# Burned Area Emergency Response Assessment
# Fork Complex
# Shasta Trinity National Forest

## Hydrology Specialist Report

## September 6, 2015

View NE from Plummer Peak Lookout

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**Fire and site description**

This report summarizes the results from the hydrologic assessment of the Fork Complex in Northern California, as part of the Burned Area Emergency Response (BAER). The Fork Complex was lightning-caused and burned portions of 12 HU_12 watersheds; however, eight HU_12 watersheds comprise the bulk of the fire area. These include Barker Creek-Hayfork Creek, Carr Creek, Tule Creek, Salt Creek, East Fork Hayfork Creek, Upper Browns Creek, Dubakella Creek-Hayfork Creek, and Rattlesnake Creek. Major streams in this area include Tule Creek, Salt Creek, Hayfork Creek, Potato Creek, Browns Creek and Rattlesnake Creek. Sixty four miles of perennial streams are found within the fire area along with 73 miles of intermittent channels.

The Fork Complex took place in a region that experiences summer convective thunderstorms, such as the one that created the fire. The majority of the precipitation in the area occurs between October and April as multiple day frontal storms. Elevation within the burned perimeter ranges between 2310-6320 feet and average annual precipitation ranges from 39.6 to 74.1 inches. The majority of the precipitation in the upper elevations occurs as snow in the winter.

To address an erosive storm that has a high likelihood to occur, the 2-year, 6-hour duration design storm was utilized for this analysis. This storm has high rainfall intensity. Such storms have been known to generate significant runoff and erosion in nearby, recently burned areas.

**Burn severity assessment**

A Burned Area Reflectance Classification (BARC) image was acquired from the Forest Service Remote Sensing Applications Center. Based on comparisons with archived images, this image classifies the extent of the burned area into unburned, low severity burn, moderate severity burn, and high severity burn. BAER team member's verified this image through on the ground observations. The BARC image was found to have a relatively high degree of accuracy. Modifications were made to the initial map based on field data. The final map is shown on Plate 1 at the end of this document. A breakdown of acres by severity is shown in Table 1 and 2.

**Table 1: HUC 6 watersheds and soil burn severity.**

| HUC 6 Watershed | Total Acres | Unburned/Low Acres | Moderate Acres | High Acres |
|---|---|---|---|---|
| Barker Creek – Hayfork Creek | 20,774 | 16,938 | 3,549 | 288 |
| Carr Creek | 18,114 | 17,315 | 735 | 65 |
| Tule Creek | 14,908 | 13,496 | 1406 | 6 |
| Salt Creek | 36,830 | 31,825 | 4,998 | 7 |
| East Fork Hayfork Creek | 16,783 | 14,893 | 1,889 | 1 |
| Upper Browns Creek | 25,564 | 23,878 | 1,650 | 36 |
| Dubakella Creek – Hayfork Creek | 32,507 | 27,131 | 5,322 | 54 |
| Rattlesnake Creek | 29,904 | 27,861 | 2,040 | 2 |

## Design Flow Runoff Response

After a fire it is necessary to predict the increase in runoff that results from reduced infiltration, fire-induced water repellency and lack of ground cover. This increased runoff may cause downstream flooding that can impose a risk to life and property. Increased flows also increase the amount of sediment entering the river system as well the potential for debris flows.

For this fire, the model developed by Gotvald, et al, 2012 was used. It is a regional regression analysis utilizing stream gages on gaged streams in California to estimate water discharge on ungaged streams. The equations for the North Coast region were used which utilizes drainage area and mean annual precipitation of the desired watershed to determine peak discharge for streams in that watershed.

To model the effects of the fires on the watersheds within the fire boundary it was first determined that a two year storm event would be the design storm for this analysis (Q2). A five year flood was modelled as well. To model the effects of increased soil hydrophobicity and decreased soil cover an adjustment to the model was necessary. Terry Kaplan-Henry, 2004 determined that the acres of unburned and low soil burn severity would be modeled at the two year (Q2) level. For moderate soil burn severity the acres would be modeled at the five year (Q5) level and for high soil burn severity a ten year storm event (Q10) was used. These values were then added together to provide a predicted post-fire discharge value for each watershed. Post-fire 5 year flows were calculated using the Q5 for low and unburned, Q10 for the moderate burn area and Q25 for high severity burn.

In order to assess potential values at risk within the fire, pour point basins were identified and mapped. These basins are various sizes and are determined by the desired outlet or pour point above a value at risk or area of concern. These sites may be within or downstream of the burned area. The size of the watershed is dependent on the local flow patterns in addition to the need to evaluate a basin for values at risk. Pour point basins are listed in table 2 along with acres of burn severity. They are also shown on Plate 1.

**Table 2: Pour Point Basins affected by the Fork Complex.**

| Pour Point Basins | Total Acres | Burn Severity | | |
|---|---|---|---|---|
| | | Low/Unburned | Moderate | High |
| Little Barker Creek | 1,328 | 351 | 688 | 289 |
| 32N17 Crossing | 448 | 136 | 248 | 64 |
| Tule Creek | 13,005 | 11,719 | 1,280 | 6 |
| 31N42 Crossing | 439 | 72 | 367 | 0 |
| Bridge Gulch | 2,007 | 827 | 1,180 | 0 |
| County Road 302 | 52 | 0 | 52 | 0 |
| Potato Creek | 3,814 | 2,122 | 1,692 | 1 |
| 32N16 Crossing | 888 | 153 | 707 | 28 |
| Wilson Creek | 1,093 | 246 | 800 | 47 |
| County Road 351 | 886 | 552 | 333 | 1 |
| Rattlesnake Creek | 4,424 | 2,793 | 1,630 | 1 |

Table 3 provides predicted post-fire discharges in cubic feet per second for the watersheds affected by the fire. Watershed analysis takes into account the entire watershed size. Due to the large percentage of unburned lands in some watersheds there is a tendency to dilute the effects of the fire. Also, some of the pour point basins were completely within the fire, thus showing a greater response in post-fire peak flows.

**Table 3: Peak Flows from a 2 and 5 year flood event**

| Pour Point Basin | Drainage Area (sq. mi.) | Peak Flows in Cubic Feet per Second (cfs) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Pre fire Q2 | Post fire Q2 | Increase in Q2 | Pre fire Q5 | Post fire Q5 | Increase in Q5 |
| Little Barker Creek | 2.08 | 141 | 300 | 112% | 281 | 439 | 56% |
| 32N17 Crossing | 0.70 | 49 | 102 | 108% | 101 | 153 | 52% |
| Tule Creek | 20.32 | 1542 | 1761 | 14% | 2756 | 2987 | 8% |
| 31N42 Crossing | 0.69 | 54 | 103 | 92% | 108 | 149 | 37% |
| Bridge Gulch | 3.14 | 208 | 349 | 68% | 410 | 536 | 31% |
| County Road 302 | 0.08 | 7 | 16 | 111% | 16 | 22 | 40% |
| Potato Creek | 5.96 | 420 | 636 | 51% | 798 | 999 | 25% |
| 32N16 Crossing | 1.39 | 117 | 222 | 91% | 225 | 316 | 40% |
| Wilson Creek | 1.71 | 126 | 243 | 92% | 249 | 353 | 42% |
| County Road 351 | 1.38 | 146 | 209 | 43% | 269 | 329 | 22% |
| Rattlesnake Creek | 6.9 | 720 | 992 | 38% | 1251 | 1508 | 21% |

**Table 4: Hydrologic design factors**

| | |
|---|---|
| A. Estimated Vegetative Recovery Period | 3-5 years |
| B. Design Chance of Success | 80 % |
| C. Equivalent Design Recurrence Interval | 2 years |
| D. Design Storm Duration | 6 hours |
| E. Design Storm Magnitude | 1.47-2.34 inches |
| F. Design Flow | 81 cfs / $mi^2$ |
| G. Estimated Reduction in Infiltration | 73% |
| H. Adjusted Design Flow | 140 cfs / $mi^2$ |

**Summary of Watershed Values at Risk**

Forest Service BAER teams utilize the risk matrix (Table 5) to designate the risk to different values and see if a treatment is warranted**.**

**Table 5. Risk assessment matrix**

| 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 |

Due to the increase in post-fire peak flows, values at risk were evaluated for potential damage. Values at risk for hydrology include:

**Private Property**

Access to private property in the burn area was limited; therefore, reviews included aerial reconnaissance and air photo interpretation. No buildings or other improvements appear to be at risk of flooding, due to these features being situated well away from stream channels.

Magnitude of Consequences: Moderate
Probability of Damage or Loss: Unlikely
Risk: Low
Treatment: Share assessment information with private property owners and NRCS.

**Forest Service, Trinity County, and State of Califorinia roads within burn perimeter**

Increased post-fire flood flows may overwhelm existing road crossing structures, causing washouts, and stream diversion down the road. This can result in a threat to public safety, damage to infrastructure, and increased sediment delivery to downstream channels. In order to determine whether increased post-fire flows will threaten existing crossing structures, the predicted peak-flows were compared to culvert capacity charts produced by the Federal Highway Administration (Lester, 1972).

Forest Service roads needing treatment are included in the roads report. Post-fire peak flow predictions show that crossings at 32N16, 31N42, and 32N17 are all undersized and likely to be overwhelmed by a 2-5 year event.

Trinity County Roads 331, 301 and 351 all have crossings downstream of burned area. County Road 331 has a 72 inch culvert on Little Barker Creek. Post-fire peak flows at that crossing are expected to double for the 2 year flood and go up 56% for the 5 year flood. On County road 302, the 48 inch culvert on Bridge Gulch may not be large enough to handle the post-fire floods that may increase by 68 and 31 percent for the 2 and 5 year floods. The 24 inch culvert just south of the Shiell Gulch hunter camp appears to be large enough to handle post-fire flows. Finally county road 351 has 3 crossings within and downstream of the fire. All three of these crossings are at risk of overtopping by post-fire flows.

State highway 36 traverses the southern end of the complex. Field review of this section showed no post-fire threat to the highway.

Magnitude of Consequences: Moderate/High
Probability of Damage or Loss: Likely
Risk: High/Very High
Treatment: Implement Forest Service road treatments identified in the roads report. Share assessment information with County. The county may want to implement proactive treatments on 331, 302 and 351 to prevent road damage and hazardous conditions this winter. Also, maintenance patrols during and after storms may help minimize such damage and identify unsafe conditions.

**Water quality for Domestic, and Irrigation Uses**

Turbid water from the burned area will impact the quality of domestic and irrigation water within and downstream of the complex. This impact will be short-term and only occur during and shortly following storm events.

Magnitude of Consequences: Minor
Probability of Damage or Loss: Very likely
Risk: Low
Treatment: Share assessment information with water users and NRCS. Increase maintenance at water intake facilities. Consider adding storage to ensure a clean water source during high turbidity events.

**Water quality within local streams**

Water quality in the South Fork Trinity River watershed is listed as impaired under section 303(d) of the Clean Water Act. Impairments include sediment and temperature. Due to post-fire conditions, additional sediment will be routed into streams within and downstream of the fire. This will be a medium term impact as elevated rates of erosion from the burn are expected to recover to pre-fire conditions within 3 to 7 years (MacDonald and Robichaud 2008). Also, several miles of riparian habitat burned in the fire. This removal of stream side shade will result in increased water temperatures in perennial channels. Some of this shade will reestablish within the next year as riparian brush species re-sprout. Full recovery of shade from forest canopy will take decades as alders and conifer species mature.

Magnitude of Consequences: Moderate
Probability of Damage or Loss: Likely
Risk: High
Treatment: Treatments outlined in the roads report will reduce sediment input to streams. Aside from road work, large scale mulch application on the uplands is the only effective way to reduce sediment erosion from the fire. Upland mulching is not being proposed. This due to high cost and the steep slopes in the burn area make treatment impractical.

## References

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