BAER Assessment Soils Report – Route Complex

SIX RIVERS AND SHASTA-TRINITY NFs

CA-SRF-001476

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29 September 2015

Introduction

The Route Complex is one of a series of fires that occurred within the 4th field South Fork of the Trinity River Watershed; portions of five complexes have the potential to feed sediments into the river, which could have significant effects to federally listed fish and their habitat. These lightning caused fires began on 30 July 2015 and in some cases portions were still active during the various BAER Assessments.

The Route Complex includes the Johnson, Buck and a series of small spot fires totaling 35,676 acres according to the modeling completed for the soils assessment. The landscape for the Route Complex is similar to the Mad River Complex, which is roughly five miles south of the Johnson Fire.

This report summarizes the potential post-wildfire effects to soil resources within the Route Lightning Complex. It is based on findings of aerial reconnaissance and field investigations of soil burn severities within the perimeter of the two largest fires in addition to modeling of soil erosion processes. Field investigations of post-fire soil conditions and corresponding model results were used to determine the potential effects to Values at Risk identified within or downstream of each fire. The BAER assessment was conducted from 7 September through 15 September 2015.

Dominant Soils

There were two isolated large polygons within the Route Complex in addition to a series of small spot fires. The Buck Fire was 1,669 acres and located about one and one-half miles southwest of the Mad River Ranger District office in Mad River, California. The vegetative and soil burn severities were predominantly low. The Team did not find any Values at Risk instigating the need for further investigation beyond initial field observations.

The spot fires within the Route Complex totaled 52 acres. As with the Buck Fire, they sustained primarily low vegetative and soil burn severities and did not warrant exhaustive analysis.

The Johnson Fire had the largest perimeter within the complex at 33,957 acres and is the focus of this report.

The dominant soils within Johnson Fire included the following: Melbourne-Holland (Fine, mixed, mesic Ultic Haploxeralfs - Fine loamy, mixed, mesic Ultic Haploxeralfs); Albus-Race Deep (Loamy skeletal, micaceous, frigid Ultic Haploxeralfs-Fine loamy, micaceous, frigid, Dystric Xerochrepts); and Hecker Deep (Loamy skeletal, mixed, mesic Mollic Haploxeralfs).

The dominant soils on the Buck Fire was Skalan-Kistirn-Holland, deep (Loamy-skeletal, mixed mesic Ultic Haploxeralfs-Loamy skeletal, mixed, mesic Typic Haploxerults- Fine loamy, mixed, mesic Ultic Haploxeralfs). See Table 1 for a complete list of the dominant soils and Appendix A, Maps 1 and 2 for a spatial display of the Johnson and Buck Fires.

Table 1. Soil Map Units for the various fires within the Route Complex perimeter.

Fire	Map Unit	Association	Surface Texture	Hydrologic Group	Acres
Buck	237	Clallam, mod. deep, unstable-Melbourne	loam	B-C/C	192
	259	Nanny, Deep-Woodseye-bins, deep	gravelly loam	B-C/C/B-C	253
	280	Deadwood-Clallam, deep, ext. gravelly	gravelly loam	C/C/D	362
	260	Skalan-Kistirn-Holland, deep	gravelly loam	B/C/C	576
Johnson	252	Melbourne-Holland	Clay loam/gravelly loam	C/B-C	7,596
	258	Albus Race Deep	Gravelly loam	B-C/C	3,624
	256	Hecker Deep	Gravelly loam	B-C	3,584
	222	Neuns	Sandy Loam	B	2,231
	121	Holland, Deep	Gravelly Loam	B/B	1,719
	187	Marpa	Loam	B/B	1,296
	131	Hugo	Loam	B	1,170
Spot Fires	8	Atter	Sandy Loam	A	32
	251	Rock Outcrop	N/A	D	9
	227	Neuns	Sandy Loam	B	4

The majority of the soils had loam surface textures with varying degrees of gravel. Rock outcrops occur as a minor component throughout the various fire perimeters. Many of these soils are formed from weathering metasedimentary rocks, which have naturally high erosion hazard ratings. Although all four hydrologic soil groups are represented within the Route Complex, the vast majority of the soils would be rated as “low” or “low-moderate” run-off potential on the Shasta-Trinity and Six Rivers NFs, respectively.

<u>Soil Burn Severity</u>

Soil Burn Severity (SBS) was assessed following principles described in Parsons et. al. (2010). The team downloaded the Burned Area Reflectance Classification (BARC) imagery from the Remote Sensing Applications Center (RSAC) in Salt Lake City on 28 August 2015. Soil scientists collected data at various locations within the Buck and Johnson fire perimeters to validate the imagery concentrating on the areas that appeared the greatest Values at Risk. Soil Burn Severity ratings for the fires within the complex are summarized in Table 2 and displayed spatially for the Johnson and Buck Fires on Maps 3 and 4 in Appendix A.

Table 2. Soil Burn Severity percentages for each fire within the Route Complex.

Soil Burn Severity (SBS) - Percent				
Fire	**High**	**Moderate**	**Low**	**Very Low/Unburned**
Buck	0.14	6	81	13
Johnson	7	20	66	7
Spot Fires	0	12	65	23

The initial BARC imagery gave a reasonable approximation of soil burn severities found within the Johnson Fire, the largest fire within the complex. For the Buck Fire, the "unburned/very low" SBS threshold was adjusted up as appropriate based on field observations.

There was no field validation of the spot fires, due to their small size and lack of Values at Risk (VAR); the presence of which VAR's would have triggered greater scrutiny. Therefore, there will be no further analysis of the spot fires, except where they are included in tables for the sake of data continuity.

As can be seen in Table 2, the Buck Fire was dominated by low Soil Burn Severity. The areas that sustained moderate SBS were concentrated at the western edge of the fire. There were no Values at Risk within or adjacent to the moderate soil burn severity, so the Buck Fire was dropped from further analysis.

Although the Johnson Fire was dominated by "low" and "unburned/very low" SBS (sixty-six and seven percent, respectively), there were large concentrations of "high" SBS in several 7th field watersheds (Pelletreau Creek, Big Creek-Hyampom, and Upper as well as Middle Pilot Creek), which triggered the need for greater investigation. These areas of high SBS were frequently encountered on the ridge tops; however, the vicinities of the 3N10, 3N19, 3N33, 3N06, and 3N14 roads had contiguous patches of high SBS as well (See Map 3 in Appendix A). These areas were characterized by a lack of any surface litter. Since there would be no recruitment of needle cast from overstory trees, there is a concern that these areas could provide significant sediment inputs to down slope creeks, which house federally listed fish or their potential habitat. Ash was discontinuous throughout the polygon and appeared to be "compacted" by the earlier precipitation event.

Strong surface hydrophobicity was detected in all the plots located within moderate and high SBS on forest system lands (Table 3). The strong hydrophobicity was most frequently found down to three inches, although a few areas had depths down to four and one-half inches. There were a few locations on the private timberlands, where no hydrophobicity was observed at the surface. Dave Young attributed this lack of hydrophobicity to localized compaction (D. Young, pers. comm.).

One confounding fact was the presence of strong background hydrophobicity within the unburned fir stands. Since the litter layer was intact within the unburned/very low SBS and present in a patchy distribution in the low SBS polygons, it was disregarded in terms of watershed response for the purpose of this analysis.

Table 3. Acres of Soils with Water Repellency at Surface

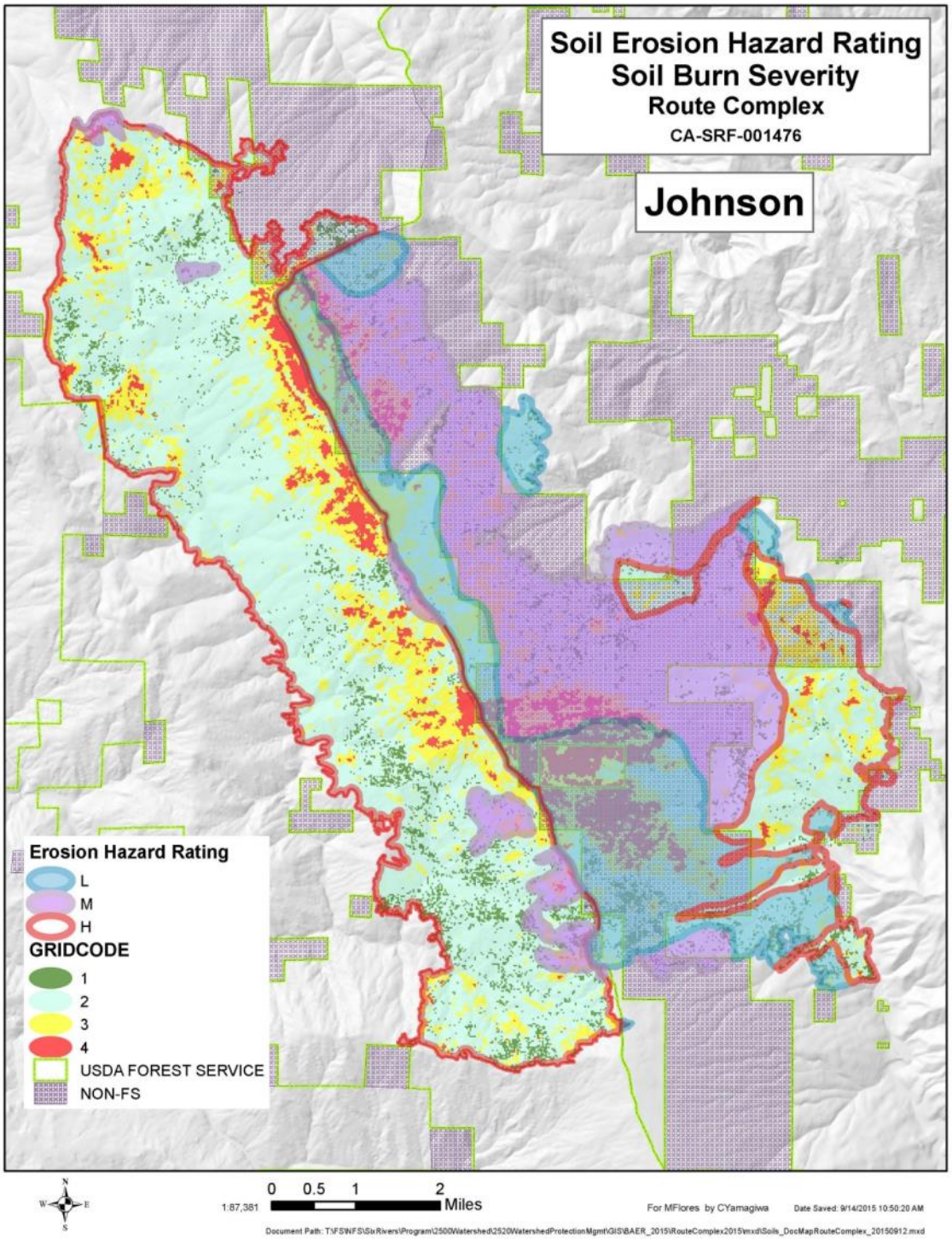
Fire	Strong	Medium	Weak	Total
Buck	0	167	1,502	1,669
Johnson	9,118	0	2,000	33,957
Spot Fires	No data	No data	No data	No data
Total	**30,000**	**167**	**3,502**	**35626**

Erosion Hazard Rating

To determine Erosion Hazard Rating (EHR), the soil scientists utilized the California Erosion Hazard Rating system for sheet and rill erosion. The same method used to determine EHR on the Mad Complex BAER assessment was employed to determine EHR for the Route Complex. Pre-fire, the erosion hazard ratings for the Johnson Fire ranged from “low” to “high”.

Using an overlay of the soil burn severity map, with the erosion hazard rating map, two facts become apparent. First, most of the areas with the highest EHR’s, sustained low to unburned/very low soil burn severities. Conversely, many of the areas that sustained high soil burn severities were typed with low erosion hazard ratings (e.g. Pelletreau Creek) (Figure 1).

Figure 1. Johnson Fire Soil Burn Severity by Erosion Hazard Rating.



The baseline erosion rate for the forest system lands within the fire perimeter was estimated as 0.2 tons per acre in vegetated forests (D. Young, pers. comm.). Based on conversations with various Six Rivers staff, roads were considered to be the greatest source of sediments in unburned areas. A sediment source analysis conducted in part near Ruth Lake (which was situated near the Buck Fire), provided an estimated background sedimentation rate of 8 tons/acre, due to roads (Graham Matthews & Associates. 2007).

To determine the potential sediment yield in tons per acre attributed to the fire, the soil scientist used the Erosion Risk Management Tool (ERMiT) model. Documentation may be found at http://forest.moscowfsl.wsu.edu/fswepp/. This model only uses single hillslopes and single storm runoff events, and not annual estimates. A custom climate was used for the vicinity of the 3N14 road to determine, if there would be significant changes in potential sediment yields at higher elevations; this climate was generated using the PRISM module integrated within the ERMiT tool. The probability level to determine potential erosion was modelled at 10%, which equates to a 10 year run off event. Stated model output accuracy is +/- 50%; therefore, the absolute numbers would be considered **best estimates** only.

An average yield for the potential erosion based on ERMiT runs was 27.2 tons/acre for all but one dominant 7th field watershed. An average of the potential soil erosion was determined for one separate location, the Pelletreau Creek 7th field watershed. The average potential erosion from the ERMiT runs was 28.4 tons/acre for this area. See Appendix B for the full data for high and moderate SBS for the dominant watersheds in the Johnson Fire.

Although ERMiT also models the probable success of potential treatments in terms of reduction in sediment production, only the untreated values were used for the soils analysis, since no hillslope treatments were proposed by the BAER team for soil productivity.

Values at risk for soils including emergency determination

Threats to Soils Resources

A single Value at Risk was determined for soil resources, the decrease in soil productivity from fire induced erosion. The combination of deep, medium-textured (i.e., loamy) soils, steep slopes, and lack of soil cover (vegetation and litter) in moderate and high severity burn areas would likely result in accelerated erosion of these areas. Accelerated soil erosion would not be as pronounced in areas subjected to very low and low soil burn severities.

Onsite fire effects include physical, chemical, and biological changes to soils caused directly by soil heating that damages soil structure, porosity, aggregate stability, and oxidizes nutrients. Indirect effects include subsequent soil loss through wind and water erosion caused by loss of soil cover. The removal of the cover leads to decreased soil productivity and hydrologic function. Loss of soil nutrients and microbial communities could occur in some areas, with these adverse effects increasing by soil burn severity class. These conditions could result in short- to long-term degradation of ecosystem function, depending on site specific effects.

Seventy-three percent of the soils within fire affected areas exhibited unburned/very low to low burn severities within the Johnson Fire. Therefore, effects of the fire upon soil productivity and hydrologic function are considered within the 'normal' range of variability at most locations within the fire perimeters. However, soils that were burned at moderate and high burn severity have been identified as Values at Risk, since the potential loss in soil productivity that would occur on these soils, if eroded, would be substantial. The identified areas encompass approximately twenty-seven percent of the burned area.

There is no doubt that fires can have negative effects on soil properties, but determining the magnitude of these effects is difficult. A very brief query of the literature yielded one paper of interest. The study on changes in phyllosilicates was conducted on several soils throughout California including samples from the Klamath NF. Dave Young, North Zone Soil Scientist, felt the results would be germane to the soils in the Route Complex. The authors found that fires produced no visible soil alterations except in areas that had heavy enough fuels to sustain high residence times (e.g. under logs) (Ulery et. al. 1996.).

Data specific to the Six Rivers NF is as follows. To test sedimentation from fire affected areas, Adam Dresser, a long-tenured Six Rivers NF hydrologist, positioned silt fences with replicates in areas typed as unburned and high burn severity within three fires. The soils were gravelly loams typical of the Route Complex. The elevation at two of the fires was about 2,000 feet, which would be considered as "outside of the snow zone". Six Rivers NF staff felt this fact was important, since the snow can act as a "blanket" aiding in maintaining soils in place. The amount of potential sedimentation was measured the first year post-fire. There was little to no sedimentation detected from that sustained high soil burn severity within any of the three fires (A. Dresser, pers. comm.).

Negative effects to soil productivity, due to erosion can be dramatic, but in the case of the Johnson Fire they are distributed throughout the fire instead concentrated for the most part. For example, 16.6 percent of Pelletreau Creek was categorized with high soil burn severity, which was the largest concentration of high SBS within the Johnson Fire. To contrast, six percent of Upper and Middle Pilot Creeks was typed with high burn severity.

Hillslope treatments can be cost prohibitive and are usually targeted for areas with VAR's, where some efficacy in treatment can be achieved. Pelletreau Creek was selected for an analysis to determine the effectiveness and costs associated with treating a forest system land inholding. Roughly four percent of the watershed would be treated within the inholding. The ERMiT runs indicated that there would be a decrease of approximately fifty percent in the potential sedimentation from the high SBS within the inholding by applying mulch.

To determine the cost of the treatment, the values for wood straw was used. The Route BAER Team botanists recommended utilizing wood straw, because of the concern of introducing weeds through mulching efforts. Since protection of native plant communities was one of the VAR's the team is requesting funding, utilizing the agricultural straw could be counter–productive. The cost of treating the 321 acres of inholding would be $642,000, which was not a cost effective treatment for the area.

Ultimately, the degree of loss of soil productivity, due to erosion will depend upon the intensity and duration of future precipitation events and the rates of natural vegetative recovery. Effective vegetative ground cover is anticipated to recover on areas that sustained high and moderate soil burn severity within three years (R. Butz, pers. comm.). Erosion rates are expected to decline each year as revegetation and natural recovery processes occur.

Although there are acreages that could be treated for soil productivity, there is no way to treat them at a scale large enough to effectively decrease the potential loss of soil productivity associated with the fire. The emergency determination is summarized below:

Very High Risk (very likely, moderate) to soil quality is expected, due to accelerated erosion from areas, which sustained moderate to high burn severities; six percent of the Buck Fire and twenty-seven percent of the Johnson Fire were categorized with these soil burn severities. To be consistent with the BAER matrix, eight to ten years was the estimated length of time for recovery from the loss of effective ground cover and above ground organic matter. Over the long term, the loss of surface soils can lead to deceased commodity production (e.g. timber or livestock forage). In addition, the decrease in site productivity has the potential to increase the spread of invasive plant species, since noxious weeds are able to more readily establish occurrences on degraded sites. In the short term, unauthorized OHV intrusions can continue the degradation of soil productivity in localized areas of use, due to the loss of litter cover associated with the fire. **No treatments were recommended for soil productivity, since the various fires within the complex sustained predominately low to very low soil burn severities with a mosaic of unburned areas within the fire perimeters.**

Personal Communications

Butz, Ramona. September 2015. Province Ecologist, Six Rivers NF. Eureka, CA

Dresser, Adam. September 2015. Hydrologist, Six Rivers NF. Eureka, CA

Young, D. September 2015. Pacific Southwest Region - North Zone Soil Scientist. Redding, CA

References

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

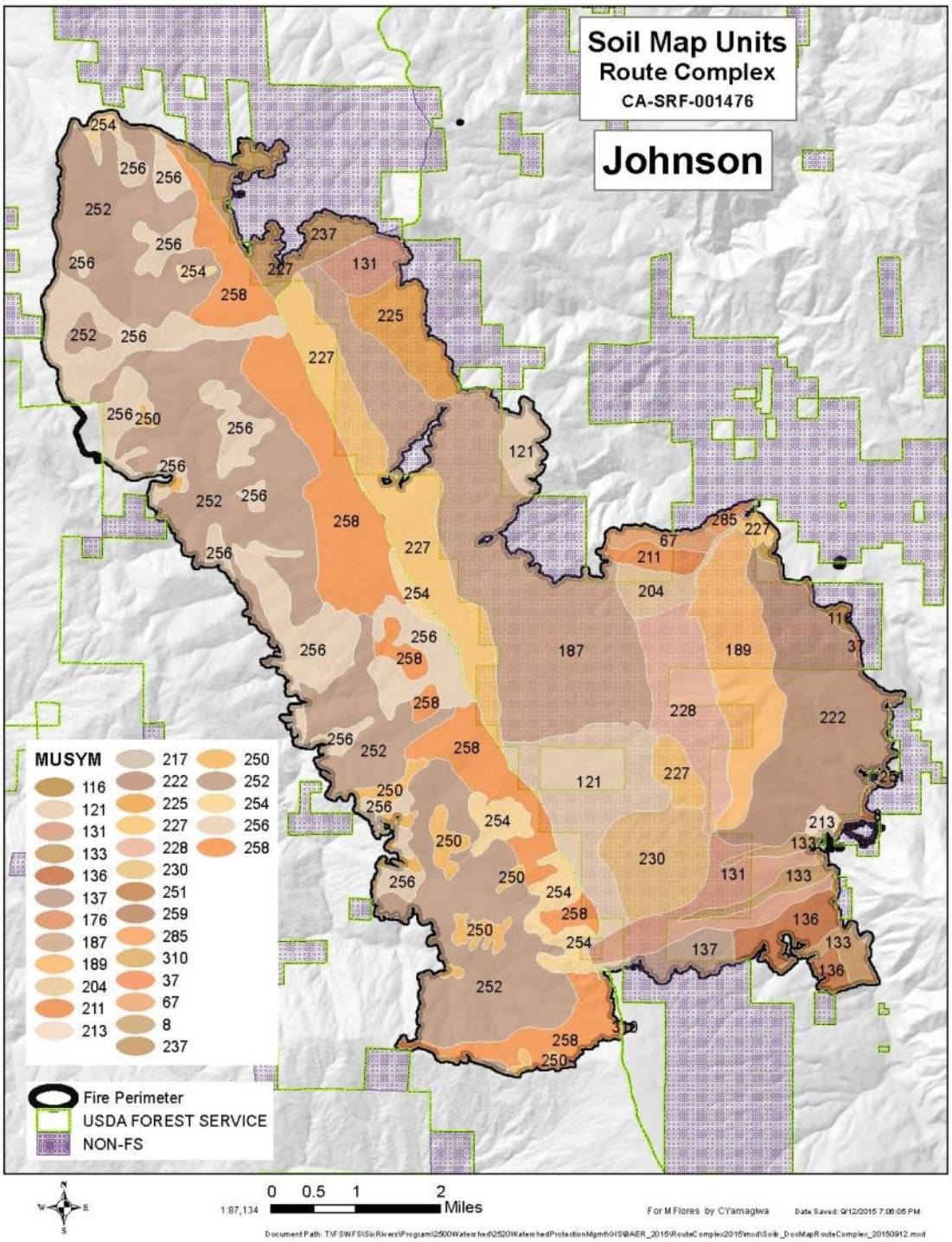
Ulery, A. R. Graham, and L. Bowen. 1996. Forest fire effects on soil phyllosilicates in California. Soil Science Society of America Journal 60: 309-315.

United States Department of Agriculture, Forest Service. 1993. Soil Survey of the Shasta-Trinity National Forest, California. Pacific Southwest Region. Completed in cooperation with the U.S.D.A. Soil Conservation Service.

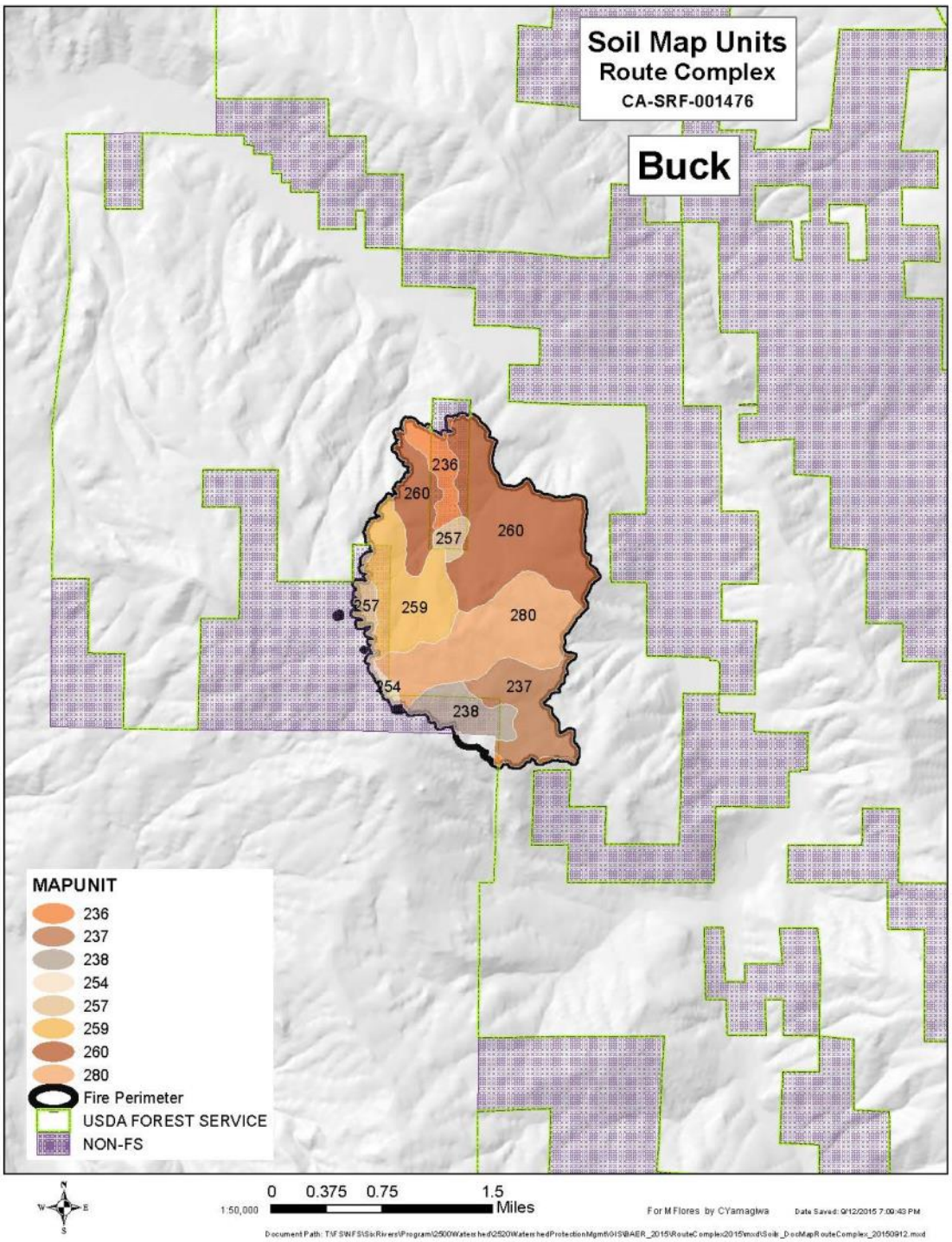
United States Department of Agriculture, Forest Service. 1993. Soil Survey of the Six Rivers National Forest, California. Pacific Southwest Region. Completed in cooperation with the U.S.D.A. Soil Conservation Service.

APPENDIX A – MAPS

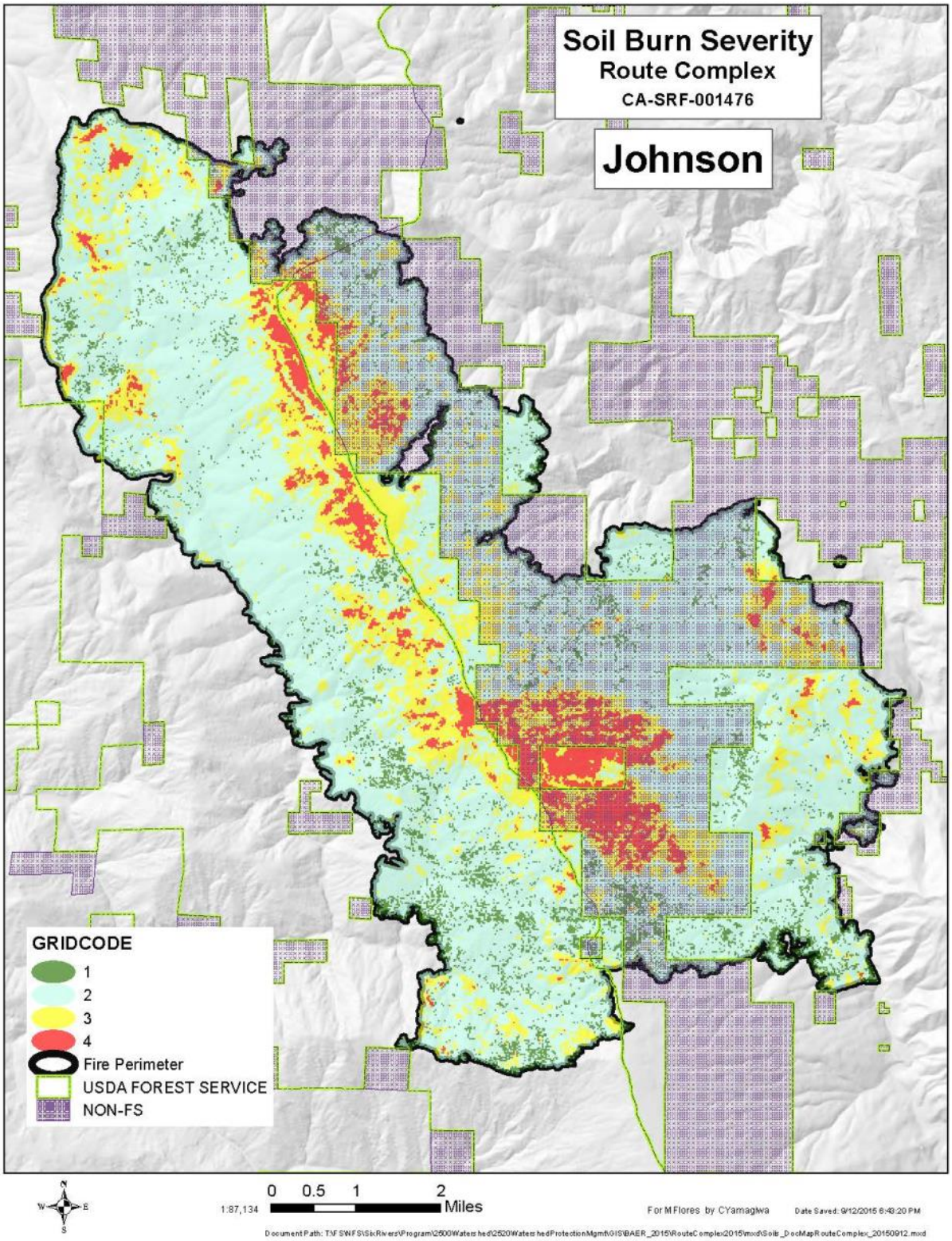
Map 1 – Soil Map Units for the Johnson Fire



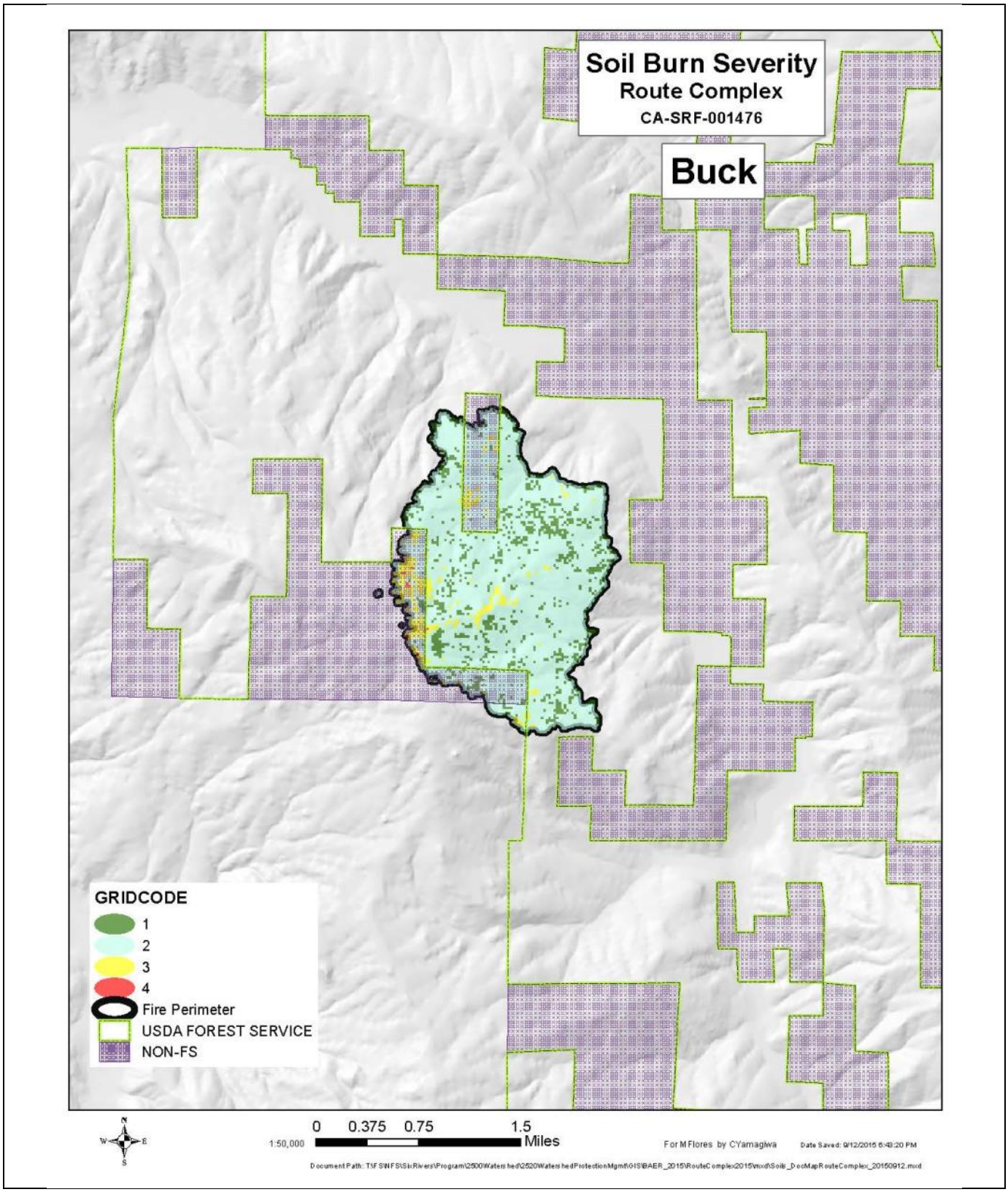
Map 2 – Soil Map Units for the Buck Fire



Map 3 – Soil Burn Severity for the Johnson Fire



Map 4 – Soil Burn Severity for the Buck Fire



APPENDIX B – RESULTS OF ERMIT MODELING

ERMiT generated potential hillslope erosion (+/-50%) for 7th field watersheds in the Johnson Fire

7th Field Watershed	Acres	Sediment Yield in tons/ac during the 1st season (10 year run off event)
Big Creek-Hyampom		
High		
187	147	34.1
227	127	22.8
Moderate		
121	1	29.7
131	33	27.9
187	295	28.7
225	72	20.8
227	504	17.5
East Creek		
High		
252	7	26.1
254	12	39.4
258	26	44.3
Moderate		
250	23	32.3
252	182	21
254	120	31.1
256	6	32.8
258	329	36.8
Hitchcock Creek-Oak Flat		
High		
131	5	33.19
133	2	27.9
222	16	25.4
230	36	21.7
Moderate		
8	6	
121	27	

7th Field Watershed	Acres	Sediment Yield in tons/ac during the 1st season (10 year run off event)
131	92	27.9
133	27	27.9
136	27	38.6
137	5	
189	0	
213	2	
217	0	
222	184	21.2
228	2	32.1
230	133	21.7
Hyampom Valley		
High		
222	19	25.4
227	5	22.8
Moderate		
121	2	29.7
187	232	24.3
222	46	21.2
227	217	17.5
Middle Pilot Creek		
High		
252	35	26.1
254	6	39.4
256	68	39.6
258	255	44.3
Moderate		
250	11	32.3
252	187	21
254	39	31.1
256	283	32.8
258	572	36.8
Pelletreau Creek		
High		

7th Field Watershed	Acres	Sediment Yield in tons/ac during the 1st season (10 year run off event)
121	719	35.1
187	229	28
189	18	53.7
222	9	25.4
227	63	22.8
228	4	39.8
230	182	30.4
Moderate		
121	382	29.7
187	394	24.3
189	97	47.4
204	20	52.7
222	43	21.2
227	147	17.5
228	26	32.1
230	157	21.7
Upper Pilot Creek		
High		
252	65	26.1
254	9	39.4
256	88	39.6
258	179	44.3
Moderate		
250	14	32.34
252	548	21
254	10	31.1
256	333	32.8
258	357	36.8
Wintoon Flat-Deep Gulch		
High		
222	33	25.4
Moderate		

7th Field Watershed	Acres	Sediment Yield in tons/ac during the 1st season (10 year run off event)
116	4	
189	1	47.4
222	371	21.2