Hayden Pass Fire
July 2016

Photo by Resource Advisor Steve Sunday

Date of Report: August 1, 2016

BURNED-AREA REPORT
(Reference FSH 2509.13)

PART I - TYPE OF REQUEST

A. Type of Report

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

B. Type of Action

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

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

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

PART II - BURNED-AREA DESCRIPTION

A. Fire Name: Hayden Pass

B. Fire Number: CO-PSF-001022

C. State: CO

D. County: Fremont/Custer

E. Region: 02

F. Forest: PSICC

G. District: Salida/San Carlos

H. Fire Incident Job Code: P2KE7R16-0212

I. Date Fire Started: July 8, 2016

J. Date Fire Contained: N/A

K. Suppression Cost: Est. $9.5 million as of 07/30/2016). Suppression costs likely to extend to Fall, 2016.

L. Fire Suppression Damages Repaired with Suppression Funds
1. Fireline waterbarred (miles): 14
2. Fireline seeded (miles): 4

3. Other (identify): Mulching/Chipping, Fire suppression reapirs are ongoing.

M. Watershed Numbers and Percentage Burned

6th Field Sub-watershed	HUC Number	Total Acres	Acres Burned	Percent Burned
Hayden Creek	110200010905	14,130	4,567	32%
Hamilton Creek-Arkansas River	110200010907	15,774	1,259	8%
Big Cottonwood Creek	110200010906	15,723	7,305	46%
Falls Gulch	110200011403	24,748	3,140	13%
Middle Texas Creek	110200011003	19,734	210	1%
Sand Gulch	110200011404	12,455	31	0.2%

N. Total Acres Burned:

Land ownership	Acres burned	Percent of burned area
USDA Forest Service (USFS)	15,065	91%
BLM	912	6%
State of Colorado	358	2%
Private	185	1%

O. Vegetation Types

Forest cover types that are present across the burn area are spruce-fir, mixed conifer, aspen, lodgepole pine, pinon juniper and Gambel oak. Tree species represented on the landscape include: Ponderosa Pine (Pinus ponderosa), Douglas-fir (Pseudotsuga menziesii), Limber Pine (Pinus flexilis), Bristlecone pine (Pinus aristata), Lodgepole pine (Pinus contorta), White fir (Abies concolor), Sub-alpine fir (Abies lasiocarpa), Engelmann spruce (Picea engelmanii), Aspen (Populus tremuloides). Shrub species include Pinon pine (Pinus edulis), Juniper (Juniperus scopulorum), and Gambel Oak (Quercus gambelii).

P. Dominant Soils

Leadville, Perfrin, Mollic Cryonoralfs-Lithic Cryoboralfs, Bowen, and Leighcan. Soils within the burned area are generally deep, well-drained, have sandy loam textures and high rock content. Ground cover, critical for soil stabilization, is lacking throughout most areas mapped as moderate and high soil burn severity. These soils are sensitive to fire effects, and soil productivity is likely impacted where heavy surface fuels were consumed. High rates of erosion are expected in moderate and high burn soil severity where ground cover was burned.

Q. Geologic Types: Marine Limestone – Minturn – Belden Formation, Arkosic Sandstone and Conglomerate – Sangre de Cristo Formation, Lahar,

Soda Granite, Boulder Alluvium – Santa Fe Formation, Glacial Till, Slocum Alluvium, Bull Lake Deposits, Pinedale Deposits and Landslide Deposits. The geology in the area lends to pebbly, cobbly, and sandy soils. Mesozoic plutonic rock and Precambrian mixed rock comprise approximately 87% of the burned area. Paleozoic and Quaternary sedimentary rock makes up the remaining 13% of the area. Geologic types include mixed granitic and metamorphic rocks, Gneissic granitoid rocks and gneiss, Monzogranite of San Gorgonio Mountain, Bonanza King Formation and Granodiorite of Anderson Peak. The area features very young to old alluvial fan deposits, very young to old landslide deposits, young and old alluvial valley deposits, very young talus deposits, very young glacial deposits and very young wash deposits. Debris flow channels and fans were observed in numerous locations the field. The mapping and field observations indicate that debris flows and other natural geologic processes, described above, will continue to occur in this relatively active landscape.

R. Miles of Stream Channels by Order or Class:

24 miles perennial, 27 miles intermittent

S. Transportation System

Trails: 12.0 miles Roads: 17.0 miles (NFS)

PART III - WATERSHED CONDITION

A. Soil Burn Severity for the Whole Burned Area (acres):

Severity	Acres Burned	Percent
High	2974	18%
Moderate	9240	56%
Low	2613	16%
Unburned	1693	10%

Soil Burn Severity by Modeled Drainages in Peak Flow Analysis

Modeled drainages	Unburned acres (%)	Low acres (%)	Moderate acres (%)	High acres (%)
South Prong Hayden Creek	812 (24%)	548 (16%)	1,841 (54%)	197 (6%)
Italian Gulch	298 (24%)	297 (24%)	482 (39%)	168 (13%)
Pole Gulch	264 (20%)	116 (9%)	501 (38%)	436 (33%)
Wolf Creek	136 (6%)	259 (11%)	1,507 (63%)	497 (21%)
Big Cottonwood Creek	7,135 (85%)	373 (4%)	758 (9%)	298 (4%)
Butter Creek	68 (7%)	13 (1%)	610 (60%)	326 (32%)
Little Cottonwood Creek	605 (25%)	285 (12%)	1,229 (52%)	260 (11%)

Deep Gulch	540 (67%)	41 (5%)	89 (11%)	134 (17%)
Mosher Creek	734 (46%)	142 (8%)	592 (35%)	218 (13%)
Oak Creek	627 (50%)	173 (14%)	405 (32%)	47 (4%)
Sullivan Creek	989 (49%)	136 (7%)	605 (30%)	279 (14%)

B. Water Repellent Soils and Increased Runoff: The degree and extent of water repellent soils is estimated to be 3054 acres or 25% of the moderate and high burn severity areas. However, observations indicated strong repellency at the surface over several vegetation types and moderate to high burn severities. Areas with coarse textured surface layers, high burn severities, and/or thick ash layers commonly had strong water repellency at a depth of ½ inch. The pattern of water repellent soils is likely to be patchy and mosaic.

Increased runoff due to hydrophobic conditions is reflected in the peak flow analysis contained in the Hydrology Report. Increased overland flow due to the hydrophobic conditions may increase hill-slope rill and sheet erosion. Hydrophobic layers will usually take six months to two years to break down. Plant root development, soil microbial activity, and freeze-thaw cycling all contribute to the degradation of hydrophobic conditions.

C. Soil Erosion Hazard Rating: The pre-fire erosion hazard rating (EHR) for burned area soils was obtained from existing soil erosion hazard rating information in the San Isabel soil dataset. The EHR interpretation is based on soil properties such as soil texture, slope, aggregate stability, infiltration rate, subsoil permeability, depth to restrictive layers, and soil rock content. The rating is the maximum EHR for the soil map units. Actual pre and post fire erosion potential is better reflected by the ERMiT modeling runs for this project.

Erosion Hazard Rating	**Acres**
Low	1,994
Moderate	2758
High	11,768

D. Erosion Potential

Erosion response is heavily influenced by soil burn severity and hill slope. The burn affected soil aggregate stability, canopy cover, ground cover, and infiltration rates. Before the fire, most of the forested areas had protective ground cover in the form of litter, duff, or ground vegetation. In high and moderate soil burn severity areas, it is highly likely that increased rates of soil erosion and sediment delivery to stream channels will occur, in the first and second year following the fire, particularly on steep slopes.

The ERMiT models allows users to predict the probability of a given amount of sediment delivery to the base of a hillslope following variable burns on forest, rangeland, and chaparral conditions in years following wildfire. The ERMiT model can be accessed at http://forest.moscowfsl.wsu.edu/fswepp/

ERMiT Model Assumptions and Inputs:

- Slope length was 300 feet for all ERMiT runs
- Soil surface texture was sandy loam
- Soil Rock Content was 20% Volume
- There is a low (10%) probability the rates of erosion will exceed the amounts shown in the preceding table in the first year following the fire.

Erosion in Tons/Acre by Soil Burn Severity							
Vegetation Type	**Soil Burn Severity**	**Percent Slope**					
		< 10 %	10 - 20 %	20 - 30 %	30 - 40 %	40 – 50%	50 - 60 %
Forest	Low	≤ 1.82	1.82 – 3.25	3.25 – 4.35	4.35 – 5.29	5.29 – 6.05	6.05 – 6.54
	Moderate	≤ 2.67	2.67 – 4.73	4.73 – 6.28	6.28 – 7.74	7.74 – 8.85	8.85 – 9.54
	High	≤ 3.17	3.17 – 5.72	5.72 – 7.76	7.76 – 9.41	9.41 – 10.73	10.73 – 11.77
Shrub	Low	≤ 2.36	2.36 – 4.04	4.04 – 6.19	6.19 – 7.43	7.43 – 8.33	8.33 – 9.01
	Moderate	≤ 3.15	3.15 – 6.00	6.00 – 8.27	8.27 – 10.1	10.1 – 12.02	12.02 – 13.22
	High	≤ 4.02	4.02 – 7.65	7.65 – 10.56	10.56 – 12.91	12.91 – 15.45	15.45 – 17.01

Forested: The majority of the burned area was forested. Burned forested areas ranged from low to high soil burn severity. Extensive removal of forest floor ground cover occurred in moderate and high soil burn severity areas. Some needle cast is likely to occur in the low and moderate soil burn severity polygons and recovery of slope stability and watershed hydrologic response will be accelerated where this occurs.

Shrub: Shrub species included Pinon pine, Juniper and Gambel Oak. Shrub vegetation within the burned area was mapped ranging from low to high soil burn severity. Although these areas had areas of bare ground before the fire, removal of ground cover was often high and it is expected that erosion and sediment delivery to stream channels from these slopes will be high. Recovery of watershed hydrologic response depends on many factors and is likely to take at least 3-5 years.

Grass, Bare Ground and Rock Outcrop: Grass, bare ground and rock outcrop areas within the burn were mapped as unburned or low burn severity. Soil heating in these areas was very low and minimally affected by the fire therefore, recovery of watershed response is expected to occur rapidly.

Conclusions:

- There is a high probability that rates of soil erosion and sediment delivery to stream channels will be significantly higher in moderate and high soil burn severity areas.
- High intensity, short duration summer thundershowers are storm events of concern.

E. Sediment Potential: 8,064 cubic yards / square mile

PART IV - HYDROLOGIC DESIGN FACTORS

A. Estimated Vegetative Recovery Period, (years): 3-5

B. Design Chance of Success, (percent): 80%

C. Equivalent Design Recurrence Interval, (years): 10 and 2

D. Design Storm Duration, (hours): 1 and 0.5

E. Design Storm Magnitude, (inches): 1.01 and 0.6

F. Design Flow, (cubic feet / second/ square mile): 22 and 0

G. Estimated Reduction in Infiltration, (percent): 74%

H. Adjusted Design Flow, (cfs per square mile): 76 and 13

The fire was divided into drainages with "pour points" established at the bottom of burned watersheds, or where values at risk were located. In most cases the pour points are located where tributaries join the mainstem perennial stream. Watershed runoff response is referenced to these points.

Pre and post-fire peak flow predictions from Wildcat Rainfall-Runoff Hydrograph Model

Modeled Drainage	Percent USFS land	2-year, 30 minute event		10-year, 1-hour event	
		Pre-fire estimated discharge (cfs)	Post-fire estimated discharge (cfs)	Pre-fire estimated discharge (cfs)	Post-fire estimated discharge (cfs)
South Prong Hayden Creek	100%	0	120	35	465
Italian Gulch	100%	0	71	35	225
Pole Gulch	49%	0	93	45	282
Wolf Creek	98%	0	137	32	468
Big Cottonwood Creek	100%	0	55	89	220
Butter Creek	74%	0	97	53	288
Little Cottonwood Creek	85%	0	86	114	365
Deep Gulch	41%	0	27	6	77
Mosher Creek	62%	0	57	33	202
Oak Creek	59%	0	26	29	109
Sullivan Creek	58%	0	74	23	238

Debris Flow Potential

Debris flows are highly probable in the Hayden Pass Fire Area. Within the burned area, some watersheds show past debris flow activity. The highest potential for debris flows seems to correlate to the Sangre de Cristo Formations. The Sangre de Cristo is a detrital sedimentary rock, typically unconsolidated during aggradation and contains feldspar, sandstone and conglomerate. This geologic formation type is susceptible to becoming brittle and erosive post-fire. Much of the burned area is comprised of the Minturn-Belden Formation, which is a very fine to fine grained marine limestone. This geologic feature holds water well due to the high silts, clays, and fines.

The United States Geological Survey (USGS)-Geologic Hazards Division provided predictive debris flow model results with quantitative and qualitative results. This analysis shows predictions for channel and basin probability, volume, and hazard for a design storm with a 15 minute intensity of 24 millimeters per hour. The channel segment probability model is particularly informative for comparison analysis and to extrapolate results by comparing hydrologic modeling predictions. More information on the USGS model and processes used can be found at the following website. http://landslides.usgs.gov/hazards/postfire_debrisflow/

Throughout the burned area, the combined hazard ratings for debris-flow in first order tributaries to the main stem stream channels are moderate to high. At the fire perimeter exiting the burned area, the hazard ratings are high for all main stem channels, except the Italian Gulch and Deep Gulch channels which have moderate hazard ratings. At the burned area perimeter, volumes are predicted to be >100,000m^3 for Little Cottonwood Creek. Volumes in the range of 10,000 to 100,000m^3 are predicted for Oak Creek, Mosher Creek, Sullivan Creek, Butter Creek, Big Cottonwood Creek, Wolf Creek, Pole Gulch, Italian Gulch and South Prong Hayden Creek.

Pre-fire slope stability and recovery of watershed hydrologic response is dependent on many factors and typically occurs within 3-5 years following the fire. Recovery of high burn severity areas is slower because little or no vegetative ground cover remains, the potential for needle cast is low and soils may be impacted by fire effects. Potential debris flows produced by the burn scar is high. Debris flows will likely deposit in locations of lower gradient but, can cause significant negative effects if they migrate downstream.

PART V - SUMMARY OF ANALYSIS

Introduction/Background:

As of July 20, 2016 the Hayden Pass Fire had burned approximately 16,520 acres and full containment is not expected until October. The soil burn severity (SBS) map shows approximately 74% burned at high and moderate soil burn severity. The rest of the fire was either low soil burn severity or unburned. Large contiguous areas of high and moderate soil burn severity occur throughout the burned area. Increased post fire soil soil erosion, runoff and debris flows within and downstream from these areas is likely to cause flooding, scouring and/or deposition of materials.

High intensity summer thundershowers are the precipitation events of primary concern. Based on historic precipitation patterns, thunderstorms are likely to occur in the weeks and months following the Hayden Pass Fire. The risk of flooding and erosional events has increased as a result of the fire, creating hazardous conditions within and downstream of the burned area.

The duration, volume, and location of debris flows and steam channel processes are highly influenced by rainstorm patterns and intensities. The predictive values represented in this report are based on rapid assessment models for specific high intensity/short duration storms.

Recovery of pre-fire slope stability and watershed hydrologic reponse is dependent on many factors and typically occurs within 3-5 years following

the fire. Recovery of high burn severity areas is slower because little or no vegetative ground cover remains, the potential for needle cast is low and soils may be impacted by fire effects.

A. Describe Critical Values/Resources and Threats:

Potential impacts on human life and safety, property, natural resources and cultural resources were identified by the BAER team. Values at risk include roads, trails, bridges, water diversion/conveyance/storage infrastructure, a fish barrier, water quality, critical habitat for the threatened and endangered Colorado Greenback Cutthroat Trout, recovery of native vegetation due to increased risk for establishment and/or spread of noxious weeds.

The BAER team began assessing the area for post-fire emergencies on July 22, 2016. In that time the team has identified the following values at risk and post-fire threats. Interim reports may be submitted as additional assessments are completed and/or the need to repair or maintain BAER treatments emerges.

The risk matrix below, Exhibit 2 of Interim Directive No.: ***2520-2010-1*** *was used to evaluate the Risk Level for each value identified during Assessment. Only values at risk that had a risk of Intermediate or above are discussed in this report but all values at risk inventoried and described by the BAER Team are contained in a value at risk tracking spreadsheet (project file)*

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**

Human Life, Safety and Property

1) Roads, Bridges and Trailheads

National Forest System Roads impacted by the Hayden Pass Fire are located on the Salida and San Carlos districts of the PSICC. Of the 17 miles of affected NFS Roads, 2 miles are classified as suitable for passenger vehicles (Maintenance Level 3) and 15 miles are classified as suitable for high clearance vehicles (Maintenance Level 2.). On the north perimeter of the fire, CR-6 follows Hayden Creek from CO-50 and transitions to NFSR 6 at the forest boundary and continues over the pass. NFSR 6.2A, 6.3B and 6.3C branch off NFSR 6 and provide access to campgrounds and trailheads. At the middle perimeter of the fire, CR-40 sits in the Big Cottonwood drainage and provides access to roughly 25 homes before transitioning to NFSR 40 at the BLM boundary and continuing next to the stream for 1.2 miles through State Land and NFS land to a trailhead. NFSR 35 [Mosher Creek] is accessed solely through private roads but services several irrigation ditches and a reservoir on NFS land. On the south perimeter of the fire, NFSR 198 accesses two large reservoirs and a trailhead.

The majority of these roads escaped direct fire damage but roughly 25% are located downstream of major burn drainages and are projected to be exposed to increased flows, debris and sediment years 1-5 following the fire.

Roads BAER Risk Ratings			
Low	**Intermediate**	**High**	**Very High**
• NFSR 198	• NFSR 6	• NFSR 6.3B • NFSR 6.3C • NFSR 35	• NFSR 6.2A • NFSR 40

Roads were assessed by both location (Probability of Damage or Loss) and primary use (Magnitude of Consequences.) Regularly used roads in highly impacted drainages with inadequate ability to handle projected flood flows ranked High or Very High. Less traveled roads in secure locations with acceptable drainage features ranked either Intermediate or Low.

NFS Roads Risk Assessment	
Risk	**Miles**
Very High	1.3
High	2.7
Intermediate	4.9
Low	8.1

Over 4 miles of unauthorized trails and 2-track roads access the Rainbow Trail in the Little Cottonwood drainage. Poor or inexistent drainage features on these roads paired with advanced entrenchment will channel the increased runoff, eroding nearby areas and causing impacts to water quality, soil productivity and increased potential for establishment or spread of noxious weeds.

The probability of impacts to soil and water resources, expansion of impacts to due loss of vegetation and /or establishment or spread of noxious weeds is **Likely**. Magnitude of consequences is **Major**. Therefore, the BAER risk is **High**.

Several trail bridges for the Rainbow Trail span streams which are modeled to have greatly increased flows. The trail bridge at Coaldale Campground is located on a high risk stream but has adequate freeboard to pass flood flows and rests on concrete abutments that will withstand flood debris. The Bridge deck is at risk of being destroyed by large logs that could be entrained in flood flows. The trail bridge in Hayden Creek Campground is located in a highly impacted drainage but spans the Middle Prong of Hayden Creek which is not expected to receive any increased flows.

The trail bridge on the Rainbow Trail above NFSR 6.3C spans the South Prong of Hayden Creek and has inadequate freeboard to pass the expected flood flows and debris from the above drainage.
The trail bridge at the trailhead at the end of NFSR 40 spans the Big Cottonwood Creek. The freeboard is borderline for passing expected flows and the abutments are older and are currently constricting the stream channel. Both increased flow and debris are expected to impact these abutments and cause bridge failure.

Trail Bridges - BAER Risk Ratings	
High	Very High

• Trail Bridge at Coaldale Campground	• Trail Bridge on the Rainbow Trail above NFSR 6.3C • Trail Bridge on the Rainbow Trail at trailhead at NFSR 40

2) Trails and Dispersed Campsites

Emergency conditions exist for specific trails and sections of trail within the burned area. These emergency conditions are based on threats associated with anticipated post wildfire impacts on trails and trail users. Threats to trails include excessive erosion of the trail tread caused by interception and diversion of runoff from steep burn hill slopes. Trails may also be impacted where they intersect with drainages. Approximately 5 miles of the Rainbow Trail (NFST 1336) are in high burn severity areas with 6 miles in moderate burn severity areas (due to topography and post-fire conditions moderate severity is estimated to have a high watershed response). Life and safety of trail users is also at risk in some areas within the burn. This determination is based on professional judgement and field based identification of segments of trail where implementing treatments would effectively lower the risk of major trail damage, thus a favorable benefit to cost ratio was determined. Also based on professional judgement and field review, the BAER Team recommended against treatments for Black Mountain trail based on concerns for treatment effectiveness and an unfavorable benefit to cost ratio.

Value at Risk	**Risk Rating**
Dispersed campsite along NFSR6	Very High
Rainbow Trail	Very High
Black Mountain Trail (756)	Low

3) Water Diversion, Conveyance and Storage Infrastructure: Ditches, Dams and Reservoirs

There are currently two draft Ditch Bill Easements for the Little Cottonwood and the Oak Creek ditches on NFS lands. Oak Creek Irrigation Ditch and Little Cottonwood Ditch both run to Mosher Reservoir in a highly burned drainage above NFSR 35. Impacts to the ditch itself and the function of the ditch to deliver water for agricultural use are likely. Additionally, severe erosion on NFS lands adjacent to the ditch would occur if the ditch failed. Mosher Reservoir stands to receive flood flows from both the drainage above and the diverted flows from Little Cottonwood Creek and Oak Creek. The spillway is substantially overgrown and would likely catch debris and potentially cause overtopping of the dam.

Balman Reservoir and Rainbow Lake are both located along NFSR 198 on the south perimeter of the burn. No post fire related impacts are expected.

The BAER team identified similar water infrastructure exists below the burned area on private land. The team recorded general information in the project's VAR spreadsheet but extensive inventory and detailed descriptions of these VARs on private land were not completed by the BAER Team. The team liaison will continue to communicate information on burned watershed conditions to potentially affected parties.

Value at Risk	**Risk Rating**
Oak Creek Ditch	High
Little Cottonwood Ditch	High

Mosher Creek Reservoir/Dam	High
Balman Reservoir	Low

4) Fish Barrier to Protect TES – Greenback Cutthroat Trout

In 2005-2006, habitat in the South Prong of Hayden was enhanced by building a manmade barrier to exclude downstream brown trout from migrating into cutthroat habitat, installing structures to increase sediment transport, creation of deeper pool habitats, and converting a road that was within the WIZ to a single track multiple use trail. This population was once in danger of extinction and when last surveyed in 2014 at least five age classes were present and numerous fry were collected. A self-sustained, robust population resided in the habitat improved reach easily meeting population stability criteria.

In 2014 the Arkansas River from Lake Fork near Leadville to Parkdale (102 miles) was designated as a “gold medal” water by the Colorado Division of Wildlife, a tag meaning the site has the highest quality habitat for trout that exists in Colorado and also offers the greatest potential for trophy trout fishing. Only 322 miles of Colorado's 9000 miles of trout streams, carry the "Gold Medal" signature.

Post Fire Threats: Breach of fish barrier due to high stream flows & debris flows; Plunge pool filling in reducing hydraulic jump rendering barrier ineffective. Invasion of non-native brown trout. Loss of threatened Cutthroats.

Probability of Damage or Loss: Very Likely.
Magnitude of Consequence: Major.
Risk Ratings: Very High

5) Developed Campgrounds

Coaldale Campground: The Coaldale Campground is located immediately adjacent to Hayden Creek. It has 7 campsites that have picnic tables and fire rings. To reach campsites 1-4 visitors must cross a small foot bridge that spans over Hayden Creek. There are two vault toilets and one bear-proof storage container near sites 1-4.

Probability of Damage or Loss: Likely. This determination is based on the proximity of the campground infrastructure and Hayden Creek. The campground road is likely to be damaged by post fire streambank erosion and all are in flood prone areas.

Magnitude of Consequence: Major. This determination is due to threat to the safety and/or life of visitors or forest workers were inhabiting.

Risk Ratings:

- Impacts to property and infrastructure - very high.
- Life and Safety – very high

Hayden Creek Campground: The Hayden Creek Campground is a small campground located below the Middle Prong of Hayden Creek drainage. It has 11 sites, all containing campfire rings and picnic tables. There is one vault toilet and one bear-proof storage container near sites 1-4.

Probability of Damage or Loss: Unlikely. This determination was established because the drainage directly above the campground

did not have any burn activity.
Magnitude of Consequence: Moderate. This determination is due to the low probability of damage and the fact that the fire did not burn in the drainage above the campground.
Risk Level: Low

6) Land Survey Monuments

The monuments that have been identified all control the National Forest boundary, are within drainages that will be prone to flooding due to the fire or are on slopes within high intensity burn areas and are at risk of flash flooding, landslides and debris flow. If the monuments in question were lost it would cost a considerable amount of funding to reestablish the boundaries based on controlling land survey monuments in areas that have not been effected by the fire.

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

Natural Resources

1) Ecosystem Stability and Vegetation Recovery

Invasive Weeds

Removal of competitive vegetation by fire and disturbances from suppression efforts such as bulldozer lines and staging areas have created openings for noxious weeds to establish and/or spread and impede or prevent recovery of desirable vegetation.

Areas within the Hayden Pass Fire that have the greatest potential for noxious weed invasion are burned and/or disturbed areas adjacent to or downstream of existing weed infestations. Currently there are weed infestations out of the burn area that are known and/or have been historically treated throughout the area since 2009.

Within the burned area, noxious weed infestations are **not** high. Nine hundred acres of BLM lands were burned but only 5-15 acres of weeds treatments are proposed, and 40 acres of NFS weeds treatments are proposed.

Probability of Damage or Loss: Likely.
Magnitude of Consequence: Moderate.
Risk Level: High

2) Municipal and Irrigation Water Supply – Water Quality

Water Quality – Municipal Water Supply
Wildfires primarily affect water quality through increased ash laden flows and sedimentation. Primary impacts include color changes and increased sediment, settleable material, suspended material, and turbidity. Post-fire delivery of organic debris to stream channels can potentially decrease dissolved oxygen concentrations in streams. Fire-derived ash inputs can increase pH, alkalinity, conductivity, and nutrient flux (e.g. ammonium,

nitrate, phosphate, and potassium). Although these changes are generally short lived, they could impact drinking water providers drawing from the Arkansas River.

The most noticeable effects on water quality will be likely increases in sediment and ash from the burned area into the tributaries within the burned area, the Arkansas River, and other waterbodies downstream of the fire area. Sediment and ash laden flows are expected to occur in response to high intensity summer thunderstorms.

Post-fire water quality is not anticipated to impact municipal or domestic water supply where wells are used as intakes. The closest surface water supply is approximately 35 miles downstream, near Canon City, CO.

> **Probability of Damage or Loss**: Unlikely. This determination is due to the fact that water supply in the areas adjacent to the fire is from groundwater rather than surface water. In addition, the water treatment plant in Canon City is able to shut down their system for a few days if necessary and the Florence has the ability to take water from another source if necessary.
> **Magnitude of Consequence**: Major.
> **Risk Level**: Intermediate

The loss of riparian shading and the sedimentation of channels by floods and debris flows may increase stream temperature. Floods and debris flows will likely entrain large material. Debris flows are likely to occur within and directly downstream from steep burned watersheds. In response to short duration rainfall events, deposition of most large entrained material is likely to occur on the gently sloping terrain further downstream from the burned area without making it all the way to the Arkansas River. However, some material could potentially make it to the river during higher intensity/long duration rainfall events.

Water Quality - Irrigation Water Supply

Impacts to irrigation water quality could occur downstream of the burned area. These impacts would occur in direct response to heavy rain events and subside quickly following storm generated peak flows. Irrigation water providers and users may need to test periodically to ensure water quality meets standards for irrigation or livestock watering. Sedimentation and/or other physical damage to water diversion, conveyance or storage infrastructure is described in the “property” section of this report.

3) Soil Productivity

Although very high rates of post fire soil erosion are expected to occur, an emergency for long-term soil productivity was not caused by the direct effects of fire. However, threats to long-term soil productivity from increased unauthorized OHV use in the burned area and the expansion of noxious weeds in the burned area were identified (see Roads and Trails Report). Despite high rates of post-fire soil erosion (sediment transport, increased overland flow and wind), soils in the burned area will support recovery of fire adapted vegetation.

4) Critical habitat or suitable occupied habitat for federally listed threatened or endangered terrestrial, aquatic animal or plant species on NFS lands

The cutthroat trout, their habitats, and habitat improvements within the fire perimeter have largely been unaffected by the fire itself. The South Prong of Hayden Creek is 4.34 miles from the headwater to the confluence with Hayden Creek. 2.43 miles of adjacent land were unburned, 0.74 miles are of low soil burn severity, 0.80 miles of moderate and 0.37 miles of high as shown in Figure 1. The highest quality habitat exists for the first mile upstream of the confluence and slowly reduces in quality as you move upstream. A majority of occupied habitat and surrounding riparian vegetation has not burned but some uplands and a majority of the headwater is burned. The habitat and cutthroat are at risk to future losses,

disturbances, and habitat degradation from post-fire watershed events. These impacts include potential for localized extirpations due to ash flows; reduced water quality and changes in water chemistry due to ash delivery and changes in water temperature from loss of canopy shading; and scouring of riparian/aquatic vegetation and changes in streambed/pool habitat due to debris flows and sediment delivery. Because of the fish barrier, fish that swim downstream to escape debris flows will not be able to return to their native habitat and will be lost to the population.

Floods, debris flows and sediment deposits may result in a temporary loss or reduction of suitable stream habitat. This small and isolated populations is at great risk of local extinction and the precarious situation of only existing in the hatchery and an extremely small population that was moved to another stream on July 20th 2016.

If the barrier were to breach, non-native sport fish could invade the stream. It is well documented that brown and brook trout outcompete cutthroat and rainbow trout will hybridize.

The following risk assessment is based on potential impacts to the TES. This is highly dependent on the proper functioning condition of the fish barrier which is described in the "property" section of this report.

Probability of Damage or Loss: Very Likely.
Magnitude of Consequence: Major.
Risk Ratings: Very High

The fire caused loss of significant amounts of overstory and understory vegetation, impacting habitat for the Mexican Spotted Owl and the Canada Lynx. Post fire flooding, debris flow and erosion are not likely to exacerbate this issue for the Canada Lynx but could continue to impact Mexican Spotted Owl Habitat. The wildlife specialist's report, in the project file, provides additional information.

5) Cultural Resources

Historic and cultural resources potentially at risk from post wildfire processes included historic cabin remnants, a historic cabin and the Hayden Pass Road. No BAER actions were proposed for protection of these resources. However, a need for Archeologist input to support other BAER treatments was identified.

Historic Cabin Remnants	Very Low
Historic Hayden Pass Road	Very Low
Historic Cabin on State Land	Very High

B. Emergency Treatment Objectives:

1. **Roads**
   - Minimize or prevent post fire impacts on selected NFS roads (or sections of road)
   - Minimize or prevent impacts on soil and water resources resulting from increased post fire erosion and storm water runoff from roads
   - Minimize risk for potential impacts to the life and safety of road users

2. **Trails**
   - Storm proof trails
   - Close selected trails to minimize risk for potential impacts to the life and safety forest visitors

3. **Ecological integrity -** Reduce the potential for impaired vegetative recovery and introduction/spread of invasive weeds by conducting detection surveys and rapid response eradication efforts where feasible.

4. **Heritage** – No treatments proposed.

5. **Fish Barrier Stabilization -** Lower risk for impacts to TES–Greenback Cutthroat Trout**.** Maintain proper functioning condition of a fish barrier to protect the viability of the species

6. **Ditch and Reservoir Stabilization –** Implement treatments to protect ditch and reservoir (property). Maintain functioning condition to lower risk for erosion on NFS lands adjacent to reservoir. Maintain agricultural water supply.

7. **Interagency Coordination** - Continue to work with affected parties and stakeholders

8. **Protection and Safety:** Implement trail and campground closure treatments to protect the life and safety of forest visitors and workers.

9. **Land Survey Monuments –** Preserve the location of land survey monuments on the Forest boundary that are located in areas at risk of flash flooding, erosion, and/or deposition.

G. Skills Represented on Burned Area Survey Team:

[x] Hydrology	[x] Soils	[x] Geology	[ ] Range	[x] Liaison
[x] Forestry	[x] Wildlife	[x] PIO	[x] Engineering	[x] Trails/Recreation
[ ] Contracting	[x] Ecology	[x] Botany	[x] Archaeology	
[x] Fisheries	[ ] Research	[ ] Landscape Arch	[x] GIS	

Team Leader: Eric Schroder, Arapaho and Roosevelt National Forests

H. Treatment Narrative:

(Describe the emergency treatments, where and how they will be applied, and what they are intended to do. This information helps to determine qualifying treatments for the appropriate funding authorities. For seeding treatments, include species, application rates and species selection rationale.)

1) Land Treatments

Noxious Weed Detection and Eradication Treatments
Detection and eradication treatments will occur:

- Where disturbances from suppression efforts such as bulldozer lines and staging areas created openings for noxious weeds to establish and/or spread and impede or prevent recovery of desirable vegetation
- Burned and/or disturbed areas adjacent to or downstream of existing weed infestations. Currently there are weed infestations out of the burn area that are known and/or have been historically treated throughout the area since 2009

Unauthorized Road Decommissioning/OHV Trespass
Approximately 4 miles of unauthorized trails and 2-track roads access the Rainbow Trail and are expected to greatly impact the Big Cottonwood Drainage. Poor or inexistent drainage features on these roads paired with advanced entrenchment will catch the increased runoff, eroding nearby areas and channeling all sediment further down the watershed. Decommissioning these roads will improve drainage on impacted slopes and increase infiltration during storm events. Decommissioning is recommended as an effective treatment to minimize erosion, accelerate natural recovery, effectively prevent trespass in the area, prevent expansion of impacts and and lower risk for potential threats to life and safety.

Land Survey Monument Protection
The monuments will be located on the ground using survey grade GPS so that the monument and its location can be put to future use if necessary. Then we will set a new monument, if needed, in its place. The new monument will be a 2 ½" aluminum post with a 3 ¼" aluminum cap with the corner markings stamped into the top. We will then protect any official bearing trees by painting the existing tree and attaching a sign to it, or by cutting the burned tree to a stump and attaching a sign to the stump in order to preserve the evidence. We then would set a steel fence post along-side the new monument so that it can be easily identified, this post will also reinforce the monument. This rehabilitation will help protected against flooding and debris flow caused by the residual effects of the fire. These corners will then be described and recorded for future use

2) Channel Treatments

Fish Barrier Stabilization – Protection of Property and TES greenback Cutthroat Trout
Heavy equipment (backhoe) work is needed to remove sediment from above and below the structure to prevent damage to the structure and also maintain its ability to prevent migration of Brown Trout into the Greenback Cutthroat Trout habitat. Inspection and monitoring are expected to continue in years two and three and appropriate documentation will be submitted at that time.

Ditch and Reservoir Stabilization - Mosher and Little Cottonwood Ditch and Reservoir
Ditch treatment would involve ditch cleaning to improve it's functioning condition before the first damaging storms. This work would be completed by USFS crews. Clearing vegetation and debris from the reservoir spillway is also recommended to improve it's functioning condition before damaging storms and lower the risk for dam breaching and failure. Storm inspection and response is also recommended.

3) Roads Treatments

Of the 17 miles of NFS Roads impacted by the Hayden Pass Fire, 4 miles are expected to be threatened directly by increased storm flows or contribute greatly to sedimentation in adjacent stream channels. Treatments to protect property and natural resources include:

- Improving existing drainage features that are not adequate for the projected flow increases
- Armoring road fill slopes which are in floodplains or adjacent to active streams
- Temporary road closures accomplished by means of gates and signing

Several trail bridges for the Rainbow Trail span streams which are modeled to have greatly increased flows. Two of these have inadequate

freeboard or abutments to pass these storm flows without failure. As the cost of removing these bridges is roughly 15% of the bridge's value, they can easily be partially dismantled and set aside for future re-installation.

The two irrigation ditches at Little Cottonwood and Oak Creek are threatened with failure by flood flows and debris. This threat can be mitigated by reinforcing the ditches and maintaining the spillway of the downstream Mosher Reservoir.

4) Trails Treatments

Trail Storm Proofing: Within the first year following the fire, storm proofing is recommended to minimize erosion of the trail tread. Storm proofing treatments, implemented with hand-tools and motorized equipment, would include out-sloping, de-berming, water-bars, armored crossings at ephemeral drainages, and other suitable treatments outlined in the BAER Treatments Catalog to protect the trails from accelerated post fire flows and soil erosion. The Rainbow trail is the only trail that would be treated. Repairs are recommended for at least 11 miles of trail within high and moderate soil burn severity where high watershed responses are anticipated.

Trail Storm Inspection and Response: The inspectors would repair and maintain storm proofing treatments by correcting minor expected problems. Information gathered during these site visits may also be used to submit an interim funding request to the region. This treatment would be applied in the same zones of concern identified in the trail storm proofing section above.

Forest Closure orders are needed to protect human life and safety of visitors to NFS lands along the Rainbow Trail, at a dispersed camping area along Hayden Creek, and at the Coaldale Campground. Costs for this treatment are described below.

5) Interagency Coordination

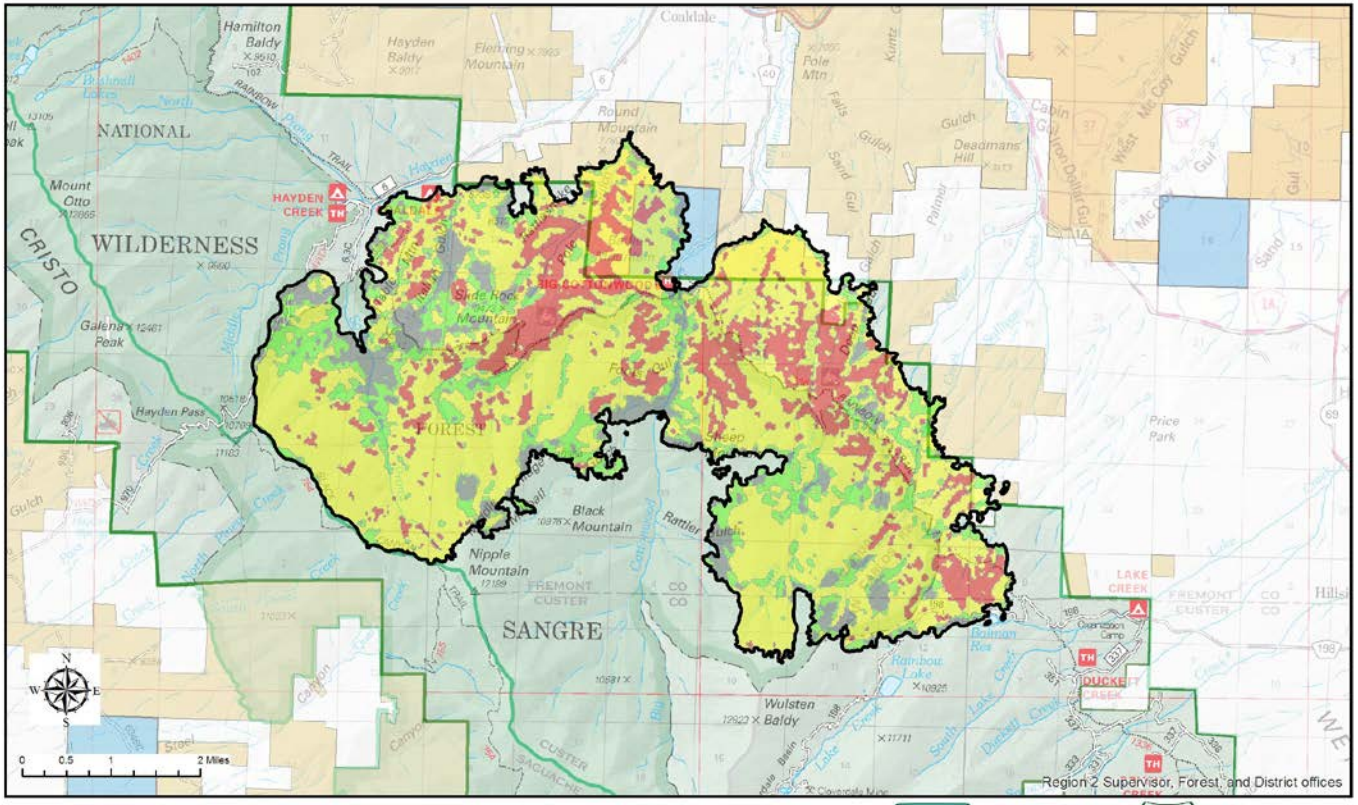
There is a need to continue the interagency coordination initiated during the BAER assessment. This involves communication and coordination with other federal, state and local agencies with jurisdiction over lands where life and property and water quality are at risk from post-fire conditions. Actions include but are not limited to cooperating with other agencies on hazard notification systems, exchanging information and coordinating the BAER implementation plan as needed when subsequent recovery plans are developed by other agencies.

Threats to life, property and water quality requires coordination with many agencies. The Forest Service plans on continuing to collaborate and communicate with partnering agencies, other entities and organizations and the public.

I. Monitoring Narrative:

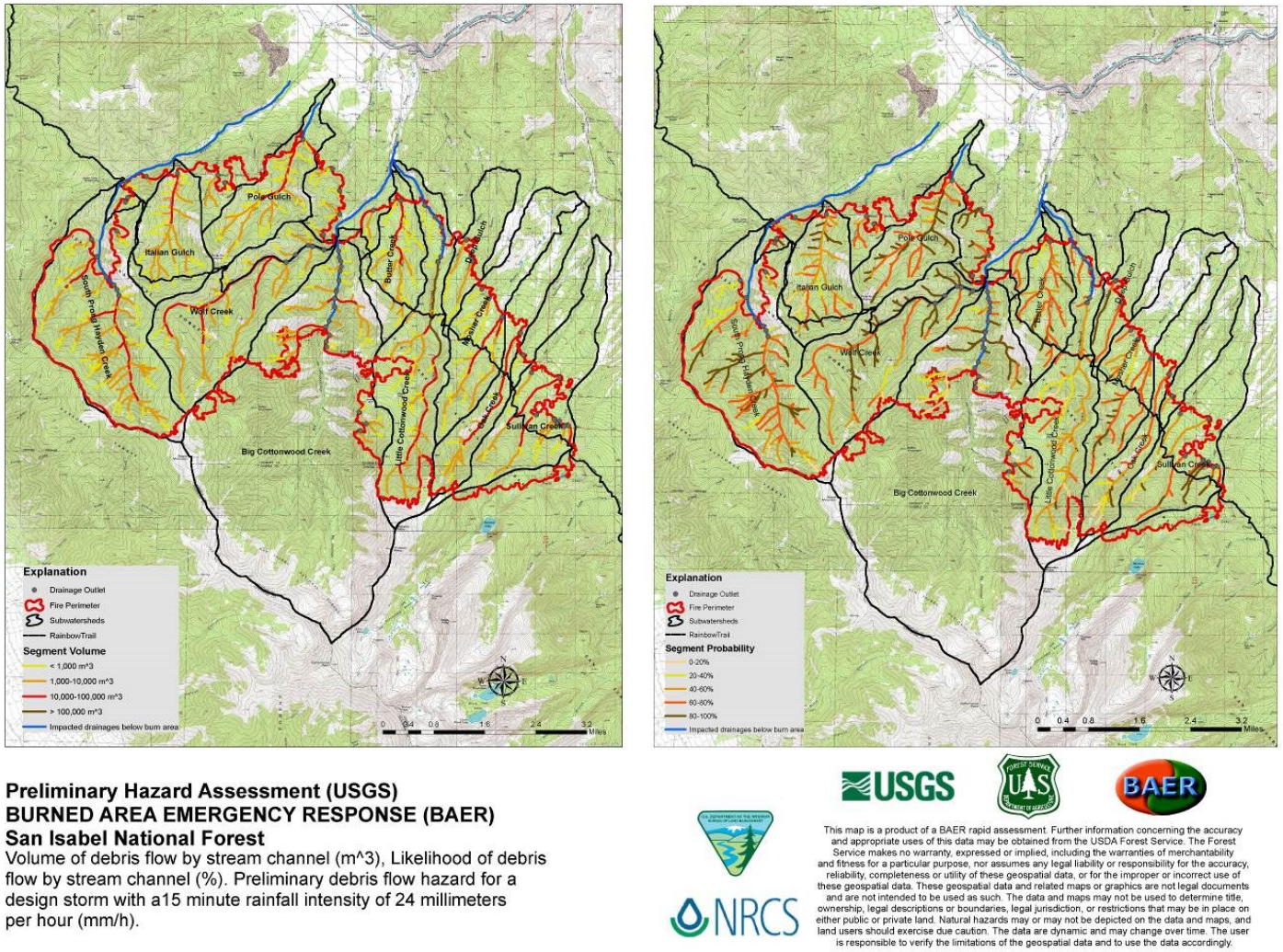
(Describe the monitoring needs, what treatments will be monitored, how they will be monitored, and when monitoring will occur. A detailed monitoring plan must be submitted as a separate document to the Regional BAER coordinator.)

Treatment Effectiveness Monitoring: Monitoring of closures is needed to ensure that warning and closure signs are effective. Effectiveness monitoring for road and trail treatments is also recommended to determine if treatments are working and if/when maintenance or repairs are required. Monitoring will be conducted by USFS staff.



Acres vs Soil Burn Severity				
SOIL BURN SEVERITY				
BURNED EMERGENCY RESPONSE (BAER)				
High	Moderate	Low	Unburned	Grand Total
2,974	9,240	2,613	1,693	16,520

Figure 1: Soil Burn Severity Map.



Preliminary Hazard Assessment (USGS)
BURNED AREA EMERGENCY RESPONSE (BAER)
San Isabel National Forest
Volume of debris flow by stream channel (m^3), Likelihood of debris flow by stream channel (%). Preliminary debris flow hazard for a design storm with a15 minute rainfall intensity of 24 millimeters per hour (mm/h).

Figure 2: Landslide Assessment Maps showing predicted volume of debris flow, and likelihood of debris flow by channel