Lake Christine Burned Area Emergency Response Summary
White River National Forest
July 31, 2018
Prepared by Liz Schnackenberg and Beth Anderson

FIRE BACKGROUND

The Lake Christine Fire started on July 3, 2018 approximately one mile northwest of Basalt, Colorado. A Burned Area Emergency Response (BAER) assessment was initiated on July 25, 2018 prior to containment as summer thunderstorms could pose significant threats to values at risk within and downstream of the fire. This initial BAER assessment covers approximately 9,800 acres and provides information to inform threats to public safety and infrastructure from post-fire effects. Since the assessment was initiated the fire size has increased to over 12,500 acres; it is anticipated that there will be a follow-up BAER assessment to cover these additional acres as the fire nears containment.

Southern End of the Lake Christine Fire

BAER PROCESS

The BAER assessment focuses on imminent post-fire threats to life/safety, property, natural resources, and cultural resources. Threats include determining where post-fire precipitation events could increase runoff and flooding, erosion and sediment delivery, debris flows, and high risk areas for the spread of invasive weeds.

Hydrologists, soil scientists, engineers, weed specialists, archaeologists, a wildlife/fisheries biologist, and GIS support all contributed to the BAER assessment. In addition to the assessment team, the US Geological Survey (USGS) provides model results on debris flow potential following the fire.

The BAER team identified 'Values at Risk' (VAR), a term used to note key concerns related to life and safety, property, natural resources, and cultural resources. The team develops a Soil Burn Severity (SBS) map to document the degree to which soil properties changed as a result of the fire within the burned area. Fire damaged soils have low strength, high root mortality, and increased rates of water runoff and erosion. Using the SBS map, BAER team members run models to estimate changes in stream flows from summer thunderstorm events, and debris flow potential. The models compare pre-fire conditions to predicted post-fire conditions to determine relative changes as a result of the fire. These changes are then used to determine the relative risk to different VARs, and recommendations to address those things determined to be an emergency. Modelling results are not intended for site specific actions such as sizing culverts etc.

ANALYSIS OVERVIEW

The U.S. Forest Service Geospatial and Technology and Applications Center provided the BAER team with an initial Burned Area Reflectance Classification (BARC) map derived from satellite imagery that compares pre and post fire images. The team conducted reconnaissance and field verification surveys to adjust the BARC and create a final soil burn severity map. BAER specialists classified 906 acres (9%) as unburned, 2,507 (26%) burned at low severity, 5,195 acres (53%) burned at moderate burn severity and 1,189 acres (12%) burned at high severity (Figure 1).

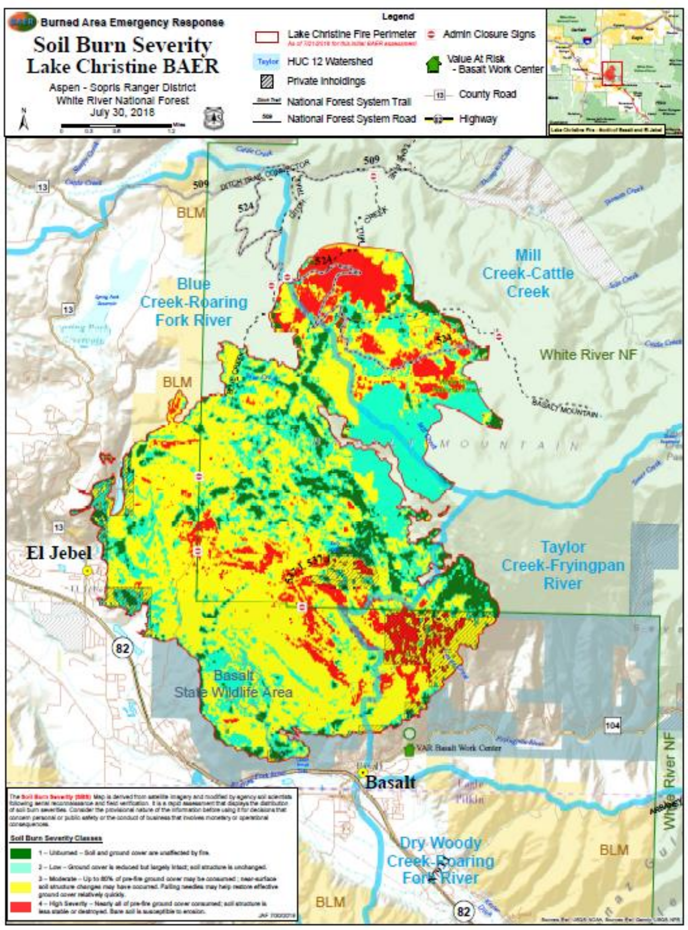

Figure 1. Soil Burn Severity.

Physical Characteristics of the Burned Landscape

<u>LANDSCAPE</u>

Basalt Mountain is an ancient shield volcano with a geology consisting of basalt flows, landslide deposits, and sedimentary layers of Mancos shale, evaporites, and Dakota sandstones. The land cover varies from grasses/sagebrush, oak brush, and pinyon/juniper at the lower and middle elevations to aspen and spruce/fir at the higher elevations. The terrain varies from rolling hills to very steep basalt-rock cliffs.

<u>SOILS</u>

An estimated 65% of the area within the Lake Christine Fire perimeter had high or moderate SBS and may have developed water repellent soils as a result of the fire. Water repellent soils develop when organic material (dead plant debris) on the soil surface burns during a fire, releasing waxy substances that coat soil particles—basically “shrink-wrapping” the soil and filling in the pores that allow water to soak in during rain events; this condition is referred to as hydrophobicity. When water can’t infiltrate into the soil because the pores are blocked, water runs off over the surface causing erosion and increased flood flow potential.

Soil erosion models indicate that relative to pre-fire conditions, erosion rates are expected to increase from negligible to 3.3 tons of soil per acre. For perspective, one acre of soil equal to the thickness of one sheet of paper is equal to one ton of sediment. The increased erosion can result in downstream sediment delivery that bulks flows resulting in increased flooding affects. Increased erosion can also block culverts and other infrastructure, and degrade water quality.

While wildfire will have a negative effect on soil productivity and vegetative recovery in the short-term, over time it is expected that natural processes will result in effective revegetation of these soils. While soil loss may be greater in localized patches, these impacts are not considered significant and will not result in permanent impairment of soil productivity in the long-term (10 years).

High Soil Burn Severity in the northern spruce-fir portion

Moderate-high SBS in the southern portion. Note lack of ash relative to the northern portion

Field reconnaissance on July 28, 2018 found that grasses and shrubs are already starting to regrow. Recovery of the vegetation will help restore the soil and landscape, and reduce post-fire flooding and debris flow potential.

HYDROLOGY

The stream network in the southern Basalt Mountain area is heavily disjointed as a result of the volcanic/sedimentary geology, land cover, terrain, and land uses. As a result, the stream network is primarily discontinuous ephemeral and intermittent streams. On the northern portion of the fire the stream network follows a more traditional dendritic pattern as it drains into Cattle Creek.

Prior to the fire, the surface duff and litter acted as a ‘sponge’ that naturally absorbed water during rainfall events and promoted infiltration into the soils. Post-fire the loss of the surface cover in combination with water repellent soils that won’t absorb water results in increased flooding, particularly downstream of areas of high and moderate soil burn severity.

The hydrology modelling focused on a 10 year one hour thunderstorm event as those types of events are the most likely to cause increased flood flows and debris flows. Subwatersheds were delineated using the USGS Streamstats tool. Pre and post-fire flood flows were modelled using Wildcat 5. Wildcat5 is an interactive Windows Excel®-based software package designed to assist watershed specialists in analyzing rainfall runoff events to predict peak flow and runoff volumes generated by single-event rainstorms for a variety of watershed soil and vegetation conditions. The model is intended for small catchments responsive to conditions of upland soils and cover. Relative increases in flood flows for selected watersheds are displayed in Figure 2. These estimates are conservative as the geology is dissected with limestone and basalt caps interspersed with faults which can result in some surface flows becoming subsurface flows. As a result, the potential for subsurface drainage is higher in the southern portion due to geologic conditions which would reduce flood flows.

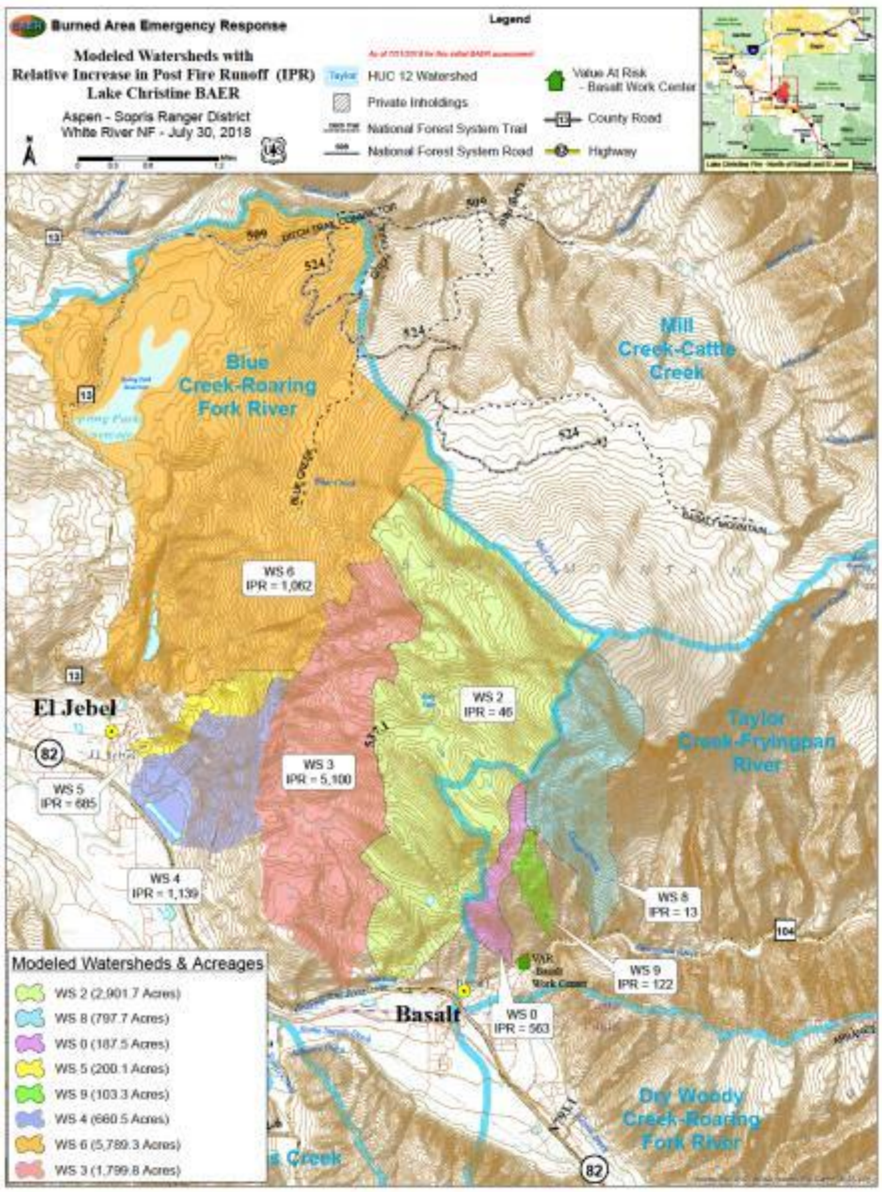

Figure 2: Relative increases in flood flows for a 10 year one hour thunderstorm for modelled watersheds

In addition to the increase in flood flows, the time for flood flows to reach a downstream area will also be more rapid following the fire. This shorter duration in the time to flood flows being translated downstream means less time to respond to these flood flow events. Table 1 summarizes the relative change in peak flood flows as well as the predicted time to peak flows for pre and post-fire conditions.

Table 1: Pre and post fire modelled flood flows for a 10 year one hour thunderstorm, and predicted time to peak.

Sub-Watershed Number	Pre-fire Q (cfs)	Post-fire Q (cfs)	Bulked post-fire Q (cfs)	Relative Increase Post-fire Q (Post Q /Pre Q)	Pre-fire time to peak (min)	Post-fire time to peak (min)
0	0.1	45	56	563	65	34
2	13	480	600	46	65	35
3	0	408	510	5100	No flow	37
4	0	91	114	1139	No flow	35
5	0	54	69	685	No flow	34
6	0.4	364	400	1062	67	37
8	9	106	117	13	65	35
9	0.3	27	33	122	65	34

It is important to note that these are relative increases for summer thunderstorms as that is when the most damaging post-fire effects are likely to occur. In addition to increased flood flows from summer thunderstorms, there is a chance that debris will collect and create debris dams and subsequently dislodge during later storms. These debris dam outburst floods could pose additional risk to life and property downstream during high flow events since they carry logs, rocks, and a deluge of mud.

GEOLOGY

Debris flows are among the most hazardous consequences of rainfall on burned hillslopes. Debris flows pose a hazard distinct from other sediment-laden flows because of their unique destructive power. Debris flows can occur with little warning and can exert great impulsive loads on objects in their paths. Even small debris flows can strip vegetation, block drainage ways, damage structures, and endanger human life. Additionally, sediment delivery from debris flows can "bulk" the volume of flood flows, creating an even greater downstream flooding hazard. The U.S. Geological Survey (USGS) used the SBS in conjunction with historic debris flow occurrence, rainfall characteristics and soil properties in their modeling to predict the risk of debris flows. The results of the USGS debris flow modelling effort will be available at: https://landslides.usgs.gov/hazards/postfire_debrisflow/.

There are several unique physiographic characteristics of the area burned by the Lake Christine fire that contribute to an atypical degree of uncertainty in the U.S. Geological Survey (USGS) estimates of post-fire debris-flow hazard. First, the southern portion of the burn area is situated on a pre-historic landslide complex. The topographic and structural properties of the landslide complex introduces a high degree of complexity in the surface and subsurface hydrologic function of the area. Second, the metrics used to characterize fire severity in the model equations tend to have values that are atypically high for the type of vegetation burned in the Lake Christine fire. Finally, the database used to characterize the erosion potential of the soils in the area also tend to be very high. The net effect of these unique characteristics of the area burned by the Lake Christine fire are estimates of post-fire debris-flow likelihood and magnitude that likely overestimate the potential hazard. However, hazardous flash flooding and debris flow are still possible during intense rainfall, and residents of downstream communities should heed all warnings issued by local officials.

Figure 3 displays the probability of a debris flow initiating. As noted above, these probabilities may be over-estimated due to local conditions and the data used in the model. Examples of over estimation can be seen where a high probability is shown in flat terrain.

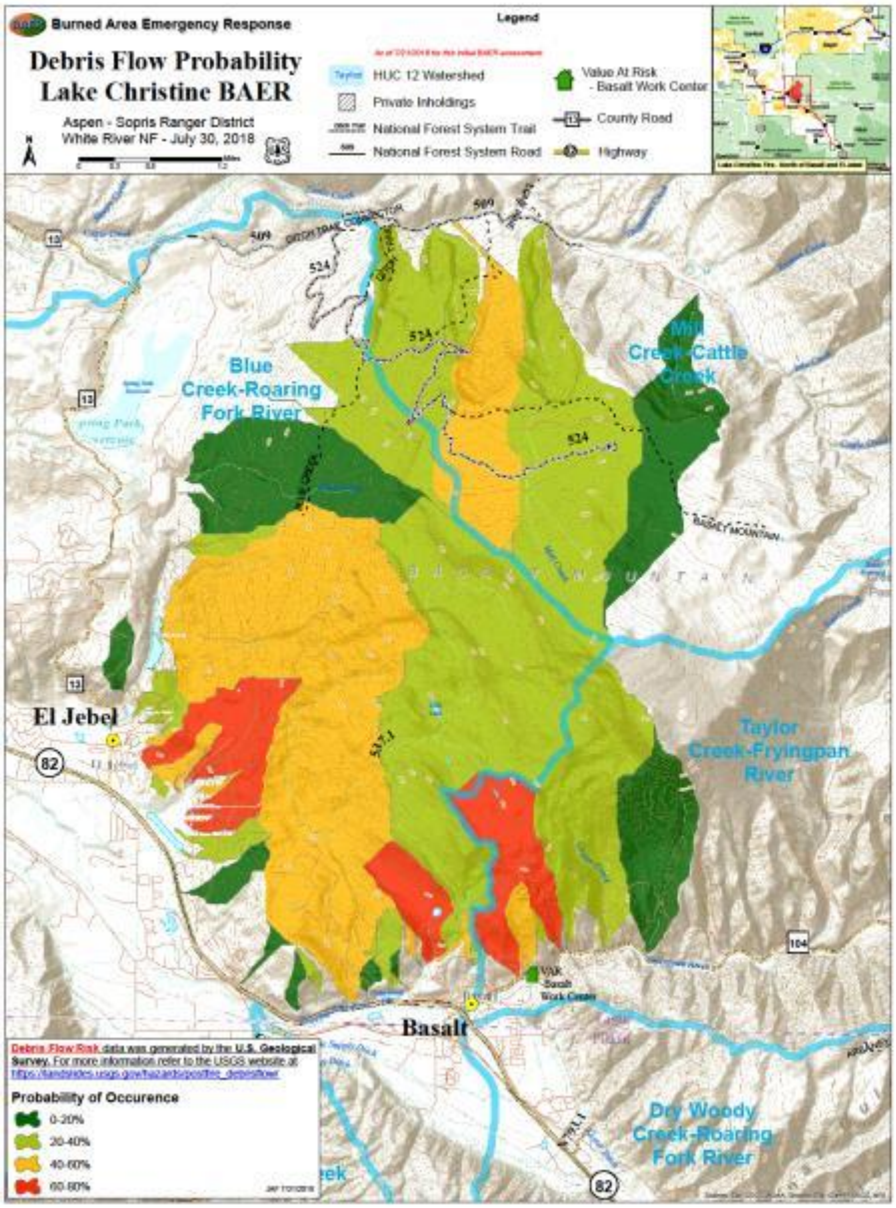

Figure 3. USGS debris flow probability of occurring.

IDENTIFIED VALUES AT RISK

The BAER team analyzed the fire related threats to the values-at-risk (VAR) below for potential impacts from increased stream flows, loss of water control on trails and roads, increased debris flow risk, increased sediment delivery to streams, and establishment of invasive weeds. The team used a risk matrix (Probability of Damage or Loss and the Magnitude of Consequences) to determine the risk each VAR.

Human Life and Safety

Threats to human life and safety have increased due to hazard trees. Even trees that still appear green may have a weakened root system due to smoldering at the base of the tree. For this reason, the Forest will maintain an area closure for the burned area until the risk of hazard trees subsides.
Threats to life and safety have also increased in and below areas of high and moderate burn severity due to increased flood and debris flow potential. Debris flows can be initiated with as little as 0.25 inches of rain. Rain gages have been established in key areas to provide advanced notice of rainfall events that could cause debris flows.

Roads and Trails

Roads and trails within the White River National Forest are currently closed and will remain closed until hazards are mitigated and crews conduct repair work. NFSR 524 which accesses the upper Basalt Mountain area as well as the Mill Creek and Basalt Mountain Trails will be monitored after significant rain events to determine if drainage culverts are still functioning and/or if damage to the road has occurred and identify necessary repairs.

Noxious Weeds

Noxious weeds are the most serious ecological threat due to the fact that large burned areas open the watersheds to the rapid spread of species adapted to colonizing disturbed soils. Noxious weeds displace native species and can disrupt ecological relationships and connections, reducing ecosystem stability. The appearance, function, economic values, and resilience of large landscapes can be substantially changed by invasive species. The BAER team recommends conducting noxious weeds surveys in areas of moderate to high burn severity and are most prone to the spread of noxious weeds (along roads and trails).

Fisheries

Changes in supplies of water and sediment are commonly observed after wildfire. A population of Greenback Cutthroat Trout is present in Cattle Creek. Cattle Creek was not included in this assessment due to fire suppression activity and the fire continuing to spread in this watershed. Effects to the cutthroat trout will be considered in a follow up BAER assessment. Inter-agency coordination with the Colorado Parks and Wildlife is ongoing regarding potential threats to these fisheries.

CONCLUSION

The BAER team has identified imminent threats to values at risk based on a rapid scientific and engineering assessment of the area burned by the Lake Christine Fire. The assessment was conducted using the best available methods to analyze the potential for flooding and debris flows. Options for reducing post-fire peak stream flows, soil erosion, and debris flow potential are limited due to the nature of the burn and slope characteristics. As a result, treatment recommendations focus on mitigation measures to minimize loss of life and damage to values at risk. These mitigations include area closures, warning signs, and public safety approaches such as installation of an early warning system to notify area residents and users of when damaging storms may be approaching.

The findings provide the information that can assist in preparing for post-fire threats. Agencies and landowners are encouraged to use the findings to prepare plans and take actions to protect values at risk. The US Forest Service will continue to participate in inter-agency efforts to address threats resulting from the Lake Christine Fire.
. Post-fire there will be an increase in watershed response. This means that:

- Areas that flood or have debris flows pre-fire will have larger magnitude events
- Areas that occasionally flood or have debris flows will see more frequent events
- Areas that previously did not have streamflow or debris flows may now flood or have debris flows

These potential changes should be taken into consideration when developing post-fire response plans.