Hydrology and Watershed Specialist Report
Erskine Fire BAER Assessment
Sequoia National Forest
July 13, 2016

Burned over vehicles in the Kelso Creek Drainage

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Executive Summary

The Erskine Fire started June 23, 2016 and burned a total of 48,019 acres south of Lake Isabella Reservoir in the Piute Mountain area and the Kelso Creek drainage. The fire burned over Private, BLM, and National Forest land ownership (Table 5), and had a devastating impact on the communities of Squirrel Valley, South Lake, and settlements in Kelso Valley. A Total of 285 homes were destroyed with two confirmed fatalities. The fire progression was extreme due to strong winds and light, flashy fuels and moved east from the town of Lake Isabella to South Lake within a few hours of ignition, eventually reaching more than 35,000 acres in less than 24 hours. The fire then moved in a southerly direction, burning in the Piute Mountains parallel to and within the Kelso Creek drainage to approximately 2 miles south of Cortez Canyon (Figure). It is ranked as the 15th most destructive fire in California's history.

The overall soil burn severity showed approximately 1% high, 43% moderate, 45% low, and 11% very low to unburned. Hydrological analysis evaluated seven 6th-Field (HUC12) watersheds and 23 pour points defined at potential Values at Risk. Most HUC12 watersheds showed minimal increases (<50%) in runoff from fire effects, except Lower Kelso Creek, which showed a 112% increase in Q2 runoff for a 2 year 6 hour design storm. Of the 23 pour points modeled, seven showed increases in runoff (relative to Q2) over 100% (119% to 250%) and seven showed increases in runoff between 50-100%. It is important to note that, although the increases are high relative to normal Q2 discharge, none of the pour points modeled exceeded a Q10 discharge. Stream channels measured in the vicinity of Values at Risk showed confinement to >Q50 and in many cases >Q100. As such, risks from flooding alone are considered moderate to-low for a 2 year, 6 hour design storm.

The key Values at Risk were those residential areas below basins that showed both high increases in runoff and increased potential for debris flow. These conditions exist for basins on the west flank of Cook Peak adjacent to the town of Lake Isabella, which ranked as a "very high" on the BAER risk matrix, and the areas immediately below the steeper slopes in the Squirrel Valley and Goat Ranch area, which rated as "High" on the BAER risk matrix.

Although some runoff might be attenuated with large scale hillslope treatments for smaller storms thus slowing debris flow initiation, preventing debris flows with hillslope treatments alone is not effective. As such, no hillslope treatments are recommended for the basins west of Cook Peak or above the communities of Squirrel Valley or South Lake. Rather, an early weather warning system should be established to advise residents in these areas of possible debris flow activity.

Objectives

1. Identify Values at Risk downstream and down slope from the burn areas.
2. Assess watershed changes caused by the fire, particularly those that pose substantial threats to human life, property, and critical natural and cultural resources.
3. Assess the potential for post-fire effects to downstream values at risk.

Initial Concerns

- Threats to human health and life within and downstream of the burned area.
- Threats to roads, stream crossings, or other man-made developments or property that are downstream of the fire and are at risk of being removed or damaged from future storm events.
- Threats to Values at Risk identified for potential ***flooding*** and/or ***flood damage*** include:
    - 48" culvert on private road in the community of Goat Ranch
    - Road damage from flooding due to an undersized culvert along Erskine Creek Road in Lake Isabella at the outlet of pour point 1.

I. Resource Condition Assessment

A. Resource Setting

The Erskine Fire started June 23, 2016 and burned a total of 48,019 acres south of Lake Isabella Reservoir in the Piute Mountain area and the Kelso Creek drainage. The fire burned over Private, BLM, and National Forest land ownership (Table 5), and had a devastating impact on the communities of Squirrel Valley, South Lake, and settlements in the Kelso Creek Valley. A Total of 285 homes were destroyed with two confirmed fatalities. The fire progression was extreme due to strong winds and light, flashy fuels and moved east from the town of Lake Isabella to South Lake within a few hours of ignition, eventually reaching more than 35,000 acres in less than 24 hours. The fire then moved in a southerly direction, burning in the Piute Mountains parallel to and within the Kelso Creek drainage to approximately 2 miles south of Cortez Canyon (Figure).

6th-Field Hydrologic Unit Code 12 (HUC 12) watersheds affected by the fire are included in Table 1 and displayed in Figure 1. Within the Erskine Fire perimeter, the NHD GIS data show 15 miles of perennial streams, 173 miles of intermittent streams, and 357 miles of ephemeral streams.

Table 1. HUC 12 watersheds affected by the Erskine Fire.

HUC 12 Watershed Name	HUC 12 Watershed Number	Acres
Isabella Lake-South Fork Kern River	180300020702	88,073
Middle Kelso Creek	180300020602	36,187
Isabella Lake-Kern River	180300010607	30,431
Upper Kelso Creek	180300020601	28,558
Erskine Creek	180300030101	23,258
Lower Kelso Creek	180300020604	18,296
Black Gulch-Kern River	180300030105	14,994

Relief within the burn area ranges from approximately 2,600 feet near Lake Isabella Reservoir to 7200 feet near Woolstalf Meadow. Precipitation varies with elevation, which ranges over 5000 feet throughout the burn area. Foothill areas (<4000 feet) are characterized by mild winters and hot dry summers from mid-January to mid-May, with an average annual rainfall of 14 inches. Middle elevations (4000-7000 feet) receive 16 inches of annual precipitation from December to May, with snow dominating the higher elevations. Short duration, high intensity summer storms are also common in the Piute and Scodie Mountains, which can result in flash flooding.

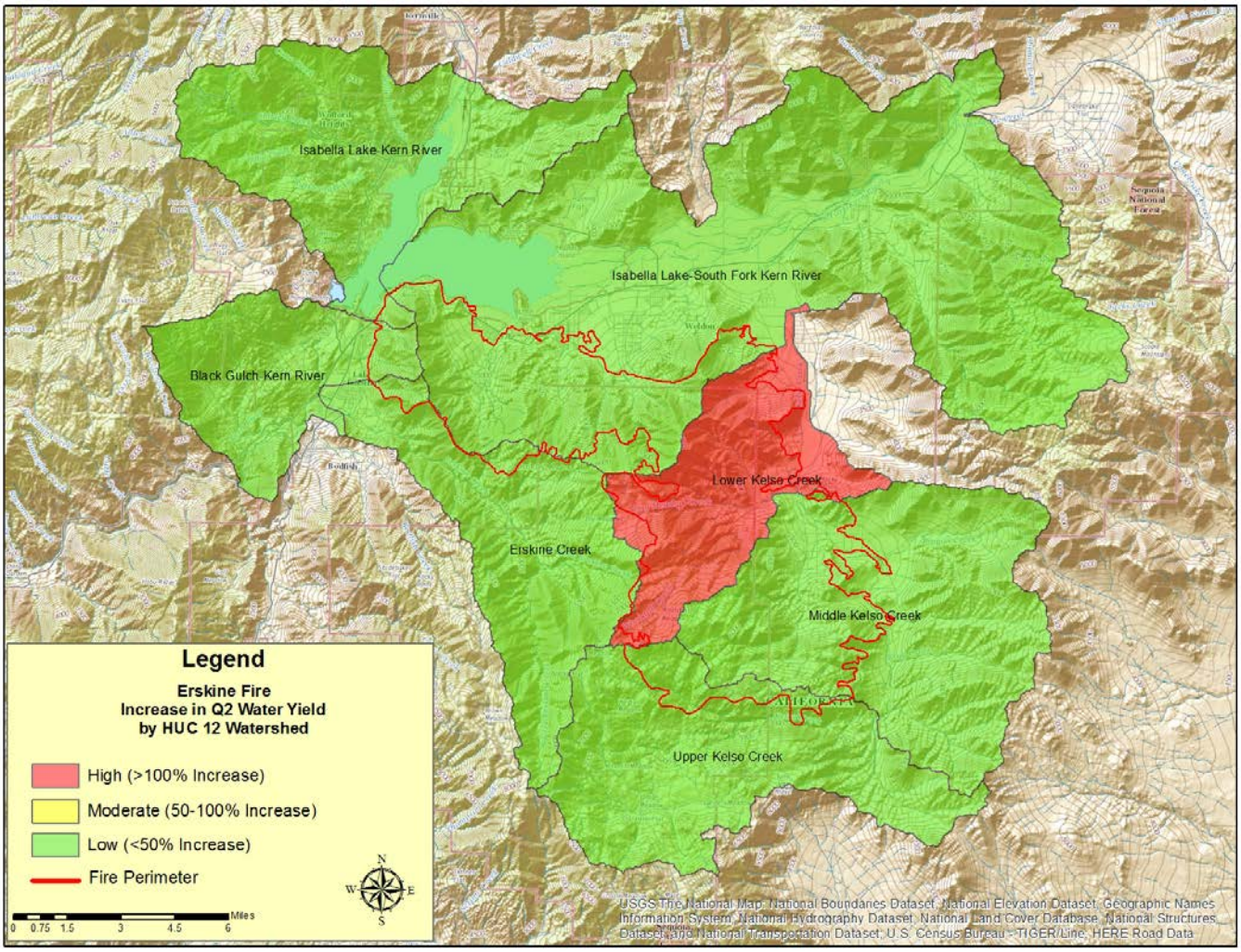

Figure 1. 6th-Field HUC 12 watersheds affected by the Erskine Fire. The red line denotes the fire perimeter; the color code indicates the increase in water yield based on soil burn severity: green = <50% increase; yellow = 50-100% increase; red >100% increase.

B. Summary of Findings, On-the-Ground Survey

For analysis purposes, the burn area was separated into seven 6th field HUC 12 watersheds (Figure 1) and 23 subdrainages based on pour points located at potential Values at Risk (VAR). Figure 2 shows the location of each VAR pour point. Figures 3a,b

show the contributing area above pour points and their corresponding increases in water yield.

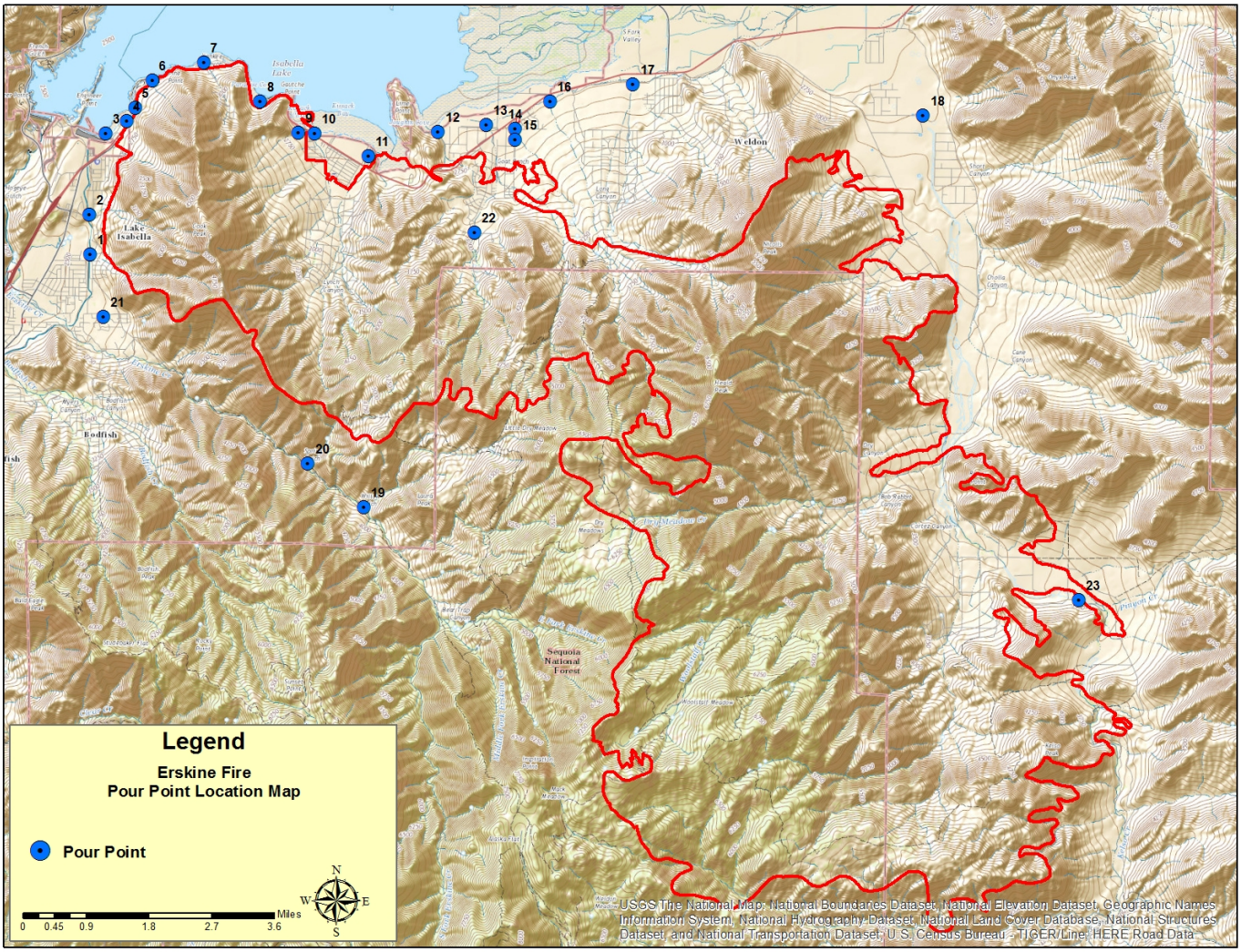

Figure 2. Locations of pour points used to model runoff response for the Erskine Fire.

1. Identify Values at Risk

Emergency determinations were conducted using the risk assessment matrix in the Forest Service Manual for the BAER program (USFS, 2012). This matrix (Table 2) uses a combination of the probability of damage or loss and the magnitude of consequences associated with that damage or loss to determine a level of risk. The risk level is then used to determine if an emergency exists.

Table 2. BAER risk matrix table.

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**

Probability of Damage or Loss: The following descriptions provide a framework to estimate the relative probability that damage or loss would occur within 1 to 3 years (depending on the resource):

- Very likely. Nearly certain occurrence (90% - 100%))
- Likely. Likely occurrence (50% - 89%)
- Possible. Possible occurrence (10% - 49%)
- Unlikely. Unlikely occurrence (0% - 9%)

Magnitude of Consequences:

- Major. Loss of life or injury to humans; substantial property damage; irreversible damage to critical natural or cultural resources.
- Moderate. Injury or illness to humans; moderate property damage; damage to critical natural or cultural resources resulting in considerable or long term effects.
- Minor. Property damage is limited in economic value and/or to few investments; damage to critical natural or cultural resources resulting in minimal, recoverable or localized effects.

Table 3 identifies the Values at Risk in the Erskine Fire. The primary potential threat to the VAR's is flooding and mobilization of woody and floatable debris within the affected stream channels (for detailed evaluation of road or trail impacts from erosion, please see the roads and trail reports). Debris flow potential is considered high in some areas (see soils and geology report for information on debris flow hazard, erosion and sediment yield). VAR's are listed from high to low.

Table 3: Values at Risk in and downstream of the Erskine Fire. Risk is determined by the magnitude of consequence vs. the probability of damage or loss.

Value at Risk From Flooding	Risk Assessment	Comments
Life/Property: Community of Lake Isabella (Private); Pour Points 1, 2, 3, and 4 (Figure 2).	Likely/Major = **Very High**	Pour point modelling at drainages along the west-facing flank below Cook Peak show high (118-250%) increases in Q2 runoff for the 2 year, 6 hour design storm. Although the risk from flooding from burn-related runoff is considered intermediate for these pour points (i.e., none will exceed a Q10 event and most structures in the area are situated at or above the Q50 flood elevation), there is a high to moderate probability of debris flow in these drainages. The drainage outlet for pour point 1 is routed to an undersized (12") culvert on Erskine Creek road. Blockage potential is high for this culvert, which could result in damage to the roadway and downstream structures. Although the risk from flooding to life and property is considered intermediate for these pour points, the risk from debris flow is considered likely, thus a "very high" rating was used overall. Debris flow potential and/or bulking from ash, sediment, and woody debris could block culverts, potentially causing bypass, and in extreme cases, road prism failure. The county should be advised to keep culverts free of debris before and during the first runoff-producing storms.
Life/Property: Yankee Canyon (Private). Pour point 7. (Figure 2)	Likely/Major = **Very High**	Pour point modelling at the outlet of Yankee Canyon shows 144% increase in Q2 runoff for the 2 year, 6 hour design storm. Although the risk from flooding from burn-related runoff is considered intermediate for this pour points (i.e., it will not exceed a Q10 event and most structures in the area are situated at or above the Q50 flood elevation), there is a moderate to high probability of debris flow in this drainage. Although the risk from flooding to life and property is considered intermediate for this pour points, the probability of damage or loss from debris flow is considered likely, thus a "Very High" rating was used overall. Debris flow potential and/or bulking from ash, sediment, and woody debris could block culverts, potentially causing bypass, and in extreme cases, road prism failure. The county (or private residents) should be advised to keep culverts free of debris before and during the runoff-producing storms.
Life/Property: Community of Squirrel Valley (Private). Pour points 10, and 11 (Figure 2).	Possible/Major = **High**	Pour point modelling at drainages on State Highway 178 downstream of the community of Squirrel Valley show moderate (60-82%) increases in Q2 runoff for the 2 year, 6 hour design storm. Although the risk from flooding from burn-related runoff is considered low for these pour points (i.e., none will exceed a Q5 event and most structures in the area are situated at or above the Q100 flood elevation), there is a high to moderate probability of debris flows in drainages above the community. Although the risk from flooding to life and property is considered low for these pour points, the probability of damage or loss from debris flow is considered possible, thus a "high" rating was used overall. Debris flow potential and/or bulking from ash, sediment, and woody debris could block

Value at Risk From Flooding	Risk Assessment	Comments
		culverts, potentially causing bypass, and in extreme cases, road prism failure. The county and/or private residents should be advised to keep culverts free of debris before and during the first runoff-producing storms.
Life/Property: Community of South Lake/Goat Ranch (Private). Pour Points 12, 13, and 22 (Figure 2).	Possible/Major = **High**	Pour point modelling at drainages on State Highway 178 downstream of the community of South Lake and at a road crossing within the Goat Ranch area show moderate to high (77-245%) increases in Q2 runoff for the 2 year, 6 hour design storm. Although the risk from flooding from burn-related runoff is considered moderate for these pour points (i.e., none will exceed a Q10 event and most structures in the area are situated at or above the Q50 flood elevation), there is a high to moderate probability of debris flows in drainages above the community. A culvert located at pour point 22 is damaged (crushed) with greatly diminished capacity. As such, it will be susceptible to blockage and possible road prism failure during the first runoff producing storms. It is advised that this crossing be replaced as soon as possible. Although the risk from flooding to life and property is ranked as moderate for these pour points, the probability of damage or loss from debris flow is considered possible, thus a "high" rating was used overall. Debris flow potential and/or bulking from ash, sediment, and woody debris could block culverts, potentially causing bypass, and in extreme cases, road prism failure. The county and/or private residents should be advised to keep culverts free of debris before and during the first runoff-producing storms.
Life/Property: Community of Bella Vista (Private). Pour point 17 (Figure 2).	Unlikely/Moderate = **Low**	Pour point modelling at a drainage on State Highway 178 downstream of the community of Bella Vista shows a moderate (63%) increase in Q2 runoff for the 2 year, 6 hour design storm. The risk from flooding from burn-related runoff is considered low for this pour point because flows are not predicted to exceed a Q5 event and most structures in the area are situated at or above the Q50 flood elevation. Debris flow potential is moderate to high in the upper watershed, but this is a relatively small area (~1.5 square miles), which is 0.5 to 2.3 miles from any developed infrastructure, and thus debris flow damage potential is also considered low. Bulking from ash and sediment could block culverts immediately downstream of the burn area, potentially causing bypass, and in extreme cases, road prism failure. The county and/or private residents should be advised to keep culverts free of debris before and during the runoff-producing storms.
Life/Property: Properties at the mouth of Kelso Creek near Weldon (Private). Pour point 18 (Figure 2).	Unlikely/Moderate = **Low**	Pour point modelling at the outlet of Kelso Creek near Weldon shows a moderate (62%) increase in Q2 runoff for the 2 year, 6 hour design storm. The risk from flooding from burn-related runoff is considered low for this pour point because flows are not predicted to exceed a Q5 event and most structures in the area are situated at or above the Q100 flood elevation. Debris flow potential is moderate to low in the upper watershed, which is several miles from this pour point and thus debris flow damage potential is also considered low. Bulking from ash and sediment could

Value at Risk From Flooding	Risk Assessment	Comments
		block culverts immediately downstream of the burn area, potentially causing bypass, and in extreme cases, road prism failure. The county and/or private residents should be advised to keep culverts free of debris before and during the runoff-producing storms. The Kelso Creek crossing along Kelso Valley Road (near the junction of Kelso Creek Road) is on-grade with the drainage and routinely floods. Flood warning signs are already established at this location, but the county should be prepared to further advise the public of the increased chance of flooding along this crossing during the first runoff producing storms.
Life/Property: Properties along Kelso Creek (Private). Pour point 23 (Figure 2).	Unlikely/Moderate = **Low**	Pour point 23 was modeled to estimate discharge along Kelso Creek near private homes and other infrastructure on the east side of the fire. Only a small portion of this relatively large watershed burned. The pour point modeling shows a minor increase in runoff (17.4%), with flows staying below the Q5 flood elevation. Most homes along Kelso Creek are situated on a Holocene terrace, which is well above the Q100 floodplain, and as such, the risk to life and property is rated as low. There are what appeared to be scrap yards and other residential detritus situated at approximately the Q100 elevation, but these should not be affected by a 2 year storm.
Life/Property: Private inholdings Pour points 19 and 20 (Figure 2).	Unlikely/Moderate = **Low**	A very small portion of the fire burned over into the Erskine Creek drainage. Two pour points were modeled at VAR's containing homes and ranch infrastructure (19, 20). Pour point modeling shows a low (14-48%) increase in Q2 runoff for the 2 year, 6 hour design storm. The risk from flooding from burn-related runoff is considered low for these pour points because flows are not predicted to exceed a Q5 event. Because access to private property at these VAR's was restricted, an absolute determination of flood stage elevation relative to the VAR's was not established. Bulking from ash and sediment could block culverts immediately downstream of the burn area (especially for pour point 20), potentially causing bypass, and in extreme cases, road prism failure. The county and/or private residents should be advised to keep culverts free of debris before and during the first runoff-producing storms.
Property: Highway 178 (Caltrans). Pour points 9-16 (Figure 2).	Unlikely/Moderate = **Low**	Multiple pour points along state Highway 178 were evaluated for passage potential and channel capacity. All crossings were designed to pass a Q100 event with 18-24" of head space to pass debris. Channels measured at these crossings had >Q50-Q100 capacity. Although some of these crossing showed relatively large increases for a 2 year, 6 hour design storm, none of the values exceeded a Q10 event. As such, the risk is considered low, but Caltrans should be prepared to clean these crossing as necessary during the first runoff producing storms.

2. Synopsis of Post-Fire Watershed Conditions of the Erskine Fire

For analysis purposes, the burned area was separated into 23 pour points (Figure 2). Pour points are established in order to facilitate a more detailed analysis of stream discharge in smaller un-gaged subdrainages. For the Erskine Fire, all 23 pour points relate to potential downstream Values at Risk (Table 3).

The BAER Team received a Burned Area Reflectance Classification (BARC) satellite imagery map of the Erskine Fire from the Remote Sensing Applications Center (RSAC) in Salt Lake City, Utah. The limited BAER watershed survey began on Wednesday, July 6, 2016 by conducting an on-the-ground reconnaissance within the burn area to evaluate flood plain elevation and channel morphology adjacent to VAR's, soil hydrophobicity and soil burn severity (for more detail on hydrophobicity, see soils report). The soils data were used to corroborate and/or correct the BARC map to produce a soil burn severity map (Figure 4).

The BAER Team assessment found the overall soil burn severity for the 48,019 acre Erskine Fire to be approximately: 1% high, 43% moderate, 45% low, and 11% very low to unburned (Table 4). The fire burned over private land and inholdings, BLM, military, and Sequoia National Forest System Lands, (Table 5).

Table 4. BARC map soil burn severity %breakout.

Soil Burn Severity Acres				
Unburned/V. Low	Low	Moderate	High	Total
5,404	21,557	20,715	343	48,019
11.2%	44.9%	43.1%	0.71%	100%

Table 5. Burn acres by ownership

Ownership	Burn Acres
Sequoia National Forest	21,933
BLM	17,369
Private	8,619
Military (ACOE)	98
Total	48,019

Watershed response in the burned watersheds can change significantly as compared to pre-fire conditions. Vegetation and underlying organic matter slows runoff and protects soils from direct raindrop impact, assists with water infiltration to soil and releases runoff at slower rates. Consumption of organic material and high soil heating can promote the formation of water repellent layers, at or near the soil surface, which result in the loss of soil structural stability. The strength and depth of water repellency varies greatly by the duration and intensity of soil heating, type of organic matter consumed by the wildfire, and soil texture and moisture content (see soils report for more information).

Steep upper elevations of the drainages have the ability to generate sudden releases of storm runoff of high velocity. Rainfall intensity rates during large storm events are typically higher in these areas; rates can exceed 0.5 inches or higher per hour and is not uncommon during most winter rain seasons or rain-on-snow events.

With some of the hill slopes in the moderate to high soil burn severity areas mostly devoid of vegetation and groundcover, the first large runoff producing storms will likely create increased surface flow volumes and velocities that can transport available sediment and ash from the slopes and along the channel bottoms. This scenario, coupled with existing wet antecedent soil conditions from previous storms, could trigger a flood event and/or debris flow with higher than normal sediment yield and runoff.

Fires that burn in predominately forested areas have conifers or other trees that will shed needles and/or leaf litter in the low and moderate burn areas, providing for some degree of ground cover and erosion protection before the first runoff producing winter storms. The Erskine fire, however, burned over high desert steppe terrain, mainly burning grass and shrub with only small pockets of conifers being consumed, thus little to no ground cover in the form of needle cast or litter will be available in areas of low to moderate soil burn severity. This condition, coupled with a high percentage of rock outcrop, is expected to produce more runoff than forested areas.

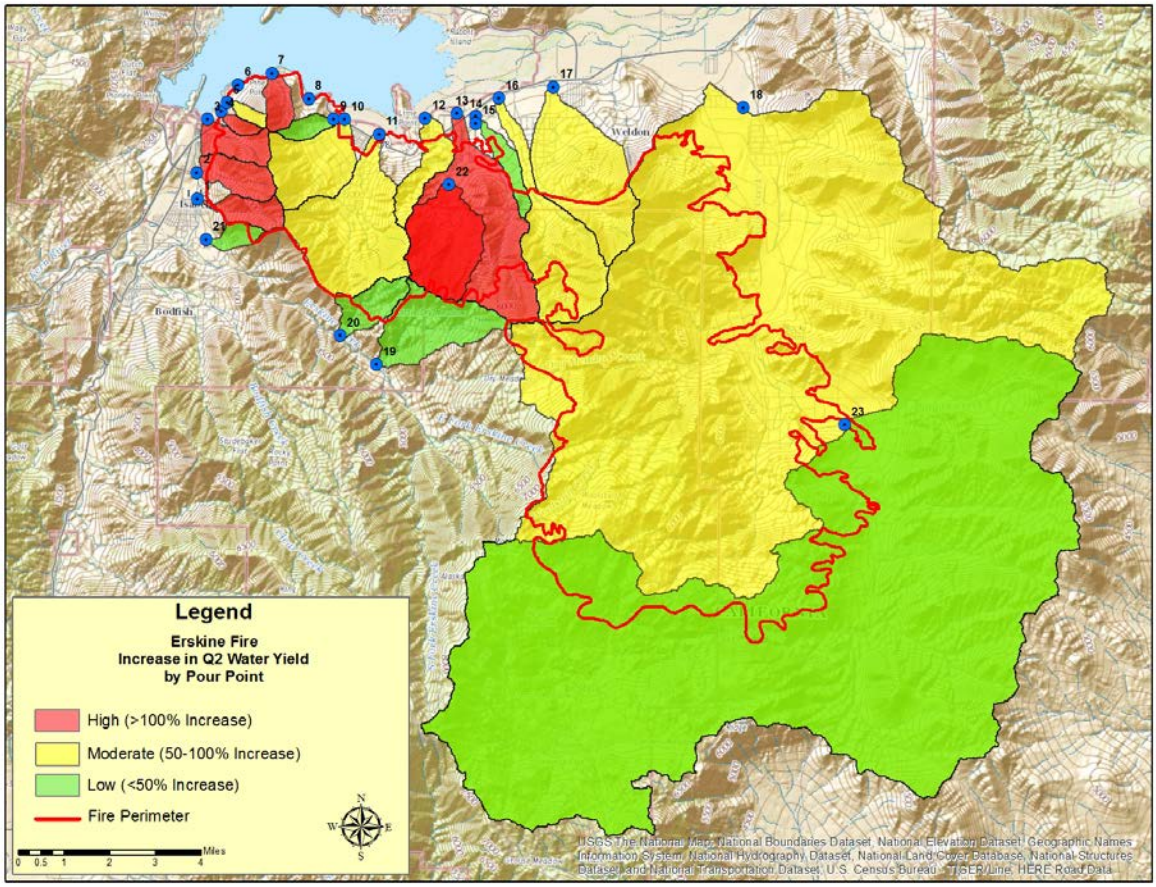

Figure 3a. Map showing the location of pour points used to model post fire runoff. Color coding denotes increase in runoff due to soil burn severity: Red (High) is greater than a 100% increase in runoff; Yellow (Moderate) is between 50-100% increased runoff; and Green (Low), which is less than 50% increased runoff.

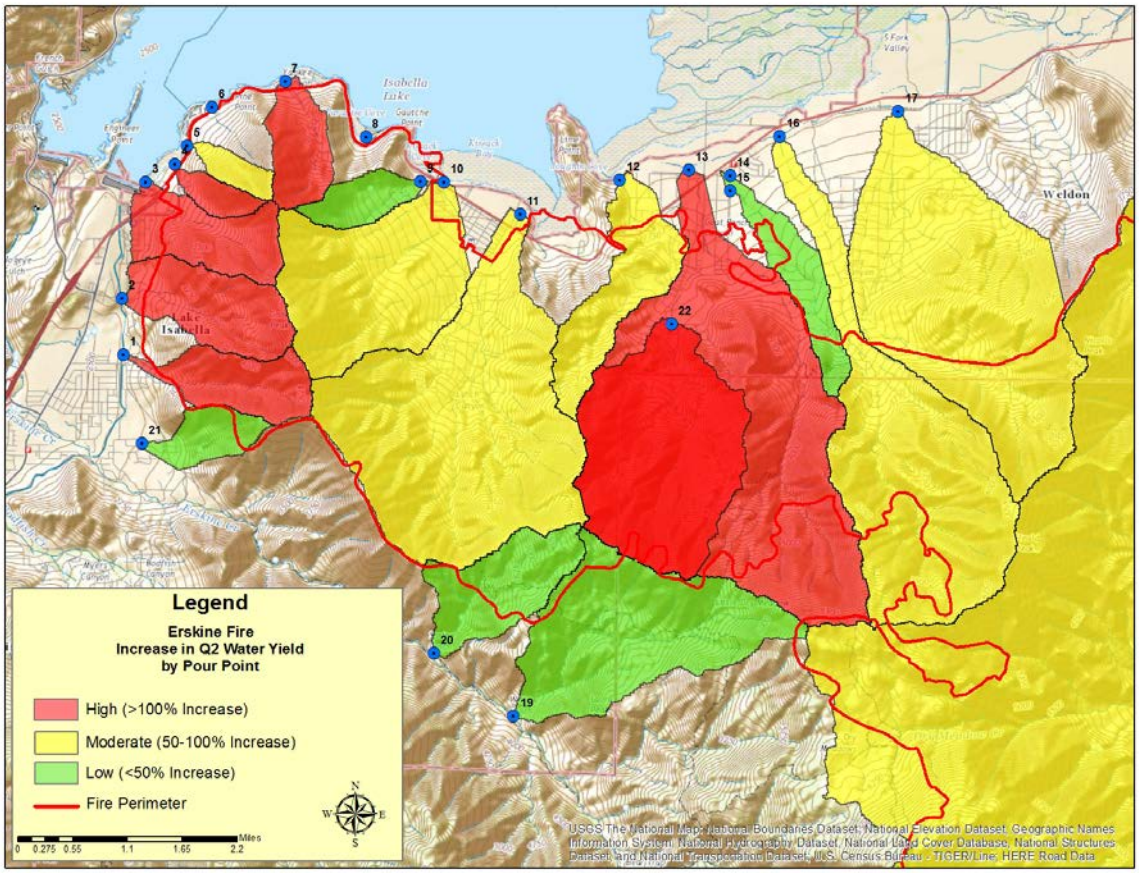

Figure 3b. Map showing the location of pour points in areas with the highest relative runoff. Color coding denotes increase in runoff due to soil burn severity: Red (High) is greater than a 100% increase in runoff; Yellow (Moderate) is between 50-100% increased runoff; and Green (Low), which is less than 50% increased runoff.

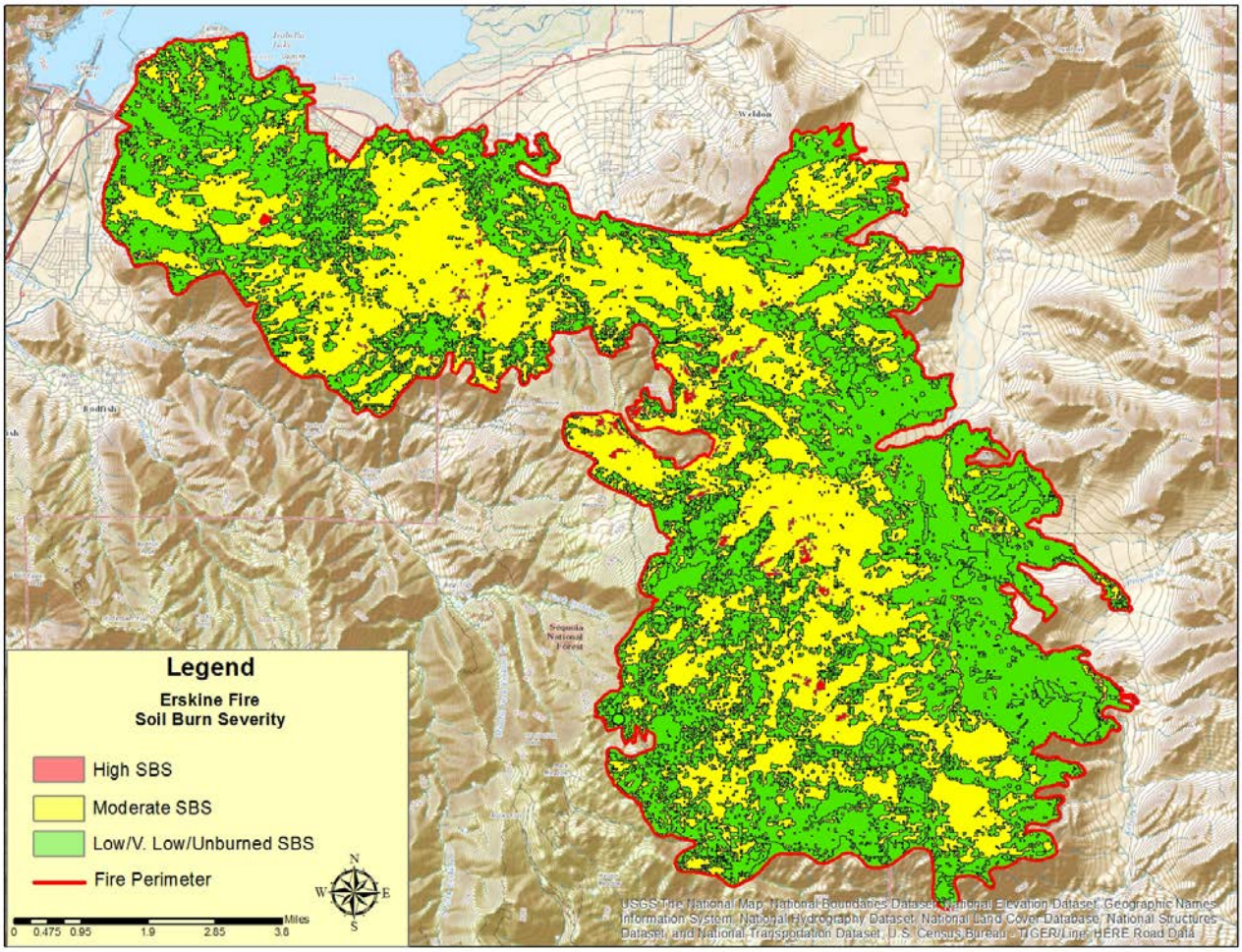

Figure 4. Soil burn severity (SBS) map of the Erskine Fire. Green denotes low, very low and unburned SBS, yellow moderate SBS and red high SBS.

Design Flow Runoff Response

Before an adjusted design flow can be determined, pre-fire design flow must be calculated. This is the flow expected to occur prior to the fire and the flow responsible for forming present day channel conditions. These flows are used to estimate proper performance of culverts and other drainage structures. Design flow estimates for the Erskine Fire have been based on the U.S. Geological Survey regression equations developed for the Sierra Nevada (Gotvald, et al., 2012).

Adjusted design flow is calculated using the same relationships as design flow; however, runoff response is estimated by assuming an increased runoff commensurate with soil burn severity in terms of recurrence interval. This recurrence interval estimates the response of the newly burnt landscape to the design storm of interest. The Erskine Fire is expected to respond to an average rainfall event differently for the unburned, low, moderate, and high soil severity burned areas. Table 6 shows the estimated runoff response for a 2 year, 6 hour design storm by soil burn severity.

Table 6. Correspondence between recurrence interval and soil burn severity.

Design Storm (Metamorphic Terrain)	Recurrence Interval Q	Soil Burn Severity			
		Unburned	Low	Moderate	High
2 year, 6 hour	2	X	X		
	5			X	
	10				X
Design Storm (Granitic Terrain)					
2 year, 6 hour	2	X			
	5		X		
	10			X	
	25				X

These recurrence intervals and commensurate burn severities were found to be in good agreement with empirical watershed studies in similar hydrophysiographic settings on the Sequoia National Forest (Kaplan-Henry, 2004).

Increases in discharge associated with predicted recurrence intervals are prorated across watersheds by soil burn severity to yield post-fire discharge or the adjusted design flow. The following assumptions were made for calculating the adjusted design flow:

- A 2 year, 6 hour storm will produce a bankfull (i.e., Q2) discharge response.
- Runoff would be commensurate with soil burn severity (Table 6).
- Granitic terrain would produce flashier and more pronounced runoff (relative to metamorphic terrain) due to the higher percentage of rock outcrop, lack of deep soils and absence of ground cover; thus a Q2, Q5, Q10 and Q25 recurrence array was used (Table 6).
- No ground cover in the form of needle cast of leaf litter would be available to armor and mitigate rain spatter impact and runoff.
- The USGS regression equations for the Sierra Nevada region underestimate Q2 by an average of 47% relative to regional curves developed for the Kern River drainage (Kaplan-Henry, 2004); as such Q2 was adjusted to reflect this change.

The fire has been analyzed at both the 6th field watershed (HUC12) and at a smaller subdrainage size where VAR pour points have been defined (Figure 2). Table 7 displays the amount of burned lands by severity for the affected 6th field HUC12 watersheds and Table 8 shows the relative burn severities for the contributing subdrainages above pour points associated with potential Values at Risk.

The USGS regression equations for the Sierra Nevada were applied to affected HUC12 watersheds and subdrainage pour points to yield discharge in cubic feet per second for the Q2 return interval and then divided by the size of the watershed to give a discharge in cubic feet per second per square mile for each design storm by watershed size. These values were then multiplied by the area of soil burn severity (in square miles), which includes unburned lands, and then summed to provide an estimated post-fire discharge for both the 6th field watersheds and pour point subdrainages (Tables 9 and 10) .

Table 7 - 6th Field HUC12 Watersheds Affected by the Erskine Fire.

6th Field Watersheds (HUC12)	Burn Severity in Miles^2				Watershed Area Miles ^{2}
	High	Moderate	Low	Unburned	
Black Gulch-Kern River	0.0	0.77	1.05	21.58	23.4
Erskine Creek	0.0003	0.72	1.05	36.4	38.2
Isabella Lake-SF Kern River	0.196	12.9	8.79	115.71	137.6
Isabella Lake-Kern River	0.0	0.11	0.467	46.92	47.5
Upper Kelso Creek	0.0	1.24	2.77	40.59	44.6
Middle Kelso Creek	0.067	7.0	10.4	39.03	56.5
Lower Kelso Creek	0.26	9.62	9.11	9.61	28.6

Table 8 – Contributing subdrainages above pour points associated with potential Values at Risk. Refer to Figure 2 for pour point location.

Subdrainage (pour point)	Burn Severity in Miles^2				Subdrainage Area Miles ^{2}
	High	Moderate	Low	Unburned	
1	0.0	0.21	0.5	0.09	0.80
2	0.0	0.56	0.43	0.11	1.10
3	0.0	0.11	0.53	0.364	1.00
4	0.0	0.016	0.2	0.02	0.20
5	0.0	0.04	0.19	0.003	0.20
6	ND	ND	ND	ND	ND
7	0.0	0.16	0.41	0.03	0.60
8	ND	ND	ND	ND	ND
9	0.0	0.092	0.22	0.12	0.40
10	0.024	0.99	1.2	0.386	2.60
11	0.006	3.1	1.62	0.674	5.40
12	0.0	0.67	0.32	0.31	1.30
13	0.08	3.6	1.99	2.13	7.8
14	0.0	0.079	0.097	0.527	0.70
15	ND	ND	ND	ND	ND
16	0.082	1.9	0.81	1.51	4.30
17	0.005	0.85	0.41	3.835	5.10
18	0.32	18.6	23.1	112.88	154.9
19	0.0	0.1	0.06	2.74	2.90
20	0.0	0.34	0.3	0.56	1.20
21	0.0	0.001	0.07	0.429	0.50
22	0.08	2.22	0.52	0.26	3.20
23	0.009	1.97	4.99	47.43	81.4

ND: No Data. These were preliminary pour points that were either too small for the model resolution, redundant or did not warrant further modelling.

Table 9 - 6th Field HUC12 Watersheds and their adjusted design flow by soil burn severity.

Watershed		Discharge by Severity in cfs*				Discharge by Watershed in cfs**		Discharge by Watershed in cfs/mi²**	
6th Field Watersheds	Affected WS Area Miles²	High Severity Burn	Moderate Severity	Low Severity	Unburned	Pre fire*	Post Fire	Pre-fire flow in cfs/ mi²	Post-fire flow in cfs/mi²
Black Gulch-Kern River	23.4	0.0	16.1	22.05	159.3	175.0	197.41	3.9	4.43
Erskine Creek	38.2	0.006	8.48	6.76	102.3	107.3	117.58	2.8	3.08
Isabella Lake-SF Kern River	137.6	5.09	187.3	82.7	619.3	736.5	894.5	5.4	6.5
Isabella Lake-Kern River	47.5	0.0	2.11	5.73	316.6	320.5	324.45	6.7	6.83
Upper Kelso Creek	44.6	0.0	16.1	22.05	159.3	175.0	197.41	3.9	4.43
Middle Kelso Creek	56.5	2.01	115.3	108.6	219.3	317.5	445.3	5.6	7.88
Lower Kelso Creek	28.6	8.03	160.1	93.65	49.39	147.0	311.2	5.1	10.88

Table 10 – Pour point basins and their adjusted design flow by soil burn severity.

Values at Risk		Discharge by Severity in cfs*				Discharge by Watershed in cfs		Discharge by Watershed in cfs/mi²	
Pour Points	Affected WS Area Miles²	High Severity Burn	Moderate Severity	Low Severity	Unburned	Pre fire*	Post Fire	Pre-fire flow in cfs/ mi²	Post-fire flow in cfs/ mi²
1	0.80	0.0	3.94	5.0	0.405	3.6	9.34	4.5	11.68
2	1.10	0.0	10.69	4.30	0.441	4.41	15.43	4.0	7.01
3	1.00	0.0	2.2	5.83	1.61	4.41	9.64	4.4	12.04
4	0.20	0.0	0.4	3.0	0.147	1.47	3.55	7.4	17.74
5	0.20	0.0	1.0	1.9	0.022	1.47	2.92	7.4	14.61
6	ND	ND	ND	ND	ND	ND	ND	ND	ND
7	0.60	0.0	2.9	4.1	0.147	2.94	7.18	4.9	11.97
8	ND	ND	ND	ND	ND	ND	ND	ND	ND
9	0.40	0.0	0.92	0.81	0.441	1.47	2.17	3.7	5.42
10	2.60	0.369	8.38	4.07	1.31	8.82	14.13	3.4	5.43
11	5.40	0.09	24.7	5.29	2.20	17.64	32.27	3.3	5.98
12	1.30	0.0	5.67	1.08	1.05	4.41	7.81	3.4	6.00
13	7.8	2.23	55.84	16.83	7.63	27.93	82.55	3.6	10.58
14	0.70	0.0	0.8	0.407	2.20	2.94	3.40	4.20	4.85
15	ND	ND	ND	ND	ND	ND	ND	ND	ND
16	4.30	1.39	17.7	3.32	6.18	17.64	28.58	4.1	6.65
17	5.10	0.15	14.17	3.78	15.47	20.58	33.57	4.0	6.58
18	154.9	4.72	150.6	101.2	209.9	288	466.4	1.9	1.89
19	2.90	0.0	1.76	0.559	11.11	11.76	13.43	4.1	4.63
20	1.20	0.0	3.4	1.10	2.06	4.41	6.56	3.7	5.47
21	0.50	0.0	0.022	0.84	2.52	2.94	3.38	5.9	6.77
22	3.20	2.48	37.5	4.71	1.07	13.23	45.72	4.1	14.29
23	81.4	0.137	16.2	21.9	134.4	147.0	172.63	1.8	2.12

Runoff Modeling Results

Most of the Erskine Fire is comprised of low to moderate soil burn severity (Table 4). As a result, modeling showed only minor increases in post-fire runoff for most HUC12 watersheds. All but one of the seven HUC12 watersheds showed runoff values over 50% relative to the design storm (Lower Kelso Creek, which showed a 112% increase); most HUC12 watersheds showed runoff increases <50%, ranging from 1.2% - 40% (Table 11). Of the 23 pour point subdrainages, seven showed marked increases in runoff potential over 100%, ranging from 119% – 250%; seven pour points showed moderate increases (50-100%) in runoff potential, and nine pour points showed low (<50%) runoff potential. Pour points 1-4, 13 and 22 showed the greatest relative increases in runoff potential (Figures 2, 3a, 3b). It is important to note that, although the increases are high relative to normal Q2 discharge, none of the pour points modeled exceeded a Q10 discharge. Stream channels measured in the vicinity of Values at Risk showed confinement to >Q50 and in many cases >Q100. As such, risks from flooding alone are considered moderate to-low for a 2 year, 6 hour design storm.

Table 11 - Percent Increase in Water Yield by HUC12 Watersheds and Subdrainages for a 2 year, 6 hour design storm.

6th Field HUC12 Watersheds and Pour Points	Watershed Area Miles^2	Percent increase in Water Yield from burn areas for Q2 Design Storm
Black Gulch-Kern River	23.4	11%
Erskine Creek	38.2	9.6%
Isabella Lake-SF Kern River	137.6	21.5%
Isabella Lake-Kern River	47.5	1.2%
Upper Kelso Creek	44.6	12.8%
Middle Kelso Creek	56.5	40.3%
Lower Kelso Creek	28.6	111.7%
Pour Point Subdrainages		
1	0.80	159.5%
2	1.10	249.9%
3	1.00	118.5%
4	0.20	141.3%
5	0.20	98.8%
6	ND	ND
7	0.60	144.2%
8	ND	ND
9	0.40	47.6%
10	2.60	60.2%
11	5.40	82.9%
12	1.30	77.0%
13	7.8	195.6%
14	0.70	15.6%
15	ND	ND
16	4.30	62.0%
17	5.10	63.1%
18	154.9	62.0%
19	2.90	14.2%

6th Field HUC12 Watersheds and Pour Points	Watershed Area Miles^2	Percent increase in Water Yield from burn areas for Q2 Design Storm
20	1.20	48.8%
21	0.50	15.1%
22	3.20	245.6%
23	81.4	17.4%

II. Emergency Determination

1. Threats to Human Life and Property

Emergency determinations were conducted using the risk assessment matrix in the Forest Service Manual for the BAER program (USFS, 2012). This matrix uses a combination of the probability of damage or loss and the magnitude of consequences associated with that damage or loss to determine a level of risk. The risk level is then used to determine if an emergency exists (Table 2). Below are the VAR's that are susceptible to flood hazards only. For a detailed discussion of rock fall and debris flow threats to VAR's, please refer to the geology and soils reports.

Hydrologic modelling using a 2 year, 6 hour design storm in some cases shows relatively high increases in runoff; however, it is important to note that, although the increases are high relative to normal Q2 discharge, none of the pour points modeled exceeded a Q10 discharge. Stream channels measured in the vicinity of Values at Risk showed confinement to >Q50 and in many cases >Q100. As such, risks from ***flooding*** alone are considered moderate to-low for a 2 year, 6 hour design storm. The VAR's most susceptible to flooding hazard would include the culvert at the pour point 1 outlet along Erskine Creek Road in Lake Isabella and the damaged culvert identified on a private road in the Goat Ranch (South Lake) community (pour point 22). In general, bulking from ash, sediment, and floatable woody debris could block these and other culverts in and downstream of the burn area causing damage to road prisms, and in extreme cases of very high runoff, cause complete road failure. It is recommended that storm patrols keep culverts free of debris along State Highway 178 and in the communities of Lake Isabella (Lakeview Estates), Squirrel Valley, and South Lake.

The above threats will be the most acute during the first runoff-producing storms, which typically occur December to May, but there is a history of intense summer thundershowers in the Piute Mountain area, so storm preparedness should commence immediately. There will be a higher level of flood risk during the next three to five years until there is sufficient vegetative recovery to mitigate increased runoff.

2. Threats to Water Quality

Surface waters in the fire area will be bulked by ash, debris, and other floatable and transportable material during storm events. It is likely that stream flows from the first post-fire runoff producing rain events will see high concentrations of ash and fine sediment that will cause considerable turbidity and degradation of water quality and the beneficial uses of water. Beneficial uses of water are identified and protected by the California State Water Quality Control Board by regulation as found in the Tulare Basin

Plan. Beneficial uses are: municipal water supply, contact and non-contact recreation, wildlife habitat, warm and cold water aquatic habitat, rare species habitat, fresh water replenishment, and spawning.

Water Quality

- The most noticeable effects on water quality will be increased sediment and ash from the burned area into the North and South Fork of the Kern River, although this may largely depend on Lake Isabella's volume (elevation) at the time of runoff events. If hydrologic connectivity is indeed present, this material could increase the rate of pool filling by fines, which may affect aquatic habitat.

III. Treatments to mitigate the flooding emergency

- Set up early warning system for weather events that could potentially trigger debris flows.

- No channel or hillslope treatments recommended except those associated with road - stream crossing emergency measures.

- Storm patrols should be conducted by all relevant parties to ensure that blockage of crossing structures do not occur during the first runoff producing storms.

- Roads should be storm-proofed as necessary.

- Share assessment information with local communities, landowners, water users, permit holders, NRCS, and NOAA/NWS to facilitate preparation for fall and winter storms.

References

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