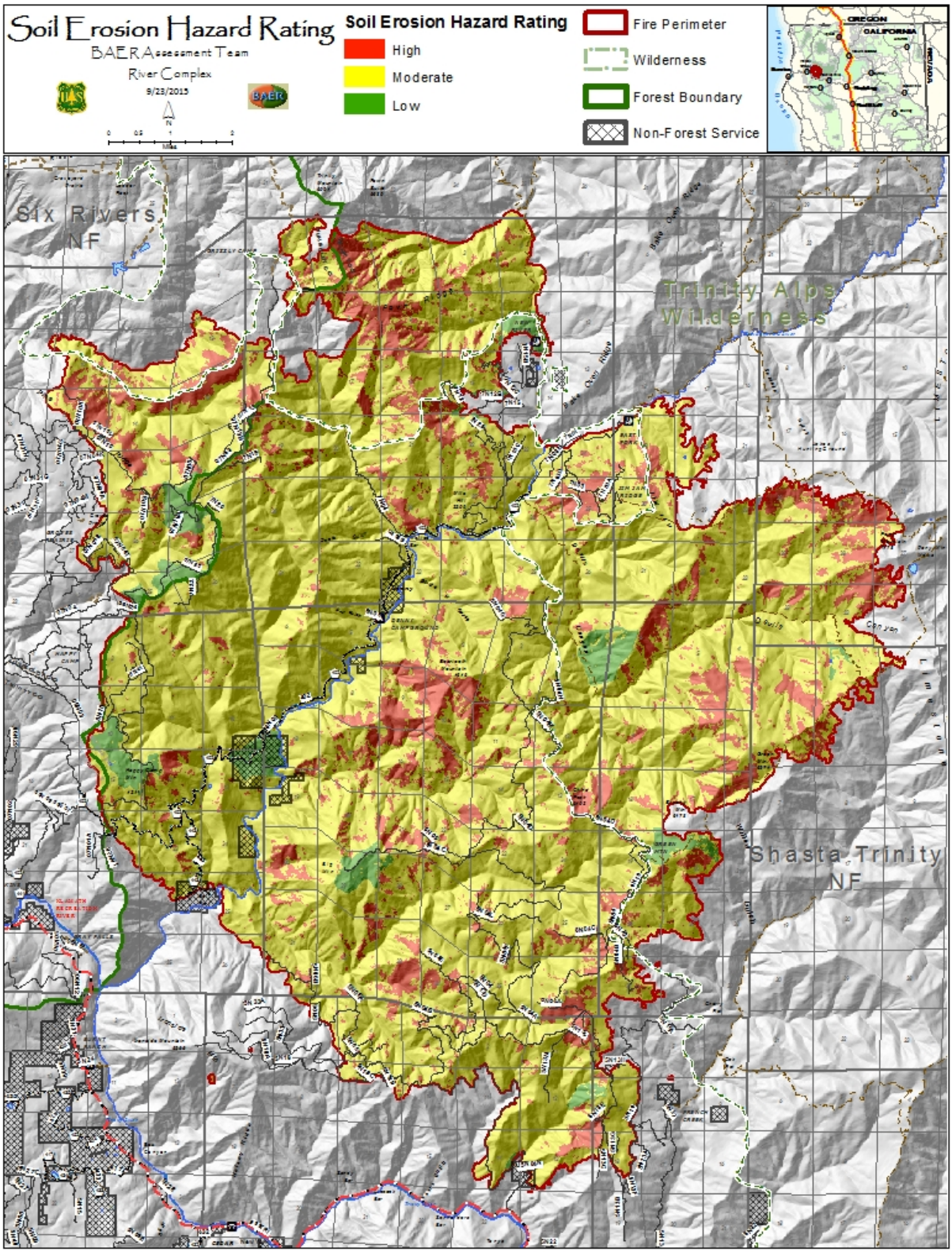
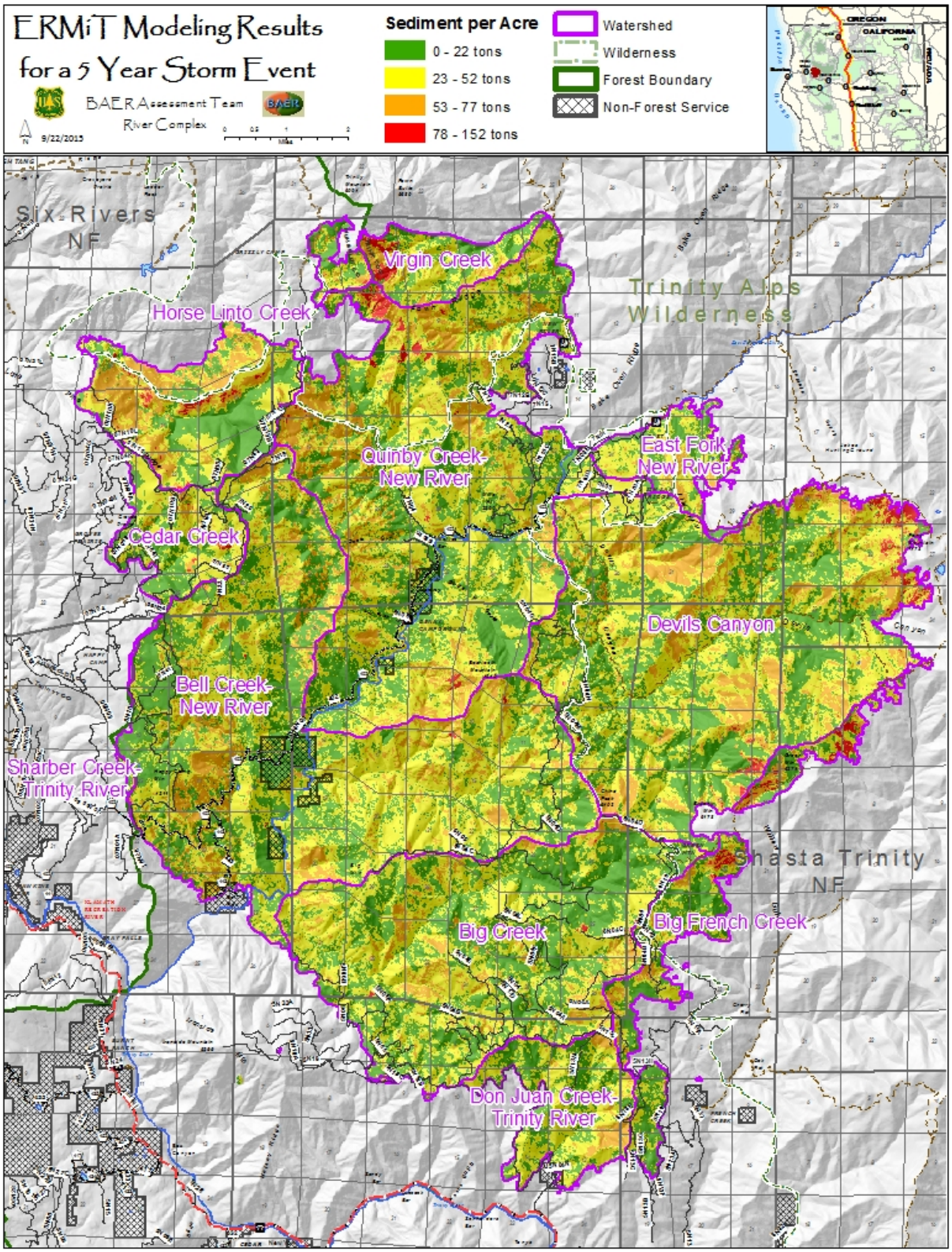
Appendix B Soil Map Characteristics Table

Map Unit	Name	Hydrologic Group	Texture	Coarse Fragments (%)	Depth to Restrictive Layer (cm)
8	Atter family, 0 to 20 percent slopes.	A	Sandy Loam	5	201
14	Beaughton family-Rock outcrop complex, 50 to 80 percent slopes.	D	Loam	20	41
20	Chaix-Chawanakee families, complex, 60 to 80 percent slopes.	B	Sandy Loam	5	74
25	Chawanakee-Chaix families complex, 60 to 80 percent slopes.	D	Sandy Loam	20	28
27	Chawanakee family-Rock outcrop complex, 60 to 80 percent slopes.	D	Sandy Loam	20	28
33	Deadwood family, 60 to 80 percent slopes.	D	Sandy Loam	35	38
35	Deadwood-Neuns families complex, 40 to 60 percent slopes.	D	Sandy Loam	35	38
36	Deadwood-Neuns fasmilies complex, 60 to 80 percent slopes	D	Sandy Loam	35	38
37	Deadwood family-Rock outcrop complex, 60 to 80 percent slopes.	D	Sandy Loam	35	38
56	Endlich family, 20 to 60 percent slopes.	B	Sandy Loam	35	91
59	Endlich family-Typic Cryaquolls association, 10 to 40 percent slopes.	B	Sandy Loam	20	91
61	Etsel family, 40 to 80 percent slopes.	D	Sandy Loam	20	23
62	Etsel-Neuns families association, 60 to 80 percent slopes.	D	Loam	35	23
81	Goulding family, 60 to 80 percent slopes	D	Loam	35	38
84	Goulding-Neuns families association, 50 to 80 percent slopes.	D	Loam	35	38
85	Goulding family-Rock outcrop complex, 50 to 80 percent slopes	D	Loam	35	38
86	Gozem family-Rock outcrop-Toadlake family complex, 30 to 70 percent slopes.	D	Loam	35	46
99	Holland family, 60 to 80 percent slopes	C	Loam	35	66
103	Holland-Goulding families association, 60 to 80 percent slopes.	C	Loam	20	66
107	Holland-Neuns families complex, 40 to 60 percent slopes.	C	Loam	20	66
108	Holland-Neuns families complex, 60 to 80 percent slopes.	C	Loam	20	66
116	Holland family, deep, 20 to 40 percent slopes.	C	Loam	20	127
126	Holland, deep-Neuns families complex, 20 to 40 percent slopes.	C	Loam	20	127
127	Holland, deep-neuns families complex, 40 to 60 percent slopes.	C	Loam	20	127
131	Hugo family, 15 to 40 percent slopes.	B	Loam	20	127
139	Hugo-Neuns families complex, 60 to 80 percent slopes.	B	Loam	5	127
155	Jayar family, 40 to 60 percent slopes.	B	Loam	5	66
156	Jayar family, 60 to 80 percent slopes.	B	Sandy Loam	35	66
159	Jayar-Skymor families complex, 60 to 80 percent slopes.	B	Sandy Loam	35	66
174	Marpa family, 20 to 40 percent slopes.	C	Sandy Loam	35	66
183	Marpa-holland, deep families complex, 40 to 60 percent slopes.	C	Loam	20	66
184	Marpa-Holland, deep families association, 60 to 80 percent slopes.	C	Loam	20	66
188	Marpa-Neuns families complex, 60 to 80 percent slopes.	C	Loam	20	66
202	Neuns family, 20 to 40 percent slopes.	B	Loam	20	58
204	Neuns family, 60 to 80 percent slopes.	B	Sandy Loam	35	58
205	Neuns-Deadwood families complex, 20 to 40 percent slopes.	B	Sandy Loam	35	58
206	Neuns-Deadwood families complex, 40 to 60 percent slopes.	B	Sandy Loam	35	58
207	Neuns-Deadwood families complex, 60 to 80 percent slopes.	B	Sandy Loam	35	58
209	Neuns-Goulding families association, 60 to 80 percent slopes.	B	Sandy Loam	35	58
212	Neuns-Holland families complex, 60 to 80 percent slopes.	B	Sandy Loam	35	58
214	Neuns-Holland, deep families complex, 40 to 80 percent slopes.	B	Sandy Loam	35	58
217	Neuns-Hugo families complex, 60 to 80 percent slopes.	B	Sandy Loam	35	58
218	Neuns-Marpa families complex, 40 to 60 percent slopes.	B	Sandy Loam	35	58
222	Neuns family-Neuns family, deep complex, 60 to 80 percent slopes.	B	Sandy Loam	35	58
223	Neuns family-Rock outcrop association, 40 to 60 percent slopes.	B	Clay Loam	35	58
224	Neuns family-Typic Xerorthents association, 50 to 80 percent slopes.	B	Sandy Loam	35	58
226	Neuns family, deep, 60 to 80 percent slopes.	B	Sandy Loam	35	201
228	Neuns family, deep-Neuns family complex, 40 to 70 percent slopes.	B	Loam	35	201
259	Rock outcrop-Goulding family complex, 40 to 80 percent slopes.	D	Loam	35	0
270	Rock outcrop-Skymor family complex, 30 to 90 percent slopes.	D	Sandy Loam	50	0
271	Rock outcrop-Skymor-Tallac families association, 60 to 80 percent slopes.	D	Sandy Loam	50	0
280	Deadwood family-Clallam family, deep, extrmly grvly-Rock outcrop, metasedimentary assn, 45-85%	B	Sandy Loam	50	46

Appendix B Soil Map Characteristics Table (continued)

Map Unit	Name	Hydrologic Group	Texture	Coarse Fragments (%)	Depth to Restrictive Layer (cm)
281	Clallam family, deep, extremely gravelly-Deawood family association, 35 to 75 percent slopes	B	Loam	20	135
282	Deawood family-Rock outcrop, metasedimentary-Voorhies family, moderately deep assn, 40-85% s	B	Loam	50	0
331	Clallam family, moderately deep-Skalan family, deep association, 35 to 75 percent slopes	C	Loam	20	66
340	Clallam family, moderately deep-Rock outcrop, metaigneous complex, 45 to 80 percent slopes	B	Loam	35	66
351	Xerofluvents-Riverwash association, 0 to 20 percent slopes.	A	Loam	35	142
356	Raisio-Clallam families complex, moderately deep, 45 to 75 percent slopes	A	Loam	35	102
501	Rock outcrop-Maymen family complex, doiritic, 50 to 90 percent slopes	D	Sandy Loam	35	0
520	Chaix family, moderately deep, 30 to 50 percent slopes	A	Sandy Loam	50	102
522	Chaix family, moderately deep-Holland family, deep,dioritic association, 25 to 65 percent slopes	A	Sandy Loam	20	102
524	Deadman-Rogue familes association, deep, 20 to 70 percent slopes	A	Sandy Loam	20	135
530	Maymen family, dioritic, 45 to 70 percent slopes	D	Loam	5	43
282sr*	Deawood family-Rock outcrop, metasedimentary-Voorhies family, moderately deep assn, 40-85% s	D	Sandy Loam	20	0
331sr*	Clallam family, moderately deep-Skalan family, deep association, 35 to 75 percent slopes.	C	Loam	20	66
351sr*	Skalan-Holland families association, deep, 20 to 65 percent slopes.	C	Loam	35	142
356sr*	Raisio-Clallam families complex, moderately deep, 45 to 75 percent slopes.	A	Sandy Loam	35	102
501sr*	Rock outcrop-Maymen family complex, doiritic, 50 to 90 percent slopes.	D	Sandy Loam	50	0
520sr*	Chaix family, moderately deep, 30 to 50 percent slopes.	A	Sandy Loam	20	102
522sr*	Chaix family, moderately deep-Holland family, deep,dioritic association, 25 to 65 percent slopes.	A	Sandy Loam	20	102
FM1	Rock outcrop-Lithic Xerorthents-Lithic Xerochrepts association, moderately steep to steep.	A	Loam	35	0
FM2	Rock outcrop-Pachic Xerumbrepts-Dystric Xerochrepts association, steep.	A	Sandy Loam	50	0
FM3	Dystric Xerochrepts-Ultic haloxeralfs association, moderately steep	A	Sandy Loam	20	201
FU1	Rock outcrop-Lithic Xerumbrepts association, moderately steep to steep.	D	Sandy Loam	50	0
FU2	Rock outcrop-Lithic Xerochrepts-Typic Xerochrepts association, gently sloping to steep.	D	Sandy Loam	50	0
> sr* denotes Six Rivers National Forest soil map unit					

Appendix C. Erosion Hazard Rating Map



Appendix D. ERMiT soil erosion map for a 5 year storm event