BAER Soils Report
Fork Complex Fires

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Moderate soil burn severity in the Shiell Fire

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Resource Setting

The fires in the Fork Complex were ignited by dry thunderstorms that occurred on July 30-31, 2015 near the town of Hayfork, CA during a record heat wave. A number of starts occurred. The fires in the Fork Complex include the Barker, Peak, Rail, Schiell, Telephone and Blue Fire. Initial fire-suppression efforts by the Forest Service and Cal-Fire were unsuccessful in containing these fires. Therefore, the Forest authorized extended attack to protect human life, property and resource values at risk. Red Flag warnings were issued on August 10-12 for the Fork Complex, due to gusty winds (peaked at 25-30 mph) and marginally low humidity. The result of the fire behavior observed during this incident is a mosaic pattern of burn severity within the fire perimeters. The area within the Fork Complex perimeter is approximately 36,498 acres. Most of the burned area (33,192 acres) is on the Shasta-Trinity National Forest. However, the Fork Complex extended onto approximately 3,306 acres of non-NFS lands.

The fires are located geologically in the Klamath Mountains of California. The Klamaths are composed of 6 major belts of rock which range in age from Ordovician (500 m.y.) to Jurassic (135 m.y.). Major lithologies include shales, chert, limestone, metasedimentary phylites, metavolcanic greenstone, peridotite, serpentine, diorite, gabbro, and granodiorite. Major intrusions within the Klamaths include the Hayfork-Bally Batholith. Geomorphic development of this province is as complex as the geology. Slopes are generally steep and dissected with some flat upland areas. Elevations range from 2,400 feet at the south end of the Hayfork Valley in the Rail fire to 6,300 feet near Chanchelulla Peak in the northeast portion of the Shiell fire.

The major plant community in the area is mixed conifer-hardwoods consisting of Douglas-fir, ponderosa pine, sugar pine, canyon live oak and California black oak with associated species of brush such as green leaf manzanita and various species of Ceanothus. These areas are generally less than 4,000 feet in elevation. At higher elevations, white fir are the dominant conifers grading into and red fir above 5,500 feet with green leaf manzanita, pinemat manzanita and shrub tanoak dominating the understory.

Common soils in the area include Nuens Family very gravelly sandy loam, Deadwood Family very gravelly sandy loam, Chaix Family sandy loam, Hohmann Family gravelly loam, Holland Family gravelly loam, Goulding Family very gravelly loam. Other surface soil textures found were clay loam, sandy clay loam and silt loam

Soil information is based on the Order 3 *Soil Survey for the Shasta-Trinity National Forest* and the Natural Resources Conservation Service database found on the Web Soil Survey.

Soil Burn Severity

It is very important to understand the difference between *fire intensity* or *burn severity* as discussed by fire behavior, fuels, or vegetation specialists, and *soil burn severity* as defined for watershed condition evaluation in BAER analyses. Fire intensity or burn severity as defined by fire, fuels, or vegetation specialists may consider such parameters as flame height, rate of spread, fuel loading, thermal potential, canopy consumption, tree mortality, etc. For BAER analysis, we are not mapping simply vegetation mortality or above-ground effects of the fire. Soil burn severity considers additional surface and below-ground factors that relate to soil hydrologic function, runoff and erosion potential, and vegetative recovery.

Burn severity was initially mapped using satellite imagery of burned area reflectance classification (BARC) produced by the remote sensing group. Air and ground reconnaissance was used to verify and adjust the initial BARC map and produce the final burn severity map. The burn intensity for the burned area was estimated to be 13,438 acres of unburned and low severity, 22,600 acres of moderate severity, and 459 acres of high severity.

Figure 1: Soil Burn Severity Map

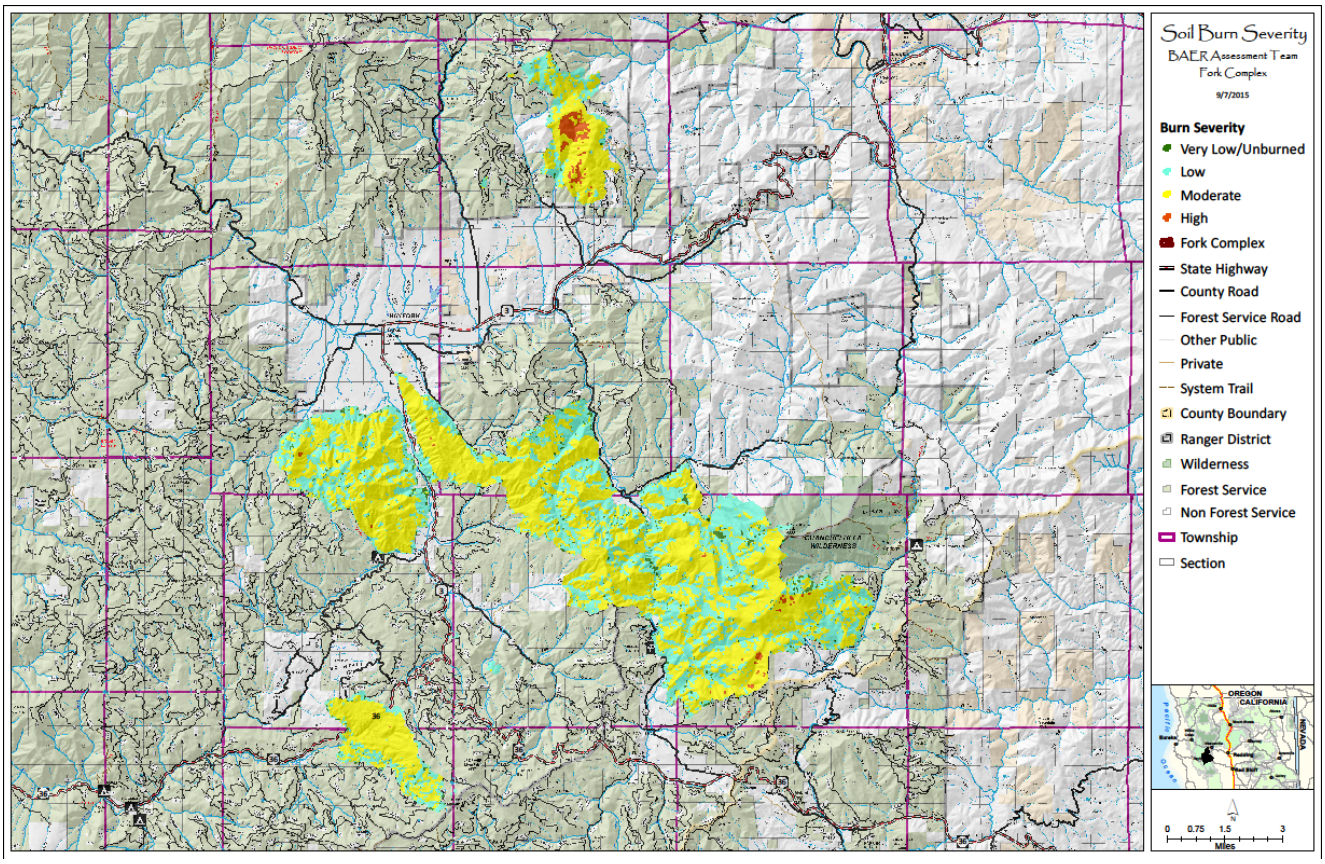

Table 1: Soil Burn Severity by Fire

	Soil Burn Severity			
FIRE	**V Low/Unburned**	**Low**	**Moderate**	**High**
Blue	2%	26%	73%	0%
Peak	2%	35%	64%	0%
Rail	2%	34%	65%	0%
Shiell	2%	40%	58%	1%
Barker	1%	26%	63%	11%
Other Fires	0%	89%	5%	7%
Total	**2%**	**35%**	**62%**	**1%**

The soil burn severity (heat effects to the soil) is mostly moderate with some small areas of high severity due to the speed at which the fire moved through the area. Ground observations in the areas of low soil burn severity showed coarse duff was still present. Moderate soil burn severity areas still had soil structure and fine roots still present. Duff was partially to completely consumed. In high soil burn severity areas the duff and fine roots near the surface were completely consumed. Soil structure was weakened.

Water-Repellent Soil

Soil observations indicated moderately to strongly hydrophobic soils within the high burn intensity areas and no to weak hydrophobicity within the low and moderate burn intensity areas in the areas checked. Hydrophobic soils are estimated to be found in 37% of the burn area. The strength and depth of the hydrophobicity varied widely. Much of the strong water repellency was found only on the surface. In other areas moderate water repellency was found up to one inch deep. Not all areas were checked due to the lack of access to much of the fire.

Erosion Potential

Erosion in the burned area is expected to be high within the high and moderate soil burn severity areas. Areas with low or very low soil burn severity will have low to moderate erosion rates relative to the burned areas but are capable of producing significant erosion where the vegetation cover is sparse or lacking during high intensity precipitation events. Areas that burned at a moderate and high soil burn severity can produce a high amount of erosion due to the lack of cover and high inherent soils erosion properties. The erosion may be an issue at the localized level impacting roads and trails and may develop debris flows on some of the steeper slopes. Debris flows and rockfall may be a threat to life and property on roads and trails and for wildland recreational users in the depositional areas. Roads within the depositional areas may get blocked. Deposition onto areas may cause streams to divert onto roads and cause the road to wash out.

The Erosion Risk Management Tool (ERMiT) was used to model post-fire sediment response for the burned area. This model is a web based application that uses Water Erosion Prediction Project (WEPP) technology to estimate erosion. This model predicts how much hill-slope erosion will occur by overland flow. The ERMiT model is storm event based. Table 2 below summarizes the results of the modeling effort.

Table 2: Average Erosion Potential for all Fork Complex fires (tons/acre)

	10 Year Storm	5 Year Storm	2 Year Storm
Year 1	60.71	32.70	20.28
Year 2	45.22	21.68	12.63
24 month total	105.93	54.38	32.91

Using a 2 year storm event (50% chance of exceedance) erosion rates ranged from 0 tons/acre to 55 tons/acre one year after the fire. By year two erosion rates are predicted to drop to the range of 0 tons/acre to 31 tons/acre. After five years the average erosion rate is predicted to be 4 tons/acre. Erosion in a mature forest under normal conditions is said to be 2 tons/acre/year.

Table 2: Pour Point Basins affected by the Fork Complex.

Pour Point Basins	Total Acres	Burn Severity		
		Low/Unburned	Moderate	High
Little Barker Creek	1,328	351	688	289
32N17 Crossing	448	136	248	64
Tule Creek	13,005	11,719	1,280	6
31N42 Crossing	439	72	367	0
Bridge Gulch	2,007	827	1,180	0
County Road 302	52	0	52	0
Potato Creek	3,814	2,122	1,692	1
32N16 Crossing	888	153	707	28
Wilson Creek	1,093	246	800	47
County Road 351	886	552	333	1
Rattlesnake Creek	4,424	2,793	1,630	1

Conclusions on Hill-Slope Erosion Field Observations and WEPP Modeling:

- High rates of erosion and sediment delivery to stream channels are expected to occur where slopes are greater
- There is a high probability (>90%) that soil erosion and sediment delivery to stream channels will occur within these watersheds within the next year.
- Most soil erosion and sediment delivery to stream channels will be associated with precipitation events of short duration and high intensity. The highest rates of soil erosion are expected to occur on the steep slopes within the moderate and high burn severity polygons.

In addition to fire, existing ground disturbance (roads, OHV trails, etc) influence soil erosion and watershed response to precipitation events within the burned area but are not included in the modeling.

Erosion Hazard Rating

Soils in the Fork Complex Fires were assessed for erosion potential using the California Soil Survey Committee Erosion Hazard Rating System. Soil attributes from soil survey data coupled with field observations were used to calculate erosion hazard. The factors used in the assessment include, soil texture, soil burn severity, slope, permeability and cover. Most of the project area is quite steep and many of the soils have reduced permeability due to clay layers or shallow bedrock. The high burn severity soils are strongly hydrophobic and have lost their soil structure near the soil surface, reducing water infiltration rates. These factors coupled with the lack of soil cover due to the near complete consumption of the forest floor in the high and moderate soil burn severity areas cause the erosion hazard to be elevated throughout the burned areas. The table below summarizes the erosion hazard for the Fork Complex Fires:

Table 3: Erosion Hazard Rating for Fork Complex Fires

Erosion Hazard Rating	Acres	% of Fire
Low	1164	3
Moderate	11060	30
High	15163	42
Very High	7927	22
Unrated Rock Units	1166	3

Threats to Soil Productivity

Soil productivity was determined to be a value at risk. Soils here are inherently only moderately productive (Forest Survey Site Class 4-7) due to the geographic and climatic setting. The ecosystems here are also fire-adapted, so periodic post-fire erosion is a natural ecological and geomorphic process. The watersheds affected by the fires all flow downstream to Hayfork Creek or the South Fork of the Trinity River, so resident fish will be impacted by sediment. Impacts to T&E habitat will be significant but temporary. The assessment team did identify emergency threats to critical values at risk that would drive land treatments but due to the steepness of slopes (>65%) land treatments were not feasible. Point protection treatments for roads are being recommended.

References

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Appendix A: Dominant Soils Table

The following soil series comprise most of the burned area in the Fork Complex.

Soil #	Soil Classification	Depth	Surface Soil Texture	Surface Horizon Rock Fragments	Hydro Group		Forest Survey Site Class
Chaix	coarse-loamy, mixed, mesic Dystric Xerochrepts	20-40”	Gravelly loam	10%	B		5
Deadwood	loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts	20-40”	Gravelly sandy loam	45%	C		6-7
Hohmann	Fine-loamy, mixed, mesic Typic Xerochrepts	20-35”	Gravely loam	20%	B		5
Neuns	loamy-skeletal, mixed, mesic Dystric Xerochrepts.	20-40”	Very gravely sandy loam	10%	B		5
Holland	fine-loamy, mixed, mesic Ultic Haploxeralfs	40-60”	Gravelly loam	30%	B		4-5
Goulding	Loamy-skeletal, mixed, mesic Lithic Xerochrepts	10-20”	Very gravely loam	42%	D		7