Eldorado King Fire – Burned Area Emergency Response

Soil Resource Assessment Report

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Figure 1: Rubicon River at Ellicott Bridge (Eleven Pines Road), typical of veg burn severity in much of the Rubicon drainage.

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Soil Resource Setting

Fire area access for field assessment was adequate to allow for a representative survey of most watersheds and those not easily accessible were observed by helicopter reconnaissance. Field surveys were conducted in part to verify soil map units, but also to assess other factors affecting soil hydrologic function, productivity, erosion potential, and fire effects. Such factors include vegetative burn intensity, aspect and slope gradient, slope length and profile, soil cover, duff consumption, soil heating and char, soil structure and aggregate stability, texture, porosity, organic matter, fine root condition, and water repellency. These more detailed and GPS-located survey points were supplemented with numerous additional spot checks between to quickly assess water repellency and soil heating characteristics in more locations along travel routes. Unburned areas were also looked at to gauge fire effects relative to natural conditions for similar soils, particularly with respect to naturally occurring water repellency without fire.

Overall soil burn severity (SBS) was found to be 23% unburned/very low, 31% low, 23% moderate and 23% high. The greatest concentration of high soil burn severity occurs in the northern fire area within the watersheds of the Rubicon River Drainage from Hell Hole Reservoir to the fire perimeter, this includes the Deer Creek-Rubicon River and Little Grizzly Canyon-Rubicon River HUC12 watersheds. The southern fire area also contains high soil burn severity but not to the extent or scale of the northern area. Within the southern fire area the high soil burn severity is fragmented within low and unburned/very low soil burn severities.

Table 1: King Fire soil burn severity

Soil Burn Severity	Acres	Percent of Fire Area
Unburned/Very Low	22,404	23%
Low	30,527	31%
Moderate	22,699	23%
High	22,087	23%

The Eldorado and Tahoe NF Soil Resource Inventories as well as soil coverage from NRCS (USDA Natural Resources Conservation Service) were used for assessment purposes, covering all ownerships in the burned area. There were 108 soil map units present within the fire perimeter. Corresponding map unit data and interpretations were obtained for further analyses. This provided the basic soil information for making interpretations of fire effects upon the various soils, particularly as many areas were not field visited due to access and time constraints.

The dominant soil families within the burned area included the McCarthy, Holland, Cohasset, Mariposa, Jocal, Maymen and Chaix soil families. These soils were the seven largest soil map units within the fire area, ranging in size from 5,000 to 15,000 acres each. An additional 30 soil map units less than 5,000 acres in size were also present. Based upon dominant soil component, approximate coverage of dominant soils are: McCarthy (16%), Holland (15%), Cohasset (14%), Mariposa (13%), Jocal (9%), Maymen (5%) and Chaix (5%); the remaining soil families were present in relatively minor amounts.

Soil map unit data was combined with field data and site-specific observations to generate interpretations of fire effects upon known (visited) soils, and extrapolate interpretations for unvisited areas. Subsequent erosion hazard ratings and erosion modeling estimates were based in part upon soil survey information and modified using field-calibrated data where appropriate.

Post-Fire Condition Assessment

Rapid assessment and mapping of areas in soil burn severity (SBS) classes is necessary for incorporation with other site factors such as soil type, slope, hydrologic characteristics, and biological or human resource issues to identify source areas of potential flooding and erosion, and areas where critical ecosystem values may be degraded.

A Burned Area Reflectance Classification (BARC) map was created by the Remote Sensing Applications Center (RSAC, Salt Lake City, Utah) using satellite imagery and standard pre-post differential processing (dNBR) methods. BARC imagery is a very useful starting point for a SBS map; the BARC only "sees" aboveground effects of the fire, and must usually be modified as appropriate to become the SBS map. BARC imagery was adjusted based on processed field data, and aerial reconnaissance, and then processed into a final soil burn severity map.

Soil burn severity and water repellency (hydrophobicity) are fairly independent aspects of fire effects on soils. While it's generally assumed higher SBS will lead to higher water repellency in repellency-prone soils, this is certainly not always the case, and such relationships must be determined for the individual fire, especially when natural repellency in unburned areas is present. Slight to severe repellency is present in unburned and low SBS, attributed as natural and not fire-induced. Thus it is difficult to estimate how much is fire-exacerbated in the moderate and high SBS classes. Using the water drop penetration test, hydrophobicity was measured as severe on approximately 40 percent of the moderate and high SBS plots.

It should be understood that **soil burn severity is NOT vegetative burn severity or mortality**. Vegetative burn severity is but one component taken into consideration – soil burn severity goes beyond aboveground vegetation impacts to belowground soil heating effects and associated impacts to soil hydrologic function, runoff and erosion potential, and vegetative recovery. Such additional factors include amount and condition of residual ground cover, viability of native seed banks, condition of residual fine roots, degree of fire-induced water-repellency, soil physical factors (texture, structural stability, porosity, restricted drainage), soil chemical factors (oxidation, altered nutrient status), and topography (slope gradient, length, and profile). While above-ground burn severity is more related to peak temperatures and fire behavior during the fire, below-ground soil burn severity is related strongly to the length of time that heat is in contact with the soil (residence time).

Understanding these differences is crucial to meeting the objectives of the BAER assessment. A high intensity fire (high flame lengths, rapid rate of spread, crown fire, etc.) in a stand-replacement event can result in a moderate (or even low) soil burn severity, if the residence time is short and soil characteristics are not altered significantly. Conversely, a slow-moving fire with complete consumption of accumulated surface fuels can leave trees alive, but heat the soil severely with predictable negative consequences to soils and streams. Soil burn severity, used in this context, is a much better index of soil damage, watershed response, and potential for natural vegetative recovery after the fire. Residual soil cover post-fire is the most crucial aspect of aboveground fire effects for potential erosion, but there is a tendency for some to consider only cover at the expense of belowground soil conditions.

Soil Burn Severity Indicators used for this burned area are generalized best in Parsons et al., 2010 [excerpted]:

- **Low soil burn severity**: Surface organic layers are not completely consumed and are still recognizable. Structural aggregate stability is not changed from its unburned condition, and roots are generally unchanged because the heat pulse below the soil surface was not great enough to consume or char any

underlying organics. The ground surface, including any exposed mineral soil, may appear brown or black (lightly charred), and the canopy and understory vegetation will likely appear "green."

- **Moderate soil burn severity:** Up to 80 percent of the pre-fire ground cover (litter and ground fuels) may be consumed but generally not all of it. Fine roots (~0.1 inch or 0.25 cm diameter) may be scorched but are rarely completely consumed over much of the area. The color of the ash on the surface is generally blackened with possible gray patches. There may be potential for recruitment of effective ground cover from scorched needles or leaves remaining in the canopy that will soon fall to the ground. The prevailing color of the site is often "brown" due to canopy needle and other vegetation scorch. Soil structure is generally unchanged.

- **High soil burn severity**: All or nearly all of the pre-fire ground cover and surface organic matter (litter, duff, and fine roots) is generally consumed, and charring may be visible on larger roots. The prevailing color of the site is often "black" due to extensive charring. Bare soil or ash is exposed and susceptible to erosion, and aggregate structure may be less stable. White or gray ash (up to several centimeters in depth) indicates that considerable ground cover or fuels were consumed. Sometimes very large tree roots (> 3 inches or 8 cm diameter) are entirely burned extending from a charred stump hole. Soil is often gray, orange, or reddish at the ground surface where large fuels were concentrated and consumed.

Field sites were evaluated to validate the BARC map and to determine the degree of water repellency present within the top soil. During field verification of the BARC map, locating areas with high soil burn severity proved difficult in the field. Commonly within the areas identified as high soil burn severity (23% of the fire area) a moderate soil burn severity was observed. The depth of soil charring was variable from ¼ inch to 2 inches, fine roots were commonly present but charred within this same depth range, coarse roots were present with very minor charring in some areas and soil structure was never completely destroyed resulting in a granular structure. The presence of non-consumed organic matter within the surface soil caused the soil structure to vary between slightly and highly altered, as the soil structure became more altered as the soil aggregates became weaker and weaker. Soil water repellency (hydrophobicity) was variable from half an inch in some areas and up to four inches in other areas; included were areas of moderately (10-40 seconds) to strongly (>40 seconds) hydrophobic soils. See Figure 2 for a visual representation of water droplets not infiltrating into the subsoil due to the strong soil water repellency.

Figure 2: Strong soil water repellency

In certain areas fire-wide a moist soil layer has formed below the strong soil hydrophobic layer, after a 1-2" wetting rain during assessment. This layer apparently formed from preferential flow of water through macropores or small subsurface channels. In areas where this moist soil layer was located the strong hydrophobic layer would immediately change in most cases to a weak hydrophobic layer; in a few areas it would change to a moderate hydrophobic layer first for approximately ½ inch but then change into a weak hydrophobic layer. See Figure 3 for a

visual example of the soil profile found within the high SBS areas. However within these same areas identified as high SBS, greater than 80-100% of the ground cover had been consumed and the majority of the canopy was consumed as well. With almost complete to complete consumption of the ground cover paired with the loss of any influx of needle cast for ground cover from the canopy above in the future, these areas will likely see a high watershed response. Depending on the storm intensity and duration, the amount of hillslope erosion will be variable. During a low-intensity short-duration storm, precipitation will slowly infiltrate into the soil subsurface via preferential flow, avoiding runoff and initiation of hillslope erosion. Whereas if a more intense, long-duration storm occurs, precipitation rate will likely surpass soil infiltration capacity, causing increased runoff and hillslope erosion.

Figure 3: Soil profile of a sample point taken in the high soil burn severity in the preliminary BARC layer

Within the areas identified with a moderate SBS (23% of the area) the ground conditions were more representative of moderate SBS than the previously discussed high. In these areas soil charring was variable, observed from ¼ inch to 1 inch, fine roots were commonly present but charred within this same depth range and soil structure was slightly to moderately altered. Soil water repellency (hydrophobicity) was variable from ½ inch in some areas and up to 3 inches in other areas, and included are moderately (10-40 seconds) to strongly (>40 seconds) hydrophobic. Just as within the high areas, a moist soil layer has formed below the strong soil hydrophobic layer, formed from preferential flow of water through macropores or small subsurface channels. In areas where this moist soil layer was located the strong hydrophobic layer would immediately change to a weak hydrophobic layer. Ground cover in these areas was variable, between less than 50% consumption to greater than 80% consumption, and the canopy was partially to completely intact. See Figure 4 for a visual example of a soil within moderate SBS. With an intact brown canopy providing needle cast for ground cover in addition to present ground cover, a less intense watershed response is expected. Infiltration of storm precipitation will vary depending on storm intensity and duration, possibly resembling a high watershed response similar to high SBS areas in the event of a severe storm. But in general moderate SBS areas have higher infiltration capacity and higher soil cover than high SBS, so a lesser erosion risk.

Figure 4: Soil profile of a sample point taken in the moderate soil burn severity in the preliminary BARC layer

The remaining 54% of the burned area contains unburned/very low to low soil burn severity. Very little evidence of significant soil heating was observed; no changes in soil color, structure, organic matter or fine root combustion occurred within these soils. Water repellency is hit-or-miss, from slight to severe, and is attributed as natural, not fire-exacerbated. Seed source was present in most topsoils and natural understory revegetation is

expected to progress without delay. These areas currently have 50 to 100% soil cover and should produce little accelerated runoff or erosion above natural "background" rates.

From the BAER rapid-assessment process, the final soil burn severity (SBS) was found to be 23% unburned/very low, 31% low, 23% moderate and 23% high. The original BARC map estimated the preliminary SBS at 23% unburned/very low, 31% low, 20% moderate and 26% high. To better reflect the current soil conditions altered by the fire, the moderate SBS was raised by 3%, resulting in a 3% reduction in high SBS. The reduction was aimed at reducing those areas within the high where the fire had only marginally altered the soil profile and brown canopy and some ground cover were present. This was accomplished by looking at pre-fire aerial imagery and photos taken from several helicopter reconnaissance flights throughout the fire area.

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 erosion processes only, and was developed primarily for land use activities such as agriculture or logging. The rating system is based on soil texture, depth, clay content, infiltration, amount of rock fragments, effective surface cover, slope gradient, and climate. Risk ratings range from low to very high, with low ratings meaning low probability of surface erosion occurring. Moderate ratings mean that accelerated erosion is likely to occur in most years and water quality impacts may occur for the upper part of the moderate numerical range. High to very high EHR ratings mean that accelerated erosion is likely to occur in most years and that erosion control measures should be evaluated. For BAER purposes, fire induced changes to soil infiltration, ground cover, and runoff from adjacent areas can be factored in to determine changes in erosion hazard by soil burn severity classes, to produce a customized "post-fire EHR" map displaying erosion hazards on a relative basis.

For EHR purposes, soil map units were evaluated using information for texture, rock content, slope gradient, and characteristics relating to infiltration, permeability, and depth of the soil. EHR ratings were calculated for each soil with soil burn severity characteristics also factored in. Ratings thus represent a summary of soil physical characteristics, slope gradient, soil cover present, and level of hydrophobicity (water repellency) as observed in the field. Fire has altered the erosion hazard rating of the soils and the altered EHR ratings were as follows: 19,960 acres (Low), 42,324 acres (Moderate), 31,498 acres (High) and 3,935 acres (Very High).

Table 2: King Fire soil erosion hazard ratings (EHRs)

EHR Rating	Acres	%
Low	19,960	20%
Moderate	42,324	43%
High	31,498	32%
Very High	3,935	4%

Hydrologic soil groups are a standard soil-survey index of potential for runoff generation and subsequent erosion, regardless of fire effects of soil burn severity or water repellency. The greatest majority of soils have a hydrologic soil group B, indicating a moderately low to moderately high potential for runoff during prolonged rain events. Additional effects of the fire will cause more runoff, accelerated sheet and rill erosion throughout the fire areas, as well as accelerated occurrence of shallow landslides and debris flows. In moderate soil burn severity areas, strong water repellency was observed to 2" inch depths. In areas of high soil burn severity strong water repellency exists

on approximately 40 to 70% of the area and generally began about 1/2 inch beneath the surface and extended up to 4 inches deep in certain areas.

Table 3: King Fire soil hydrologic groups

Hydrologic Group	Acres	Percent Fire Area
B	6,2596.2	64%
D	16,472.7	17%
C	10,585.4	11%
A	6,550.21	7%
None	1,408.12	1%
C/D	104.10	<1%

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 was 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 Tahoe 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. As an interpretive visual, tons/ac is roughly equivalent to that many sheets of paper stacked being removed from the soil surface, and 1000 tons of sediment would fill about 120 standard 10-yard dump trucks. 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 1,889,185 tons of sediment may be produced (27.09 tons/acre), equivalent to 9,310 cubic yards per square mile (using a conversion factor of 1.35 tons per cubic yard). Increased hillslope erosion is expected to occur throughout the fire area, especially within those areas in the high soil burn severity. Unburned, pre-fire conditions estimated an average 4,933 tons of sediment could be produced (0.47 tons/acre) for a 5-year event (20% probability). Stated model accuracy is +/- 50%.

Table 4: King Fire ERMiT modeling results for the 2, 5 and 10 year storms in total sediment and average sediment delivery in tons/acre

ERMiT Results	2 Year Storm	5 Year Storm	10 Year Storm
Tons	713,449	1,889,185	2,832,057
Tons/Acre	11.83	27.09	38.45

Table 5: HUC12 ERMiT results for the 5 year storm in total sediment and average sediment delivery in tons/acre

Area	5 Year - Total Sediment (Tons)	5 Year - Average Sediment Delivery (Tons/Acre)
King Fire	1,889,185.25	27.09
Brush Creek-South Fork American River	272,932.90	52.74
Deer Creek-Rubicon River	259,122.70	22.06
Dolly Creek-Middle Fork American River	4,334.60	13.30
Gerle Creek	674.60	8.00
Hell Hole Reservoir-Rubicon River	8,108.30	16.23
Little Grizzly Canyon-Rubicon River	573,403.60	37.12
Little Silver Creek-Silver Creek	489,935.80	31.26
Long Canyon	112,941.50	17.16
One Eye Creek-Rock Creek	2.80	2.83
Pilot Creek	23,028.00	11.95
Plum Creek-South Fork American River	252,723.40	25.15
Slab Creek	144,136.60	25.92
South Fork Rubicon River	35,000.40	30.56
South Fork Silver Creek	0.10	0.36
Whaler Creek	189.10	28.53

In addition to ERMiT modeling, a new GeoWEPP variant was utilized on the King Fire. We utilized the remote services of Bill Elliot (Research Engineer, USFS Rocky Mountain Research Station, Moscow, ID) and Mary Miller (Research Engineer, Michigan Tech Research Institute, Ann Arbor, MI) to test a new erosion model being developed in conjunction with a new NASA database developed for rapid modeling purposes. The database includes pre-set model inputs, and along with soil burn severity input, is run in GeoWepp for sediment production and routing at watershed scale. Output may be storm-event based, which is conventional for assessment of various hazards, or on an annual basis, which may be more applicable to particular VARs such as reservoir sediment infilling. Output from this model was provided to the BAER soils team in raster format to be utilized in GIS for risk assessments and treatment prescriptions relative to downstream values.

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

In one sense, fire and post-fire erosion are integral parts of the local disturbance regime; however many of the BAER critical values we are concerned with did not naturally occur in the fire area prior to historic times. Soil quality and hydrologic function throughout the fire was assessed by determining soil burn severity, soil erosion hazard, and evaluating potential on- and off-site effects of topsoil loss and sediment production. The combination

of soil types, steep slopes, and lack of soil cover will create watershed responses with elevated erosion and sedimentation, the degree depending upon the severity of the coming winters over the next 3-5 years at least. Potential impacts can be categorized into both on-site and off-site effects. On-site effects include the physical, chemical, and biological response of the soils to the fires, and likely recovery rates. Off-site effects due to sedimentation and stream bulking are downstream; these in a general sense include potential adverse effects to life and facilities (roads, buildings, reservoirs), water quality deterioration for sensitive aquatics species and human use, and risk to human life and property from potential flooding, mudslides, and debris flows, both on and off of Forest Service lands.

On-site effects of this fire will be some level of topsoil loss via accelerated erosion, with subsequent damage to soil nutrient status and microbial communities. Erosional loss would result in declined soil productivity, which in turn could cause declines in ecosystem productivity in the short-term. Based upon modeling and local knowledge, the decrease in soil productivity is a much lesser threat to native plant communities than the potential spread of noxious weeds within the area. Therefore ecosystem stability as a function of soil impacts was not judged to be a serious VAR here. Impacts to soil productivity as a VAR in itself are expected to range from minor in roughly half of the area, to moderate where soil burn severity and erosion hazards are higher.

Off-site effects of soil erosion will be accelerated sediment production into stream systems containing resident wild trout populations (non-T&E), stream bulking leading to increased debris-flow potential (particularly in the Rubicon drainage), and increased runoff possibly elevating landslide potential in particular areas. Sediment-laden ("bulked") runoff and stream water has much greater erosive power than similar flows of clean water in the stream system. There are private structures possibly threatened by potential sedimentation and mudflow activity. In addition, risks to roads and trails exist throughout the fire area, which are necessary to the transportation system; these represent valuable infrastructure investments that warrant protection. Risk management in the form of engineering and trails treatments as well as coordination with NRCS has been proposed by the team. See the 2500-8 and respective reports for specifics.

Erosion and sedimentation would contribute to debris flows and mudflows IF they were to occur, which would have a high potential to threaten life and property in particular drainage outlets, as well as water quality for beneficial uses. Natural hillslope erosion rates are rather low (< 1 ton/acre) when vegetated and covered with duff; vegetation mortality and lack of cover in high SBS areas will certainly accelerate runoff and erosion processes in the post-fire environment, the degree depending on the magnitude and intensity of coming storm events. While this may or may not pose an unacceptable risk to on-site soil resources, it would contribute to downstream hazards, particularly if larger storm events occur in the first several winters. More notably, the Rubicon drainage and a few other sub-watersheds have an obviously active debris flow history, which is expected to re-activate post-fire. Modeled post-fire hillslope erosion rates are rather high, averaging around 30 tons/acre for a 5-year event but exceeding 60 tons/acre in some areas. Such erosion rates are difficult to put in context, considering that post-fire erosion is a very natural geomorphic process, and considering in these watersheds that debris flow activity may deliver orders of magnitude more sediments than sheet and rill erosion processes. That said, treatments to limit hillslope erosion would reduce runoff and reduce re-loading of debris flow channels in the near term prior to revegetation.

Another soil VAR encountered on this fire was a threat of soil gullying caused by non-system FS roads concentrating runoff and draining in uncontrolled locations. Such "non-system roads" are meant to include relatively impermeable features such as skid trails, landings, and temporary roads. While most of these features

were not a problem with pre-fire cover conditions, they become hydrologically active hillslope features post-fire. Soil gullying is notoriously difficult to repair once it occurs, and gully erosion processes tend to be long-term problems, so prevention of gullying in this post-fire environment is warranted.

Downstream reservoirs are also at risk of infilling with sediments, and floatable debris damaging control gates. These private values would benefit from possible land (mulch) treatments, but these interests are not a BAER critical value according to policy.

Emergency Determination

Effects of the fire on the various resources have created emergency conditions, posing unacceptable risks to critical values, specifically to life, property, forest road and trail infra-structure, native plant community stability, water quality for non-T&E fisheries, and cultural resources; risk mitigation for these are discussed in appropriate specialist reports, and are not repeated here.

Specific to soil productivity, modeled erosion rates are quite high, posing a likely impact to soil productivity in about one-quarter of the burned area (high SBS). Water repellency is common, and is patchy and discontinuous where it occurs, as evidenced by wet-up below the repellent layer with the rain event during assessment; natural repellency was observed in unburned areas; thus, increased repellency is not considered a large factor contributing to watershed response here. 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. While soil erosion is always irreversible (major magnitude of consequences?), the damage to soil productivity is considered recoverable in most cases, as forest soils are generally resilient and post-fire pulse erosion is a very natural geomorphic process.

Specific to off-site effects of soil erosion, bulking of runoff and contribution to debris flows was considered a high risk specifically for Eleven Pines Road in the Rubicon drainage. Threats to this road are extreme, mainly in the form of debris flows. Standard & enhanced road treatments are being proposed to mitigate this risk. The assessment team determined that land treatments *in addition* would reduce runoff bulking and increase the efficacy of road treatments, in order to maximize risk reduction efforts for this very-high-value road; not doing the land treatment portion would lessen the efficacy of other proposed treatments.

The threat of soil gullying from non-system roads and impermeable legacy logging system features does constitute a BAER emergency, having a likely probability of occurrence and moderate consequences (considerable and long term effects), for a high risk rating.

The home sites in the White Meadows area were not determined to be a BAER emergency, as sediment production from FS lands would constitute only “nuisance” sediment and not a threat to life and safety. FS watershed area above these sites is quite small (< 8 acres) and not steep, judged as insufficient to mobilize enough sediments or flows to seriously threaten the structures. Consultation with NRCS for point-protection measures was determined to be more effective and more appropriate to mitigate risks of possible private property damage.

Treatments to Mitigate the Emergency

Only Eleven Pines Road was determined a BAER Emergency sufficient to warrant land treatments, as an in-concert element additional to other road treatments. Hazards to this VAR can be substantially reduced by targeted

upslope land treatments to reduce hillslope runoff bulking-factor and sediment delivery into debris flow prone channels. Threats to this road are extreme, and the value of the road warrants an aggressive treatment approach.

BAER policy requires that proposed risk-mitigation treatments must be proven effective, technically feasible, justified by the values at risk, and of a magnitude to make a meaningful difference in reducing risk levels. Proposed treatments are considered the minimum necessary response to significantly reduce the threat to the value at risk. In this context, the suite of possible treatments and treatment locations are scrutinized and narrowed to the minimum necessary response to manage and reduce risk levels to acceptable levels, or as close as we can feasibly achieve toward that objective given reasonably expected magnitudes of damaging events.

Slopes uphill of Eleven Pines Road on both sides of the Rubicon canyon were evaluated for treatment potential. The first screen was areas with high SBS and slope gradients from 15-60%: slopes less than 15% don't produce much runoff or erosion, so they are not cost-effective; treatments above 60% will not remain in place, so ineffective in reducing risk; slopes 50-60% are marginal and pushing capabilities – some of these were included and some excluded based upon spatial arrangement and contiguity with the 15-50% slopes. Next stream buffers of 100 feet and road buffers of 50 ft were removed, as well as inclusions of rock outcrop. Next areas within and next to debris flow channels were removed, hand-digitized using the bare-earth LiDAR coverage as a guide (invaluable!).

Recommendations beyond BAER

Reservoirs: Downstream reservoirs are certainly threatened by pulses of sediment and debris coming from FS lands. However such private infrastructure is not a BAER critical value, so BAER treatments are not possible to respond to such risks. Land (mulch) treatments would certainly benefit these values to some degree, which would also help mitigate economic impacts of shutting down these facilities and dredging sediments. The same screening procedures that occurred for the Eleven Pines Road mulch treatments were conducted for the entire Rubicon and Brush Creek drainages, and feasible treatment units were delineated in GIS. Discussions with management entities for Oxbow Reservoir (PCWA) and Brush Creek Reservoir (SMUD) are ongoing to determine if they have an economic interest in cost-sharing or outright paying for treatments on FS lands to defer sediment inputs in these reservoirs; treatment refinements and cost-benefit analyses are ongoing as of BAER assessment closeout.

Salvage Planning: RAVG imagery, derived from the same imagery as BARC but purposed toward vegetation mortality, often takes several weeks post-fire to obtain. In the meantime, it is reasonable to assume that moderate and high soil burn severity areas have complete vegetation mortality, so planning efforts if desired could start in these areas immediately. GIS coverage can be provided by request, from report authors here or the Forest BAER Coordinator (Eric Nicita) who is the custodian of BAER assessment records.

References

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Figure 5: King Fire Soil Map Units

Figure 6: King Fire Soil Erosion Hazard Ratings

Figure 7: King Fire Soil Hydrologic Groups

Table 6: King Fire soil soil families

Soil Family	Acre	Percent Present
McCarthry	15,402.80	16%
Holland	14,924.10	15%
Cohasset	13,239.40	14%
Mariposa	12,247.40	13%
Jocal	8,912.48	9%
Maymen	5,278.51	5%
Chaix	5,115.35	5%
Zeibright	4,668.03	5%
Crozier	2,639.44	3%
Lithic Cryumbrepts	2,270.74	2%
Ledmount	2,250.42	2%
Waca	1,945.00	2%
Hartless	1,751.66	2%
Neuns	1,710.35	2%
Tallac	753.98	1%
Metamorphic Rock Land	745.61	1%
Pilliken	530.42	1%
Acidic Rock Land	425.06	0%
Hangtown	277.56	0%
Fluvents	238.28	0%
Ahart	151.24	0%
Gerle	143.57	0%
Water	138.08	0%
Aquepts	115.44	0%
Ledford	113.88	0%
Josephine	110.46	0%
Rock Outcrop	103.26	0%
Musick	71.87	0%
Windy	59.68	0%
Meiss	55.25	0%
Pits	54.84	0%
Shaver	52.45	0%
Riverwash	44.76	0%
Sites	41.47	0%
Horseshoe	1.34	0%
Gravel Pits	1.25	0%
Mieruf	0.88	0%

Table 7: King Fire soil map units (SMUs)

Soil Map Unit	Soil Map Unit Name	Acres
103	AQUEPTS AND UMBREPTS, 0 TO 15 PERCENT SLOPES	115.44
106	CHAIX COARSE SANDY LOAM, 30 TO 75 PERCENT SLOPES	2,919.86
107	CHAIX-PILLIKEN COARSE SANDY LOAM, 5 TO 30 PERCENT SLOPES	18.89
108	CHAIX-PILLIKEN COARSE SANDY LOAMS, 30 TO 75 PERCENT SLOPES	1,523.06
109	CHAIX-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES	554.15
110	COHASSET LOAM, 2 TO 30 PERCENT SLOPES	5,721.40
112	COHASSET-MCCARTHY ASSOCIATION, 2 TO 30 PERCENT SLOPES	2,090.87
113	COHASSET-MCCARTHY ASSOCIATION, 30 TO 50 PERCENT SLOPES	2,245.74
114	COHASSET-MCCARTHY ASSOCIATION, RHYOLITIC SUBSTRATUM, 5 TO 30 PERCENT SLOPES	405.68
115	COHASSET-MCCARTHY ASSOCIATION RHYOLITIC SUBSTRATUM, 30 TO 75 PERCENT SLOPES	2,757.98
116	CROZIER-COHASSET LOAMS, 5 TO 30 PERCENT SLOPES	724.76
117	CROZIER-COHASSET LOAMS, 30 TO 50 PERCENT SLOPES	249.02
118	CROZIER-MCCARTHY COMPLEX, 5 TO 30 PERCENT SLOPES	844.22
119	CROZIER-MCCARTHY COMPLEX, 30 TO 50 PERCENT SLOPES	821.44
125	FLUVENTS, 0 TO 10 PERCENT SLOPES	238.28
128	GERLE-TALLAC COMPLEX, 5 TO 30 PERCENT SLOPES	143.57
131	HANGTOWN-LITHIC XERUMBREPTS COMPLEX, 15 TO 50 PERCENT SLOPES	258.72
133	HANGTOWN-SMOKEY COMPLEX, 30 TO 50 PERCENT SLOPES	18.84
134	HARTLESS VERY GRAVELLY LOAM 5 TO 30 PERCENT SLOPES	214.18
135	HARTLESS VERY GRAVELLY LOAM, 30 TO 50 PERCENT SLOPES	93.80
137	HARTLESS-MIERUF VERY GRAVELLY LOAMS, 30 TO 50 PERCENT SLOPES	212.88
138	HARTLESS-MIERUF VERY GRAVELLY LOAMS, 50 TO 75 PERCENT SLOPES	110.42
139	HARTLESS-NEUNS COMPLEX, 15 TO 30 PERCENT SLOPES	5.52
140	HARTLESS-NEUNS COMPLEX, 30 TO 75 PERCENT SLOPES	1,114.86
142	HOLLAND LOAM, 5 TO 30 PERCENT SLOPES	605.91
143	HOLLAND LOAM, 30 TO 50 PERCENT SLOPES	28.35
144	HOLLAND-BIGHILL COMPLEX, 5 TO 30 PERCENT SLOPES	133.47
145	HOLLAND-BIGHILL COMPLEX 30 TO 75 PERCENT SLOPES	623.09
146	HOLLAND-MUSICK LOAMS, 5 TO 30 PERCENT SLOPES	151.40
147	HOLLAND-MUSICK LOAMS, 30 TO 50 PERCENT SLOPES	2,735.66
148	HOLLAND-PILLIKEN ASSOCIATION, 5 TO 30 PERCENT SLOPES	121.52
149	HOLLAND-PILLIKEN ASSOCIATION, 30 TO 50 PERCENT SLOPES	619.04
150	JOCAL LOAM, 5 TO 30 PERCENT SLOPES	10,043.00
151	JOCAL LOAM, 30 TO 50 PERCENT SLOPES	4,313.41
152	JOCAL-HARTLESS COMPLEX, 5 TO 30 PERCENT SLOPES	377.55
153	JOCAL-HARTLESS COMPLEX, 30 TO 50 PERCENT SLOPES	554.29

154	JOCAL-MARIPOSA-UMBREPTS ASSOCIATION, 30 TO 75 PERCENT SLOPES	3,449.36
155	JOCAL-SITES LOAMS, 5 TO 30 PERCENT SLOPES	80.53
157	LEDFORD-NOTNED COMPLEX, 5 TO 30 PERCENT SLOPES	113.88
159	LEDMOUNT-ROCK OUTCROP ASSOCIATION, 2 TO 30 PERCENT SLOPES	982.47
160	LEDMOUNT-ROCK OUTCROP ASSOCIATION, 30 TO 75 PERCENT SLOPES	1,267.95
161	LITHIC CRYUMBREPTS, 15 TO 75 PERCENT SLOPES	537.36
162	LITHIC CRYUMBREPTS-WACA ASSOCIATION, 5 TO 30 PERCENT SLOPES	48.19
163	LITHIC CRYUMBREPTS-WACA ASSOCIATION, 30 TO 50 PERCENT SLOPES	297.01
164	LITHIC XERUMBREPTS-ROCK OUTCROP COMPLEX, 15 TO 75 PERCENT SLOPES	1,388.18
167	MARIPOSA GRAVELLY SILT LOAM, 5 TO 30 PERCENT SLOPES	193.27
168	MARIPOSA GRAVELLY SILT LOAM, 30 TO 50 PERCENT SLOPES	313.45
169	MARIPOSA-JOCAL COMPLEX, 5 TO 30 PERCENT SLOPES	2,498.53
170	MARIPOSA-JOCAL COMPLEX, 30 TO 75 PERCENT SLOPES	3,051.05
171	MARIPOSA-MAYMEN COMPLEX, 5 TO 30 PERCENT SLOPES	317.70
172	MARIPOSA-MAYMEN COMPLEX, 30 TO 75 PERCENT SLOPES	5,077.96
173	MAYMEN-ROCK OUTCROP ASSOCIATION, 30 TO 75 PERCENT SLOPES	2,253.88
174	MAYMEN-ROCK OUTCROP ASSOCIATION, 75 TO 100 PERCENT SLOPES	3,024.62
175	MCCARTHY GRAVELLY SANDY LOAM, 2 TO 30 PERCENT SLOPES	1,539.50
176	MCCARTHY GRAVELLY SANDY LOAM, 30 TO 50 PERCENT SLOPES	1,206.14
177	MCCARTHY-LEDMOUNT ASSOCIATION, 2 TO 30 PERCENT SLOPES	7,505.95
178	MCCARTHY-LEDMOUNT ASSOCIATION, 30 TO 75 PERCENT SLOPES	4,899.32
179	MCCARTHY, RHYOLITIC SUBSTRATUM-ROCK OUTCROP COMPLEX, 15 TO 75 PERCENT SLOPES	251.90
180	MIERUF VERY GRAVELLY LOAM, 5 TO 30 PERCENT SLOPES	0.88
182	NEUNS GRAVELLY LOAM, 15 TO 30 PERCENT SLOPES	36.74
184	NEUNS GRAVELLY LOAM, 50 TO 75 PERCENT SLOPES	625.64
185	NEUNS-LITHIC XERUMBREPTS-ROCK OUTCROP ASSOCIATION, 50 TO 100 PERCENT SLOPES	1,047.97
192	PILLIKEN COARSE SANDY LOAM, 5 TO 30 PERCENT SLOPES	27.08
193	PILLIKEN COARSE SANDY LOAM, 30 TO 50 PERCENT SLOPES	116.50
195	PILLIKEN-ROCK OUTCROP COMPLEX, 30 TO 50 PERCENT SLOPES	386.84
196	PITS, BORROW	54.84
197	RIVERWASH	44.76
198	ROCK OUTCROP	103.26
201	TALLAC VERY COBBLY SANDY LOAM, 2 TO 30 PERCENT SLOPES	136.07
202	TALLAC VERY COBBLY SANDY LOAM, 15 TO 30 PERCENT SLOPES, STONY	191.74
203	TALLAC-CRYUMBREPTS, WET ASSOCIATION, 15 TO 30 PERCENT SLOPES	95.00
204	TALLAC VARIANT-LITHIC XERUMBREPTS-ROCK OUTCROP COMPLEX, 15 TO 50 PERCENT SLOPES	297.72
211	WACA COBBLY SANDY LOAM, 5 TO 30 PERCENT SLOPES	41.98
212	WACA COBBLY SANDY LOAM, 30 TO 50 PERCENT SLOPES	209.82
213	WACA-LITHIC CRYUMBREPTS ASSOCIATION, 30 TO 50 PERCENT SLOPES	466.59

217	WACA-WINDY COMPLEX, 30 TO 50 PERCENT SLOPES	1,162.34
218	WINDY GRAVELLY SANDY LOAM, 5 TO 30 PERCENT SLOPES	31.98
219	WINDY GRAVELLY SANDY LOAM, 30 TO 50 PERCENT SLOPES	27.70
221	ZEIBRIGHT EXTREMELY GRAVELLY COARSE SANDY LOAM, 2 TO 30 PERCENT SLOPES	291.51
222	ZEIBRIGHT EXTEMELY GRAVELLY COARSE SANDY LOAM, 30 TO 75 PERCENT SLOPES	3,032.26
224	ZEIBRIGHT-ROCK OUTCROP ASSOCIATION, 15 TO 75 PERCENT SLOPES	1,344.26
AaF	Acidic rock land	425.06
ACF	Ahart-Waca, rhyolitic substratum complex, 30 to 50 percent slopes	56.92
ADF	Ahart-Waca, rhyolitic substratum-Cryumbrepts, wet complex, 30 to 50 percent slopes	41.74
AEF	Ahart-Rock outcrop-Ledmount variant complex, 30 to 50 percent slopes	52.58
CcE	Chaix very rocky coarse sandy loam, 9 to 50 percent slopes	99.38
CoE	Cohasset cobbly loam, 15 to 50 percent slopes	17.76
GP	Gravel pits	1.25
HsE	Horseshoe gravelly loam, 30 to 50 percent slopes	1.34
JrD	Josephine gravelly loam, 15 to 30 percent slopes	3.13
JsE	Josephine very rocky loam, 15 to 50 percent slopes	107.33
MbE	Mariposa very rocky silt loam, 3 to 50 percent slopes	99.43
MbF	Mariposa very rocky silt loam, 50 to 70 percent slopes	580.74
McE	Mariposa-Josephine very rocky loams, 15 to 50 percent slopes	115.29
MfF	Maymen very rocky loam, 15 to 70 percent slopes	0.02
MIG	Meiss-Rock outcrop complex, 30 to 75 percent slopes	42.19
MKE	Meiss-Waca complex, 2 to 30 percent slopes	12.47
MLG	Meiss-Waca-Cryumbrepts, wet complex, 30 to 75 percent slopes	0.59
MmF	Metamorphic rock land	745.61
MrD	Musick sandy loam, 15 to 30 percent slopes	26.99
MtE	Musick very rocky sandy loam, 15 to 50 percent slopes	44.88
SdE	Shaver very rocky coarse sandy loam, 15 to 50 percent	52.45
SrE	Sites very rocky loam, 15 to 50 percent slopes	41.47
TBE	Tallac-Cryumbrepts, wet complex, 2 to 30 percent slopes	16.04
TBF	Tallac-Cryumbrepts, wet complex, 30 to 50 percent slopes	17.40
W	Water	138.08
WBF	Waca-Cryumbrepts, wet-Windy complex, 30 to 50 percent slopes	3.89
WDF	Waca-Meiss complex, 30 to 50 percent slopes	60.38

Table 8: King Fire soil map units and their corresponding erosion hazard rating (EHR) per soil burn severity

Soil Map Unit	Soil Map Unit Name	Erosion Hazard Rating			
		Unburned	Low Soil Burn Severity	Moderate Soil Burn Severity	High Soil Burn Severity
103	AQUEPTS AND UMBREPTS, 0 TO 15 PERCENT SLOPES	Low	Low	Low	Low
106	CHAIX COARSE SANDY LOAM, 30 TO 75 PERCENT SLOPES	Moderate	Moderate	High	High
107	CHAIX-PILLIKEN COARSE SANDY LOAM, 5 TO 30 PERCENT SLOPES	Low	Low	Low	Moderate
108	CHAIX-PILLIKEN COARSE SANDY LOAMS, 30 TO 75 PERCENT SLOPES	Moderate	Moderate	High	High
109	CHAIX-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES	Moderate	Moderate	High	High
110	COHASSET LOAM, 2 TO 30 PERCENT SLOPES	Low	Low	Moderate	Moderate
112	COHASSET-MCCARTHY ASSOCIATION, 2 TO 30 PERCENT SLOPES	Low	Low	Moderate	Moderate
113	COHASSET-MCCARTHY ASSOCIATION, 30 TO 50 PERCENT SLOPES	Low	Moderate	Moderate	High
114	COHASSET-MCCARTHY ASSOCIATION, RHYOLITIC SUBSTRATUM, 5 TO 30 PERCENT SLOPES	Low	Moderate	Moderate	High
115	COHASSET-MCCARTHY ASSOCIATION RHYOLITIC SUBSTRATUM, 30 TO 75 PERCENT SLOPES	Moderate	Moderate	High	High
116	CROZIER-COHASSET LOAMS, 5 TO 30 PERCENT SLOPES	Low	Moderate	Moderate	Moderate
117	CROZIER-COHASSET LOAMS, 30 TO 50 PERCENT SLOPES	Moderate	Moderate	High	High
118	CROZIER-MCCARTHY COMPLEX, 5 TO 30 PERCENT SLOPES	Low	Moderate	Moderate	Moderate
119	CROZIER-MCCARTHY COMPLEX, 30 TO 50 PERCENT SLOPES	Low	Moderate	High	High
125	FLUVENTS, 0 TO 10 PERCENT SLOPES	Low	Low	Low	Moderate
128	GERLE-TALLAC COMPLEX, 5 TO 30 PERCENT SLOPES	Low	Low	Low	Low
131	HANGTOWN-LITHIC XERUMBREPTS COMPLEX, 15 TO 50 PERCENT SLOPES	Low	Low	Moderate	Moderate
133	HANGTOWN-SMOKEY COMPLEX, 30 TO 50 PERCENT SLOPES	Moderate	Moderate	High	High
134	HARTLESS VERY GRAVELLY LOAM 5 TO 30 PERCENT SLOPES	Low	Low	Moderate	Moderate
135	HARTLESS VERY GRAVELLY LOAM, 30 TO 50 PERCENT SLOPES	Low	Moderate	Moderate	High
137	HARTLESS-MIERUF VERY GRAVELLY LOAMS, 30 TO 50 PERCENT SLOPES	Low	Moderate	Moderate	High
138	HARTLESS-MIERUF VERY GRAVELLY LOAMS, 50 TO 75 PERCENT SLOPES	Moderate	Moderate	High	High
139	HARTLESS-NEUNS COMPLEX, 15 TO 30 PERCENT	Moderate	Moderate	High	High

	SLOPES				
140	HARTLESS-NEUNS COMPLEX, 30 TO 75 PERCENT SLOPES	Moderate	High	High	Very High
142	HOLLAND LOAM, 5 TO 30 PERCENT SLOPES	Low	Low	Moderate	Moderate
143	HOLLAND LOAM, 30 TO 50 PERCENT SLOPES	Low	Moderate	Moderate	High
144	HOLLAND-BIGHILL COMPLEX, 5 TO 30 PERCENT SLOPES	Low	Low	Moderate	Moderate
145	HOLLAND-BIGHILL COMPLEX 30 TO 75 PERCENT SLOPES	Moderate	Moderate	High	High
146	HOLLAND-MUSICK LOAMS, 5 TO 30 PERCENT SLOPES	Low	Low	Moderate	Moderate
147	HOLLAND-MUSICK LOAMS, 30 TO 50 PERCENT SLOPES	Low	Moderate	Moderate	High
148	HOLLAND-PILLIKEN ASSOCIATION, 5 TO 30 PERCENT SLOPES	Low	Low	Low	Moderate
149	HOLLAND-PILLIKEN ASSOCIATION, 30 TO 50 PERCENT SLOPES	Low	Moderate	High	High
150	JOCAL LOAM, 5 TO 30 PERCENT SLOPES	Low	Moderate	Moderate	High
151	JOCAL LOAM, 30 TO 50 PERCENT SLOPES	Low	Moderate	Moderate	High
152	JOCAL-HARTLESS COMPLEX, 5 TO 30 PERCENT SLOPES	Low	Moderate	Moderate	High
153	JOCAL-HARTLESS COMPLEX, 30 TO 50 PERCENT SLOPES	Moderate	Moderate	High	High
154	JOCAL-MARIPOSA-UMBREPTS ASSOCIATION, 30 TO 75 PERCENT SLOPES	Moderate	Moderate	High	High
155	JOCAL-SITES LOAMS, 5 TO 30 PERCENT SLOPES	Low	Moderate	Moderate	High
157	LEDFORD-NOTNED COMPLEX, 5 TO 30 PERCENT SLOPES	Low	Moderate	Moderate	High
159	LEDMOUNT-ROCK OUTCROP ASSOCIATION, 2 TO 30 PERCENT SLOPES	Low	Low	Moderate	Moderate
160	LEDMOUNT-ROCK OUTCROP ASSOCIATION, 30 TO 75 PERCENT SLOPES	Moderate	Moderate	High	High
161	LITHIC CRYUMBREPTS, 15 TO 75 PERCENT SLOPES	Moderate	Moderate	High	High
162	LITHIC CRYUMBREPTS-WACA ASSOCIATION, 5 TO 30 PERCENT SLOPES	Low	Moderate	Moderate	High
163	LITHIC CRYUMBREPTS-WACA ASSOCIATION, 30 TO 50 PERCENT SLOPES	Moderate	Moderate	High	High
164	LITHIC XERUMBREPTS-ROCK OUTCROP COMPLEX, 15 TO 75 PERCENT SLOPES	Moderate	High	High	Very High
167	MARIPOSA GRAVELLY SILT LOAM, 5 TO 30 PERCENT SLOPES	Low	Moderate	High	High
168	MARIPOSA GRAVELLY SILT LOAM, 30 TO 50 PERCENT SLOPES	Moderate	Moderate	High	High
169	MARIPOSA-JOCAL COMPLEX, 5 TO 30 PERCENT SLOPES	Moderate	Moderate	High	High
170	MARIPOSA-JOCAL COMPLEX, 30 TO 75 PERCENT SLOPES	Moderate	High	High	Very High
171	MARIPOSA-MAYMEN COMPLEX, 5 TO 30 PERCENT SLOPES	Moderate	High	High	Very High

172	MARIPOSA-MAYMEN COMPLEX, 30 TO 75 PERCENT SLOPES	Moderate	High	Very High	Very High
173	MAYMEN-ROCK OUTCROP ASSOCIATION, 30 TO 75 PERCENT SLOPES	Moderate	High	Very High	Very High
174	MAYMEN-ROCK OUTCROP ASSOCIATION, 75 TO 100 PERCENT SLOPES	High	High	Very High	Very High
175	MCCARTHY GRAVELLY SANDY LOAM, 2 TO 30 PERCENT SLOPES	Low	Low	Low	Low
176	MCCARTHY GRAVELLY SANDY LOAM, 30 TO 50 PERCENT SLOPES	Low	Low	Low	Moderate
177	MCCARTHY-LEDMOUNT ASSOCIATION, 2 TO 30 PERCENT SLOPES	Low	Low	Low	Moderate
178	MCCARTHY-LEDMOUNT ASSOCIATION, 30 TO 75 PERCENT SLOPES	Low	Moderate	Moderate	High
179	MCCARTHY, RHYOLITIC SUBSTRATUM-ROCK OUTCROP COMPLEX, 15 TO 75 PERCENT SLOPES	Moderate	Moderate	High	High
180	MIERUF VERY GRAVELLY LOAM, 5 TO 30 PERCENT SLOPES	Low	Low	Low	Low
182	NEUNS GRAVELLY LOAM, 15 TO 30 PERCENT SLOPES	Low	Low	Low	Moderate
184	NEUNS GRAVELLY LOAM, 50 TO 75 PERCENT SLOPES	Moderate	Moderate	High	High
185	NEUNS-LITHIC XERUMBREPTS-ROCK OUTCROP ASSOCIATION, 50 TO 100 PERCENT SLOPES	Moderate	High	Very High	Very High
192	PILLIKEN COARSE SANDY LOAM, 5 TO 30 PERCENT SLOPES	Low	Low	Low	Moderate
193	PILLIKEN COARSE SANDY LOAM, 30 TO 50 PERCENT SLOPES	Moderate	Moderate	High	High
195	PILLIKEN-ROCK OUTCROP COMPLEX, 30 TO 50 PERCENT SLOPES	Moderate	High	High	High
196	PITS, BORROW	-	-	-	-
197	RIVERWASH	-	-	-	-
198	ROCK OUTCROP	-	-	-	-
201	TALLAC VERY COBBLY SANDY LOAM, 2 TO 30 PERCENT SLOPES	Low	Low	Low	Moderate
202	TALLAC VERY COBBLY SANDY LOAM, 15 TO 30 PERCENT SLOPES, STONY	Low	Moderate	Moderate	High
203	TALLAC-CRYUMBREPTS, WET ASSOCIATION, 15 TO 30 PERCENT SLOPES	Low	Low	Moderate	Moderate
204	TALLAC VARIANT-LITHIC XERUMBREPTS-ROCK OUTCROP COMPLEX, 15 TO 50 PERCENT SLOPES	Moderate	Moderate	High	High
211	WACA COBBLY SANDY LOAM, 5 TO 30 PERCENT SLOPES	Low	Low	Low	Low
212	WACA COBBLY SANDY LOAM, 30 TO 50 PERCENT SLOPES	Low	Low	Moderate	Moderate
213	WACA-LITHIC CRYUMBREPTS ASSOCIATION, 30 TO 50 PERCENT SLOPES	Low	Moderate	High	High
217	WACA-WINDY COMPLEX, 30 TO 50 PERCENT SLOPES	Low	Moderate	Moderate	High

218	WINDY GRAVELLY SANDY LOAM, 5 TO 30 PERCENT SLOPES	Low	Low	Low	Low
219	WINDY GRAVELLY SANDY LOAM, 30 TO 50 PERCENT SLOPES	Low	Moderate	Moderate	Moderate
221	ZEIBRIGHT EXTREMELY GRAVELLY COARSE SANDY LOAM, 2 TO 30 PERCENT SLOPES	Low	Low	Low	Low
222	ZEIBRIGHT EXTEMELY GRAVELLY COARSE SANDY LOAM, 30 TO 75 PERCENT SLOPES	Low	Moderate	Moderate	Moderate
224	ZEIBRIGHT-ROCK OUTCROP ASSOCIATION, 15 TO 75 PERCENT SLOPES	Moderate	Moderate	High	High
AaF	Acidic rock land	Moderate	High	High	Very High
ACF	Ahart-Waca, rhyolitic substratum complex, 30 to 50 percent slopes	Low	Moderate	Moderate	Moderate
ADF	Ahart-Waca, rhyolitic substratum-Cryumbrepts, wet complex, 30 to 50 percent slopes	Low	Moderate	Moderate	High
AEF	Ahart-Rock outcrop-Ledmount variant complex, 30 to 50 percent slopes	Moderate	High	High	Very High
CcE	Chaix very rocky coarse sandy loam, 9 to 50 percent slopes	Low	Moderate	Moderate	High
CoE	Cohasset cobbly loam, 15 to 50 percent slopes	Low	Moderate	Moderate	High
GP	Gravel pits	Moderate	High	High	Very High
HsE	Horseshoe gravelly loam, 30 to 50 percent slopes	Low	Moderate	Moderate	High
JrD	Josephine gravelly loam, 15 to 30 percent slopes	Low	Moderate	Moderate	High
JsE	Josephine very rocky loam, 15 to 50 percent slopes	Low	Moderate	Moderate	High
MbE	Mariposa very rocky silt loam, 3 to 50 percent slopes	Low	Moderate	Moderate	High
MbF	Mariposa very rocky silt loam, 50 to 70 percent slopes	Moderate	High	High	Very High
McE	Mariposa-Josephine very rocky loams, 15 to 50 percent slopes	Low	Moderate	Moderate	High
MfF	Maymen very rocky loam, 15 to 70 percent slopes	Low	Moderate	Moderate	Moderate
MIG	Meiss-Rock outcrop complex, 30 to 75 percent slopes	Moderate	High	High	Very High
MKE	Meiss-Waca complex, 2 to 30 percent slopes	Moderate	Moderate	High	High
MLG	Meiss-Waca-Cryumbrepts, wet complex, 30 to 75 percent slopes	Moderate	Moderate	High	High
MmF	Metamorphic rock land	Moderate	High	Very High	Very High
MrD	Musick sandy loam, 15 to 30 percent slopes	Moderate	Moderate	High	High
MtE	Musick very rocky sandy loam, 15 to 50 percent slopes	Moderate	Moderate	High	High
SdE	Shaver very rocky coarse sandy loam, 15 to 50 percent	Low	Moderate	Moderate	Moderate
SrE	Sites very rocky loam, 15 to 50 percent slopes	Low	Moderate	Moderate	High
TBE	Tallac-Cryumbrepts, wet complex, 2 to 30 percent slopes	Low	Low	Moderate	Moderate
TBF	Tallac-Cryumbrepts, wet complex, 30 to 50 percent slopes	Low	Moderate	High	High
WBF	Waca-Cryumbrepts, wet-Windy complex, 30 to 50 percent slopes	Moderate	Moderate	High	High
WDF	Waca-Meiss complex, 30 to 50 percent slopes	Low	Moderate	High	High