# Valley Fire Post-Fire Watershed Response: Hydrology Report

Valley Fire, Descanso Ranger District, Cleveland National Forest, September 2020.

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## 1) Objectives

This assessment is focused on evaluating possible post-fire hydrologic threats to critical values for the Valley Fire on the Cleveland National Forest, San Diego County, California. Hydrologic post-fire threats include post-fire flooding, slope instability, and bulking of flows from sediment and debris. Potential threats also include braiding and migration of channels within unconfined flats. Possible points of channel diversion such as culverts, road crossings, and other such anthropogenic channel and floodplain alterations are of concern as woody debris and increased sediment loads along with increased runoff can cause infrastructure to fail.

## 2) Critical Values

The burn area spans across mixed ownership including NFS lands, local government, and private land. The NFS jurisdiction is limited to NFS lands so interagency coordination is essential to adequately identify areas at risk from post-fire threats.

FS critical values include life and safety on NFS lands, FS roads, FS trails, natural resources, and cultural resources. See 2500-8 for a detailed list of critical values.

In addition to FS critical values, numerous non-FS owned values are located within or downstream of the burn area. Utilities, municipal water sources, reservoirs, and private inholdings are located within the FS administrative boundary and are described as non-FS-owned critical values.

Downstream there are communities, roads, utilities, and privately-owned infrastructure that could be affected by post-fire effects. Infrastructure in low-lying areas adjacent to channels, on floodplains, and on alluvial fans are of concern. Additional areas of concern are: 1) at points along the creek where flow can be diverted (such as culverts/stream crossings), and 2) the runout paths associated with flow diversions.

This assessment will focus on FS critical values. Interagency coordination will be essential to adequately assess post-fire threats to values on private and non-FS lands.

# 3) Resource Condition

## a) Resource Setting:

The Valley Fire started on September 5, 2020 and burned approximately 16,769 acres near the Pine Creek and Hauser Wilderness areas, within the Descanso Ranger District and surrounding lands, California. The fire area extends from Lawson Valley and Hidden Glen in the northwest end to the north edge of Barrett Reservoir in the southeast and into Pine Creek wilderness in the northeast corner. The fire burned through dense to sparse mixed chaparral, oak woodlands, mixed conifer and oak woodlands, sage scrub, non-native grasslands and riparian. Previous burns in 2006 (Horse Fire) and 1970 (Laguna Fire) have limited the amount of duff accumulation and density of vegetation.

Watershed resources located within and downstream of the burn area include springs, perennial, intermittent and ephemeral streams, and small infiltration basins. The fire lies within 5 HUC 6 level watersheds. See Table 1 for acres and percent moderate and high soil burn severity (SBS).

**Table 1. List of HUC 6 Watersheds within the Valley Fire burn perimeter, acres burned at different soil burn severities, and percent moderate and high SBS.**

| HUC 6 Name | HUC code | Total Acres | Unburned | Low SBS | Moderate SBS | High SBS | % Moderate & High SBS |
|---|---|---|---|---|---|---|---|
| Taylor Creek | 180703040802 | 13,431 | 11,079 | 629 | 1,628 | 95 | 13% |
| Loveland Reservoir-Sweetwater River | 180703040901 | 24,127 | 21,066 | 898 | 2,131 | 32 | 9% |
| Middle Pine Valley Creek | 180703050802 | 25,445 | 24,515 | 346 | 568 | 16 | 2% |
| Lower Pine Valley Creek | 180703050803 | 12,256 | 4,926 | 2,401 | 4,858 | 71 | 40% |
| Morena Reservoir-Cottonwood Creek | 180703050903 | 3,627 | 1,636 | 1,144 | 804 | 43 | 23% |

Elevation across the Valley Fire burn area ranges from about 1,600 to 4,040 feet. Average annual precipitation for select pour points is about 20 inches annually and mostly arrives between November and April although summer thundershowers are common in August and early fall (Table 2).

**Table 2. Elevation and Average Annual Precipitation for Select Pour Points.**

| Select Pour Points | Max Elevation (ft) | Min. Elevation (ft) | Average annual precip (in) |
|---|---|---|---|
| PP1. Barrett Camp | 2,954 | 1,641 | 19.1 |
| PP3. Hidden Glen | 3,124 | 2,101 | 20.1 |
| PP7. Rudnick Road | 2,961 | 1,934 | 20 |
| PP10. Lawson Creek be | 3,810 | 914 | 19.8 |
| PP12. Lyons Valley Road | 3,800 | 2,205 | 20 |

Damaging Storms. Although not the only types of storms that could occur, two common storm types that could cause significant damage within the burn area are monsoonal thunderstorms and storms related to atmospheric rivers. Short duration, high intensity storms (such as a monsoonal thundershowers) frequently trigger debris flows and flash floods. Precipitation rates exceed infiltration rates and cause rapid runoff. These storm types are common in August and early fall.

The second storm type is a long duration storm, commonly linked to atmospheric rivers. Major flooding events have occurred across Southern California due to atmospheric rivers which contain large amounts of water vapor. One such weather system referred to as the "Pineapple Express" transports subtropical moisture to Southern California from the Hawaiian Islands.

## b) Assessment (field and modeling) and Observations

***Fire Impacts to Watershed Resources:***

Functioning of Hydrologic Processes: Functioning of hydrologic processes is connected to vegetation (type, density, litter and organic matter accumulation) and soil types. Fire causes impacts to several hydrologic processes including reduction in interception, transpiration, and infiltration, and increases in soil moisture and the rate of runoff (due to lack of litter and decreased surface roughness). Removal of vegetation and changes to soil such as increases in hydrophobicity, changes in soil structure, and removal of duff and organic matter alters these processes and ultimately lead to increases in runoff, peak flows and erosion. These alterations are typical of soils classified as having incurred moderate to high soil burn severity. The majority of the Valley Fire burned at moderate and low soil burn severity with very little high soil burn severity. In general, the depth of soil heating was relatively shallow with minimal ash. These characteristics along with significant rock content and low gradient slopes may help temper post-fire watershed response (Table 6, Figure 1 in Appendix A). Despite those characteristics, increases in runoff and bulking of flows within the burn area are still expected to increase approximately 100-150%, which is significant (see modeling).

Rock content could both prevent erosion by intercepting rainfall and providing surface roughness but could also increase erosion downslope by shedding water quickly. In unburned conditions, vegetation helps stabilize soils around boulders and bedrock outcrops, slow runoff, and aid infiltration. It's possible that those exposed shallow soils could be mobilized in post-fire flows due to lack of vegetation. Areas with rock content (Low SBS) that were not expected to contribute to increased erosion and runoff were adjusted in the model. Other areas still anticipated to contribute to increased runoff and erosion were not adjusted.

Water Quality: Wildfires primarily affect water quality through increased sedimentation. As a result, the primary water quality constituents or characteristics affected by this fire include color, sediment, suspended material, and turbidity. The loss of riparian shading and the sedimentation of channels may increase stream temperature. Vegetation mortality can result in increases in floatable material such as large woody debris. Post-fire delivery of organic debris to stream channels can potentially decrease dissolved oxygen concentrations in streams, pools, and lakes. 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.

Loveland and Barrett reservoirs (municipal water supplies) as well as a few of their tributaries have been included on the 303d list of impaired waters. Both reservoirs have sizable watersheds with the fire burning only a small fraction (4-6%) of the total acreage. Increases in post-fire runoff to the reservoirs will not be significant. Sediment, ash and woody debris delivery could be more impactful due to the proximity of the burn, which burned up to the reservoirs edge in Barrett Reservoir. Annual sediment delivery to Barrett Reservoir is estimated to be ~12 times that of normal (RCS). One thing to consider is that ERMIT modeling estimates moderate increases in sediment potential due to the gradient of some of the slopes and the high rock content. Low-lying riparian areas at the reservoir inlets are likely to experience sedimentation. Transported sediment from the fire to the reservoir is likely to settle in the reservoir and not travel further.

Loveland Reservoir has unburned, intact riparian area downstream of the burn area so threats of sedimentation are lower than for Barrett Reservoir. Ash and sediment delivered to Loveland Reservoir is likely to settle in the reservoir, not travel further downstream, and not significantly impact water quality.

Sediment potential: The Soil Report discusses erosion potential and the amount of sediment that could be available for transport within the burn area. Sediment potential is an estimate of amount of sediment that could be transported to channels. Rowe, Countryman, and Storey (1949) developed estimates of annual erosion rates based on measurements of sedimentation in reservoirs. Besides soil and topographical characteristics, actual erosion and sediment potential depend on number and type of storms, and amount and intensity of precipitation. For the burn area, we averaged RCS estimates for sediment from representative pour points (Table 3). On average, across the burn area, annual sediment delivery is estimated to increase 12-18 times greater than normal with an average of 26,000 cubic yards per square mile. Field observations of high sediment delivery rates includes sediment filled channels and swales, and previously installed channel treatments filled with sediment. Sedimentation from sediment-laden flows appears to be the main depositional process.

**Table 3. RCS Estimates of Erosion in select pour points.**

| Select Pour Point | Post-Fire Sediment (cubic yards) | Pre-Fire Sediment (cubic yards) | Times Increase |
|---|---|---|---|
| PP2 Barrett Reservoir | 246,011 | 20,973 | 11.7 |
| PP3 Hidden Glen | 30,794 | 1,718 | 17.9 |
| PP4 Japatul Road | 26,997 | 1,506 | 17.9 |
| PP10 Lawson Creek (near confluence with Sweetwater) | 90,116 | 5,536 | 16.3 |

Changes in Ground Cover: Recovery of vegetation will vary depending on SBS. In areas with low SBS, recovery will be rapid (within 1-2 years); however, for areas with moderate SBS, recovery is estimated at 3 to 7 years.

Lack of groundcover and vegetation (that can intercept precipitation) leaves the soil surface at risk from raindrop impact as well as reduces surface roughness and infiltration capacity. Initial erosion of ash and disaggregated soil during the first storm events will reduce slope roughness by filling depressions above rocks, stump holes, remaining vegetation, and pools within stream channels. Reduced surface roughness increases potential for higher peak flows and will increase the distance that eroded materials are transported. In areas with remaining overstory and low to moderate SBS, leaf litter, and woody debris beneath remaining canopies will provide some soil protection and promote water infiltration. The existence of fine roots and seeds in the low and moderate severity burn areas will aid plant recovery.

During field investigations, the team observed channels and swales full of sand and gravel-sized sediment that were previously stabilized by vegetation. Without vegetation to intercept precipitation and reduced root strength from soil heating, loose sediment may be transported in increased peak flows. Noteworthy was the large percentage of bedrock outcrop and boulders. Over 5,800 acres of bedrock outcrop are located within the burn perimeter. Bedrock and boulder fields are not susceptible to post-fire erosion.

Water Repellency: Water repellency is a natural soil property that limits the initial water infiltration into soil, particularly when dry and is a result of water repellent compounds that coat soil particles. Although water repellency is not an indicator of burn severity due to the natural occurrence of hydrophobicity in some vegetation communities, fire increases water repellency and in turn, the risk of flooding. Severity and depth of water repellency vary spatially across the burn area. Water repellent soils were found in approximately 24% of the fire area and will contribute to watershed response. The water repellent layer was shallow, on average less than 2mm deep.

***Field Observations***

Despite a large portion of the fire being in wilderness, several roads allowed access to either viewpoints or access to various parts of the fire. Overall, bedrock outcrop dominates ridges and steep slopes, comprising over 5,800 acres of the fire. Weathered igneous rock contributes to the sand and gravel deposits that have accumulated in channels and swales, on slopes, and pockets within the bedrock outcrops. Channels are full of sand and gravel sized sediment which will be available for transport in post-fire flows. Large, rounded boulders are common in the burn area and have resulted from in situ weathering and erosion as well as rock fall. The terrain is generally comprised of steep, rocky cliffs, gentle hills, and low gradient flats (both on ridges and in low-lying areas).

The Valley Fire resulted in mostly moderate to low soil burn severity with minimal ash and char, averaging less than 2mm thick. Despite the minimal amounts of observed ash, post-fire watershed response will still result in increased runoff and sediment delivery. The burn area has loose sands and gravels that are likely to be transported in increased post-fire runoff. Very few to no boulders were observed in most of the flats, indicating lack of a transport mechanism (such as debris flow runout). Sediment-laden flows and flooding are the main post-fire watershed threats to low-lying areas. (See geology report for information on rockfall and debris flows.) While storms are necessary to generate floods, flooding is more likely to occur from smaller storms given the fire impacts to soils, vegetation, and hydrologic function. Burned flats are less likely to result in runoff and erosion and may allow runoff to infiltrate and deposit sediment. Low gradient riparian areas will trap sediment and are likely to aggrade, filling in shallow pools.

*Site Specific locations*:

Japatul Station is located on a flat depositional area at the confluence of several ephemeral drainages (Figure 2 Appendix A). Rocky cliffs make up the headwaters above Lyons Valley Road and thick vegetation used to populate the gentle slopes below the road and above the station. Annual runoff causes minor sedimentation, flooding and erosion around the station. Modeling estimates post-fire runoff to double in size exacerbating these issues. A small swale draining through the recreation yard and under a fence requires regular maintenance to address erosion. Gravel and sand-sized sediment has accumulated in the previously vegetated swales. Although these swales are low gradient, sediment is no longer stabilized and will be easily transported with increased runoff. The main access road to the station has a culvert in need of maintenance (half-plugged). Given the expected increase in sediment and depositional nature of the location, it is possible for the culvert to plug and pooled water to cause damage to the road.

Post-fire watershed response threats to Japatul Station include flooding, sedimentation, and erosion, especially in areas that experienced issues in normal pre-fire years.

Horsethief Trailhead is located on a ridge and is unlikely to be impacted directly by post-fire watershed response; however, road access to the trailhead may be impacted by unstable slopes above Japatul and Lyons Valley Road. Secret Trail only has a short segment of trail within the fire. The burned slope above the trail has low soil burn severity and will not significantly impact the trail. The non-system trail at the trailhead enters the burn area and could be a risk for life and safety due to instability of the burn area. Loss of the trail due to increased runoff and erosion is likely but it is not an official system trail.

Lawson Valley Community and Roads: In Lawson Valley, homes have been constructed on rolling hills, ridges and slopes as well as adjacent to channels and in floodplains of smaller order channels (Figure 4 Appendix A). Infrastructure has also been constructed at the base of the steep slopes on alluvial fans and debris cones. Channels have been ditched alongside native surfaced roads and some culverts are partially buried. There's evidence of concentrated diverted flow down road segments. Infrastructure in depositional areas such as along the channels, in the flats, and in floodplains are likely to experience sedimentation and possible flooding related to increased runoff (modeled to double in size). Increased runoff from the burn will increase flows downstream within the community. Infrastructure on the alluvial fans and debris cones are susceptible to sedimentation and flooding from hillslope runoff. Drainage on alluvial fans can change course when they carry high sediment loads. Although some of the hillslope catchments are not that large, fans are inherently depositional locations so infrastructure located on them could be buried.

Although bulked runoff is modeled to be over 100% of normal (PP6 and PP7), these estimates may be high. The pour point includes flatter foothills as moderate SBS. These areas would not have as much runoff or sediment production as steeper slopes with moderate SBS. Flat terrain with low SBS was removed from contributing increases in runoff in the model.

Hidden Glen Community and Japatul Road: Hidden Glen community is located at the base of steep rocky cliffs in a depositional flat (Figure 5 Appendix A). Runoff is expected to double in size posing a threat to infrastructure in low-lying areas and at catchment outlets on alluvial fans. Increased flows, sediment, and woody debris could threaten to overwhelm crossings, especially crossings that have difficulty handling flows in pre-fire conditions. Low SBS within these pour points are not estimated to contribute to runoff (flat terrain), thus it was removed in the modeling.

Skye Valley Watershed: Skye Valley inholding has infrastructure that is located away from steep slopes. Low soil burn severity and nature of the terrain are unlikely to result in flooding. A privately maintained reservoir will experience sedimentation and increased runoff. Water quality will be negatively impacted. 17S06 leaving the inholding, descends bedrock dominated cliffs down to the reservoir and will experience increased runoff, which could threaten life, safety, and infrastructure. Bedrock naturally sheds runoff rapidly, but with fire impacts to hydrologic processes, there is increased risk of flashier peak flows and overland flow.

Barrett Camp: Barrett Camp is located at the confluence of two catchments. Post-fire flooding and sedimentation threatens infrastructure located in low lying areas and along the channel banks (Figure 3 Appendix A). Discharge is estimated to increase 150%. The low gradient and increased sediment, woody debris, and runoff could lead to buried culverts and divert flow out of the channel into the compound. Hazmat related to burned infrastructure could negatively impact water quality if transported off site. Pre-fire vegetation in some of this subwatershed was sparse brush and grasslands. Recovery of these vegetation types should be rapid. Areas with low soil burn severity were not estimated to contribute to increases in post-fire discharge.

Barrett Reservoir: The burned area in Barrett Reservoir watershed is only 6% of the larger watershed. Although the increases in post-fire runoff to Barrett Reservoir will not be significant compared to the normal inputs, water quality will be negatively impacted due to proximity of the burn area (see *water quality*). Sediment and ash will be delivered directly to the waterbody. Low-lying riparian areas at reservoir inlets may fill in and vegetation could get buried locally. Low soil burn severity was not included in the model as a source of increased discharge.

Stream Habitat downstream of Loveland Reservoir: Fire impacts above Loveland Reservoir are unlikely to transfer downstream below the dam; however, the mainstem will experience moderate impacts from Lawson Creek. Inputs from Lawson Creek are estimated to increase 36% and annual sediment delivery to increase 17%. This may an overestimate because of the incorporation of moderate SBS on flatter foothills into runoff and sediment delivery estimates. Flat terrain is less likely to contribute to increases in discharge and sediment compared to steep slopes with the same soil burn severity. It's important to note that contributions from Lawson Creek are only a fraction of the greater watershed size (Lawson Creek is about 8,840 acres and the greater watershed is 71,433 acres). Impacts in Sweetwater Creek will be most significant near the confluence with Lawson Creek. Impacts will diminish with greater distance.

***Hydrologic Modeling***

Flood potential will decrease as vegetation reestablishes, providing ground cover, increasing surface roughness, and stabilizing and improving the infiltration capacity of soils. Modeling for post-fire flooding was conducted on selected pour points that were associated with specific critical values and/or that might be representative of watershed response in a general area, Attached Map. Pour points are points on the landscape through which all water upslope of the point passes through.

The model designed by Rowe, Countryman, and Storey (RCS), 1949, was used to estimate post-fire increases in peak flows. Kinoshita, Hogue, and Napper, 2014 validated continued use and applicability of this model for Southern California. The model designed by RCS provides data for pre- and post-fire discharges and erosion rates in southern California watersheds. Individual rates for various subwatersheds were developed over long observation periods. The analysis in this report is based on the information in RCS tables 2, 3, 7, 8, 9, and 10 (RCS, 1949). The RCS multipliers for the Valley Fire area range from 1.8 to 3.0 for completely burned watersheds. USGS regional regression equations for the South Coast Region (region 5) were used to determine pre-fire flow estimates (Gotvard, et al., 2012). (The Region 5 regional regression equation is a function of drainage area and precipitation.) A "fire intensity" multiplier of 1 and 0.7 were used to further refine the post-fire discharge for high and moderately burned areas. Low soil burn severity discharge is estimated to increase 15% of normal. Deviations from this method included eliminating increases in discharge from low soil burn severity if the low soil burn severity occurred in areas with high rock content or flat terrain.

The analysis for pre- and post- fire hydrologic response and probability of flows is based on the probability of a 2-year 24-hour storm occurring in the fire area. This is the design storm used in the development of the model that was used to estimate flows, (Rowe, Countryman, and Storey, 1949). The 2-year, 24-hour duration storm for the burn area ranges between 2.4-2.6 inches based on NOAA precipitation tables (NOAA website, 2020). However, although the RCS model is based on the 24 hour duration storm, the storm expected to occur within the fire burned area that could produce damaging post-fire effects is a short duration, high intensity storm (such as the storm used in the debris flow model, Geology report) or a rain event associated with an atmospheric river. Intensity within a storm and antecedent soil moisture are both spatially variable. Ultimately, when precipitation intensity is greater than infiltration rates or exceeds infiltration capacity, runoff initiates and erosion potential increases. Characteristics of the RCS design storm are listed in Table 4.

**Table 4. Hydrologic Modeling Design Factors**

| | |
|---|---|
| Storm Recurrence Interval | 2 years |
| Design Storm Duration | 24 hour |
| Design Storm Magnitude | 2.4-2.6 inches |

The 2-year design storm has a 50% chance of occurring in any given year, and a 97% chance of occurring in the next five years. Conversely, there is a less than 0.1% chance that the 2-year storm event will not occur in the next 10 years (during the recovery period).

The risk or probability (R) that a certain return interval storm (T) will occur over different time periods (n) was calculated by the following equation: $R = 1 - (1 - (1/T))^n$… (Chow *et al.* 1988).

**Table 5. Probability of a 2-year RI Storm occurring with a given time period**

| Number of years | 1 Year | 2-Years | 5-Years | 10-Years |
|---|---|---|---|---|
| Probability | 50% | 75% | 97% | 99.9% |

**Table 6. Comparison of pre- and post-fire peak flow related to the 2 and 10 year return interval.**

| | | | 2 yr. RI Peak Flow | | | | 10 yr. RI Peak Flow | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RCS Watershed | Modeled Pour Point | % of Mod & High SBS | Pre-Fire Q (CFS) | Post-Fire Q (CFS) | Post-Fire Bulked Q (CFS) | Percent of Q (bulked) | Pre-fire Q (CFS) | Post-Fire Q (CFS) | Post-fire Bulked Q (CFS) | Percent of Q (bulked) |
| Pine Valley Creek | P1. Barrett Camp | 84% | 58 | 101 | 147 | 252% | 296 | 396 | 574 | 194% |
| Pine Valley Creek | P2. Barrett Reservoir | 4% | 1,570 | 1,627 | 1,669 | 106% | 14,300 | 14,540 | 14,910 | 104% |
| Sweetwater Reservoir | P3. Hidden Glen | 62% | 53 | 77 | 104 | 197% | 269 | 323 | 438 | 163% |
| Sweetwater Reservoir | P4. Japatul Road | 48% | 57 | 78 | 100 | 176% | 294 | 342 | 441 | 150% |
| Pine Valley Creek | P5. Japatul Station | 64% | 15 | 25 | 34 | 227% | 62 | 82 | 113 | 183% |
| Peterson Valley | P6. Lawson Community | 68% | 27 | 43 | 60 | 222% | 122 | 154 | 215 | 176% |
| Peterson Valley | P7. Rudnick Road | 69% | 60 | 97 | 135 | 224% | 311 | 397 | 552 | 177% |
| Skye Valley Watershed | P8. Skye Valley Reservoir | 59% | 11 | 17 | 23 | 204% | 44 | 55 | 75 | 170% |
| Peterson Valley | P10. Lawson Creek | 22% | 194 | 233 | 263 | 136% | 1,210 | 1,318 | 1,490 | 123% |
| Pine Valley Creek | P12. Lyons Valley Road | 76% | 13 | 23 | 32 | 245% | 103 | 139 | 197 | 191% |

Bulking factor: Post-fire flows will be bulked with sediment and woody debris increasing the volume of runoff, which could negatively impact culverts, constructed channel ways, and other infrastructure designed to pass "normal" flows. Bulking and increased flows may cause channels to flood, divert, or migrate to areas that do not usually flood. Following the 2003 Cedar Fire on the Cleveland National Forest, non-bulked results calculated using Rowe, Countryman and Storey were compared to a modified rational equation model which considered bulked flow using the U.S. Army Corps of Engineers Los Angeles district method for prediction of debris yield (2000). This comparison found that predicted bulked flows were 2.14 times larger than unbulked flows. Other studies have indicated a bulking factor of 2.5 for flows is appropriate. Estimated annual sediment rates are significant, Table 3, and support the need to include a bulking coefficient.

Summary of Modeling Results: Calculated bulking factors for the pour points are listed in Table 6. Post-fire bulked flows have increases of ~36 to 152% above non-bulked, pre-fire peak flows. These values represent significant increases in runoff. Post-fire modeling results are most applicable during the first year of recovery; hydrologic response will decrease in subsequent years as the burned area recovers.

***Summary of Post-Fire Threat:***

Overall, the primary watershed responses are expected to include: 1) an initial flush of ash, 2) rill and gully erosion in drainages and on steep slopes within the burned area, and 3) increased peak flows and sediment deposition. Channel crossings, depositional fans, and floodplains have an inherent risk of flooding which will be intensified by the fire. Increased runoff and sediment delivery (ex. surface erosion and sediment-laden flows) may cause channel migration and braiding across unconfined flats.

Watershed response in the burn area will pose a high risk to life, safety, and infrastructure. The combination of increased flows, sediment loads, and woody debris are very likely to cause drainage control structures to fail (culverts, ditches, infrastructure crossing drainages, etc.). It is important to note that downstream areas that experience regular flooding or difficulty controlling drainage during small storms will be very likely to experience flooding and/or failure in post-fire storms.

## 4) Risk Assessment

The 2500-8 has a list of critical values evaluated in the assessment. Potential post-fire threats are listed as well as risk determination and treatment recommendation. Only critical values with very high, high or intermediate risk requiring treatment are discussed in detail in this assessment narrative.

| **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** |

*Life and Safety*

Throughout the burn area, post-fire threats to life and safety vary depending on location in the watershed, presence of hazard trees, and proximity to steep slopes. Some areas with higher risk are low-water crossings and roads located in floodplains, at drainage outlets, and on alluvial fans that will experience increased peak flows and sediment-laden flows. Post-fire flows at low-water crossings pose a risk to life and safety if users are attempting to cross during runoff events. The risk to life and safety is exceptionally high for 17S06 which is the only ingress/egress for a private inholding. With the exception of one system trail and one non-system trail within the burn, nearby trails are located upstream of the burn and will not be affected by increased post-fire flows. Use of the non-system trail or exploring the channel within the burn area could be an intermediate to high risk to life and safety due to increased slope instability and runoff during storms.

**Probability of post-fire impacts**: Unlikely to Very Likely
**Magnitude of consequences**: Minor to Major
**Risk**: Low to Very High
**Determination:** BAER treatments are recommended for some areas. See 2500-8 for treatments.

*Japatul Station (Life and Safety, Property)*

Japatul Station is at risk from increased post-fire runoff and sediment laden flows (see *Site Specific Field Observations*). Sedimentation and runoff could impact access slowing emergency response and ability to leave the station (life and safety). Sedimentation and increased runoff also pose a risk to property (road and buildings). Runoff to the station is modeled to double in size. Areas around the station that require annual maintenance from pre-fire flows are likely to be at risk in post-fire runoff events.

**Probability of post-fire impacts**: Likely to Possible
**Magnitude of consequences**: Moderate
**Risk**: High to Intermediate
**Determination:** BAER treatments are recommended. See 2500-8 for recommended treatments.

*All FS roads within the burn area*

Some roads within the burn area are at risk from increased post-fire runoff, sediment laden flows, and mass wasting (see geology report for geologic hazards). Post-fire flows across the burn area are expected to double in size compared to pre-fire flows and some roads (ex. 16S05, 16S02) lack adequate drainage control structures to manage these increases. There are culverts at risk of plugging, diversion, and potential road failure due to increases in peak flow, sediment laden flows, and woody debris.

Slope failure, increased sediment delivery, and mobilization of woody debris increase the risk of channel diversions down roads. Swales that normally have minimal runoff are expected to have increased runoff and could divert down roads causing moderate damage. Channel and drainage diversion could lead to complete road prism loss and irrecoverable damage to hillslopes. Diversion of stream crossings and plugging of culverts poses a risk to FS infrastructure, water quality, and natural resources as well as life and safety.

**Probability of post-fire impacts**: Likely to Unlikely
**Magnitude of consequences**: Moderate to Low
**Risk**: High to Low
**Determination:** BAER treatments are recommended for some. See 2500-8 for recommended treatments.

*All recreation trails within or below the burn area:*

One section of Forest System trail is within the burn area. It is not at risk from post fire runoff.

**Probability of post-fire impacts**: Unlikely
**Magnitude of consequences**: Moderate
**Risk**: Low
**Determination:** BAER treatments are not recommended. See 2500-8 for treatments.

*Hydrologic Function:*

As mentioned previously in this report, fire impacts proper functioning of hydrologic processes. These impacts are recoverable and expected to recover as vegetation reestablishes. The greatest threats to recovery are threats from OHV and failure of post-fire drainage control on roads. Threats of OHV incursion are high because of the close proximity to Corral Canyon, a managed OHV trail area. The Forest has struggled in the past to limit unauthorized OHV incursion. Thick vegetation (pre-fire) helped to prevent OHV access. Removal of vegetation has opened up access and poses a threat to recovery of hydrologic processes and vegetative recovery.

**Probability of post-fire impacts**: Very Likely-Likely
**Magnitude of consequences**: Major-Minor
**Risk**: Very High-Low
**Determination:** BAER treatments are recommended for some threats. See 2500-8 for treatments.

*Water Quality for Municipal and Domestic Use:*

As mentioned, fire can negatively impact both physical and chemical constituents of water quality. Chemical impacts will be relatively short as ash is flushed through the system. Increased sediment delivery can be expected to continue until vegetation reestablishes and erosion is slowed. Hazmat resulting from burned infrastructure (on private lands) could pose a risk to water quality if mobilized. Most observed hazmat is in low-lying areas subject to flooding or with little buffer to filter transported material. Changes to water quality will need to be considered prior to human consumption and how increased sediment may impact treatment facilities.

**Probability of post-fire impacts**: Very Likely-Likely
**Magnitude of consequences**: Minor
**Risk**: Low
**Determination:** BAER treatments are recommended. See 2500-8 for treatments.

**<u>Non-FS owned Values.</u>**

Several non-FS owned values are located within and downstream of the burn area. These sites will be addressed through interagency coordination with various agencies. Some of the non-FS owned values are listed below and described in the *Site Specific Field Observations* section of this report. This is not a complete list of non-FS owned values. A detailed assessment of these values should be completed by the agencies that can assist private landowners or the agency responsible for the infrastructure.

*Non-FS Infrastructure: Utilities*

There are several utilities on FS lands within the fire burned perimeter. Flooding and increased peak flows could threaten power poles and buried lines located in low-lying areas, buried under channels, or located in floodplains. Increased sediment delivery is likely to cause channel aggradation within the main depositional area.

**Probability of post-fire impacts**: Very Likely-Likely
**Recommended Action:** See 2500-8 for treatments. Interagency Coordination.

*Non-FS Infrastructure: Non-FS Roads*

Multiple non-FS roads are within and downstream of the burn area. Some have evidence of past issues with drainage control. Of great concern are low-water crossings and at-risk roads that are used as the only ingress/egress for communities. Given the increase in sediment, slope instability, and increase in post-fire flows, life, safety and infrastructure associated with many of these roads is threatened by the post-fire watershed response.

**Probability of post-fire impacts**: Very Likely-Likely
**Recommended Action:** See 2500-8 for treatments. Interagency Coordination.

*Non-Forest Service Property and Inholdings*

The 2500-8 critical value spreadsheet has a list of inholdings and nearby lands that were noted from maps and site visits to be within or downstream of the burn area. This is NOT a complete list of all values at risk on private or non-FS lands that may be impacted by the post-fire environment. All non-FS private inholdings within, near, or downstream of the burn area should contact the NRCS or County for a detailed assessment of their property and potential post-fire risks that may exist.

**Probability of post-fire impacts**: Very Likely-Likely
**Recommended Action:** See 2500-8 for treatments. Interagency Coordination.

## 5) Summary of Recommended Response Actions

*Life and Safety*

Closure of the three areas and signage along burn area entry points are recommended until hydrologic processes have recovered to the point that flooding and sediment laden flow risks are diminished.

*Japatal Station*

Placement of erosion control materials around the compound will reduce potential for damage to infrastructure. Stormpatrol of the access road will prevent washout.

*All FS roads and trails within the burn area*

Closure of the burn area is recommended until hydrologic processes have recovered to the point that flooding and sediment laden flow risks are diminished. Some roads should be stormproofed to prevent loss of infrastructure and impacts to water quality. Low-water crossing throughout the burn area will experience increased peak flows and sediment laden flows. It is recommended that 1) warning signs be installed at burn area entry points and 2) interagency coordination for use of FS roads maintained by other parties.

*Hydrologic Function:*

Closure of the burn area is recommended until hydrologic processes have recovered to the point that flooding and sediment-laden flow risks are diminished. Roads should be stormproofed to prevent gullying and impacts to water resources. Monitoring and barriers are needed to prevent OHV incursion.

*Water Quality for Municipal and Domestic Use:*

Interagency coordination is needed to prepare for changes to water quality and to prevent mobilization of hazmat material.

**Non-FS owned Values At Risk Located with the Forest Service official boundary.**
Interagency coordination is recommended for all non-FS owned values.