USDA-FOREST SERVICE
(7/08)

FS-2500-8

Date of Report: 09/17/2015

ELK FIRE BURNED-AREA REPORT
(Reference FSH 2509.13)

PART I - TYPE OF REQUEST

A. Type of Report

[x] 1. Funding request for estimated emergency stabilization funds
[ ] 2. Accomplishment Report
[ ] 3. No Treatment Recommendation

B. Type of Action

[x] 1. Initial Request (Best estimate of funds needed to complete eligible stabilization measures)

[ ] 2. Interim Report #____
[ ] Updating the initial funding request based on more accurate site data or design analysis
[ ] Status of accomplishments to date

[ ] 3. Final Report (Following completion of work)

PART II - BURNED-AREA DESCRIPTION

A. Fire Name: Elk Fire

B. Fire Number: CA-LNU-008268

C. State: California

D. County: Lake

E. Region: 5

F. Forest: Mendocino

G. Districts:Upper Lake

H. Fire Incident Job Code: PNJ23Q

I. Date Fire Started: 9-2-2015

J. Date Fire Contained: 9-11-2015

K. Suppression Cost: Final suppression costs are still being calculated due to fire personnel being occupied by the Valley Fire. Approximate suppression cost is expected to $3.5 million.

L. Fire Suppression Damages Repaired with Suppression Funds
1. Dozerline repaired / waterbarred: 8 miles
2. Hand line repaired: 2 miles
3. Hand line still needing repair: 0 miles

M. Watershed Numbers and Names: Upper Lake; 1802011601

N. Total Acres Burned: 684 acres; NFS Acres: 570; Private: 114

O. Vegetation Types: Dominant is California mixed chaparral mostly chamise and including ceonothes, manzanita, scattered oaks and signficiant stands of knobcone pine. Lower elevations mostly on private include a few acres of oak woodlands. Canyon bottoms,such as along Decy Canyon, have more oaks and limited riparian brush and trees.

P. Dominant soils: Soil types in the burn area derived from NRCS data are:

Soil Complex	Percentage	Acres
Lupoyoma silt loam, protected	2.3	15.7
Maymen-Etsel-Snook complex, 30 to 75 percent slopes	2.0	13.4
Maymen-Etsel-Speaker association, 30 to 50 percent slopes	37.2	253.4
Maymen-Hopland-Etsel association, 15 to 50 percent slopes	41.3	281.5
Maymen-Hopland-Mayacama association, 30 to 50 percent slopes	16.8	114.3
Xerofluvents-Riverwash complex	0.5	3.3

Overall Maymen is the dominant soil and is described as "loamy, mixed, active, mesic, shallow Typic Dystroxerepts." And, "The Maymen series consists of shallow, somewhat excessively drained soils that formed in residuum weathered from shale, schist, greenstone, sandstone and conglomerate. Maymen soils are on mountains. Slopes range from 5 to 100 percent. The mean annual precipitation is about 42 inches, and the mean annual temperature is about 54 degrees F."

Q. Geologic Types: Franciscan Assemblage, Central Belt, melange argillite-matrix: Melange is heavily sheared and is landslide prone. Argillite (shale) is a clay dominated marine sedimentary rock.

R. Miles of Stream Channels by Order or Class: 0 Miles Perennial; 1.2 Miles Intermittent; 7 Miles Ephemeral

S. Transportation System:

Trails: 0 miles – no trails within this fire

Roads: 0.9 miles (Road 16N21) – roads lie along the fire perimeter, but there are no road segments within the burned area.

PART III - WATERSHED CONDITION

A. Burn Severity by total and FS (acres): Note that the soil burn severity acquisition for the Elk Fire was quite cloudy and hazy due to heavy smoke from the Valley Fire and incoming clouds associated with a weather front. Remote Sensing Applications Center staff were able to generate a BARC product, however the results are highly questionable. Thus, the initial BARC only provided a general sense of the distribution of change across the burned area, while the magnitude of that change remains uncertain. This initial BARC did not properly capture the fire perimeter.

Ground checking of the burn severity further complicated the picture as many areas were found to have burn severities differing from the imagery. The differences included both more severely burned locations and less severly burned areas, thus rendering the adjustment of data thresholds to define burn severity classes as ineffective. A final modified burn severity image was generated using extensive ground and aerial photography and site visits.

Overall conditions on the ground showed largely moderate soil burn intensity with large pockets of low soil burn intensity where significant living and dead vegetation was retained. Adding to the lower soil burn intensities was the characteristic burning of chaparral fuels at a rapid rate, reducing fire residence time and soil heating. More intensly burned areas largely retained the "skeletons" of burned chaparral plants and organic matter was common on the surface and in the subsoil. Infrequent and small pockets of high intensity soil burning were present, apparently associated with large fuel loads, but were widespread and composed only a small percentage of the burned area. Rock outcrops, large rocks, and abundant angular gravel are present in soils throughout the burn area.

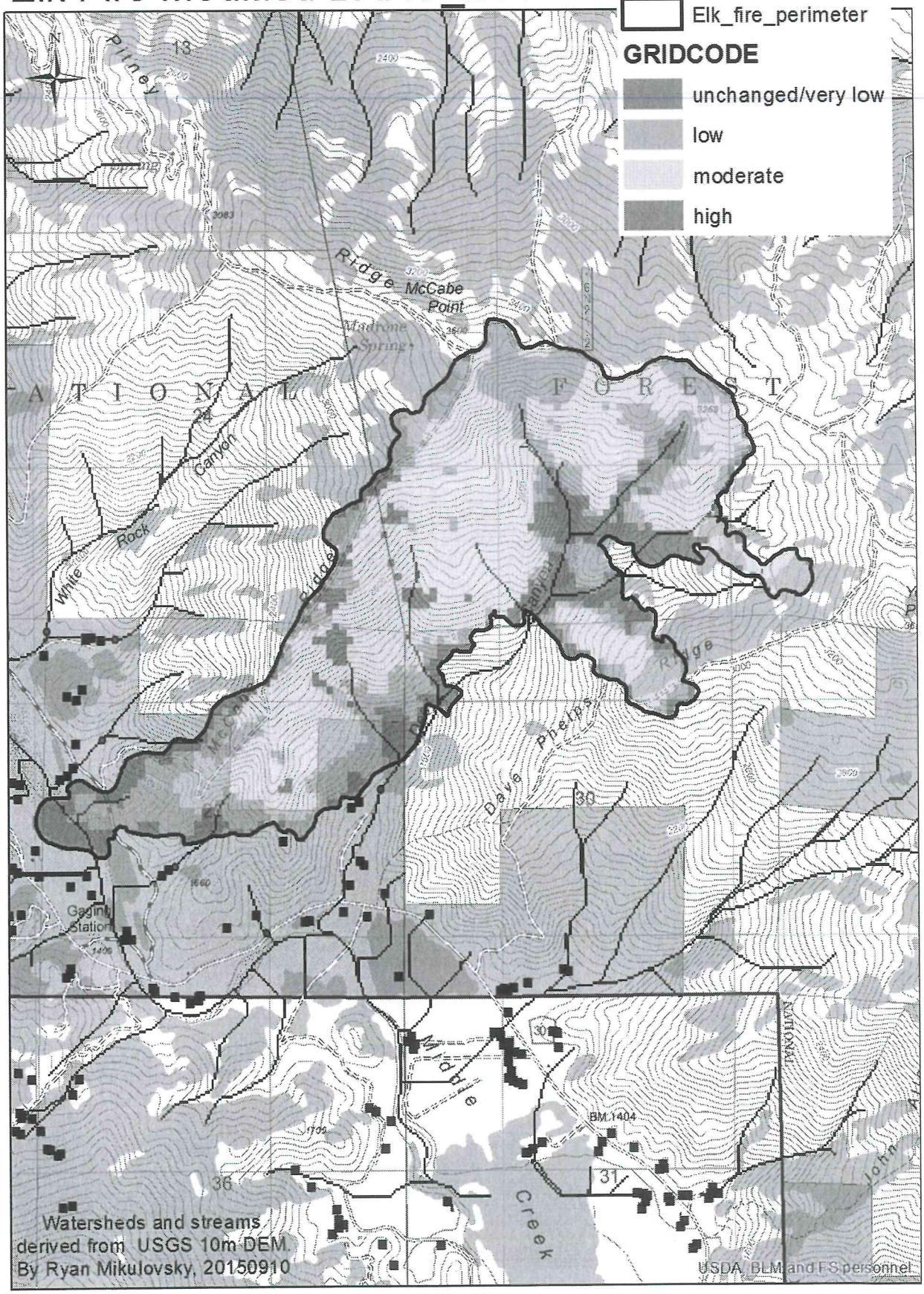
Soil Burn Severity Acres and Percentage					
Fire and Ownership	Unburned and Very Low	Low	Moderate	High	Total Acres
FS	85.2	132.9	348.4	13.1	579.6
Mendocino	14.7%	22.9%	60.1%	2.2%	
Private	36.5	47.2	20.6	0	104.3
	35%	45.3%	19.7%	0	
Totals	121.7	180.1	369	13.1	683.9
	17.8%	26.3%	53.9%	1.9%	

B. Water-Repellent Soil by total and FS: Water repellency was moderate to low, widely scattered and very localized.

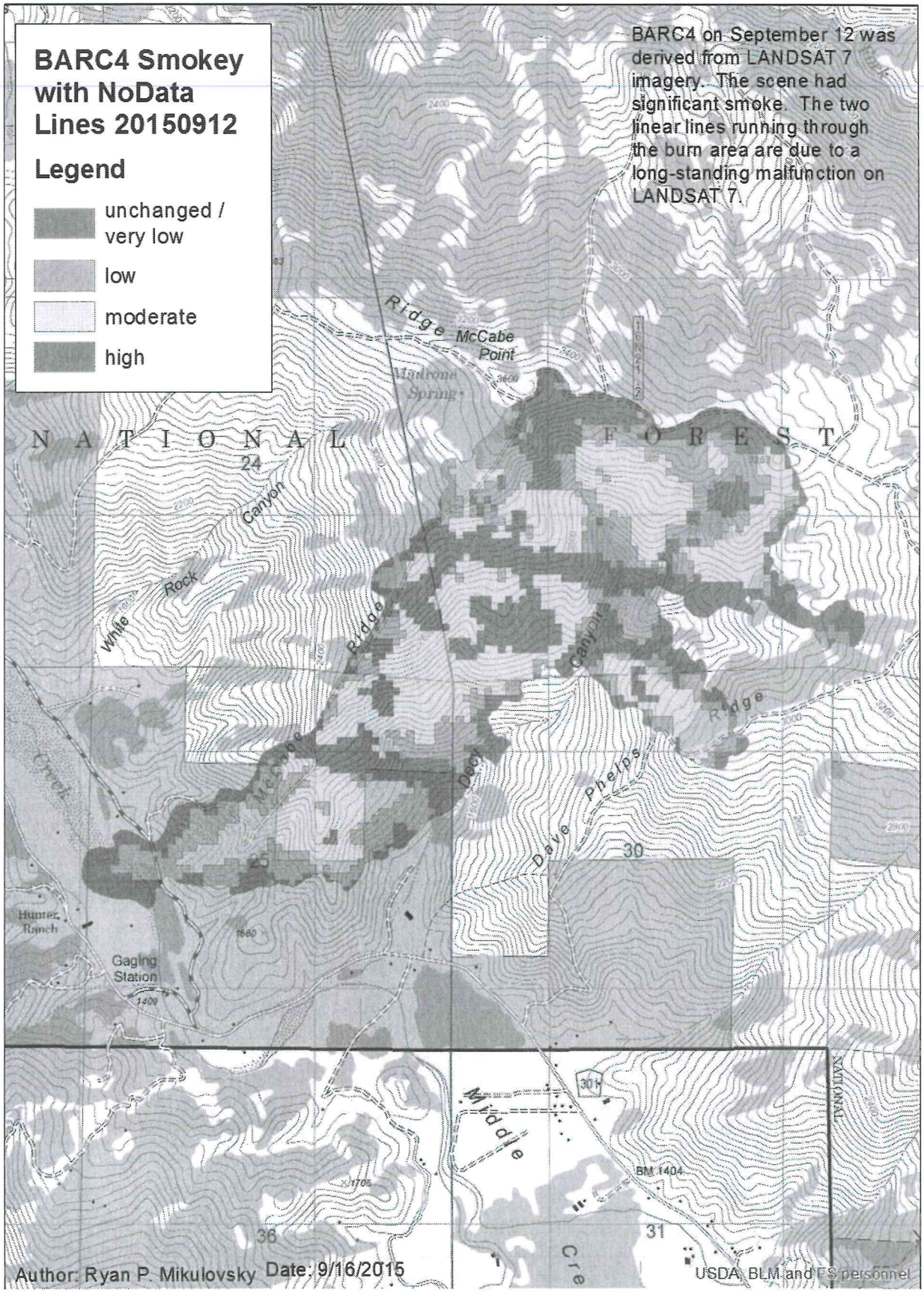
C. Sediment potential, soil erosion hazard rating and erosion potential were not calculated for this BAER using the WEPP modeling approach, but rather were assessed in directly in the field. This approach was possible due to the relatively small size of this fire.

Elk Fire Burn Severity Maps:
Below are the original, unmodified BARC map and also the modified BARC map used for analysis for this report.

Elk Fire Modified BARC_20150912



Elk Fire - Initial BARC4



PART IV - HYDROLOGIC DESIGN FACTORS

A. Estimated Vegetative Recovery Period, (years):	5 (CA chaparral)
B. Design Chance of Success, (percent):	80%
C. Equivalent Design Recurrence Interval, (years):	2
D. Design Storm Duration, (hours):	48
E. Design Storm Magnitude, (inches):	4.28
F. Design Flow, (cubic feet / second/ square mile):	94.88 cfs/mi^2
G. Estimated Reduction in Infiltration, (percent):	10%
H. Adjusted Design Flow, (cfs per square mile):	117.03 cfs/mi^2

PART V - SUMMARY OF ANALYSIS

A. Describe Critical Values and Resources and Threats to Them:

Background:
The Elk Fire started near the banks of Middle Creek in west central Lake County on private property on September 2, 2015. The fire spread quickly upslope into upland canyons and into the Forest. Local fire crews quickly responded, and luckily the ignition location is near a major road and within a few miles of fire stations. High heat and very low fuel moistures due to the drought added to the blaze. Bombers were key in the suppression response and effectively "painted" the ridgelines ahead of several fire fronts. A Forest road along the ridgeline (Pitney Ridge) became the obvious location to hold the fire using the road, bomber drops and bulldozer lines through thick brush. Firefighters gained an upper hand within a few days leading to containment nine days after ignition on September 11th.

Approximately 54% burned at high and moderate soil burn severity (see soil burn severity maps and table above). The rest of the fire was either low or very low soil burn severity.

An important caveat for this analysis is 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.

Values at Risk:

Below are Exhibit 1 and 2 of Interim Directive No.: 2520-2010-1 that list values and resources at risk considered in BAER analysis and also the Risk Matrix used to evaluate the Risk Level for each value identified during a fire BAER assessment.

Values and Resources considered in BAER analysis are:

1. Human life and safety on or in close proximity to burned NFS lands.
2. Buildings, water systems, utility systems, road and trail prisms, dams, wells or other significant investments on or in close proximity to the burned NFS lands.
3. Water used for municipal, domestic, hydropower, or agricultural supply or waters with special state or federal designations on or in close proximity to the burned NFS lands.
4. Soil productivity and hydrologic function on burned NFS lands.
5. Critical habitat or suitable occupied habitat for federally listed threatened or endangered terrestrial, aquatic animal or plant species on or in close proximity to the burned NFS lands.
6. Native or naturalized communities on NFS lands where invasive species or noxious weeds are absent or present in only minor amounts.
7. Cultural resources on NFS lands which are listed on or potentially eligible for the National Register of Historic Places.

Risk Matrix:

Probability of Damage or Loss	**Magnitude of Consequences**		
	Major	Moderate	Minor
	RISK		
Very Likely	**Very High**	**Very High**	**Low**
Likely	**Very High**	**High**	**Low**
Possible	**High**	**Intermediate**	**Low**
Unlikely	**Intermediate**	**Low**	**Very Low**

On the Elk Fire, roads and associated infrastructure, listed and sensitive plant species, invasive plants and animals, terrestrial wildlife and native species, and heritage and cultural resources were determined by Forest Service specialists to **not** be values at risk. There are no emergency situations post-fire threatening these resources. These conclusions are based upon consultation with the District Ranger, Forest Engineer, District and Forest Archaeologists, District Biologist, Forest Botanist, fire management staff and other Forest and District staff persons.

The Elk Fire burned over one larger (Decy Canyon ~ 800 acres) and several smaller canyons on Forest land. At the base of these canyons and near Middle Creek lies private land, homes

and out-buildings, putting at risk human health and safety, property and infrastructure. The Elk Fire produced largely moderate to low intensity soil burning with small pockets of greater soil heating and a greater loss of organic matter. Much of the burned area retains some organic matter on the soil surface and the prevalent angular rock in the soil provides additional protection from erosion. Most of the burned area retains "skeletons" of chaparral plants that are expected to crown re-sprout with the onset of winter rains. Much of the lower channel of Decy Canyon did not burn and sections that did burn did so at low intensity with the retention of most trees and vegetation. Privately owned buildings in lower Decy Canyon were constructed on terraces and do not lie adjacent to the stream channel.

Risk Assessment – Debris Flow, Landslides and Flooding

The risk to life, health and property from debris flows, landslides and flooding in the areas downstream of Decy and McCabe canyons were analyzed by the Forest Geologist and Upper Lake and Covelo Hydrologist. Please see their reports in the appendices to this form. The risk from debris flows, debris slides and landslides was determined to be low or very low but the magnitude of such an issue is major leading to an overall risk level of intermediate. The risk of flooding was determined to be high, but of short duration.

Risk Assessment – Debris flow or landslides

Probability of Damage or Loss: Low
Magnitude of Consequence: Major
Risk Level: Intermediate

Risk Assessment – Flooding

Probability of Damage or Loss: High
Magnitude of Consequence: Major
Risk Level: High

In consideration of a risk of flooding, the most effective treatments for effects of the Elk Fire on private land would be actions proximal to buildings or infrastructure of concern. Private property owners may consult with the Natural Resources Conservation Service or state agencies to consider options to protect their properties. Possibilities include temporary barriers to flooding such as sand bags, when possible, moving personal property away from stream channels, increasing vegetation between infrastructure and the channel. Upland treatments on Forest land to reduce flooding are limited in number, expensive to implement and are often not effective. An example is mulching, which has been used on many fires in an attempt to reduce erosion or flooding. Application would require the use of helicopters, much of the mulch would be blown away due to natural winds and mulch may often not necessarily be effective at reducing flooding.

Risk Assessment – Middle Creek Fisheries, the Clear Lake Hitch

The Clear Lake Hitch is a large minnow endemic to Clear Lake and its tributaries. Hitch spawn in streams above the lake and their largest spawning area is in Middle Creek, immediately below the Elk Fire. Spawning takes place within the water column and fertilized eggs settle into the gravels in the stream bed. The eggs hatch rapidly and fry move downstream to the lake within a couple of weeks in an apparent adaptation to the intermittent flow characteristics of

streams in the area. The Clear Lake Hitch has been petitioned to be listed under the Endangered Species Act, but no action has been taken on this species at this time.

The Elk Fire impacted a very small area of the upland watershed of the Middle Creek. Middle Creek naturally has a very high sediment load particularly in the gravel and cobbles size classes. The Decy Canyon channel was partially burned during the Elk Fire and areas that did so burned at a low intensity retaining both living and dead vegetation. While flooding is a risk from Decy Canyon, debris flows and landslides are not likely. Thus due to the small size of the catchment, the likely small impact on the greater habitat found in Middle Creek the probability of damage is and the magnitude is low with an overall risk level of low.

Risk Assessment – Impacts to the Clear Lake Hitch

Probability of Damage or Loss: Low
Magnitude of Consequence: Minor
Risk Level: Low

B. Emergency Treatment Objectives: There are no proposed treatments for the Elk Fire. The Elk Fire was not an extreme event with largely moderate soil burn severity. Full recovery of the vegetation and the watershed is expected over a relatively short time frame, since plants will re-grow from root crowns and no major earth movements are expected.

Elk Fire Values at Risk Emergency Determination Matrix

Value at Risk	Emergency U%(yes/no)T%			Reason	Treatment
Life and property including homes on private land below the fire area	100%	N	0%	Treatments on Forest are not likely to be effective and could be cost prohibitive	None
Middle Creek Fisheries – the Clear Lake Hitch	100%	N	0%	Impacts and magnitude are low due to the small percentage of the watershed effected by the fire. Low risk of debris flows.	None
U% = untreated; T% = treated; Where Y = yes, M = maybe, and N = no					

C. Probability of Completing Treatment Prior to Damaging Storm or Event:
No proposed treatment.

D. Probability of Treatment Success
No proposed treatment.

E. Cost of No-Action (Including Loss): 0

F. Cost of Selected Alternative (Including Loss): 0

G. Skills Represented on Burned-Area Survey Team:

[x] Hydrology	[] Soils	[x] Geology	[ ] Range	[ ]
[ ] Forestry	[x] Wildlife	[ ] Fire Mgmt.	[x] Engineering	[ ]
[ ] Contracting	[x] Aquatics	[x] Botany	[] Archaeology	[ ]
[x] Fisheries	[ ] Research	[ ] Landscape Arch	[x] GIS	

Team Leader: Joel Despain

Email: jddespain@fs.fed.; Phone: 530-934-1152 or 530-472-1560 (teleworking); Fax: 530-934-7384

H. Treatment Narrative for Forest Service:

No proposed treatments

I. Monitoring Narrative:

There will be no monitoring of treatments on the Elk Fire since there are no proposed treatments.

Part VI – EMERGENCY STABILIZATION TREATMENTS AND FUNDING

There is no funding request for this BAER since there are no recommended treatments.

PART VII - APPROVALS

1. _____ 9/18/15
for Forest Supervisor (signature) Date

2. _____ _____
Regional Forester (signature) Date

APPENDICES: Supporting Information:

Appendix A: Elk Fire BAER Team

Appendix B: Hydrolgist's Report

Appendix C: Geologist's Report

Appendix A: BAER Team:

Position	Name	Quals	Work Phone
BAER Team Leader	Joel Despain	Forest Hydrologist	530 934 1152
GIS Analysis	Ryan Mikulovsky	Forest Geologist	530 934 1188
Geology Report	Ryan Mikulovsky	Forest Geologist	530 934 1188
Hydrology Report	Hilda Kwan	District Hydrologist	707 275 1413
Roads Assessment	Cesar Villa	Forest Roads Manager	530 934 1186
Fisheries Assessment	Derrick Bowden	District Fisheries Biologist	707 275 2361
Botany	Lauren Johnson	Forest Botanist	530 934 1153

Elk Fire
Burned Area Emergency Response
Mendocino National Forest- Upper Lake Ranger District
Geology Report

PHOTO 1 - ELK FIRE OFF PITNEY RIDGE NEAR MCCABE POINT

September 17, 2015

Submitted by:
Ryan Mikulovsky, Geologist
Minerals and Geology Management

BACKGROUND

The Elk Fire was caused by a private landowner and began on September 2, 2015. As of September 10, 2015, the fire has burned approximately 681 acres and is 100% contained. The fire affected private property and land within Forest Service jurisdiction.

WEATHER PATTERNS

Based on historical hydrologic records the BAER hydrologist set the design storm at a two year reoccurrence interval with 48 hours of rainfall. The total spatially average weighted rainfall within the Decy Canyon and McCabe catchments (see Hydrology report for boundaries) is estimated to be 4.7 to 4.8 inches with a range between 3.83 and 4.87 inches. Over a 48 hour period, the average rainfall intensity is 0.1 in/hr. These precipitation metrics were derived from NOAA's Atlas 14 Precipitation Frequency Estimates (Bonnin, Martin, Lin, & Parzybok, 2011) using GIS-based analysis.

In addition to the hydrologist's design storm, convective storms are also considered. Northern California has a rich history of one hour convective summer storms in the Coast Ranges. The most recent within the Mendocino National Forest occurred north of the Eel River Station along the Blands Cove Road. While NOAA's Precipitation Frequency Estimates do not include convective storms, storms of five, ten and 25 year reoccurrence intervals with one hour storm durations were used as inputs to approximate a range of plausible convective storms.

HISTORICAL CONTEXT

Long-time employees of the Upper Lake Ranger District were interviewed on the past flood events of 1997 and 2005 at Upper Lake. In December of 2005, downtown Upper Lake had a significant flood event as Middle Creek overflowed an upstream levee. This resulted in over a foot of water at downtown Upper Lake. However, no debris flows or landslides were observed by residents. Indeed, a review of pre- and post-flood air photos showed that no hillslope failures had occurred but there was significant deposition of gravels within the Decy Canyon channel. As for the 1997 event, which occurred shortly after the September 1996 Fork Fire, Upper Lake did not endure any major impacts. However, the post- 1964/1965 flood event 1968 air photos show a small length (a few hundred yards) of scoured channel denuded of vegetation about 0.5 miles upstream from the private property line. Scoured channels are generally interpreted as being the result of debris flows.

DEBRIS FLOW MODEL

The intermountain western U.S. debris flow model utilized for this risk analysis was developed by Cannon et al (2009). The model is utilized by the United States Geological Survey when they are called upon for BAER (United States Geological Survey, 2015). It is an empirical model that is based on historical bulking debris-flow occurrence in the intermountain western United States. This model has not yet been specifically tuned for California's Coast Range and its landslide-prone Franciscan Assemblage but it is informative. Catchment metrics required for the model were derived using a Geographical Information System (GIS). The output of the model is a probability of debris flows occurring at the catchment outlet or pour point. Additional information, including model equations and inputs, can be found at http://landslides.usgs.gov/hazards/postfire_debrisflow/background.php.

RESULTS AND DISCUSSION

The Decy catchment is expected to have a low risk of debris slides and bulking debris flows over the next winter. Debris slides are shallow hillslope failures where the mobilized material is typically deposited into drainages and then flushed out. During particularly wet weather, debris slides can generate debris flows. Bulking debris flows occur when stream flows entrain material eroded from hillslopes and stream incision. The debris flow model only models bulking debris flows, not the potential for debris slides that may result in debris flows. As the debris flow model results indicate (TABLE 1), there is a low 4% probability of debris flow for a two year, 48-hour duration storm. The total predicted volume for such a debris flow was calculated to be 14,399 yd^3 but as shown above, this has a low probability to occur. The debris flow model resulted in a 21%, or moderate, probability of debris flow for a storm with a 25 year and 24% with a 100 year reoccurrence interval and one-hour duration.

TABLE 1 - STORM REOCCURRENCE, DURATION AND BULKING DEBRIS FLOW PROBABILITY

CATCHMENT	5-YEAR, 1-HOUR	10-YEAR, 1-HOUR	25-YEAR, 1-HOUR	100-YEAR, 1-HOUR	2-YEAR, 2-DAY (DESIGN STORM)	2-YEAR, 2-DAY PROBABLE VOLUME (YD^3)
DECY CANYON	11%	13%	21%	25%	4%	14,399
MCCABE CREEK	9%	11%	17%	21%	4%	1,271

In the long term, no significant increase in landslide potential is expected to occur. The fire adapted chaparral vegetation community – primarily composed of chamise – dominated the burn area on the steeper hillslopes and up to the ridges. In areas that did not burn at high severity, the chaparral are expected to resprout from their crowns and burned knob cone stands will quickly regenerate. With quick resprouting of chamise this winter and spring, soils will benefit from reduce erosion despite modestly reduced soil infiltration rates.

In areas where soils were sampled for hydrophobicity, fine roots and larger tap roots did not burn thus soil holding capacity is likely retained. However, some root die-off may occur but vigorous regrowth of plants is expected to quickly counteract decaying, dead roots. Evapotranspiration in these plant communities is not considered to be high thus there would be negligible impact on groundwater elevations in the immediate aftermath of the fire. Thus the risk of new deep-seated landsliding and reactivated deep-seated landsliding is expected to be very low. Based on observations of the 2012 Mill Fire in similar soils and slightly different climate, the chaparral community is expected to quickly recover in the next three years. In addition, no recent (0-30 years) debris slides or active deep-seated landslides were observed within the burn area. The area does have a few dormant, > 400 year old deep-seated slides but they are not expected to be reactivated.

CONCLUSION

Values at Risk included structures below Decy Canyon and McCabe Ridge (see hydrology report). While per the hydrology report flooding is likely, fire-induced potential for debris flow, debris slides and deep-seated landsliding is low and judged as unlikely for the design storm. A storm with a 25 year and greater reoccurrence interval may cause debris flows but these storms are outside of the BAER treatment scope. This conclusion is based on historical context of catchment response to past storms (such as the 2005

event), field observations that showed a lack of recent (0-30 years) slope failures, and the bulking debris flow model results. No treatments are necessary to prevent these unlikely processes. However, private citizens that own property at the mouth of Decy Canyon should always be prepared for a range of natural disasters, including floods, debris flows and earthquakes.

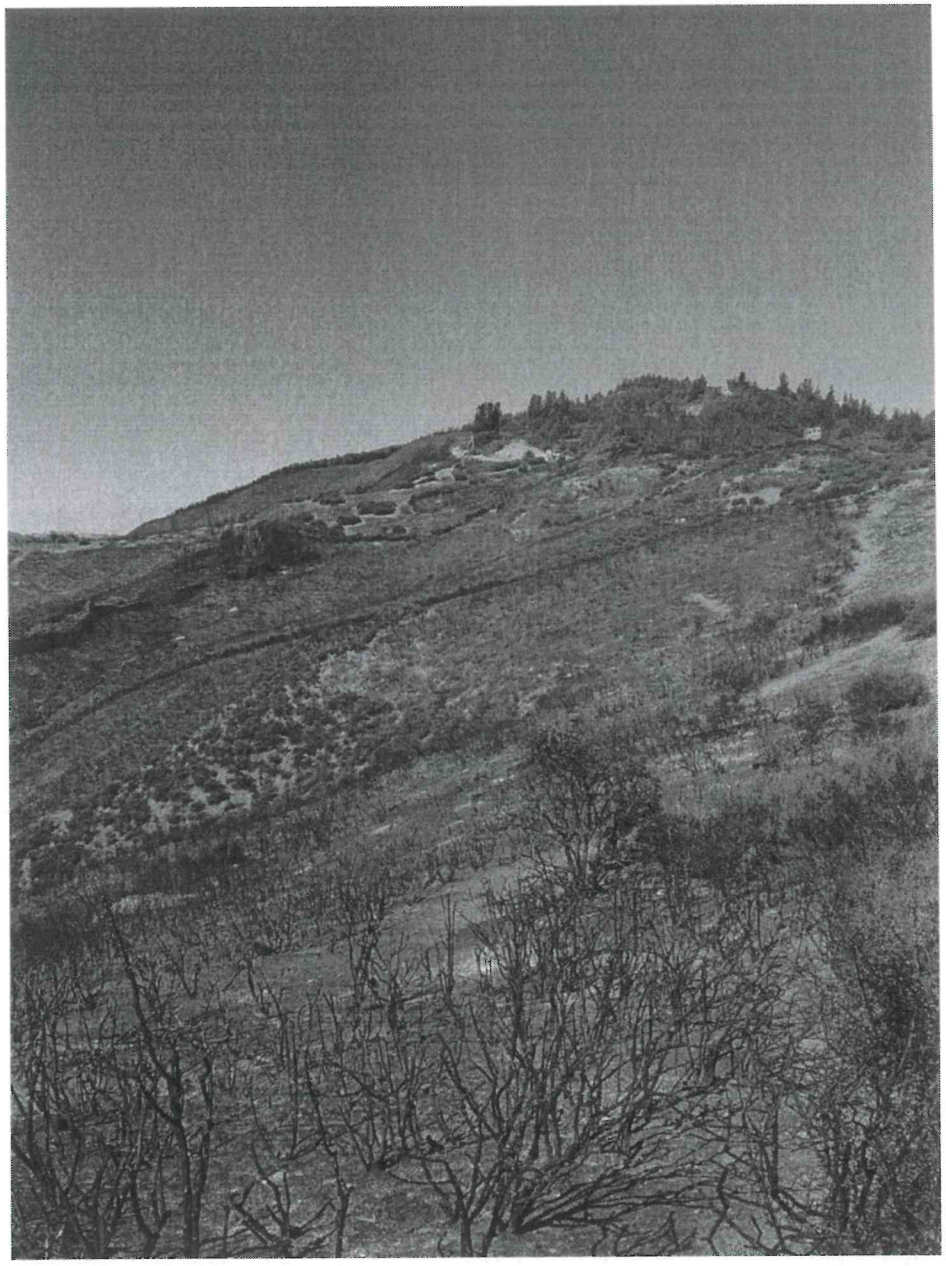
REFERENCES

Bonnin, G., Martin, D., Lin, B., & Parzybok, T. (2011). *Precipitation-frequency atlas of the United States* (Vol. 6). Retrieved from http://hdsc.nws.noaa.gov/hdsc/pfds/docs/NOAA_Atlas_14_Volume1_Version4_Addendum.pdf

Cannon, S. H., Gartner, J., Rupert, M., Michael, J., Rea, A., & Parrett, C. (2009). Predicting the probability and volume of postwildfire debris flows in the intermountain western United States. *Geological Society of America Bulletin*, *122*(1-2), 127–144. doi:10.1130/B26459.1

United States Geological Survey. (2015). Landslide Hazards Program - Scientific Background. Retrieved from http://landslides.usgs.gov/hazards/postfire_debrisflow/background.php

Elk Fire
Burned Area Emergency Response
Mendocino National Forest- Upper Lake Ranger District
Hydrology and Watershed Specialist Report



September 16, 2015

Submitted by:
Hilda Kwan
Mendocino National Forest (ULRD)

The Elk Fire was caused by a private landowner and began on September 2, 2015. As of September 10, 2015, the fire has burned approximately 681 acres and is 100% contained. The fire affected private property and land within Forest Service jurisdiction (Table 2). Elevation within the burned area perimeter ranges between 1404ft to 3651 ft. Moderate and high burn severities tended to occur on steeper slopes.

Table 2. Acres burned by land ownership.

Owner	Acres
Private	103
USFS	578
Total	681

This report summarizes the results from the hydrologic assessment of the Elk Fire in Northern California, as part of the Burned Area Emergency Response (BAER) assessment. This report also provides detailed hydrologic analyses conducted for several watersheds. Several Values at Risk (VARs) were identified during aerial and field reconnaissance. These VARs may include Clearlake Hitch Habitat, human life, property, and roads. The watershed above these VARs were delineated (Figure 1) and flow analyses were conducted.

Fire severity assessment

A Burned Area Reflectance Classification (BARC) image was acquired from the Forest Service Remote Sensing Applications Center. Based on comparisons with archived images, this image classifies the extent of the burned area into four categories: unburned, low severity burn, moderate severity burn, and high severity burn (Figure 2). BAER team members ground-truthed this image through field observations.

Additionally, hydrophobicity tests were conducted in the field within the Elk Fire to determine the water repellency characteristics of affected soils. Natural repellency (pre-fire) was present due to ash-capped soils. Tests in moderately burned and high burned areas indicated moderate hydrophobicity.

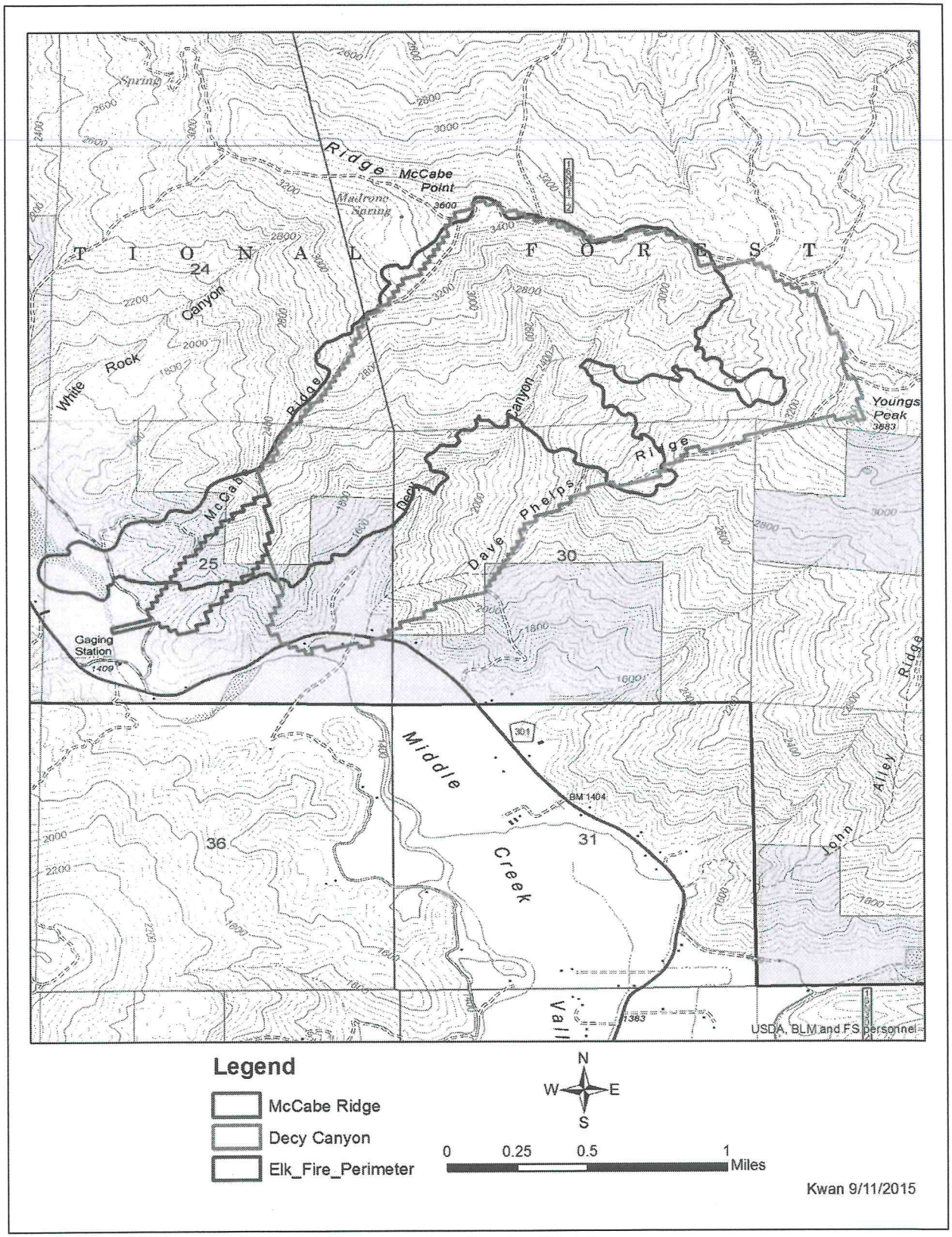


Figure 1. Watersheds identified by pour points for the Elk Fire.

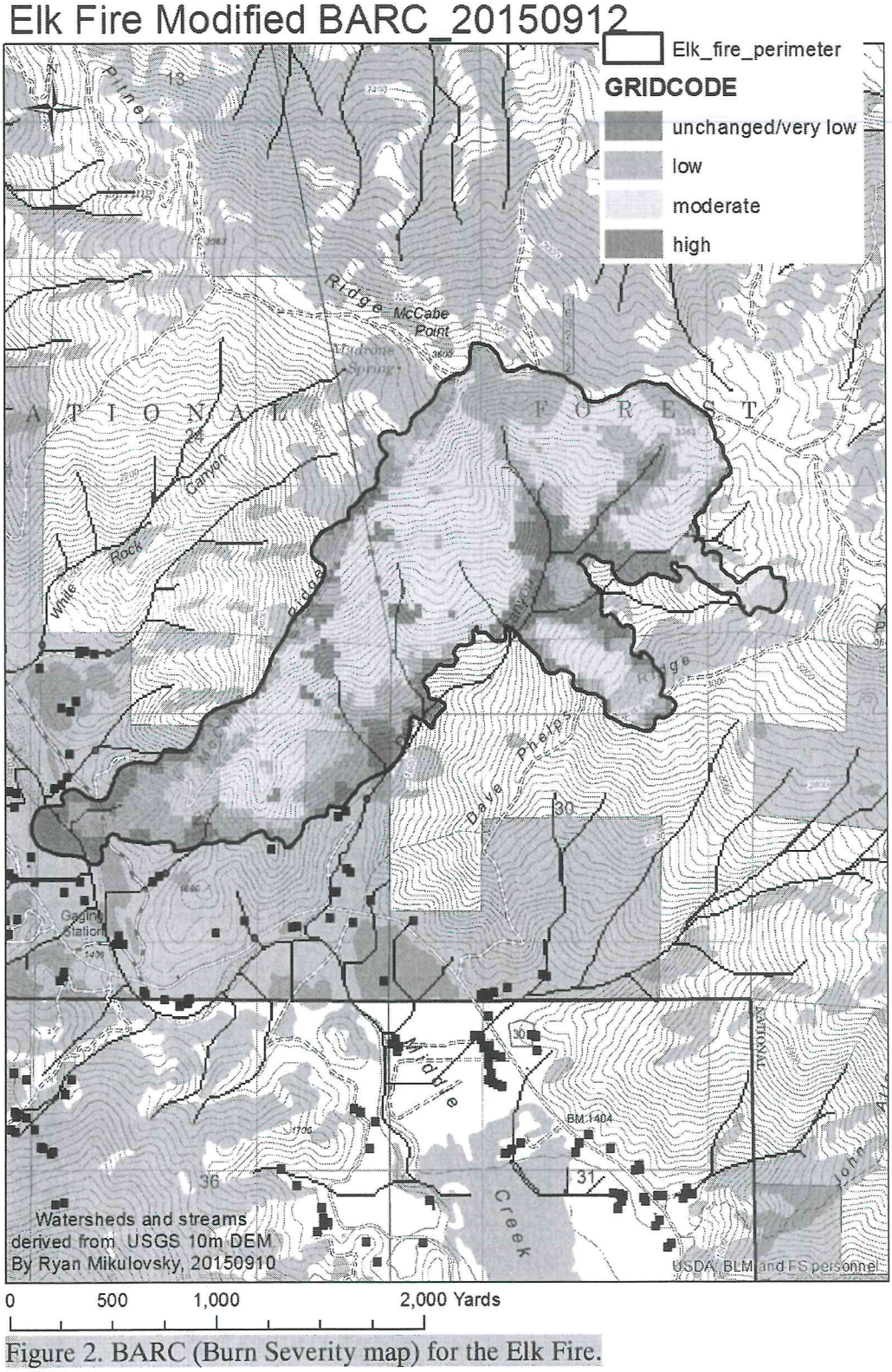


Figure 2. BARC (Burn Severity map) for the Elk Fire.

Weather Patterns

The Elk Fire took place within a region that experiences precipitation pattern of winter storms (frontal), with few thunderstorms in the summer (Figure 3).

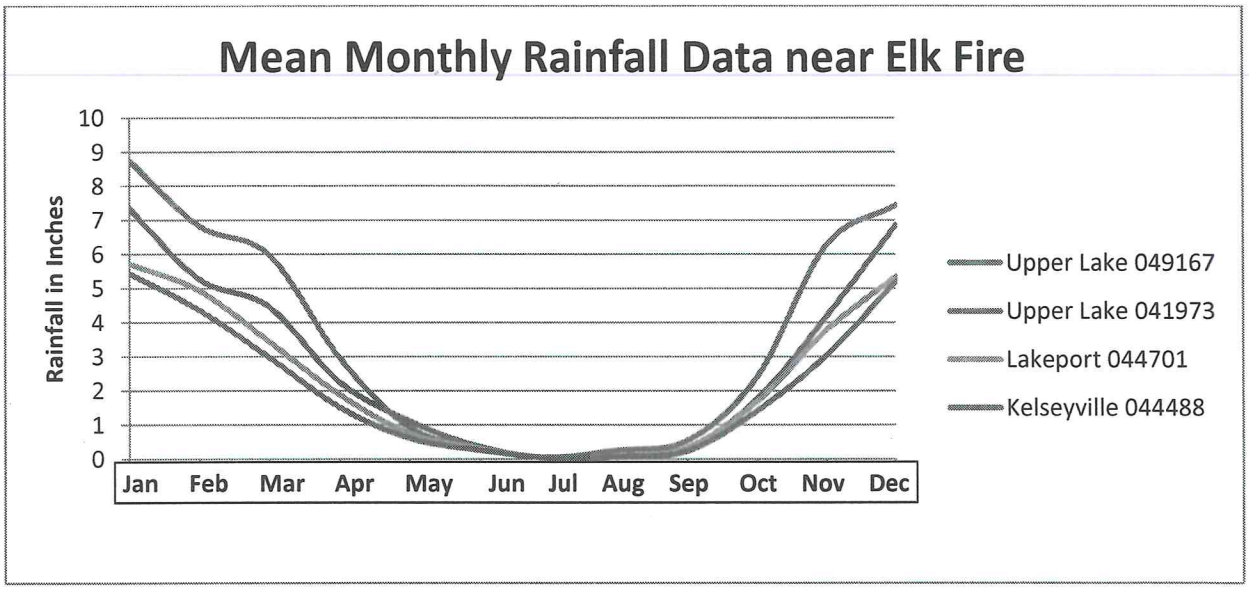


Figure 3. Average monthly precipitation at locations within and around the burned area perimeter Source: Western Regional Climate Center

Three types of precipitation runoff events can occur in the Elk Fire area: rainfall from frontal storms moving eastward from the Pacific Ocean, snowmelt, and rainfall from convective storms. Frontal storms affect larger regional areas and last over several days, where the intensities on these storms are low and tend to occur mostly in the winter. Erosion from snowmelt runoff is not of high concern since these are low intensity, long duration events. The effects of rain-on-snow are similar to a high-intensity rainstorm since they can produce a significant amount of runoff and erosion. These events can have a large effect, depending on the amount of snow melted. Convective events are of short duration and high intensity, occur rarely in this area during the summer. The frontal storm is the precipitation type modeled within the Elk Fire, since it best represents the effects from the most erosive storm within the area.

To address erosive storms that have a relatively high likelihood of occurring, the 2-year, 2-day duration design storm was utilized for this analysis.

Anticipated watershed response

The primary watershed responses of the Elk Fire are expected to include: 1) an initial flush of ash, 2) rill and gully erosion in drainages and on steep slopes within the burned area, and 3) flash floods with increased peak flows and sediment deposition. These responses are expected to be most evident during initial storm events immediately after the fire. Thereafter, responses are expected to become less evident as vegetation is reestablished, providing ground cover, increasing surface roughness, and stabilizing and improving the infiltration capacity of the soils.

The design storm of 2 years has a 50% chance of occurring in any given year. The 2-year, 2-day duration storms anticipated for these watersheds range between 3.83 and 4.87 inches (NOAA, 2015).

This storm design is meant to mimic a frontal storm producing a long duration low/moderate intensity rainfall event.

Regression equations developed by Gotvald et al (2012) for California North Coast Region were used to determine pre-fire and post-fire runoff. The regression equations were developed from peak-discharge records of 10 years or longer, available as of 2006, at more than 700 gaging stations throughout the State.

The 2-year regression equation for discharge for the North Coast Region is as follows:

$$Q_2 = 1.82(\text{Drainage Area}^{0.904})*(\text{Precip}^{0.983})$$

Drainage area was determined through pour points of interest taken in the field while precipitation is taken from USGS's Stream Stats program.

Pour points watersheds are typically related to specific values at risk that have the potential to be adversely affected by post-fire flow. Pour points include risk to road culverts and private structures. Pour point watersheds are identified in Figure 1.

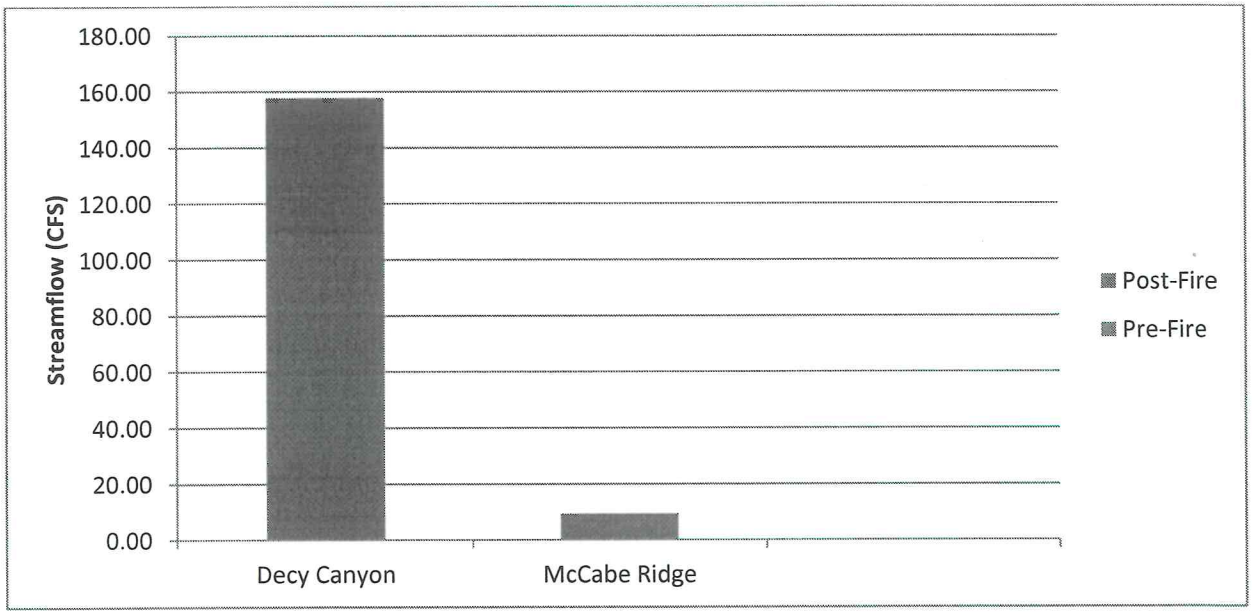


Figure 3. Pre-fire and Post-fire Streamflow for pour points identified in Elk Fire.

Due to the relatively small sizes of analyzed watersheds (with steep relief), the time of concentrations and peak discharge are expected to be fairly responsive. Hence, these watersheds with steep drainages are expected to have a greater percent increase in post-fire response. Assumptions of post-fire increases for the Elk Fire are listed on table 2.

Table 2. Post-fire increases

Burn Severity	Times Increase
Unburned	1
Low	1.2
Moderate	2
High	3

Initial erosion of ash and surface soil during the first storm events will reduce slope roughness by filling depressions above rocks, logs, and remaining vegetation. The ability of the burned slopes to detain water and sediment will be reduced accordingly. This will aid in the potential for flashy floods and will increase the distance that eroded materials are transported. However, several factors favor a quick recovery in terms of normal hydrologic response of some hillslopes. The existence of fine roots in the low and moderate severity burn areas just below the surface will likely aid plant recovery, and suggests there still might be a seed source for natural vegetation recovery.

Table 3 shows the number of acres affected by the different burn severities within the analyzed watersheds. Table 4 shows predicted pre-fire and post-fire estimates of peak flood flows for the 2-year, 2-day return interval storm. The increase in peak flows is more applicable during the first year of recovery, as hydrologic response will decrease in subsequent years. Predicted post-fire peak flow show an increase of less than one order of magnitude.

Table 3. Pour point watersheds affected by the Elk Fire.

Pour Point Names	Total Acres	Unburned	%	Burn Severity					
				Low	%	Moderate	%	High	%
Decy Canyon	925	450	48	125	14	337	36	13	1.4
McCabe Ridge	49	22	46	9.44	19	17	35		

Table 4. Pre-fire and post-fire streamflow estimates using 5-year return interval and 30-minute duration.

VAR Pour Point Watersheds	Drainage size (mi^2)	2-year, 2-day storm		Magnitude of Post-Fire streamflow increase (Post-fire/ Pre-fire)
		Pre-Fire Discharge (cfs)	Post-Fire Discharge (cfs)	
Decy Canyon	1.4	108.6	157.82	1.45
McCabe Ridge	0.08	8.69	9.46	1.09

The results of a peak flow analysis show that pre-fire area weighted flows were on average 94.88 cfs/mi^2 for a 2-year, 2-day storm. Conversely, post fire weighted flows are 117.03 cfs/mi^2. As previously mentioned, the post-fire flows could lead to plugged culverts, flow over road surfaces, rill and gully erosion of cut and fill slopes, erosion and deposition along road surfaces and relief ditches, loss of long-term soil productivity, and threats to human safety. Some sedimentation of the ephemeral channels is likely to occur at an accelerated rate until vegetation establishes itself and provides ground cover.

Table 5. Hydrologic design factors

A	Estimated Vegetative Recovery Period	5 Year
B	Design Chance of Success	80%
C	Equivalent Design Recurrence Interval	2 years
D	Design Storm Duration	2 days
E	Design Storm Magnitude	4.28 inches
F	Design Flow	94.88 cfs/mi^2
G	Estimated Reduction in Infiltration	10%
H	Adjusted Design Flow	117.03 cfs/mi^2

Emergency Determination- Implications of post-fire runoff

The objective of this analysis is to predict post-fire runoff with the goal of mitigating risk to life, property, and natural and cultural resources. After identifying potential Values at Risk (VAR), the magnitude of this risk was systematically evaluated. The risk matrix shown in Table 6 was utilized to identify values in need of mitigation efforts.

Table 6. Risk assessment matrix.

Probability of Damage or Loss	**Magnitude of Consequences**		
	Major	Moderate	Minor
	Risk		
Very Likely	Very High	Very High	Low
Likely	Very High	High	Low
Possible	High	Intermediate	Low
Unlikely	Intermediate	Low	Very Low

The probability of damage or loss within one to three years is classified into four categories: unlikely occurrence (<10%); possible occurrence (>10% to <50%); likely occurrence (>50% to <90%); and very likely or nearly certain occurrence (>90%). This information is combined with an assessment of the magnitude of the consequences. These are classified as major, with implications for loss of life or injury to humans, substantial property damage, irreversible damage to critical natural or cultural resources; moderate, indicating injury or illness to humans, moderate property damage, damage to critical natural or cultural resources resulting in considerable or long term effects; or minor, with property damage limited in economic value and/or to few investments, damage to natural or cultural resources resulting in minimal, recoverable or localized effects.

Table 7. Evaluation of Values at Risk

WSHD	Value (Life/Property/ Resources)	Value At Risk	Probability of Damage or Loss	Magnitude of Consequences	Risk	Treatment	Notes
Decy Canyon	Property	Structures at bottom of Decy Canyon	Possible- Homes downstream of burned area (risk from flooding and sedimentation)	Major/ Mod	High/Int	NRCS??	Several structures, and new foundation
Decy Canyon	Life	Residents @ bottom of Decy Canyon	Possible	Major	Very High	NRCS??	
McCabe Ridge	Property	Structures @ bottom of draw	Possible- Homes downstream of burned area (risk from flooding and sedimentation)	Major	High/Int	NRCS??	
McCabe Ridge	Life	Residents @ bottom of draw	Possible	Major	Very High	NRCS??	
Other	Natural Resources	Clearlake hitch	Possible- ash, debris, and fine material runoff from burned area	Minor	Low		Derrick's thoughts? Localized effects....short term?
Other	Natural Resources	Soil Productivity	Unlikely	Minor	Very Low		soil composition does not appear to have changed due to fire
Other	Natural Resources	Native Plants	?	?	?	?	?
Other	Property	Road (Elk Mountain road)	Unlikely	Moderate	Low	None	Pavement
Other	Property	Road (White Canyon road)	Possible	Moderate	Int	?	Dirt road, only road access to properties in area. There are several crossings along Middle Creek that might access these areas.

Treatments to Mitigate Emergency

There were no identified Burned Area Emergency Response treatments for the Elk Fire.

References

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