Cameron Peak Fire Forest Service Burned Area Emergency Response Executive Summary
Arapaho Roosevelt National Forest
December 15, 2020

FIRE BACKGROUND

The Cameron Peak Fire was reported on Thursday, August 13. The fire was burning in steep, rugged terrain, approximately 25 miles east of Walden and 15 miles southwest of Red Feather Lakes near Cameron Pass. The cause of the wildfire remains under investigation. Large scale and long duration evacuations took place throughout the fire. The fire burned through an area of 208,913 acres on the Arapaho and Roosevelt National Forests in Larimer and Jackson Counties and Rocky Mountain National Park.

After 62 days of burning, on October 14, the Cameron Peak Fire became the largest recorded wildfire in Colorado's history, surpassing the Pine Gulch Fire that burned near Grand Junction in 2020. On October 18, the Cameron Peak Fire became the first in Colorado history to burn more than 200,000 acres. Prior to 2002, there was never a fire larger than 100,000 acres in Colorado.

On the Cameron Peak Fire, extreme temperatures, low humidity, rough terrain and gusty winds reaching over 70 miles per hour contributed to extreme fire behavior and rapid rates of spread. Another contributing factor to fire growth was the large amount of beetle kill trees and the drought-stricken Ponderosa Pine, Engelmann Spruce and mixed conifer stands available as fuel.

Two BAER assessments were completed for the Cameron Peak Fire, the first assessment covered 99,209 acres and the second covered 109,551 acres. Combined these assessments cover almost the entire total of burned acres in the Cameron Peak Fire. The Cameron Peak Fire was a long duration event characterized by rapid, wind-driven increases in burned acres often quickly followed by snowfall. This made BAER assessments difficult as access to the fire and satellite imagery was impeded by snow. Despite these challenges the final Soil Burn Severity map included with the second assessment is an accurate representation of ground conditions and most critical values were accurately assessed, though additional assessment of values may need to occur in the spring. Implementation of treatments identified in the BAER report will need to occur in the spring, current winter conditions make implementation unrealistic.

BAER PROCESS

USFS BAER assessments focus on imminent post-fire threats to life and safety, property, natural resources, and cultural resources on NFS lands. Threats include determining where post-fire snowmelt and 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, recreation and weed specialists, archaeologists, wildlife and fisheries biologists, and GIS support all contribute to the BAER assessment. Additionally, the US Geological Survey (USGS) models post-fire debris flow potential; results are available at https://landslides.usgs.gov/hazards/postfire_debrisflow/.

The first step in identifying post-fire threats is development of a Soil Burn Severity (SBS) map to document the degree to which soil properties changed as a result of the fire. Fire damaged soils have low strength, high root mortality, and increased rates of water runoff and erosion. Soil burn severity is classified according to the Field Guide for Mapping Soil Burn Severity (Parsons et al, 2010). Primary soil characteristics considered in soil burn severity classification are forest floor cover, ash color, integrity of roots, integrity of structure, and water repellency[1].

Areas of low and unburned SBS have minimal effects to soil properties, and therefore little to no post-fire effects. Moderate SBS indicates that some soil properties have been affected and the duff and litter layer that acts as a sponge to absorb precipitation has mostly been consumed. High SBS areas have significant alterations to soil properties such as complete consumption of littler and duff, loss of root viability and changes to soil structure than often drive substantial watershed response including increased erosion and runoff following precipitation events.

Figure 1: Comparison of low soil burn severity with roots and structure (top of shovel) vs. high soil burn severity with no soil structure or roots to help bind soil (bottom of shovel)

The U.S. Forest Service Geospatial and Technology and Applications Center provided the BAER team with an initial Burned Area Reflectance Classification (BARC) maps derived from satellite imagery that compares pre and post fire images. The team conducted field verification surveys to adjust the BARC to create the final SBS map (Figure 2).

[1] Water repellent soils have reduced infiltration which results in increased runoff

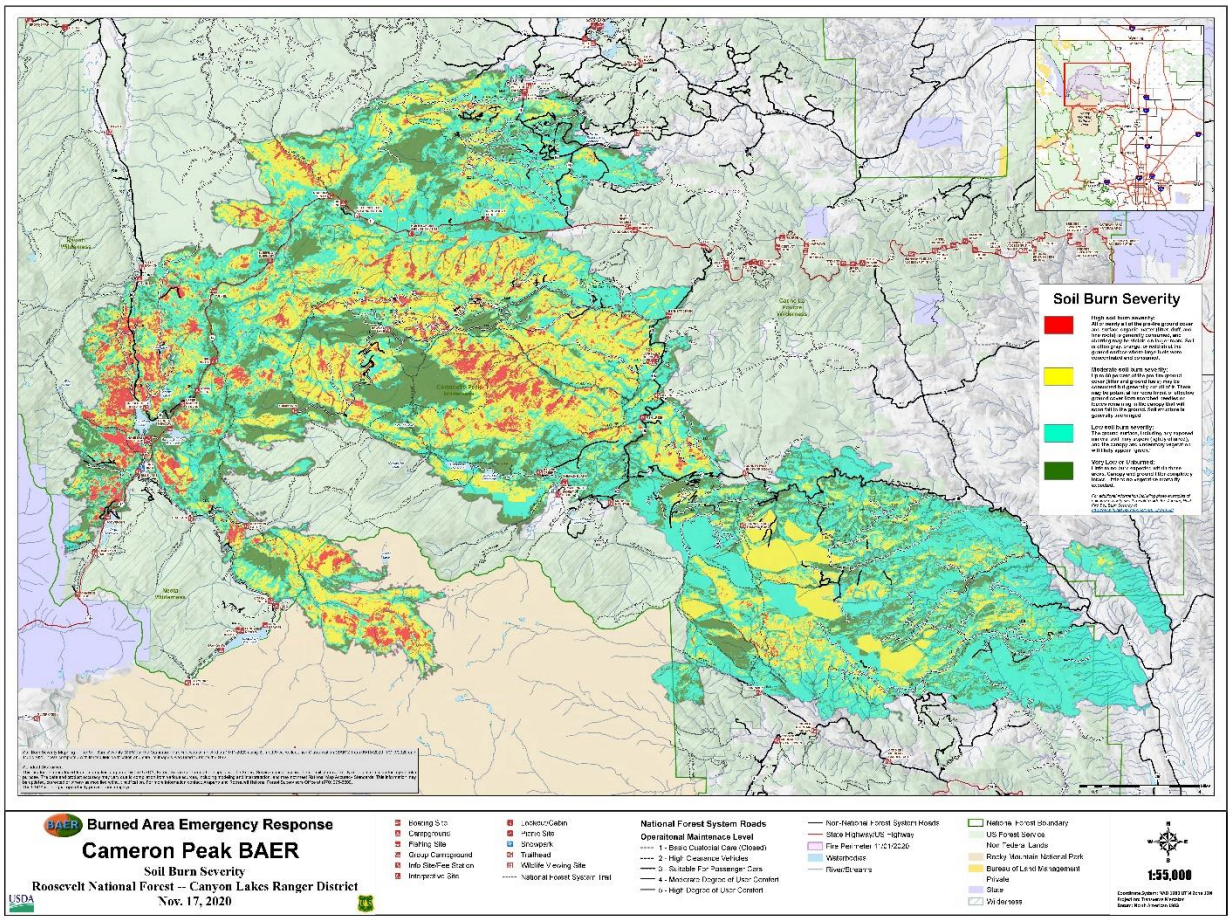

Figure 2. Cameron Peak Soil Burn Severity map

ANALYSIS SUMMARY

SOILS

Soil burn severity is often a result of fire progression and behavior. Longer fire residence times typically result in high and moderate severity effects. On the Cameron Peak Fire areas around the ignition point on the west side of the fire near Chambers Lake saw longer fire residence times and also showed higher soil burn severities. Most of the rapid growth on the Cameron Peak Fire coincided with high winds associated with weather fronts ending in precipitation. This can be observed in the wind driven patches of growth to the east of the initial ignition point. These areas had lower fire residence times that often resulted in lower soil burn severities. Often these events consumed tree canopies but left the soil structure and root health intact.

This fire behavior made mapping soil burn severity challenging. There were often short windows of time between rapid fire growth and snowfall and BARC imagery often did not capture fire growth before snowfall obscured imagery. The final Soil Burn Severity map was a product of 3 BARC datasets individually covering the initial ~99,000 acres from the first BAER assessment, the northeast expansion and the southeast lobe of the fire. The southeast lobe of the fire presented the largest challenge with snow coverage.

Table 1: Burn Severity Acres by Ownership

Soil Burn Severity	USDA Forest Service	Private	Rocky Mountain NP	Colorado State Forest	Local (includes SWAs)	Grand Total	Area within fire perimeter (%)
High	10,944	138	1,104	4	11	12,200	6
Moderate	57,276	2,775	3,241	433	144	63,869	30
Low	70,155	17,239	1,994	1,049	706	91,143	44
Unburned	34,943	4,927	1,154	351	171	41,547	20
Grand Total	173,318	25,080	7,493	1,837	1,031	208,760	
Ownership%	83.0	12.0	3.6	0.9	0.5	100	

An estimated 36% of the area within the Cameron Peak Fire perimeter has high or moderate SBS indicating increased erosion and flood flow potential. Erosion potential post-fire is contingent on a variety of site characteristics including soil texture, rock fragment content, slope, soil burn severity and the distribution of soil burn severity.

During field reconnaissance of the initial assessment, twenty hydrophobicity tests were conducted in various areas within the fire perimeter and amongst various burn severities across the fire. During the interim assessment, field conditions were impacted by a recent snow event and as such the soils were quite moist and were not conducive to collecting hydrophobicity observations by water drop test. Of the few points that we did review hydrophobicity, the presence of hydrophobic soils was inconsistent. As such, hydrophobicity observations from the initial assessment have been extrapolated to the newly burned areas.

Hydrophobicity from the Cameron Peak fire was found to be highly inconsistent. Within the small dataset of field observations collected during soil burn severity mapping, hydrophobicity did not correlate with soil burn severity class, nor was the presence of hydrophobicity consistent within any one soil burn severity class**.** The dataset collected during field work is realistically not rigorous enough to draw conclusions as to the presence of hydrophobicity across the fire. The following numbers are provided as a rough estimate, only, to get an idea of what conditions may be present on the ground.

Table 2. Summary of hydrophobicity observations for the Cameron Peak fire

Hydrophobicity	**Data points observed**	**%**	**Acres w/in Perimeter**
None	6	30.0%	62,628
Weak	3	15.0%	13,671
Mod	5	25.0%	52,190
Strong	6	30.0%	62,628

Moderate and strong hydrophobicity would be interpreted as water-repellant. Therefore, approximately 55% of the fire (114,818 acres) may have water-repellant properties. Where present, hydrophobicity effects were primarily observed between one to six centimeters in depth.

Table 5 and 6 summarizes the results of the WEPP PEP, ERMiT, and TEU T factor data, as it pertains to the selected sub-watersheds.

Table 3. Summary of Sediment Delivery potential and Soil loss potential for the Cameron Peak fire

Pour Point	**Sediment Delivery (ton/ac) (ERMiT)*+**						**Erosion (WEPP PEP)**					**T Factor (TEU)**
	Year 1			**Year 2**			**Estimated Soil Loss post-fire**			**Estimate in Undisturbed**	**Magnitude of Change**	**Acceptable soil loss**
	Untreated	Mulch (0.5 ton/ac)	Mulch (1 ton/ac)	Untreated	Mulch (0.5 ton/ac)	Mulch (1 ton/ac)	(ton/watershed)	(lb/ac/yr)	(ton/ac/year)	(ton/watershed)	% Increase post-fire	(ton/acre)**
Barnes Meadow Res	0	0	0	0	0	0	120	480	0.24	NA	NA	5 and 2
Bennett Creek lower	2.16	0.51	0.2	1.27	0.52	0.32	4200	1400	0.7	180	2233%	2 and 4
Black Hollow Fish Barrier	0	0	0	0	0	0	1400	700	0.35	NA	NA	2 and 4
Crown Point Gulch	3.11	0.78	0.4	2	0.79	0.52	1400	2800	1.4	76	1742%	2 and 4
E Sheep Cr at Poudre	3.21	1.08	0.96	2.31	1.07	1	2200	2500	1.25	82	2583%	2 and 4
Fall Creek-Chambers Lk	0	0	0	0	0	0	880	570	0.285	NA	NA	5
Laramie River Tunnel CG	0	0	0	0	0	0	2300	760	0.38	NA	NA	5
Mineral Springs Gulch	2.88	1.07	0.61	1.81	1.09	0.73	1500	2400	1.2	76	1874%	2 and 4
NF Joe Wright Cr Hwy 14	0	0	0	0	0	0	350	330	0.165	NA	NA	5
Peterson Lake Trib	0	0	0	0	0	0	150	400	0.2	NA	NA	5
Trap Creek-Chambers Lk	0	0	0	0	0	0	NA	NA	NA	NA	NA	2 and 5
Trib 1-Chambers Lk	0	0	0	0	0	0	140	1100	0.55	NA	NA	5
Trib 1-Laramie River	0	0	0	0	0	0	48	1200	0.6	NA	NA	5
Trib 2-Chambers Lk	0	0	0	0	0	0	30	950	0.475	NA	NA	5
Trib3 to Poudre River	0.86	0.06	0.05	0.25	0.06	0.05	1200	1000	0.5	110	991%	2 and 5
Trib1 to Poudre River	0.23	0	0	0.02	0	0	310	1300	0.65	24	1192%	2 and 5
Trib2 to Poudre River	0.36	0	0	0.05	0	0	190	300	0.15	33	476%	2 and 5
Tunnel Cr at Hwy 14	0	0	0	0	0	0	250	310	0.155	NA	NA	2 and 5

*20% probability that the sediment yield will be exceeded

**Several of the modelled sub-watershed contain multiple TEU map units with different T factor ratings. In sub-watersheds where there was not a clear dominant T factor rating, both ratings are listed.

Table 4. Summary of Sediment Delivery potential and Soil loss potential for the Cameron Peak Phase II assessment

Pour Point	**Sediment Delivery (ton/ac) (ERMiT)**						**Erosion (WEPP PEP)**					**T Factor (TEU)**
	Year 1			**Year 2**			**Estimated Soil Loss post-fire**			**Unburned**	**Magnitude of Change**	**Acceptable soil loss**
	Untreated	Mulch (0.5 ton/ac)	Mulch (1 ton/ac)	Untreated	Mulch (0.5 ton/ac)	Mulch (1 ton/ac)	(ton/watershed)	(lb/ac/yr)	(ton/ac/year)	(ton/watershed)	% Increase post-fire	(ton/acre)
Bear Gulch-Buckhorn Creek	1.10	0.13	0.00	0.92	0.11	0.01	1200	860	0.42	15	7900	2
Cascade Creek FSR 129	2.28	0.30	0.13	2.26	0.30	0.27	1300	1400	0.68	100	1200	2
Dry Creek-Poudre River	2.20	0.30	0.10	2.07	0.28	0.10	620	1800	0.87	15	4033	4
Elkhorn Creek CR 69	1.02	0.11	0.00	0.84	0.10	0.01	210	160	0.08	21	900	5
FSR 344B	1.89	0.25	0.07	1.77	0.23	0.15	570	2200	1.04	6.7	8407	2
Lakey Canyon	1.07	0.13	0.00	0.90	0.01	0.01	210	520	0.25	4.2	4900	2
Peterson Creek-Poudre River	1.37	0.18	0.00	1.14	0.15	0.02	170	270	0.13	21	710	2 and 5
Sevenmile Creek CR 69	2.79	0.34	0.03	2.35	0.25	0.09	2300	1000	0.50	140	1543	2 and 5
Beaver Creek FSR 145	3.16	0.58	0.23	1.62	0.56	0.46						5
Buckhorn Creek 44H	2.93	1.05	0.48	2.58	0.87	0.71						2 and 5
Buckhorn Creek FSR 129-Lower	2.93	1.05	0.48	2.58	0.87	0.71						2 and 5
Comanche Reservoir	3.16	0.58	0.23	1.62	0.56	0.46						5
Fish Creek-Buckhorn Creek	2.51	0.79	0.19	1.89	0.68	0.51						2
Miller Fork Big Thompson River	0.68	0.01	0.00	0.51	0.00	0.00						2 and 5
Sheep Creek FSR 132	2.93	1.05	0.48	2.58	0.87	0.71						2

*Several sub-catchments are greater than 5,000 and WEPP PEP can not be used to estimate hillslope loss due to erosion. These watersheds are greyed out where those values would be reported. The ERMiT sediment delivery values reported, therefore, are not generated using hillslope information derived from WEPP PEP. ERMiT results for these sub-watersheds were processed using estimates of hillslope information from derived from GIS. In watersheds that experienced a mix of low and moderate severity burns, averages of low and mod single hillslope ERMiT runs were utilized.

Hydrology

The Cameron Peak Fire has reduced or eliminated canopy and ground cover, as well as altered soil structure with varying degrees of hydrophobicity across extensive areas within the fire perimeter. These changes will lead to reduced precipitation interception and soil infiltration capacity, as well as elevated runoff compared to pre-fire conditions.

Watershed response will likely include an initial flush of ash, rill and gully erosion in headwater drainages and on steep slopes within the burned area, debris-laden flash floods in response to high-intensity rain events, elevated snowmelt peak flows and potentially debris flows. Water quality will be diminished during seasonal peak runoff, as well as after high-intensity summer rains, due to elevated ash, fine sediment, and nutrient loading. Elevated post-fire response will gradually diminish over time as vegetation and groundcover levels recover over the next several years, although some impacts are likely to persist for a decade or longer.

Portions of twenty-six 6th-field hydrologic unit code (HUC12) subwatersheds were affected by the fire (Figure 1, Table 2). These subwatersheds flow into the Cache la Poudre, Big Thompson and Laramie Rivers. The Rawah Creek-Laramie River subwatershed, has an inter-basin diversion just downstream of the fire perimeter that diverts water from the Laramie River over to the Cache La Poudre River via a tunnel through the mountain.

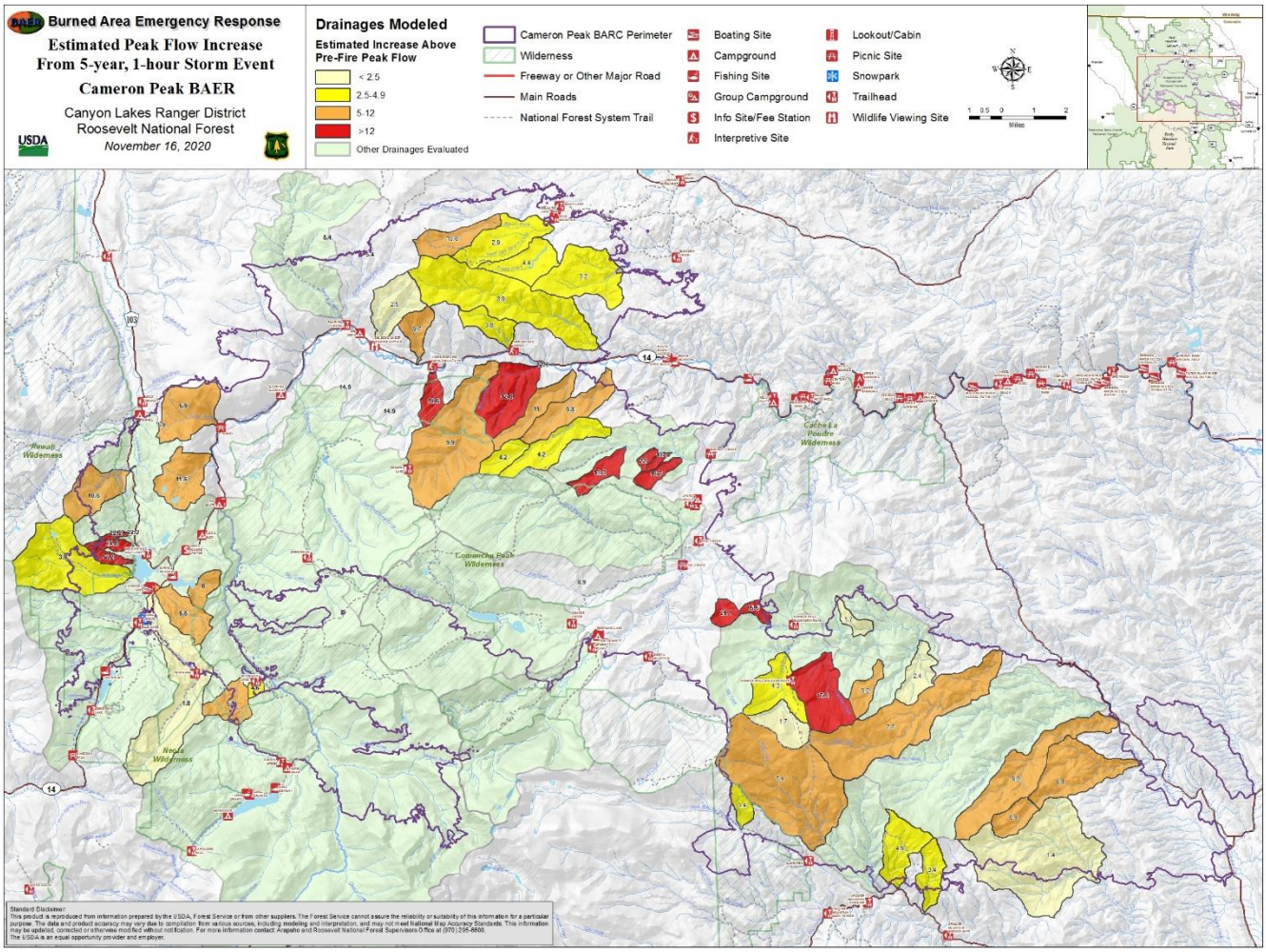

Figure 3: Percent increase above pre-fire streamflow for the WEPPcloud-PEP modeled drainages.

The WEPP *Post-fire Erosion Prediction* (PEP) distributed model was used to estimate increases in peak flows resulting from the fire for drainages under 6,000 acres. The 5-year-recurrence-interval, one-hour design storm was used in this analysis to represent a relatively common high-intensity rain event that may occur over the area. Modelling results are summarized in Table 5.

Table 5. Pre and post-fire estimated streamflow for the 5-year RI, one-hour storm.

Watershed	Pre-fire (cfs)	Post-fire (cfs)	Percent change
Barnes Meadow Reservoir	7	42	496%
Barnes Meadow Res South	13	72	445%
Bennett Creek Dispersed Site 1	5	79	1572%
Bennett Creek Dispersed Site 2	2	31	1809%
Bennett Creek Dispersed Site 3	2	40	2100%
Bennett Creek Dispersed Site 4	8	101	1229%
Bennett Creek FSR 139	7	30	315%

Bennett Creek middle	25	103	316%
Black Hollow Fish Barrier	54	540	894%
Crown Point Gulch	13	145	999%
E Sheep Creek at Poudre River	24	295	1157%
East Fork Roaring Creek	48	260	445%
Fall Creek-Chambers Lake	41	161	294%
Fish Creek at SF Poudre River	53	247	362%
Mineral Springs Gulch	17	167	877%
Monument Gulch	3	44	1455%
NF Joe Wright Creek Hwy 14	28	161	470%
NFSR 350 Crossing	4	86	2013%
Peterson Lake Tributary	10	51	411%
Peterson Lake Tributary SE	2	9	360%
Trap Creek-Chambers Lake	51	92	79%
Tributary 1-Chambers Lake	3	57	1618%
Tributary 2-Chambers Lake	1	21	2383%
Tributary 1-Laramie River	1	23	2116%
Tributary 1 to Poudre River	7	130	1863%
Tributary 2 to Poudre River	17	192	1057%
Tributary 3 to Poudre River	31	420	1262%
Tunnel Creek at Hwy 14	21	124	489%
Two and One Half Creek	14	148	961%
Bear Gulch-Buckhorn Creek	34	207.7	509%
Cascade Creek FSR 129	21	370.8	1638%
Cedar Creek FSR 299	70	99.2	42%
Dry Creek-Poudre River	9	33.3	283%
Elkhorn Creek CR 69	26	75.9	187%
Manhattan Creek CR 68C	27	86.2	224%
North Fork Trail	4	12.6	236%
Peterson Creek-Poudre River	13	33.5	152%
Sevenmile Creek CR 69	57	222.1	288%
Sheep Creek FSR 132	61	471.8	668%
Stringtown Gulch-Buckhorn Creek	36	333.0	834%
Swamp Creek CR 69	14	62.9	343%
Trib 1 Big Thompson River	12	60.6	394%
Trib 2 Big Thompson River	9	30.9	236%
Trib 4 Poudre River	6	60.0	866%
Bear Gulch FSR 153	7	43.1	539%
Buckhorn Creek FSR 154	15	63.2	331%
Elkhorn Creek FSR 198	12	131.4	960%
FSR 344B	6	58.6	817%

Lakey Canyon	10	24.7	144%
Trib to Buckhorn Creek	4	6.4	70%
Miller Fork at FS Boundary	66	483.8	637%
Buckhorn Creek FSR 129-Upper	10	17.0	75%

Post-fire response in seventeen drainages over 6,000 acres was estimated by calculating pre-fire annual peak flows using USGS regression equations (Cooper 2005) in the StreamStats web interface, and adjusting those values for post-fire conditions using a simple modifier. The modifier was based on the proportion of the drainage with moderate and high soil burn severity effects. These annual peak flows are associated with snowmelt runoff in this area and are less responsive to burned area influences than are smaller burned drainages in response to short-duration, high-intensity rainfall events. The same intense rainstorms that can cause a rapid flow response in smaller drainages typically are more limited in scale, and thus generally do not produce rainfall simultaneously across the larger watersheds.

Table 6. Estimated pre and post-fire snowmelt peak flows for drainages larger than 6,000 acres (two-year recurrence interval—50% probability in first year following fire)

Watershed	Area (ac)	Soil Burn Severity (acres)				High-mod SBS (%)	Pre-fire peak flow (cfs)	Post-fire peak flow (cfs)
		High	Mod	Low	Unburned			
Poudre River at Big South*	57,408	1,648	5,573	4,261	46,009	13%	1230	1385
Lower Poudre River Fish Barrier*	36,032	823	2,607	1,246	31,243	10%	971	1063
Joe Wright Creek at Big South*	24,576	1,960	2,346	3,223	17,058	18%	763	897
W Sheep Creek at Poudre River	14,016	841	5,338	3,432	4,380	44%	181	261
Joe Wright Creek-Chambers Lake*	11,712	689	633	1,069	9,389	11%	496	552
Little Beaver Creek at CR63E	11,520	1,933	5,904	2,063	1,578	68%	113	190
Hague Creek Fish Barrier	8,704	766	1,929	875	5,103	31%	291	382
Bennett Creek lower	6,528	350	2,620	2,314	1,208	46%	62.8	91
Laramie River Tunnel CG	6,150	1,476	1,838	1,624	1,422	52%	150	228
WF Roaring Creek	6,106	220	1,086	372	4,475	21%	131	159
Beaver Creek FSR 145	13,230	138	2329	2686	8077	19%	171	203
Buckhorn Creek 44H	17,377	28	3632	7444	6273	21%	211	255
Buckhorn Creek FSR 129-Lower	9,427	25	2396	3984	3022	26%	135	170
Comanche Reservoir	7,434	133	1609	1208	4484	23%	124	153
Fish Creek-Buckhorn Creek	10,262	26	2206	6039	1991	22%	173	211
Miller Fork Big Thompson River	8,933	181	3249	3663	1840	38%	136	188
South Fork Poudre River	9,815	1	44	193	9,577	<1%	172	173

*regulated stream (upstream impoundment[s])

Debris Flow Potential

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 impact 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 to inform their model and the results of the modelling effort are available at: https://landslides.usgs.gov/hazards/postfire_debrisflow/

TREATMENTS TO ADDRESS POST-FIRE THREATS

Human Life and Safety

Human life and safety is potentially at risk from threats associated with hazardous burned trees, debris flows, increased flooding, and loss of egress/access throughout the burned area.

Probability ratings to determine where life or safety could be impacted were determined for several trails, roads and developed recreational facilities within the burned area. Separate ratings were determined for hazard trees and flooding/debris flows to better inform closure treatment recommendations and future decisions about re-opening the closed roads, trails and facilities. For both hazard trees and flooding/debris flows, the BAER risk ratings for the roads,trails and facilities listed below ranged from possible to likely. In all cases, the magnitude of consequences was considered to be major, resulting in a high or very high risk rating.

Roads with high or very high BAER risk ratings for human life and safety based on hazard trees and/or flooding/debris flow: 126.A, 129, 132, 135.0, 139.0, 139.0, 139 A-N, 142.0, 142 A-G, 144.0, 144.A, 152.0, 152.1, 152.1A-B, 152.2, 152.2A, 152.D-G, 153, 154, 154-1C, 177.0, 177.C, 177.B, D, E-F, 191.0, 191.A-B, 259.0, 259.A, 268.0, 268.A-B, D, 344, 345, 350.0, 350.A-B, 520.0 and D139.A.

Trails with high or very high BAER risk ratings for human life and safety based on hazard trees and/or flooding/debris flow: Upper and Lower Dadd Gulch, Flowers, Zimmerman, Browns Lake, Big South, Little Beaver, Little Fish, Roaring Creek, Chambers Lake, Blue Lake, Blue Lake Spur, Jacks Gulch CG Loop Trail, Fish Creek, Blue Lake, North Fork, Emmaline Lake, Beaver Creek, and Comanche Lake.

Developed Recreational Facilities: BAER risk ratings for human life and safety based on hazardous trees and/or flooding/debris flow. The probablity that flooding would occur at developed campsites was considered to be intermediate and was applicable to selected streams and adjacent low lying sites within the campgrounds. For all developed risk facilities, especially campgrounds, longer residence times (longer exposure) within these areas was considered in the risk determinations for life and safety. In all cases the magnitude of consequences for potential impacts on life and safety was considered to be major.

Table 7. Developed Recreation Facility Risk Ratings

Facility	Threat - Life-Safety Risk Rating
Aspen Glen Campground	Flooding – Intermediate Risk*
Ansel Watrous Campground	Flooding – Intermediate Risk*
Bennett Creek Picnic Site	Flooding – Low Risk
Big Bend Campground	Flooding – Intermediate Risk*
Big South Campground	Flooding – Intermediate Risk*
Big South Trailhead	Life -Safety Concerns Not Identified
Blue Lake Trailhead	Life -Safety Concerns Not Identified
Browns Lake Trailhead	Life -Safety Concerns Not Identified
Chambers Lake Boating Site	Life -Safety Concerns Not Identified
Chambers Lake Campground	Flooding – Intermediate Risk to access road at culvert crossing Trap Creek (no flooding risk to CG itself). Hazard Trees – Very High
Chambers Lake Picnic Site	Life -Safety Concerns Not Identified
Dutch George Campground	Flooding – Intermediate*
Fish Creek Trailhead	Life -Safety Concerns Not Identified
Fish Creek Picnic Site	Life -Safety Concerns Not Identified
Green Ridge/Lost Lake Trailhead	Life -Safety Concerns Not Identified
Jacks Gulch Group Campground	Hazard Trees – Very High Risk, burned latrines – intermediate risk
Jacks Gulch Trailhead	Hazard Trees – Very High Risk
Jacks Gulch Campground	Hazard Trees – Very High Risk, burned latrines –intermediate risk
Kelly Flats Campground	Flooding – Intermediate Risk*
Long Draw Snowpark	Life -Safety Concerns Not Identified
Sleeping Elephant Campground	Rock Fall – High Risk**
Stove Prairie Campground	Flooding – Intermediate Risk*
Tunnel Picnic Site	Flooding – Low Risk
Tunnel Campground	Flooding – Intermediate Risk at four sites adjacent to Laramie River (bridge not evaluated by hydrology)
Zimmerman Trailhead	Life -Safety Concerns Not Identified
Tom Bennett Campground	Hazard trees – very high risk (at a few sites—not extensive)
Beaver Creek Trail Head	Hazard trees – very high risk
Corral Creek Trail Head	Hazard trees – very high risk
Dunraven Trail Head	Hazard trees – very high risk
Green Ridge/Lost Lake Trail Head	Hazard trees – very high risk, burned latrine – intermediate risk
Bellaire Lake Campground	Hazard trees – very high risk
Donner Pass –Ballard Road Trail Head	Hazard trees – very high risk
Emmaline Lake Trail Head	Hazard trees – very high risk
Home Moraine Geological Site	
Comanche Peak Wilderness	Hazard trees – high risk, rock fall at designated campsites – high risk

*Campgrounds along the Cache La Poudre River within and downstream from the burned area have some river adjacent sites that may be subject to flooding. The probabilty that flooding would occur and/or impact public safety is unlikely.

**Sleeping Elephant Campground has many sites that are directly adjacent to the steep burned hill-slope. Although it appears unlikely that the fire significantly exacerbated risk in this location, monitoring of rock fall is recommended through Spring freeze thaw cycles and after rainfall events.

Dispersed Camping: BAER risk ratings for human life and safety based on hazardous trees and/or flooding/debris flow. It is possible that campers at dispersed sites along the 139 road near Bennett Creek and in other locations could be impacted by flooding and/or hazard trees. The BAER risk rating is high. Risk ratings have not been completed for all dispersed camping locations within or immediately downstream from the burned area.

Property

Loss of road and trail prisms and function could occur from increased erosion, flooding, and debris flows for road and trail sections within and downstream of areas of moderate and high soil burn severity.

Risk ratings to determine if property could be impacted were determined for trails, roads and developed recreational facilities within the burned area. The probability of damage or loss was determined based on the likelihood and magnitude of damage from increased hillslope runoff, stream flooding and debris flows. The magnitude of consequences was based on the degree and extent of potential property damage.

Roads with high or very high BAER risk ratings for property: There are roughly 358 miles of Forest Service roads within the fire perimeter. This includes approximately 14 ML1 miles, 250 ML2 miles, 60 ML3 miles and 7 ML4 miles. High or very high BAER risk ratings were determined for approximately 52 road miles. Roads or road segments that received high or very high-risk ratings are NFSR 139 and Adjacent 139 Collectors, NFSR 350, 191, 129, 132, 153, 154, 344, 345.

Trails with high or very high BAER risk ratings for property: There are roughly 122 miles of trails within the burned area. High or very high BAER risk ratings were determined for 40.24 miles of trail, based on terrain, trail slope and moderate-to-high SBS surrounding or immediately upslope of the trail. Trails or trail segments that received high or very high risk ratings are: Upper and Lower Dadd Gulch, Flowers, Zimmerman, Browns Lake, Big South, Little Beaver, Little Fish, Roaring Creek, Chambers Lake, Blue Lake, Blue Lake Spur, Jacks Gulch CG Loop Trail, Fish Creek, Blue Lake, North Fork, Emmaline Lake, Beaver Creek, and Comanche Lake. With the exception of approximately 2.6 miles of class 3 trails (developed), all are trail class 2 (moderately developed). All BAER treatments would occur on class two trails.

Trail standards for class 2 trails are outlined this trail matrix document. https://www.fs.fed.us/recreation/programs/trail-management/documents/trailfundamentals/01_TrailMatrixHandout_Sec508_01-24-17_150dpi.pdf. Relevant standards to inform the BAER trail storm-proofing treatment include:

- Structures of limited size, scale, and quantity; typically constructed of native materials
- Structures adequate to protect trail infrastructure and resources
- Natural fords

Trail Bridges with high or very high BAER risk ratings for property: Blue Creek (2 bridges), Chambers Lake, Roaring Creek, North Fork (4 bridges), Emmaline Lake, Beaver Creek, and Comanche Lake Trails. The probability that these bridges would be impacted by post-fire flooding or debris flows is likely and

the magnitude of consequences is moderate. The BAER risk rating is high, based on likelihood of debris-laden flood flows in representative drainages above bridges.

Emergency Determination: An emergency was determined for property and BAER response actions, described below, are recommended.

Natural Resources

Soil Productivity and Hydrologic Function:

While post-fire erosion will have a negative effect on soil productivity and vegetative recovery, it is expected that burned area soils will support the recovery of native vegetation, provided noxious weeds do not become established in the burned area.

Soil loss due to post fire erosion should be put into context of western forests being disturbance driven ecosystems, with wildfire being the primary catalyst of disturbance. While one would not expect the WEPP PEP reported erosion rates annually in the forested ecosystems within the Cameron Peak fire, erosion immediately following fire would be expected. While soil loss should be considered a natural phenomenon in the disturbance cycle, soil productivity remains a BAER critical value and the desired condition of the site is that it be capable of supporting native vegetation post-fire. Additionally, climate change and fuel loading due to historic fire suppression are resulting in larger and more severe wildfires than those that occurred historically, so it is prudent to not assume soil loss from all fires today are comparable to those historically. In other words, not all erosion is considered an unacceptable loss, rather elevated rates of erosion that exceeds a sites ability to recover and support native vegetation is considered an unacceptable loss.

The T factor is a useful interpretation to assess whether the estimated soil loss will be great enough to impact the soils ability to support native vegetation. Of the watersheds assessed for soil loss per unit area (WEPP PEP), none of the watersheds have an estimated soil loss that exceeds the T factor of that area. That is not to say that the loss of topsoil would have no impact on site productivity: post fire degradation to soil structure, local seed bank, and nutrient storage as a result of combustion and subsequent erosion would likely slow vegetative response. However, the soil loss due to erosion is not expected to permanently impair soil productivity as slopes are expected to revegetate in 3-5 years and soil erosion is expected to decrease until it is back to pre-fire rates.

Emergency Determination: The probability of loss is likely, and the magnitude of consequence is minor; the risk is low. With a low risk rating, BAER treatments are not recommended for soil productivity. Treatments to maintain native plant communities will however, also contribute towards addressing post-fire impacts on soil productivity.

Water Quality

Soil erosion and subsequent sedimentation increases are predicted throughout and downstream from the burned area. The cumulative effect of increased peak flows and sediment-laden runoff from the burned area increases the risk of degraded water quality within and downstream from the burned area. Beneficial uses of water include aquatic habitat, public drinking water supply, and water for irrigation, among other uses. BAER and other Forest Service personnel have provided information about burned area conditions to aid in informing local agencies and water managers about potential water quality degradation.

- Probability: Very likely (90-100%) that water quality would be impacted by post-fire ash and sediment-laden runoff, nutrient loading, and potential debris flows within the first few years following the fire.
- Magnitude of Consequences: While the natural processes and associated impacts (described above) will undoubtedly impact water storage, conveyance and treatment infrastructure and processes owned and managed by water managers and providers, the BAER team did not determine a BAER risk ratings for these non-USFS values as they are outside of BAER authority and USFS responsibility. The magnitude of consequences for water quality as a BAER critical value was rated moderate.
- Based on the preceding probability and consequences determinations, the BAER risk rating is very high.

Given the risk rating, a variety of erosion/sedimentation control treatments were considered. However, no BAER treatments were recommended, as the low probability that such treatments would successfully reduce the risk to an acceptable level did not support treatment. This included the analysis and assessment of large-scale mulch treatments to reduce risks to water quality.

Native or Naturalized Plant Communities

Invasive plant infestations have been documented throughout the burned area prior to the fire. Noxious weeds, present throughout the road and trail corridors, may potentially spread throughout the burned area. The potential for spread of invasive plants is highest in areas disturbed by suppression activities areas and with moderate to high burn severity. These areas are highest priority for treatment. This BAER risk assessment/treatment proposal of 480 acres is based on known weed infestations within moderate and high soil burn severity. This area is 15% of known infested areas and 0.5% of the entire burned area. Treatments are to limit the expansion of existing invasive plants within the fire perimeter.

Invasive plants within the burned area include *Cardaria draba, Carduus nutans, Centaurea diffusa, Centaurea maculosa, Cirsium arvense, Cirsium vulgare, Cynoglossum officinale, Euphorbia esula, Leucanthemum vulgare, Linaria dalmatica, Linaria vulgaris, Potentilla recta, Tanacetum vulgare* and *Verbascum thapsus*.

The spread of noxious weeds would adversely affect multiple resources including native plant communities which in turn affects threatened and endangered species habitat for wildlife and fisheries, as well as soil productivity. Forest Service policy mandates the Forest to minimize the establishment of non-native invasive species to prevent unacceptable degradation of the burned area.

Emergency Determination: The probability of loss of native plant communities is very likely and the magnitude of consequence is moderate; the BAER risk is very high.

Areas of native vegetation communities were determined to be threatened by expansion of noxious weeds into burned areas not evaluated in the initial assessment. However, a more detailed analysis of the critical values, threats, and risks was not completed in time to be included in this interim request. An additional interim request may be filed early in 2021 to assist in reducing the post-fire threats to these plant communities.

Wildlife: Critical TES Habitat or Suitable Occupied Habitat

Canada Lynx

In total, approximately 73,330 acres of lynx habitat is mapped within the fire area. Potential lynx habitat (lodgepole pine and mixed spruce/fir/lodgepole forest above 9,000' elevation) within the fire perimeter was primarily burned by crown fire, as observed by field observation and from BARC (high and moderate). Approximately 52,770 acres (72%) of suitable lynx habitat incurred crown fire that largely removed lynx habitat. Consequently, these acres won't provide potential lynx habitat for several decades until regenerating conifer trees grow tall enough to provide snowshoe hare and lynx cover.

In the long term, burned areas are expected to re-vegetate and re-forest over time through natural recovery. Crown fire in this type of ecosystem is a natural disturbance process that ultimately provides different age classes of forest for lynx habitat.

Preble's Mouse

Field observations of Preble's habitat were made in accessible areas along Bennet Creek just off the Pingree Park road and from Highway 14 along the Poudre River. Other potential habitat areas were not accessible behind private property. Generally, it appears that the riparian zone within Preble's critical habitat along Bennett Creek and other suitable habitat reaches were either unburned or lightly burned.

Risk Assessments: These risk assessments are based on the potential for post fire impacts, such as debris flows and flooding, to adversely impact lynx or Preble's habitat**.** The probability of damage/loss for lynx habitat is rated as Unlikely and the magnitude of consequences is rated as Minor, resulting in a risk rating of Very Low. For Preble's mouse critical and other suitable habitat stream reaches, the probability of damage/loss is rated as Unlikely and the magnitude of consequences is rated as Minor, resulting in a risk rating of Very Low. No emergency was determined for either Preble's mouse or lynx habitat.

Fisheries: Critical TES Habitat or Suitable Occupied Habitat

Table 8. Streams with occupied or suitable habitat for the Federally-Threatened greenback cutthroat trout within Cameron Peak burned areas on NFS lands.

Stream Name	Date of Discovery (D) or Reintroduction (R)	Species, Genetic Origin	Conservation Status	BAER Critical Value
East Fork Roaring Creek	2020 (R)	GBCT, South Platte	ESA Threatened; occupied GBCT habitat	Yes
Roaring Creek	1962 (D)[1]	CRCT, Yampa River	R2 Sensitive; suitable GBCT habitat	No
East Fork Sheep Creek	1982 (R)[1]	CRCT, Yampa River	R2 Sensitive; suitable GBCT habitat	No
West Fork Sheep Creek	1982 (R)[1]	CRCT, Yampa River	R2 Sensitive; suitable GBCT habitat	No
Williams Gulch	1996 (R)[1]	CRCT, Yampa River	R2 Sensitive; suitable GBCT habitat	No
Black Hollow	1963 (D)[1], 1969 (R)[1], 1982 (R)[1]	CRCT, Yampa River + Colorado River	R2 Sensitive; suitable GBCT habitat	Yes, on basis of property

Despite the high and very high risk ratings for these BAER Critical Values, available BAER treatments are unlikely to prevent or effectively reduce impacts from occurring in East Fork Roaring Creek or

Black Hollow subwatersheds within the first few years of the fire. BAER treatments will not prevent the severe post-fire hydrologic responses in these stream channels from occurring. In addition, the state of the fish barrier in Black Hollow prior to the fire was functional, but in need of maintenance or replacement as the age of the wooden structure was approaching 40 years, well beyond the intended design life. Structural damage to the timbers of the barrier caused by the fire accelerated the deterioration of the barrier. Given the expected change in peak flow runoff and potential for debris flows within Black Hollow, BAER treatments are unlikely to prevent further damage or destruction of the structure. In addition, the current location of the Black Hollow fish barrier restricts the available habitat to less than 1.4 miles, which is less habitat than the minimum 1.7 mile habitat patch recommended in the Recovery Outline for greenback cutthroat trout (USFWS 2019).

Cultural Resources

There are seven historic properties within the burned area. The BAER risk ratings for these critical values are low to intermediate. No BAER treatments are proposed. However, coordination and consultation to ensure BAER roads treatments do not impact cultural resources is recommended.

Table 9. Summary of BAER Risk Assessments

Critical values	CV category: *life-safety, property, natural resource, cultural resource*	Risk rating
Roads	Property, life/safety	High, Very High
Trail	Property, life/safety	High, Very High
Native plant communities	Natural Resources	Very High
Critical habitat for GBCT	Natural Resources	High, Very High
Water quality	Natural Resources	Very High
Soil Productivity	Natural Resources	Low
Critical habitat for wildlife– Lynx, Preble's Mouse	Natural Resources	Low
Pre-historic site (eligible) (7 sites)	Cultural	Low

Emergency Treatment Objectives:

a. Minimize post-fire risks to life and safety to the extent possible through administrative and physical closures, signing, and monitoring.
b. Storm-proof and stabilize roads and trails to reduce risk to this USFS property. These treatments would also help minimize road/trail adjacent erosion and associated impacts on water quality.
c. Promote revegetation and soil stabilization by native plant communities through early detection/rapid response surveys to minimize the spread of Colorado State-listed noxious weeds.

CONCLUSION

The acreage burned in the Cameron Peak Fire currently makes it the largest fire in recorded Colorado history. It was a long duration event that burned at a wide distribution of elevations through a variety of forest types, soil types and geographic features.

The BAER team has identified imminent threats to critical values based field assessments. Assessments were conducted using the best available methods to analyze the potential for erosion, flooding, debris flows, and hazard trees in a rapid manner. 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 life/safety threats, and damage to property. These mitigations include road and trail closures, trail stabilization, campground treatments, and warning signs.

The soil erosion, hydrology, and debris flow modelling results indicate that post-fire there will be an increase in watershed response. This means:

- Increased erosion and sedimentation
- 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

The findings provide information that can assist other agencies and landowners in preparing for post-fire threats. The US Forest Service will continue to participate in interagency efforts to address threats resulting from the Cameron Peak Fire.

References

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